A Markdown Interpreter for TEX

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Contents

1 Introduction **1**
1.1 Requirements 2
1.2 Feedback 6
1.3 Acknowledgements 6

2 Interfaces **7**
2.1 Lua Interface 8
2.2 Plain TEX Interface 54
2.3 LATEX Interface 159
2.4 ConTEXt Interface 168

3 Implementation **173**
3.1 Lua Implementation 173
3.2 Plain TEX Implementation . 408
3.3 LATEX Implementation . . . 454
3.4 ConTEXt Implementation . 500

References **510**

Index **512**

List of Figures

1 A block diagram of the Markdown package 7
2 A sequence diagram of typesetting a document using the TEX interface 50
3 A sequence diagram of typesetting a document using the Lua CLI 51
4 An example directed graph 79
5 An example mindmap 80
6 An example UML sequence diagram 81
7 The banner of the Markdown package 82
8 A pushdown automaton that recognizes TEX comments 288

1 Introduction

The Markdown package[1] converts CommonMark[2] markup to TEX commands. The functionality is provided both as a Lua module and as plain TEX, LATEX, and ConTEXt macro packages that can be used to directly typeset TEX documents containing markdown markup. Unlike other converters, the Markdown package does not require any external programs, and makes it easy to redefine how each and every markdown element is rendered. Creative abuse of the markdown syntax is encouraged. 😉

This document is a technical documentation for the Markdown package. It consists of three sections. This section introduces the package and outlines its prerequisites. Section 2 describes the interfaces exposed by the package. Section 3 describes the implementation

[1] See `https://ctan.org/pkg/markdown`.
[2] See `https://commonmark.org/`.

of the package. The technical documentation contains only a limited number of tutorials and code examples. You can find more of these in the user manual.[3]

```
local metadata = {
    version   = "(((VERSION)))",
    comment   = "A module for the conversion from markdown "
             .. "to plain TeX",
    author    = "John MacFarlane, Hans Hagen, Vít Starý Novotný, "
             .. "Andrej Genčur",
    copyright = {"2009-2016 John MacFarlane, Hans Hagen",
                 "2016-2026 Vít Starý Novotný, Andrej Genčur"},
    license   = "LPPL 1.3c"
}

if not modules then modules = { } end
modules['markdown'] = metadata
```

1.1 Requirements

This section gives an overview of all resources required by the package.

1.1.1 Lua Requirements

The Lua part of the package requires that the following Lua modules are available from within the LuaTEX engine (though not necessarily in the LuaMetaTEX engine).

LPeg $\geqslant$ 0.10 A pattern-matching library for the writing of recursive descent parsers via the Parsing Expression Grammars (PEGs). It is used by the Lunamark library to parse the markdown input. LPeg $\geqslant$ 0.10 is included in LuaTEX $\geqslant$ 0.72.0 (TEX Live $\geqslant$ 2013).

```
local lpeg = require("lpeg")
```

MD5 A library that provides MD5 crypto functions. It is used by the Lunamark library to compute the digest of the input for caching purposes. MD5 is included in all releases of LuaTEX (TEX Live $\geqslant$ 2008).

```
local md5 = require("md5")
```

Kpathsea A package that implements the loading of third-party Lua libraries and looking up files in the TEX directory structure.

Only load the package outside the ConTEXt format, where we can use the resolvers API [1, Section 11.5].

```
if resolvers == nil then
  (function()
```

[3] See http://mirrors.ctan.org/macros/generic/markdown/markdown.html.

If Kpathsea has not been loaded before or if LuaTEX has not yet been initialized, configure Kpathsea on top of loading it. Since ConTEXt MkIV provides a `kpse` global that acts as a stub for Kpathsea and the lua-uni-case library expects that `kpse` is a reference to the full Kpathsea library, we load Kpathsea to the `kpse` global.

```
    local should_initialize = package.loaded.kpse == nil
                           or tex.initialize ~= nil
    kpse = require("kpse")
    if should_initialize then
      kpse.set_program_name("luatex")
    end
  end)()
end
```

All the abovelisted modules are statically linked into the current version of the LuaTEX engine [2, Section 4.3]. Beside these, we also include the following third-party Lua libraries:

api7/lua-tinyyaml A library that provides a regex-based recursive descent YAML (subset) parser that is used to read YAML metadata when the `jekyllData` option is enabled.

```
hard lua-tinyyaml
```

1.1.2 Plain TEX Requirements

The plain TEX part of the package requires that the plain TEX format (or its superset) is loaded, all the Lua prerequisites (see Section 1.1.1), and the following packages:

expl3 A package that enables the expl3 language [3] from the LATEX3 kernel. It is used to implement reflection capabilities that allow us to enumerate and inspect high-level concepts such as options, renderers, and renderer prototypes.

```
hard l3kernel
```

```
\unprotect
```

```
\expandafter\ifx\csname ExplSyntaxOn\endcsname\relax
  \input expl3-generic
\fi
```

A fairly recent version of expl3 is required: either a post-release updated TEX Live ⩾ 2025 installation or a TEX Live ⩾ 2026 release-date ISO image:

```
\NeedsTeXFormat{LaTeX2e}[2025-05-14]
\RequirePackage{expl3}[2025-05-14]
```

lt3luabridge A package that allows us to execute Lua code with LuaTEX as well as with other TEX engines that provide the *shell escape* capability, which allows them to execute code with the system's shell.

Note that this support for TEX engines other than LuaTEX comes with some limitations with respect to file and directory names. Specifically, the filenames of

your .tex files may not contain spaces[4]. If `-output-directory` is provided, it may not contain spaces either.

```
34 hard lt3luabridge
```

The plain TeX part of the package also requires the following Lua module:

Lua File System A library that provides access to the filesystem via OS-specific syscalls. It is used by the plain TeX code to create the cache directory specified by the `cacheDir` option before interfacing with the Lunamark library. Lua File System is included in all releases of LuaTeX (TeXLive $\geqslant$ 2008).

The plain TeX code makes use of the `isdir` method that was added to the Lua File System library by the LuaTeX engine developers [2, Section 4.2.4].

The Lua File System module is statically linked into the LuaTeX engine [2, Section 4.3].

Unless you convert markdown documents to TeX manually using the Lua command-line interface (see Section 2.1.7), the plain TeX part of the package will require that either the LuaTeX `\directlua` primitive or the shell access file stream 18 is available in your TeX engine. If only the shell access file stream is available in your TeX engine (as is the case with pdfTeX and XeTeX), then unless your TeX engine is globally configured to enable shell access, you will need to provide the `-shell-escape` parameter to your engine when typesetting a document.

1.1.3 LaTeX Requirements

The LaTeX part of the package requires that the LaTeX 2$_\varepsilon$ format is loaded, a TeX engine that extends ε-TeX, and all the plain TeX prerequisites (see Section 1.1.2).

The following packages are soft prerequisites. They are only used to provide default token renderer prototypes (see sections 2.2.6 and 3.3.5) or LaTeX themes (see Section 2.3.4) and will not be loaded if the option `plain` has been enabled (see Section 2.2.2.3):

url A package that provides the `\url` macro for the typesetting of links.

```
35 soft url
```

graphicx A package that provides the `\includegraphics` macro for the typesetting of images. Furthermore, it also provides a key–value interface that is used in the default renderer prototypes for image attribute contexts.

```
36 soft graphics
```

enumitem and paralist Packages that provide macros for the default renderer prototypes for tight and fancy lists.

The package paralist will be used unless the option `experimental` has been enabled, in which case, the package enumitem will be used. Furthermore, enabling tagging

[4] See https://github.com/Witiko/markdown/issues/573.

causes LaTeX to emulate most interfaces of enumitem [4], so neither package is going to be loaded.

In a future major version, enumitem will replace paralist altogether unless the emulation of enumitem becomes the default in LaTeX even without tagging, in which case both dependencies will disappear.

```
soft enumitem
soft paralist
```

fancyvrb A package that provides the `\VerbatimInput` macros for the verbatim inclusion of files containing code.

```
soft fancyvrb
```

csvsimple A package that provides the `\csvautotabular` macro for typesetting CSV files in the default renderer prototypes for iA Writer content blocks.

```
soft csvsimple
soft pgf  # required by `csvsimple`, which loads `pgfkeys.sty`
soft tools  # required by `csvsimple`, which loads `shellesc.sty`
soft etoolbox  # required by `csvsimple`, which loads `etoolbox.sty`
```

amsmath and amssymb Packages that provide symbols used for drawing ticked and unticked boxes.

```
soft amsmath
soft amsfonts
```

graphicx A package that provides extended support for graphics. It is used in the `witiko/diagrams`, and `witiko/graphicx/http` plain TeX themes, see Section 2.2.3.

```
soft graphics
soft epstopdf  # required by `graphics` and `graphicx`, which load `epsopdf-base.sty`
soft epstopdf-pkg  # required by `graphics` and `graphicx`, which load `epsopdf-base.sty`
```

soul and xcolor Packages that are used in the default renderer prototypes for strikethroughs and marked text in pdfTeX.

```
soft soul
soft xcolor
```

lua-ul and luacolor Packages that are used in the default renderer prototypes for strikethroughs and marked text in LuaTeX.

```
soft lua-ul
soft luacolor
```

ltxcmds A package that is used to detect whether the minted and listings packages are loaded in the default renderer prototype for fenced code blocks.

```
soft ltxcmds
```

luaxml A package that is used to convert HTML to LaTeX in the default renderer prototypes for content blocks, raw blocks, and inline raw spans.

```
soft luaxml
```

verse A package that is used in the default renderer prototypes for line blocks.

```
soft verse
```

1.1.4 ConTeXt Prerequisites

The ConTeXt part of the package requires that either the Mark II or the Mark IV format is loaded, all the plain TeX prerequisites (see Section 1.1.2), and the following ConTeXt modules:

m-database A module that provides the default token renderer prototype for iA Writer content blocks with the CSV filename extension (see Section 2.2.6).

1.2 Feedback

Please use the Markdown project page on GitHub[5] to report bugs and submit feature requests. If you do not want to report a bug or request a feature but are simply in need of assistance, you might want to consider posting your question to the TeX-LaTeX Stack Exchange.[6] community question answering web site under the `markdown` tag.

1.3 Acknowledgements

The Lunamark Lua module provides speedy markdown parsing for the package. I would like to thank John Macfarlane, the creator of Lunamark, for releasing Lunamark under a permissive license, which enabled its use in the Markdown package.

Extensive user documentation for the Markdown package was kindly written by Lian Tze Lim and published by Overleaf.

Funding by the Faculty of Informatics at the Masaryk University in Brno [5] is gratefully acknowledged.

Support for content slicing (Lua options `shiftHeadings` and `slice`) and pipe tables (Lua options `pipeTables` and `tableCaptions`) was graciously sponsored by David Vins and Omedym.

[5] See `https://github.com/witiko/markdown/issues`.
[6] See `https://tex.stackexchange.com`.

The TEX implementation of the package draws inspiration from several sources including the source code of LATEX 2ε, the minted package by Geoffrey M. Poore, which likewise tackles the issue of interfacing with an external interpreter from TEX, the filecontents package by Scott Pakin and others.

2 Interfaces

This part of the documentation describes the interfaces exposed by the package along with usage notes and examples. It is aimed at the user of the package.

Since neither TEX nor Lua provide interfaces as a language construct, the separation to interfaces and implementations is a *gentlemen's agreement*. It serves as a means of structuring this documentation and as a promise to the user that if they only access the package through the interface, the future minor versions of the package should remain backwards compatible.

Figure 1 shows the high-level structure of the Markdown package: The translation from markdown to TEX *token renderers* is exposed by the Lua layer. The plain TEX layer exposes the conversion capabilities of Lua as TEX macros. The LATEX and ConTEXt layers provide syntactic sugar on top of plain TEX macros. The user can interface with any and all layers.

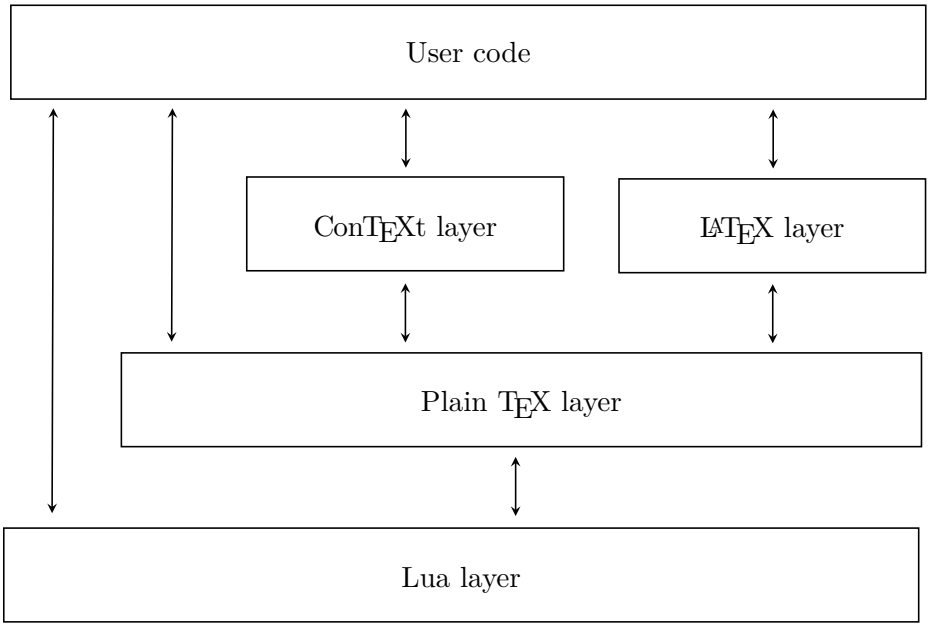


Figure 1: A block diagram of the Markdown package

2.1 Lua Interface

The Lua interface provides the conversion from UTF8 encoded markdown to plain TEX. This interface is used by the plain TEX implementation (see Section 3.2) and will be of interest to the developers of other packages and Lua modules.

The Lua interface is implemented by the `markdown` Lua module.

```
local M = {metadata = metadata}
```

2.1.1 Conversion from Markdown to Plain TEX

The Lua interface exposes the `new(options)` function. This function returns a conversion function from markdown to plain TEX according to the table `options` that contains options recognized by the Lua interface (see Section 2.1.3). The `options` parameter is optional; when unspecified, the behaviour will be the same as if `options` were an empty table.

The following example Lua code converts the markdown string `Hello *world*!` to a TEX output using the default options and prints the TEX output:

```
local md = require("markdown")
local convert = md.new()
print(convert("Hello *world*!"))
```

2.1.2 User-Defined Syntax Extensions

For the purpose of user-defined syntax extensions, the Lua interface also exposes the `reader` object, which performs the lexical and syntactic analysis of markdown text and which exposes the `reader->insert_pattern` and `reader->add_special_character` methods for extending the PEG grammar of markdown.

The read-only `walkable_syntax` hash table stores those rules of the PEG grammar of markdown that can be represented as an ordered choice of terminal symbols. These rules can be modified by user-defined syntax extensions.

```
local walkable_syntax = {
  Block = {
    "Blockquote",
    "Verbatim",
    "ThematicBreak",
    "BulletList",
    "OrderedList",
    "DisplayHtml",
    "Heading",
  },
  BlockOrParagraph = {
    "Block",
    "Paragraph",
    "Plain",
  },
  Inline = {
```

```
    "Str",
    "Space",
    "Endline",
    "EndlineBreak",
    "LinkAndEmph",
    "Code",
    "AutoLinkUrl",
    "AutoLinkEmail",
    "AutoLinkRelativeReference",
    "InlineHtml",
    "HtmlEntity",
    "EscapedChar",
    "Smart",
    "Symbol",
  },
}
```

The `reader->insert_pattern` method inserts a PEG pattern into the grammar of markdown. The method receives two mandatory arguments: a selector string in the form "⟨*left-hand side terminal symbol*⟩ ⟨*before*, *after*, or *instead of*⟩ ⟨*right-hand side terminal symbol*⟩" and a PEG pattern to insert, and an optional third argument with a name of the PEG pattern for debugging purposes (see the `debugExtensions` option). The name does not need to be unique and shall not be interpreted by the Markdown package; you can treat it as a comment.

For example. if we'd like to insert `pattern` into the grammar between the `Inline -> LinkAndEmph` and `Inline -> Code` rules, we would call `reader->insert_pattern` with `"Inline after LinkAndEmph"` (or `"Inline before Code"`) and `pattern` as the arguments.

The `reader->add_special_character` method adds a new character with special meaning to the grammar of markdown. The method receives the character as its only argument.

2.1.3 Options

The Lua interface recognizes the following options. When unspecified, the value of a key is taken from the `defaultOptions` and `experimentalOptions` tables.

```
local defaultOptions = {}
local experimentalOptions = {}
setmetatable(experimentalOptions, { __index = function (_, key)
  return defaultOptions[key] end })
```

To enable the enumeration of Lua options, we will maintain the `\g_@@_lua_options_seq` sequence.

```
\ExplSyntaxOn
\seq_new:N \g_@@_lua_options_seq
```

To enable the reflection of default/experimental Lua options and their types, we will maintain the \g_@@_default_lua_options_prop, \g_@@_experimental_lua_options_seq and \g_@@_lua_option_types_prop property lists and sequences, respectively.

```
\prop_new:N \g_@@_lua_option_types_prop
\prop_new:N \g_@@_default_lua_options_prop
\seq_new:N \g_@@_experimental_lua_options_seq
\seq_new:N \g_@@_option_layers_seq
\tl_const:Nn \c_@@_option_layer_lua_tl { lua }
\seq_gput_right:NV
  \g_@@_option_layers_seq
  \c_@@_option_layer_lua_tl
\cs_new_protected:Nn
  \@@_add_lua_option:nnn
  {
    \@@_add_option:Vnnn
      \c_@@_option_layer_lua_tl
      { #1 }
      { #2 }
      { #3 }
  }
\cs_new_protected:Nn
  \@@_add_option:nnnn
  {
    \seq_gput_right:cn
      { g_@@_ #1 _options_seq }
      { #2 }
    \prop_gput:cnn
      { g_@@_ #1 _option_types_prop }
      { #2 }
      { #3 }
    \prop_gput:cnn
      { g_@@_default_ #1 _options_prop }
      { #2 }
      { #4 }
    \@@_typecheck_option:n
      { #2 }
  }
\cs_generate_variant:Nn
  \@@_add_option:nnnn
  { Vnnn }
\cs_new_protected:Nn
  \@@_add_experimental_lua_option:n
  {
    \@@_add_experimental_option:Vn
      \c_@@_option_layer_lua_tl
      { #1 }
  }
\cs_new_protected:Nn
  \@@_add_experimental_option:nn
```

```
  {
    \seq_gput_right:cn
      { g_@@_ #1 _options_seq }
      { #2 }
    \seq_gput_right:cn
      { g_@@_experimental_ #1 _options_seq }
      { #2 }
    \prop_gput:cnn
      { g_@@_ #1 _option_types_prop }
      { #2 }
      { boolean }
  }
\cs_generate_variant:Nn
  \@@_add_experimental_option:nn
  { Vn }
\tl_const:Nn \c_@@_option_value_true_tl  { true  }
\tl_const:Nn \c_@@_option_value_false_tl { false }
\cs_new_protected:Nn \@@_typecheck_option:n
  {
    \@@_get_option_type:nN
      { #1 }
      \l_tmpa_tl
    \str_case_e:Vn
      \l_tmpa_tl
      {
        { \c_@@_option_type_boolean_tl }
          {
            \@@_get_option_value:nN
              { #1 }
              \l_tmpa_tl
            \bool_if:nF
              {
                \str_if_eq_p:eV
                  { \l_tmpa_tl }
                  \c_@@_option_value_true_tl ||
                \str_if_eq_p:eV
                  { \l_tmpa_tl }
                  \c_@@_option_value_false_tl
              }
              {
                \msg_error:nnne
                  { markdown }
                  { failed-typecheck-for-boolean-option }
                  { #1 }
                  { \l_tmpa_tl }
              }
          }
      }
  }
```

```
\msg_new:nnn
  { markdown }
  { failed-typecheck-for-boolean-option }
  {
    Option~#1~has~value~#2,~
    but~a~boolean~(true~or~false)~was~expected.
  }
\cs_generate_variant:Nn
  \str_case_e:nn
  { Vn }
\cs_generate_variant:Nn
  \msg_error:nnnn
  { nnne }
\prg_generate_conditional_variant:Nnn
  \str_if_eq:nn
  { eV }
  { p }
\seq_new:N
  \g_@@_option_types_seq
\tl_const:Nn
  \c_@@_option_type_clist_tl
  { clist }
\seq_gput_right:NV
  \g_@@_option_types_seq
  \c_@@_option_type_clist_tl
\tl_const:Nn
  \c_@@_option_type_counter_tl
  { counter }
\seq_gput_right:NV
  \g_@@_option_types_seq
  \c_@@_option_type_counter_tl
\tl_const:Nn
  \c_@@_option_type_boolean_tl
  { boolean }
\seq_gput_right:NV
  \g_@@_option_types_seq
  \c_@@_option_type_boolean_tl
\tl_const:Nn
  \c_@@_option_type_number_tl
  { number }
\seq_gput_right:NV
  \g_@@_option_types_seq
  \c_@@_option_type_number_tl
\tl_const:Nn
  \c_@@_option_type_path_tl
  { path }
\seq_gput_right:NV
  \g_@@_option_types_seq
  \c_@@_option_type_path_tl
```

```
\tl_const:Nn
  \c_@@_option_type_slice_tl
  { slice }
\seq_gput_right:NV
  \g_@@_option_types_seq
  \c_@@_option_type_slice_tl
\tl_const:Nn
  \c_@@_option_type_string_tl
  { string }
\seq_gput_right:NV
  \g_@@_option_types_seq
  \c_@@_option_type_string_tl
\cs_new_protected:Nn
  \@@_get_option_type:nN
  {
    \bool_set_false:N
      \l_tmpa_bool
    \seq_map_inline:Nn
      \g_@@_option_layers_seq
      {
        \prop_get:cnNT
          { g_@@_ ##1 _option_types_prop }
          { #1 }
          \l_tmpa_tl
          {
            \bool_set_true:N
              \l_tmpa_bool
            \seq_map_break:
          }
      }
    \bool_if:NF
      \l_tmpa_bool
      {
        \msg_error:nnn
          { markdown }
          { undefined-option }
          { #1 }
      }
    \seq_if_in:NVF
      \g_@@_option_types_seq
      \l_tmpa_tl
      {
        \msg_error:nnnV
          { markdown }
          { unknown-option-type }
          { #1 }
          \l_tmpa_tl
      }
    \tl_set_eq:NN
```

```
      #2
      \l_tmpa_tl
  }
\msg_new:nnn
  { markdown }
  { unknown-option-type }
  {
    Option~#1~has~unknown~type~#2.
  }
\msg_new:nnn
  { markdown }
  { undefined-option }
  {
    Option~#1~is~undefined.
  }
\cs_generate_variant:Nn
  \msg_error:nnnn
  { nnnV }
\cs_new_protected:Nn
  \@@_get_default_option_value:nN
  {
    \bool_set_false:N
      \l_tmpa_bool
    \seq_map_inline:Nn
      \g_@@_option_layers_seq
      {
        \seq_if_in:cnT
          { g__markdown_experimental_ ##1 _options_seq }
          { #1 }
          {
            \@@_get_option_value:nN
              { experimental }
              #2
            \bool_set_true:N
              \l_tmpa_bool
            \seq_map_break:
          }
        \prop_get:cnNT
          { g_@@_default_ ##1 _options_prop }
          { #1 }
          #2
          {
            \bool_set_true:N
              \l_tmpa_bool
            \seq_map_break:
          }
      }
    \bool_if:NF
      \l_tmpa_bool
```

```
      {
        \msg_error:nnn
          { markdown }
          { undefined-option }
          { #1 }
      }
  }
\cs_new_protected:Nn
  \@@_get_option_value:nN
  {
    \@@_option_tl_to_csname:nN
      { #1 }
      \l_tmpa_tl
    \cs_if_free:cTF
      { \l_tmpa_tl }
      {
        \@@_get_default_option_value:nN
          { #1 }
          #2
      }
      {
        \@@_get_option_type:nN
          { #1 }
          \l_tmpa_tl
        \str_if_eq:NNTF
          \c_@@_option_type_counter_tl
          \l_tmpa_tl
          {
            \@@_option_tl_to_csname:nN
              { #1 }
              \l_tmpa_tl
            \tl_set:Nx
              #2
              { \the \cs:w \l_tmpa_tl \cs_end: }
          }
          {
            \@@_option_tl_to_csname:nN
              { #1 }
              \l_tmpa_tl
            \tl_set:Nv
              #2
              { \l_tmpa_tl }
          }
      }
  }
\cs_new_protected:Nn \@@_option_tl_to_csname:nN
  {
    \tl_set:Nn
      \l_tmpa_tl
```

```
      { \str_uppercase:n { #1 } }
    \tl_set:Nx
      #2
      {
        markdownOption
        \tl_head:f { \l_tmpa_tl }
        \tl_tail:n { #1 }
      }
  }
\regex_const:Nn
  \c_@@_option_regex
  { ^markdownOption }
\prg_new_protected_conditional:Nnn
  \@@_csname_to_option_str:nN
  { T }
  {
    \tl_if_regex_match:nNTF
      { #1 }
      \c_@@_option_regex
      {
        \tl_set:Nn
          \l_tmpa_tl
          { #1 }
        \tl_regex_replace_once:NNn
          \l_tmpa_tl
          \c_@@_option_regex
          { }
        \tl_set:Nn
          \l_tmpb_tl
          {
            \str_lowercase:f
              { \l_tmpa_tl }
          }
        \str_set:Nx
          #2
          {
            \tl_head:f { \l_tmpb_tl }
            \tl_tail:V \l_tmpa_tl
          }
        \prg_return_true:
      }
      { \prg_return_false: }
  }
```

To make it easier to support different coding styles in the interface, engines, we define the `\@@_with_various_cases:nn` function that allows us to generate different variants of a string using different cases.

```
\cs_new_protected:Nn \@@_with_various_cases:nn
  {
    \seq_clear:N
```

```
      \l_tmpa_seq
    \seq_map_inline:Nn
      \g_@@_cases_seq
      {
        \tl_set:Nn
          \l_tmpa_tl
          { #1 }
        \use:c { ##1 }
          \l_tmpa_tl
        \seq_put_right:NV
          \l_tmpa_seq
          \l_tmpa_tl
      }
    \seq_map_inline:Nn
      \l_tmpa_seq
      { #2 }
  }
```

By default, camelCase and snake_case are supported. Additional cases can be added by adding functions to the `\g_@@_cases_seq` sequence.

```
\seq_new:N \g_@@_cases_seq
\cs_new_protected:Nn \@@_camel_case:N
  {
    \regex_replace_all:nnN
      { _ ([a-z]) }
      { \c { str_uppercase:n } \cB\{ \1 \cE\} }
      #1
    \tl_set:Nx
      #1
      { #1 }
  }
\seq_gput_right:Nn \g_@@_cases_seq { @@_camel_case:N }
\cs_new_protected:Nn \@@_snake_case:N
  {
    \regex_replace_all:nnN
      { ([a-z])([A-Z]) }
      { \1 _ \c { str_lowercase:n } \cB\{ \2 \cE\} }
      #1
    \tl_set:Nx
      #1
      { #1 }
  }
\seq_gput_right:Nn \g_@@_cases_seq { @@_snake_case:N }
```

2.1.4 General Behavior

`eagerCache`=`true`, `false` default: `true`

`true` Converted markdown documents will be cached in `cacheDir`. This can be useful for post-processing the converted documents and for recovering

historical versions of the documents from the cache. Furthermore, it can also significantly improve the processing speed for documents that require multiple compilation runs, since each markdown document is only converted once. However, it also produces a large number of auxiliary files on the disk.

This behavior will always be used if the `finalizeCache` option is enabled.

`false` Converted markdown documents will not be cached. This decreases the number of auxiliary files that we produce and makes it easier to use the Lua command-line interface for plumbing. However, it makes it impossible to post-process the converted documents and recover historical versions of the documents from the cache. Furthermore, it can significantly reduce the processing speed for documents that require multiple compilation runs, since each markdown document is converted multiple times needlessly.

This behavior will only be used when the `finalizeCache` option is disabled.

```
\@@_add_lua_option:nnn
  { eagerCache }
  { boolean }
  { true }
defaultOptions.eagerCache = true
```

`experimental`=`true`, `false` default: `false`

`true` Experimental features that are planned to be the new default in the next major release of the Markdown package will be enabled.

At the moment, this has the following effects:

1. The version `experimental` of the theme `witiko/markdown/defaults` will be loaded.
2. Warnings for hard-deprecated features will become errors.
3. The experimental option `htmlOverLinks` will be enabled.

In the future, the effects may extend to other areas as well.

`false` Experimental features will be disabled.

```
\@@_add_lua_option:nnn
  { experimental }
  { boolean }
  { false }
defaultOptions.experimental = false
```

`singletonCache`=`true`, `false` default: `true`

`true` Conversion functions produced by the function `new(options)` will be cached in an LRU cache of size 1 keyed by `options`. This is more time- and space-efficient than always producing a new conversion function but may expose bugs related to the idempotence of conversion functions.

This has been the default behavior since version 3.0.0 of the Markdown package.

`false` Every call to the function `new(options)` will produce a new conversion function that will not be cached. This is slower than caching conversion functions and may expose bugs related to memory leaks in the creation of conversion functions, see also #226 (comment)[7].

This was the default behavior until version 3.0.0 of the Markdown package.

```
\@@_add_lua_option:nnn
  { singletonCache }
  { boolean }
  { true }
defaultOptions.singletonCache = true
local singletonCache = {
  convert = nil,
  options = nil,
}
```

`unicodeNormalization`=`true`, `false` default: `true`

`true` Markdown documents will be normalized using one of the four Unicode normalization forms[8] before conversion. The Unicode normalization norm used is determined by option `unicodeNormalizationForm`.

`false` Markdown documents will not be Unicode-normalized before conversion.

```
\@@_add_lua_option:nnn
  { unicodeNormalization }
  { boolean }
  { true }
defaultOptions.unicodeNormalization = true
```

[7] See https://github.com/witiko/markdown/pull/226#issuecomment-1599641634.
[8] See https://unicode.org/faq/normalization.html.

`unicodeNormalizationForm`=`nfc`, `nfd`, `nfkc`, `nfkd`
default: `nfc`

`nfc` When option `unicodeNormalization` has been enabled, markdown documents will be normalized using Unicode Normalization Form C (NFC) before conversion.

`nfd` When option `unicodeNormalization` has been enabled, markdown documents will be normalized using Unicode Normalization Form D (NFD) before conversion.

`nfkc` When option `unicodeNormalization` has been enabled, markdown documents will be normalized using Unicode Normalization Form KC (NFKC) before conversion.

`nfkd` When option `unicodeNormalization` has been enabled, markdown documents will be normalized using Unicode Normalization Form KD (NFKD) before conversion.

```
\@@_add_lua_option:nnn
  { unicodeNormalizationForm }
  { string }
  { nfc }
defaultOptions.unicodeNormalizationForm = "nfc"
```

2.1.5 File and Directory Names

`cacheDir`=⟨*path*⟩ default: `.`

A path to the directory containing auxiliary cache files. If the last segment of the path does not exist, it will be created by the Lua command-line and plain TEX implementations. The Lua implementation expects that the entire path already exists.

When iteratively writing and typesetting a markdown document, the cache files are going to accumulate over time. You are advised to clean the cache directory every now and then, or to set it to a temporary filesystem (such as `/tmp` on UN*X systems), which gets periodically emptied.

```
\str_new:N
  \g_@@_unquoted_jobname_str
\str_gset:NV
  \g_@@_unquoted_jobname_str
  \c_sys_jobname_str
\bool_new:N
  \g_@@_jobname_quoted_bool
\regex_replace_all:nnNTF
  { \A ("|') ( .* ) ("|') \Z }
  { \2 }
```

```
  \g_@@_unquoted_jobname_str
  {
    \bool_gset_true:N
      \g_@@_jobname_quoted_bool
  }
  {
    \bool_gset_false:N
      \g_@@_jobname_quoted_bool
  }
\@@_add_lua_option:nnn
  { cacheDir }
  { path }
  {
    \markdownOptionOutputDir
    / _markdown_
    \str_use:N
      \g_@@_unquoted_jobname_str
  }
defaultOptions.cacheDir = "."
```

`contentBlocksLanguageMap`=⟨*filename*⟩
default: `markdown-languages.json`

The filename of the JSON file that maps filename extensions to programming language names in the iA Writer content blocks when the `contentBlocks` option is enabled. See Section 2.2.5.14 for more information.

```
\@@_add_lua_option:nnn
  { contentBlocksLanguageMap }
  { path }
  { markdown-languages.json }
defaultOptions.contentBlocksLanguageMap = "markdown-languages.json"
```

`debugExtensionsFileName`=⟨*filename*⟩
default: `debug-extensions.json`

The filename of the JSON file that will be produced when the `debugExtensions` option is enabled. This file will contain the extensible subset of the PEG grammar of markdown (see the `walkable_syntax` hash table) after built-in syntax extensions (see Section 3.1.7) and user-defined syntax extensions (see Section 2.1.2) have been applied.

```
\@@_add_lua_option:nnn
  { debugExtensionsFileName }
  { path }
  {
    \markdownOptionOutputDir
    /
```

```
    \str_use:N
      \g_@@_unquoted_jobname_str
    .debug-extensions.json
  }
defaultOptions.debugExtensionsFileName = "debug-extensions.json"
```

`frozenCacheFileName`=⟨*path*⟩ default: `frozenCache.tex`

A path to an output file (frozen cache) that will be created when the `finalizeCache` option is enabled and will contain a mapping between an enumeration of markdown documents and their auxiliary cache files.

The frozen cache makes it possible to later typeset a plain TEX document that contains markdown documents without invoking Lua using the `frozenCache` plain TEX option. As a result, the plain TEX document becomes more portable, but further changes in the order and the content of markdown documents will not be reflected.

```
\@@_add_lua_option:nnn
  { frozenCacheFileName }
  { path }
  { \markdownOptionCacheDir / frozenCache.tex }
defaultOptions.frozenCacheFileName = "frozenCache.tex"
```

2.1.6 Parser Options

`acronyms`=⟨*acronyms*⟩

Acronyms, initialisms, and other all-caps sequences that will be recognized in markdown text and formatted accordingly.

```
\cs_generate_variant:Nn
  \@@_add_lua_option:nnn
  { nnV }
\@@_add_lua_option:nnV
  { acronyms }
  { clist }
  \c_empty_clist
defaultOptions.acronyms = {}
```

`autoIdentifiers`=`true`, `false` default: `false`

`true` Enable the Pandoc auto identifiers syntax extension[9]:

[9] See https://pandoc.org/MANUAL.html#extension-auto_identifiers.

```
The following heading received the identifier
`sesame-street`:

# 123 Sesame Street
```

`false` Disable the Pandoc auto identifiers syntax extension.

See also the option `gfmAutoIdentifiers`.

```
\@@_add_lua_option:nnn
  { autoIdentifiers }
  { boolean }
  { false }
defaultOptions.autoIdentifiers = false
```

`blankBeforeBlockquote`=`true`, `false` default: `false`

`true` Require a blank line between a paragraph and the following blockquote.

`false` Do not require a blank line between a paragraph and the following blockquote.

```
\@@_add_lua_option:nnn
  { blankBeforeBlockquote }
  { boolean }
  { false }
defaultOptions.blankBeforeBlockquote = false
```

`blankBeforeCodeFence`=`true`, `false` default: `false`

`true` Require a blank line between a paragraph and the following fenced code block.

`false` Do not require a blank line between a paragraph and the following fenced code block.

```
\@@_add_lua_option:nnn
  { blankBeforeCodeFence }
  { boolean }
  { false }
defaultOptions.blankBeforeCodeFence = false
```

`blankBeforeDivFence`=`true`, `false` default: `false`

`true` Require a blank line before the closing fence of a fenced div.

`false` Do not require a blank line before the closing fence of a fenced div.

```
\@@_add_lua_option:nnn
  { blankBeforeDivFence }
  { boolean }
  { false }
defaultOptions.blankBeforeDivFence = false
```

`blankBeforeHeading`=`true`, `false` default: `false`

`true` Require a blank line between a paragraph and the following header.

`false` Do not require a blank line between a paragraph and the following header.

```
\@@_add_lua_option:nnn
  { blankBeforeHeading }
  { boolean }
  { false }
defaultOptions.blankBeforeHeading = false
```

`blankBeforeHtmlBlock`=`true`, `false` default: `false`

`true` Require a blank line between a paragraph and the following CommonMark HTML block[10].

`false` Do not require a blank line between a paragraph and the following CommonMark HTML block.

```
\@@_add_lua_option:nnn
  { blankBeforeHtmlBlock }
  { boolean }
  { false }
defaultOptions.blankBeforeHtmlBlock = false
```

`blankBeforeList`=`true`, `false` default: `false`

`true` Require a blank line between a paragraph and the following list.

`false` Do not require a blank line between a paragraph and the following list.

```
\@@_add_lua_option:nnn
  { blankBeforeList }
  { boolean }
  { false }
defaultOptions.blankBeforeList = false
```

[10]See https://spec.commonmark.org/0.31.2/#html-blocks.

`bracketedSpans`=`true`, `false` default: `false`

`true` Enable the Pandoc bracketed span syntax extension[11]:

```
[This is *some text*]{.class key=val}
```

`false` Disable the Pandoc bracketed span syntax extension.

```
\@@_add_lua_option:nnn
  { bracketedSpans }
  { boolean }
  { false }
defaultOptions.bracketedSpans = false
```

`breakableBlockquotes`=`true`, `false` default: `true`

`true` A blank line separates block quotes.

`false` Blank lines in the middle of a block quote are ignored.

```
\@@_add_lua_option:nnn
  { breakableBlockquotes }
  { boolean }
  { true }
defaultOptions.breakableBlockquotes = true
```

`citationNbsps`=`true`, `false` default: `false`

`true` Replace regular spaces with non-breaking spaces inside the prenotes and postnotes of citations produced via the pandoc citation syntax extension.

`false` Do not replace regular spaces with non-breaking spaces inside the prenotes and postnotes of citations produced via the pandoc citation syntax extension.

```
\@@_add_lua_option:nnn
  { citationNbsps }
  { boolean }
  { true }
defaultOptions.citationNbsps = true
```

[11] See https://pandoc.org/MANUAL.html#extension-bracketed_spans.

`citations`=`true`, `false` default: `false`

`true` Enable the Pandoc citation syntax extension[12]:

```
Here is a simple parenthetical citation [@doe99] and here
is a string of several [see @doe99, pp. 33-35; also
@smith04, chap. 1].

A parenthetical citation can have a [prenote @doe99] and
a [@smith04 postnote]. The name of the author can be
suppressed by inserting a dash before the name of an
author as follows [-@smith04].

Here is a simple text citation @doe99 and here is
a string of several @doe99 [pp. 33-35; also @smith04,
chap. 1]. Here is one with the name of the author
suppressed -@doe99.
```

`false` Disable the Pandoc citation syntax extension.

```
\@@_add_lua_option:nnn
  { citations }
  { boolean }
  { false }
defaultOptions.citations = false
```

`codeSpans`=`true`, `false` default: `true`

`true` Enable the code span syntax:

```
Use the `printf()` function.
``There is a literal backtick (`) here.``
```

`false` Disable the code span syntax. This allows you to easily use the quotation mark ligatures in texts that do not contain code spans:

```
``This is a quote.''
```

```
\@@_add_lua_option:nnn
  { codeSpans }
  { boolean }
  { true }
defaultOptions.codeSpans = true
```

[12] See https://pandoc.org/MANUAL.html#extension-citations.

`contentBlocks`=true, false default: `false`

`true` Enable the iA Writer content blocks syntax extension [6]:

```
http://example.com/minard.jpg (Napoleon's disastrous
  Russian campaign of 1812)
/Flowchart.png "Engineering Flowchart"
/Savings Account.csv 'Recent Transactions'
/Example.swift
/Lorem Ipsum.txt
```

`false` Disable the iA Writer content blocks syntax extension.

```
\@@_add_lua_option:nnn
  { contentBlocks }
  { boolean }
  { false }
defaultOptions.contentBlocks = false
```

`contentLevel`=block, inline default: `block`

`block` Treat content as a sequence of blocks.

```
- this is a list
- it contains two items
```

`inline` Treat all content as inline content.

```
- this is a text
- not a list
```

```
\@@_add_lua_option:nnn
  { contentLevel }
  { string }
  { block }
defaultOptions.contentLevel = "block"
```

`debugExtensions`=true, false default: `false`

`true` Produce a JSON file that will contain the extensible subset of the PEG grammar of markdown (see the `walkable_syntax` hash table) after built-in syntax extensions (see Section 3.1.7) and user-defined syntax extensions (see Section 2.1.2) have been applied. This helps you to see how the different extensions interact. The name of the produced JSON file is controlled by the `debugExtensionsFileName` option.

`false` Do not produce a JSON file with the PEG grammar of markdown.

```
\@@_add_lua_option:nnn
  { debugExtensions }
  { boolean }
  { false }
defaultOptions.debugExtensions = false
```

`definitionLists`=`true`, `false` default: `false`

`true` Enable the pandoc definition list syntax extension:

```
Term 1

:   Definition 1

Term 2 with *inline markup*

:   Definition 2

        { some code, part of Definition 2 }

    Third paragraph of definition 2.
```

`false` Disable the pandoc definition list syntax extension.

```
\@@_add_lua_option:nnn
  { definitionLists }
  { boolean }
  { false }
defaultOptions.definitionLists = false
```

`ensureJekyllData`=`true`, `false` default: `false`

`true` When the `jekyllData` and `expectJekyllData` options are enabled, then a markdown document must begin directly with YAML metadata and must contain nothing but YAML metadata. Otherwise, an error is produced.

`false` When the `jekyllData` and `expectJekyllData` options are enabled, then a markdown document may begin directly with YAML metadata and may contain nothing but YAML metadata. Otherwise, the markdown document is processed as markdown text.

See also the plain TeX macros `\yamlBegin`, `\yamlEnd`, and `\yamlInput` in Section 2.2.1, the LaTeX environment `yaml` in Section 2.3.1, and the ConTeXt macros `\startyaml`,

\stopyaml, and \inputyaml in Section 2.4.1 to see how the options jekyllData, expectJekyllData, and ensureJekyllData can be used together to implement high-level interfaces for processing YAML documents.

```
\@@_add_lua_option:nnn
  { ensureJekyllData }
  { boolean }
  { false }
defaultOptions.ensureJekyllData = false
```

expectJekyllData=true, false default: false

true When the jekyllData option is enabled, then a markdown document may begin directly with YAML metadata and may contain nothing but YAML metadata.

```
\documentclass{article}
\usepackage[jekyllData, expectJekyllData]{markdown}
\begin{document}
\begin{markdown}
- this
- is
- YAML
...
- followed
- by
- Markdown
\end{markdown}
\begin{markdown}
- this
- is
- YAML
\end{markdown}
\end{document}
```

false When the jekyllData option is enabled, then a markdown document may begin with YAML metadata if and only if the metadata begin with the end-of-directives marker (---) and they end with either the end-of-directives or the end-of-document marker (...):

```
\documentclass{article}
\usepackage[jekyllData]{markdown}
\begin{document}
\begin{markdown}
---
- this
```

```
- is
- YAML
...
- followed
- by
- Markdown
\end{markdown}
\begin{markdown}
- this
- is
- Markdown
\end{markdown}
\end{document}
```

See also the plain TEX macros `\yamlBegin`, `\yamlEnd`, and `\yamlInput` in Section 2.2.1, the LATEX environment `yaml` in Section 2.3.1, and the ConTEXt macros `\startyaml`, `\stopyaml`, and `\inputyaml` in Section 2.4.1 to see how the options `jekyllData`, `expectJekyllData`, and `ensureJekyllData` can be used together to implement high-level interfaces for processing YAML documents.

```
\@@_add_lua_option:nnn
  { expectJekyllData }
  { boolean }
  { false }
defaultOptions.expectJekyllData = false
```

`extensions`=⟨*filenames*⟩

The filenames of user-defined syntax extensions that will be applied to the markdown reader. If the kpathsea library is available, files will be searched for not only in the current working directory but also in the TEX directory structure.

A user-defined syntax extension is a Lua file in the following format:

```
local strike_through = {
  api_version = 2,
  grammar_version = 4,
  finalize_grammar = function(reader)
    local nonspacechar = lpeg.P(1) - lpeg.S("\t ")
    local doubleslashes = lpeg.P("//")
    local function between(p, starter, ender)
      ender = lpeg.B(nonspacechar) * ender
      return (starter * #nonspacechar
              * lpeg.Ct(p * (p - ender)^0) * ender)
    end
```

```
    local read_strike_through = between(
      lpeg.V("Inline"), doubleslashes, doubleslashes
    ) / function(s) return {"\\st{", s, "}"} end

    reader.insert_pattern("Inline after LinkAndEmph",
                          read_strike_through,
                          "StrikeThrough")
    reader.add_special_character("/")
  end
}

return strike_through
```

The `api_version` and `grammar_version` fields specify the version of the user-defined syntax extension API and the markdown grammar for which the extension was written. See the current API and grammar versions below:

```
metadata.user_extension_api_version = 2
metadata.grammar_version = 4
```

Any changes to the syntax extension API or grammar will cause the corresponding current version to be incremented. After Markdown 3.0.0, any changes to the API and the grammar will be either backwards-compatible or constitute a breaking change that will cause the major version of the Markdown package to increment (to 4.0.0).

The `finalize_grammar` field is a function that finalizes the grammar of markdown using the interface of a Lua `reader` object, such as the `reader->insert_pattern` and `reader->add_special_character` methods, see Section 2.1.2.

```
\@@_add_lua_option:nnV
  { extensions }
  { clist }
  \c_empty_clist
```

```
defaultOptions.extensions = {}
```

`fancyLists`=`true`, `false` default: `false`

`true` Enable the Pandoc fancy list syntax extension[13]:

```
a) first item
b) second item
c) third item
```

`false` Disable the Pandoc fancy list syntax extension.

[13] See https://pandoc.org/MANUAL.html#org-fancy-lists.

```
\@@_add_lua_option:nnn
  { fancyLists }
  { boolean }
  { false }
defaultOptions.fancyLists = false
```

`fencedCode`=`true`, `false` default: `true`

`true` Enable the commonmark fenced code block extension:

```
~~~ js
if (a > 3) {
    moveShip(5 * gravity, DOWN);
}
~~~~~~

  ``` html
  <pre>
    <code>
      // Some comments
      line 1 of code
      line 2 of code
      line 3 of code
    </code>
  </pre>
  ```
```

`false` Disable the commonmark fenced code block extension.

```
\@@_add_lua_option:nnn
  { fencedCode }
  { boolean }
  { true }
defaultOptions.fencedCode = true
```

`fencedCodeAttributes`=`true`, `false` default: `false`

`true` Enable the Pandoc fenced code attribute syntax extension[14]:

```
~~~~ {#mycode .haskell .numberLines startFrom=100}
qsort []     = []
qsort (x:xs) = qsort (filter (< x) xs) ++ [x] ++
               qsort (filter (>= x) xs)
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
```

[14] See https://pandoc.org/MANUAL.html#extension-fenced_code_attributes.

`false` Disable the Pandoc fenced code attribute syntax extension.

```
\@@_add_lua_option:nnn
  { fencedCodeAttributes }
  { boolean }
  { false }
defaultOptions.fencedCodeAttributes = false
```

`fencedDivs`=`true`, `false` default: `false`

`true` Enable the Pandoc fenced div syntax extension[15]:

```
::::: {#special .sidebar}
Here is a paragraph.

And another.
:::::
```

`false` Disable the Pandoc fenced div syntax extension.

```
\@@_add_lua_option:nnn
  { fencedDivs }
  { boolean }
  { false }
defaultOptions.fencedDivs = false
```

`finalizeCache`=`true`, `false` default: `false`

Whether an output file specified with the `frozenCacheFileName` option (frozen cache) that contains a mapping between an enumeration of markdown documents and their auxiliary cache files will be created.

The frozen cache makes it possible to later typeset a plain TEX document that contains markdown documents without invoking Lua using the `frozenCache` plain TEX option. As a result, the plain TEX document becomes more portable, but further changes in the order and the content of markdown documents will not be reflected.

```
\@@_add_lua_option:nnn
  { finalizeCache }
  { boolean }
  { false }
defaultOptions.finalizeCache = false
```

[15] See https://pandoc.org/MANUAL.html#extension-fenced_divs.

`frozenCacheCounter`=⟨*number*⟩ default: `0`

The number of the current markdown document that will be stored in an output file (frozen cache) when the `finalizeCache` is enabled. When the document number is 0, then a new frozen cache will be created. Otherwise, the frozen cache will be appended.

Each frozen cache entry will define a TEX macro `\markdownFrozenCache`⟨*number*⟩ that will typeset markdown document number ⟨*number*⟩.

```
\@@_add_lua_option:nnn
  { frozenCacheCounter }
  { counter }
  { 0 }
defaultOptions.frozenCacheCounter = 0
```

`gfmAutoIdentifiers`=`true`, `false` default: `false`

`true` Enable the Pandoc GitHub-flavored auto identifiers syntax extension[16]:

```
The following heading received the identifier
`123-sesame-street`:

# 123 Sesame Street
```

`false` Disable the Pandoc GitHub-flavored auto identifiers syntax extension.

See also the option `autoIdentifiers`.

```
\@@_add_lua_option:nnn
  { gfmAutoIdentifiers }
  { boolean }
  { false }
defaultOptions.gfmAutoIdentifiers = false
```

`hashEnumerators`=`true`, `false` default: `false`

`true` Enable the use of hash symbols (`#`) as ordered item list markers:

```
#. Bird
#. McHale
#. Parish
```

`false` Disable the use of hash symbols (`#`) as ordered item list markers.

```
\@@_add_lua_option:nnn
  { hashEnumerators }
  { boolean }
  { false }
defaultOptions.hashEnumerators = false
```

[16] See https://pandoc.org/MANUAL.html#extension-gfm_auto_identifiers.

`headerAttributes`=`true`, `false` default: `false`

`true` Enable the assignment of HTML attributes to headings:

```
# My first heading {#foo}

## My second heading ##    {#bar .baz}

Yet another heading   {key=value}
==================
```

`false` Disable the assignment of HTML attributes to headings.

```
\@@_add_lua_option:nnn
  { headerAttributes }
  { boolean }
  { false }
defaultOptions.headerAttributes = false
```

`html`=`true`, `false` default: `true`

`true` Enable the recognition of HTML entities, inline HTML tags, and block HTML elements, comments, declarations, processing instructions, and CDATA sections in the input.

HTML entities will be replaced with the corresponding Unicode codepoints and other HTML content will be ignored by default.

`false` Disable the recognition of HTML markup. Any recognized HTML content in the input will be rendered as plain text.

```
\@@_add_lua_option:nnn
  { html }
  { boolean }
  { true }
defaultOptions.html = true
```

`htmlOutput`=`basic`, `commonmark` default: `basic`

basic

: When the `html` option is enabled, produce basic coarse-grained renderers for all HTML, see Section 2.2.5.3.

commonmark

: When the `html` option is enabled, produce fine-grained renderers for each top-level non-terminal element of CommonMark's grammar for HTML blocks[17] and raw HTML[18], see sections 2.2.5.12 and 2.2.5.13, respectively.

[17] See https://spec.commonmark.org/0.31.2/#html-blocks.
[18] See https://spec.commonmark.org/0.31.2/#raw-html.

```
\@@_add_lua_option:nnn
  { htmlOutput }
  { string }
  { basic }
defaultOptions.htmlOutput = "basic"
```

`htmlOverLinks`=true, false default: `false`

`true` When the option `html` is enabled and a text can be understood either as a hyperlink or HTML, interpret it as HTML.

This is especially relevant when the option `relativeReferences` is enabled, since it makes e.g. `</foo>` a valid hyperlink.

`false` When the option `html` is enabled and a text can be understood either as a hyperlink or HTML, interpret it as a hyperlink.

This is an experimental option. Whenever the option `experimental` is enabled and this option is unspecified, it will be enabled. Like other experimental options, this option will be enabled by default and soft-deprecated in the next major release of the Markdown package.

```
\@@_add_experimental_lua_option:n
  { htmlOverLinks }
defaultOptions.htmlOverLinks = false
experimentalOptions.htmlOverLinks = true
```

`hybrid`=true, false default: `false`

`true` Disable the escaping of special plain TEX characters, which makes it possible to intersperse your markdown markup with TEX code. The intended usage is in documents prepared manually by a human author. In such documents, it can often be desirable to mix TEX and markdown markup freely.

`false` Enable the escaping of special plain TEX characters outside verbatim environments, so that they are not interpreted by TEX. This is encouraged when typesetting automatically generated content or markdown documents that were not prepared with this package in mind.

The `hybrid` option makes it difficult to untangle TEX input from markdown text, which makes documents written with the `hybrid` option less interoperable and more difficult to read for authors. Therefore, the option has been soft-deprecated in version 3.7.1 of the Markdown package: It will never be removed but using it prints a warning and is discouraged.

Consider one of the following better alternatives for mixing TEX and markdown:

- With the `contentBlocks` option, authors can move large blocks of TeX code to separate files and include them in their markdown documents as external resources:

```
Here is a mathematical formula:

 /math-formula.tex
```

- With the `rawAttribute` option, authors can denote raw text spans and code blocks that will be interpreted as TEX code:

```
`$H_2 O$`{=tex} is a liquid.

Here is a mathematical formula:
``` {=tex}
\[distance[i] =
    \begin{dcases}
        a & b \\
        c & d
    \end{dcases}
\]
```
```

- With options `texMathDollars`, `texMathSingleBackslash`, and `texMathDoubleBackslash`, authors can freely type TEX commands between dollar signs or backslash-escaped brackets:

```
$H_2 O$ is a liquid.

Here is a mathematical formula:
\[distance[i] =
    \begin{dcases}
        a & b \\
        c & d
    \end{dcases}
\]
```

```
\@@_add_lua_option:nnn
  { hybrid }
  { boolean }
  { false }
defaultOptions.hybrid = false
```

`inlineCodeAttributes`=true, false default: `false`

`true` Enable the Pandoc inline code span attribute extension[19]:

```
`<$>`{.haskell}
```

`false` Enable the Pandoc inline code span attribute extension.

```
\@@_add_lua_option:nnn
  { inlineCodeAttributes }
  { boolean }
  { false }
defaultOptions.inlineCodeAttributes = false
```

`inlineNotes`=true, false default: `false`

`true` Enable the Pandoc inline note syntax extension[20]:

```
Here is an inline note.^[Inline notes are easier to
write, since you don't have to pick an identifier and
move down to type the note.]
```

`false` Disable the Pandoc inline note syntax extension.

```
\@@_add_lua_option:nnn
  { inlineNotes }
  { boolean }
  { false }
defaultOptions.inlineNotes = false
```

`jekyllData`=true, false default: `false`

`true` Enable the Pandoc YAML metadata block syntax extension[21] for entering metadata in YAML:

```
---
title:  'This is the title: it contains a colon'
author:
- Author One
- Author Two
keywords: [nothing, nothingness]
abstract: |
  This is the abstract.
```

[19] See https://pandoc.org/MANUAL.html#extension-inline_code_attributes.
[20] See https://pandoc.org/MANUAL.html#extension-inline_notes.
[21] See https://pandoc.org/MANUAL.html#extension-yaml_metadata_block.

```
  It consists of two paragraphs.
---
```

`false` Disable the Pandoc YAML metadata block syntax extension for entering metadata in YAML.

See also the plain TeX macros `\yamlBegin`, `\yamlEnd`, and `\yamlInput` in Section 2.2.1, the LaTeX environment `yaml` in Section 2.3.1, and the ConTeXt macros `\startyaml`, `\stopyaml`, and `\inputyaml` in Section 2.4.1 to see how the options `jekyllData`, `expectJekyllData`, and `ensureJekyllData` can be used together to implement high-level interfaces for processing YAML documents.

```
\@@_add_lua_option:nnn
  { jekyllData }
  { boolean }
  { false }
defaultOptions.jekyllData = false
```

`linkAttributes`=true, `false` default: `false`

`true` Enable the Pandoc link and image attribute syntax extension[22]:

```
An inline ![image](foo.jpg){#id .class height=20px}
and a reference ![image][ref] with attributes.

[ref]: foo.jpg "optional title" {#id .class key=val}
```

`false` Enable the Pandoc link and image attribute syntax extension.

```
\@@_add_lua_option:nnn
  { linkAttributes }
  { boolean }
  { false }
defaultOptions.linkAttributes = false
```

`lineBlocks`=true, `false` default: `false`

`true` Enable the Pandoc line block syntax extension[23]:

```
| this is a line block that
| spans multiple
| even
  discontinuous
| lines
```

[22] See https://pandoc.org/MANUAL.html#extension-link_attributes.
[23] See https://pandoc.org/MANUAL.html#extension-line_blocks.

`false` Disable the Pandoc line block syntax extension.

```
\@@_add_lua_option:nnn
  { lineBlocks }
  { boolean }
  { false }
defaultOptions.lineBlocks = false
```

`mark`=`true`, `false` default: `false`

`true` Enable the Pandoc mark syntax extension[24]:

```
This ==is highlighted text.==
```

`false` Disable the Pandoc mark syntax extension.

```
\@@_add_lua_option:nnn
  { mark }
  { boolean }
  { false }
defaultOptions.mark = false
```

`notes`=`true`, `false` default: `false`

`true` Enable the Pandoc note syntax extension[25]:

```
Here is a note reference,[^1] and another.[^longnote]

[^1]: Here is the note.

[^longnote]: Here's one with multiple blocks.

    Subsequent paragraphs are indented to show that they
belong to the previous note.

        { some.code }

    The whole paragraph can be indented, or just the
    first line.  In this way, multi-paragraph notes
    work like multi-paragraph list items.

This paragraph won't be part of the note, because it
isn't indented.
```

[24] See https://pandoc.org/MANUAL.html#extension-mark.
[25] See https://pandoc.org/MANUAL.html#extension-footnotes.

`false` Disable the Pandoc note syntax extension.

```
\@@_add_lua_option:nnn
  { notes }
  { boolean }
  { false }
defaultOptions.notes = false
```

`pipeTables`=`true`, `false` default: `false`

`true` Enable the PHP Markdown pipe table syntax extension:

```
| Right | Left | Default | Center |
|------:|:-----|---------|:------:|
|   12  |  12  |    12   |    12  |
|  123  |  123 |   123   |   123  |
|    1  |    1 |     1   |     1  |
```

`false` Disable the PHP Markdown pipe table syntax extension.

```
\@@_add_lua_option:nnn
  { pipeTables }
  { boolean }
  { false }
defaultOptions.pipeTables = false
```

`preserveTabs`=`true`, `false` default: `true`

`true` Preserve tabs in code block and fenced code blocks.

`false` Convert any tabs in the input to spaces.

```
\@@_add_lua_option:nnn
  { preserveTabs }
  { boolean }
  { true }
defaultOptions.preserveTabs = true
```

`rawAttribute`=true, false default: `false`

`true` Enable the Pandoc raw attribute syntax extension[26]:

```
`$H_2 O$`{=tex} is a liquid.
```

To enable raw blocks, the `fencedCode` option must also be enabled:

```
Here is a mathematical formula:
``` {=tex}
\[distance[i] =
    \begin{dcases}
        a & b \\
        c & d
    \end{dcases}
\]
```
```

The `rawAttribute` option is a good alternative to the `hybrid` option. Unlike the `hybrid` option, which affects the entire document, the `rawAttribute` option allows you to isolate the parts of your documents that use TEX.

`false` Disable the Pandoc raw attribute syntax extension.

```
\@@_add_lua_option:nnn
  { rawAttribute }
  { boolean }
  { false }
defaultOptions.rawAttribute = false
```

`relativeReferences`=true, false default: `false`

`true` Enable relative references[27] in autolinks:

```
I conclude in Section <#conclusion>.

Conclusion {#conclusion}
==========
In this paper, we have discovered that most
grandmas would rather eat dinner with their
grandchildren than get eaten. Begone, wolf!
```

`false` Disable relative references in autolinks.

[26] See https://pandoc.org/MANUAL.html#extension-raw_attribute.
[27] See https://datatracker.ietf.org/doc/html/rfc3986#section-4.2.

```
\@@_add_lua_option:nnn
  { relativeReferences }
  { boolean }
  { false }
defaultOptions.relativeReferences = false
```

`shiftHeadings`=⟨*shift amount*⟩ default: `0`

All headings will be shifted by ⟨*shift amount*⟩, which can be both positive and negative. Headings will not be shifted beyond level 6 or below level 1.

```
\@@_add_lua_option:nnn
  { shiftHeadings }
  { number }
  { 0 }
defaultOptions.shiftHeadings = 0
```

`slice`=⟨*the beginning and the end of a slice*⟩ default: `^ $`

Two space-separated selectors that specify the slice of a document that will be processed, whereas the remainder of the document will be ignored. The following selectors are recognized:

- The circumflex (`^`) selects the beginning of a document.
- The dollar sign (`$`) selects the end of a document.
- `^`⟨*identifier*⟩ selects the beginning of a section (see the `headerAttributes` option) or a fenced div (see the `fencedDivs` option) with the HTML attribute `#`⟨*identifier*⟩.
- `$`⟨*identifier*⟩ selects the end of a section with the HTML attribute `#`⟨*identifier*⟩.
- ⟨*identifier*⟩ corresponds to `^`⟨*identifier*⟩ for the first selector and to `$`⟨*identifier*⟩ for the second selector.

Specifying only a single selector, ⟨*identifier*⟩, is equivalent to specifying the two selectors ⟨*identifier*⟩ ⟨*identifier*⟩, which is equivalent to `^`⟨*identifier*⟩ `$`⟨*identifier*⟩, i.e. the entire section with the HTML attribute `#`⟨*identifier*⟩ will be selected.

```
\@@_add_lua_option:nnn
  { slice }
  { slice }
  { ^~$ }
defaultOptions.slice = "^ $"
```

`smartEllipses`=`true`, `false` default: `false`

`true` Convert any ellipses in the input to the `\markdownRendererEllipsis` TEX macro.

`false` Preserve all ellipses in the input.

```
\@@_add_lua_option:nnn
  { smartEllipses }
  { boolean }
  { false }
defaultOptions.smartEllipses = false
```

`startNumber`=`true`, `false` default: `true`

`true` Make the number in the first item of an ordered lists significant. The item numbers will be passed to the `\markdownRendererOlItemWithNumber` TEX macro.

`false` Ignore the numbers in the ordered list items. Each item will only produce a `\markdownRendererOlItem` TEX macro.

```
\@@_add_lua_option:nnn
  { startNumber }
  { boolean }
  { true }
defaultOptions.startNumber = true
```

`strikeThrough`=`true`, `false` default: `false`

`true` Enable the Pandoc strike-through syntax extension[28]:

```
This ~~is deleted text.~~
```

`false` Disable the Pandoc strike-through syntax extension.

```
\@@_add_lua_option:nnn
  { strikeThrough }
  { boolean }
  { false }
defaultOptions.strikeThrough = false
```

[28] See https://pandoc.org/MANUAL.html#extension-strikeout.

`stripIndent`=true, false default: `false`

`true` Strip the minimal indentation of non-blank lines from all lines in a markdown document. Requires that the `preserveTabs` Lua option is disabled:

```
\documentclass{article}
\usepackage[stripIndent]{markdown}
\begin{document}
    \begin{markdown}
        Hello *world*!
    \end{markdown}
\end{document}
```

`false` Do not strip any indentation from the lines in a markdown document.

```
\@@_add_lua_option:nnn
  { stripIndent }
  { boolean }
  { false }
defaultOptions.stripIndent = false
```

`subscripts`=true, false default: `false`

`true` Enable the Pandoc subscript syntax extension[29]:

```
H~2~O is a liquid.
```

`false` Disable the Pandoc subscript syntax extension.

```
\@@_add_lua_option:nnn
  { subscripts }
  { boolean }
  { false }
defaultOptions.subscripts = false
```

`superscripts`=true, false default: `false`

`true` Enable the Pandoc superscript syntax extension[30]:

```
2^10^ is 1024.
```

`false` Disable the Pandoc superscript syntax extension.

[29] See https://pandoc.org/MANUAL.html#extension-superscript-subscript.
[30] See https://pandoc.org/MANUAL.html#extension-superscript-subscript.

```
\@@_add_lua_option:nnn
  { superscripts }
  { boolean }
  { false }
defaultOptions.superscripts = false
```

`tableAttributes`=true, false default: `false`

`true` Enable the assignment of HTML attributes to table captions (see the `tableCaptions` option):

```
| Right | Left | Default | Center |
|------:|:-----|---------|:------:|
|   12  |  12  |    12   |    12  |
|  123  |  123 |   123   |   123  |
|    1  |    1 |     1   |     1  |

  : Demonstration of pipe table syntax. {#example-table}
```

`false` Disable the assignment of HTML attributes to table captions.

```
\@@_add_lua_option:nnn
  { tableAttributes }
  { boolean }
  { false }
defaultOptions.tableAttributes = false
```

`tableCaptions`=true, false default: `false`

`true` Enable the Pandoc table caption syntax extension[31] for pipe tables (see the `pipeTables` option):

```
| Right | Left | Default | Center |
|------:|:-----|---------|:------:|
|   12  |  12  |    12   |    12  |
|  123  |  123 |   123   |   123  |
|    1  |    1 |     1   |     1  |

  : Demonstration of pipe table syntax.
```

`false` Disable the Pandoc table caption syntax extension.

```
\@@_add_lua_option:nnn
  { tableCaptions }
  { boolean }
  { false }
```

[31] See https://pandoc.org/MANUAL.html#extension-table_captions.

```
824 defaultOptions.tableCaptions = false
```

`taskLists`=true, false default: `false`

`true` Enable the Pandoc task list syntax extension[32]:

```
- [ ] an unticked task list item
- [X] a ticked task list item
```

Our implementation also supports half-ticked task list items:

```
- [/] a half-checked task list item
- [.] another half-checked task list item
```

`false` Disable the Pandoc task list syntax extension.

```
825 \@@_add_lua_option:nnn
826   { taskLists }
827   { boolean }
828   { false }
829 defaultOptions.taskLists = false
```

`texComments`=true, false default: `false`

`true` Strip TEX-style comments.

```
\documentclass{article}
\usepackage[texComments]{markdown}
\begin{document}
\begin{markdown}
Hello *world*!
\end{markdown}
\end{document}
```

Always enabled when `hybrid` is enabled.

`false` Do not strip TEX-style comments.

```
830 \@@_add_lua_option:nnn
831   { texComments }
832   { boolean }
833   { false }
834 defaultOptions.texComments = false
```

[32] See https://pandoc.org/MANUAL.html#extension-task_lists.

texMathDollars=true, false default: false

true Enable the Pandoc dollar math syntax extension[33]:

```
inline math: $E=mc^2$

display math: $$E=mc^2$$
```

false Disable the Pandoc dollar math syntax extension.

```
\@@_add_lua_option:nnn
  { texMathDollars }
  { boolean }
  { false }
defaultOptions.texMathDollars = false
```

texMathDoubleBackslash=true, false
default: false

true Enable the Pandoc double backslash math syntax extension[34]:

```
inline math: \\(E=mc^2\\)

display math: \\[E=mc^2\\]
```

false Disable the Pandoc double backslash math syntax extension.

```
\@@_add_lua_option:nnn
  { texMathDoubleBackslash }
  { boolean }
  { false }
defaultOptions.texMathDoubleBackslash = false
```

texMathSingleBackslash=true, false
default: false

true Enable the Pandoc single backslash math syntax extension[35]:

```
inline math: \(E=mc^2\)

display math: \[E=mc^2\]
```

false Disable the Pandoc single backslash math syntax extension.

[33] See https://pandoc.org/MANUAL.html#extension-tex_math_dollars.
[34] See https://pandoc.org/MANUAL.html#extension-tex_math_double_backslash.
[35] See https://pandoc.org/MANUAL.html#extension-tex_math_single_backslash.

```
\@@_add_lua_option:nnn
  { texMathSingleBackslash }
  { boolean }
  { false }
defaultOptions.texMathSingleBackslash = false
```

`tightLists`=`true`, `false` default: `true`

`true` Unordered and ordered lists whose items do not consist of multiple paragraphs will be considered *tight*. Tight lists will produce tight renderers that may produce different output than lists that are not tight:

```
- This is
- a tight
- unordered list.

- This is

  not a tight

- unordered list.
```

`false` Unordered and ordered lists whose items consist of multiple paragraphs will be treated the same way as lists that consist of multiple paragraphs.

```
\@@_add_lua_option:nnn
  { tightLists }
  { boolean }
  { true }
defaultOptions.tightLists = true
```

`underscores`=`true`, `false` default: `true`

`true` Both underscores and asterisks can be used to denote emphasis and strong emphasis:

```
*single asterisks*
_single underscores_
**double asterisks**
__double underscores__
```

`false` Only asterisks can be used to denote emphasis and strong emphasis. This makes it easy to write math with the `hybrid` option without the need to constantly escape subscripts.

```
\@@_add_lua_option:nnn
  { underscores }
  { boolean }
  { true }
\ExplSyntaxOff
defaultOptions.underscores = true
```

2.1.7 Command-Line Interface

The high-level operation of the Markdown package involves the communication between several programming layers: the plain TEX layer hands markdown documents to the Lua layer. Lua converts the documents to TEX, and hands the converted documents back to plain TEX layer for typesetting, see Figure 2.

This procedure has the advantage of being fully automated. However, it also has several important disadvantages: The converted TEX documents are cached on the file system, taking up increasing amount of space. Unless the TEX engine includes a Lua interpreter, the package also requires shell access, which opens the door for a malicious actor to access the system. Last, but not least, the complexity of the procedure impedes debugging.

A solution to the above problems is to decouple the conversion from the typesetting. For this reason, a command-line Lua interface for converting a markdown document to TEX is also provided, see Figure 3.

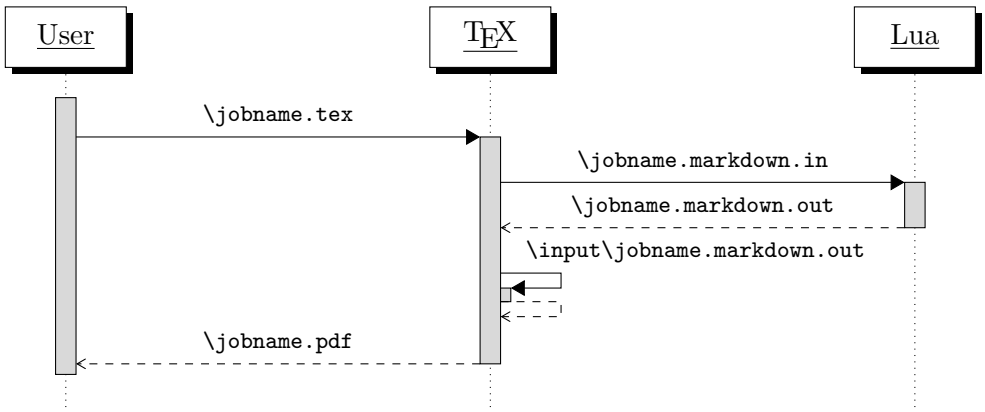


Figure 2: A sequence diagram of the Markdown package typesetting a markdown document using the TEX interface

```
.TH MARKDOWN2TEX 1 "(((LASTMODIFIED)))"
.SH NAME
markdown2tex \- convert .md files to .tex
.SH SYNOPSIS
local HELP_STRING = "Usage: " .. [[
markdown2tex [OPTIONS] -- [INPUT_FILE] [OUTPUT_FILE]

```

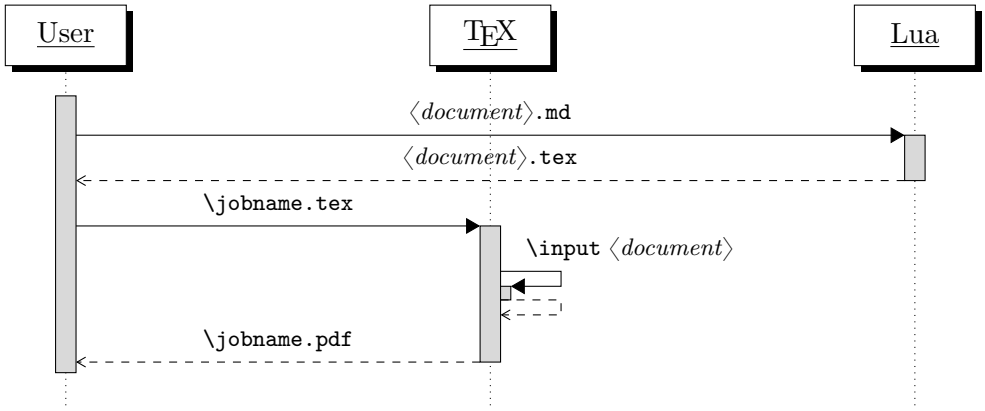


Figure 3: A sequence diagram of the Markdown package typesetting a markdown document using the Lua command-line interface

```
.SH DESCRIPTION

OPTIONS are documented in Section 2.2.1 of the Markdown Package User
Manual (https://ctan.org/pkg/markdown).

When OUTPUT_FILE is unspecified, the result of the conversion will be
written to the standard output. When INPUT_FILE is also unspecified, the
result of the conversion will be read from the standard input.

Report bugs to: witiko@mail.muni.cz
Markdown package home page: <https://github.com/witiko/markdown>]]

local VERSION_STRING = [[
markdown2tex (Markdown) ]] .. metadata.version .. [[

Copyright (C) ]] .. table.concat(metadata.copyright,
                                 "\nCopyright (C) ") .. [[

License: ]] .. metadata.license

local function warn(s)
  io.stderr:write("Warning: " .. s .. "\n")
end

local function error(s)
  io.stderr:write("Error: " .. s .. "\n")
  os.exit(1)
end
```

To make it easier to copy-and-paste options from Pandoc [7] such as `fancy_lists`, `header_attributes`, and `pipe_tables`, we accept snake_case in addition to camelCase

variants of options. As a bonus, studies [8] also show that snake_case is faster to read than camelCase.

```
local function camel_case(option_name)
  local cased_option_name = option_name:gsub("_(%l)", function(match)
    return match:sub(2, 2):upper()
  end)
  return cased_option_name
end

local function snake_case(option_name)
  local cased_option_name = option_name:gsub("%l%u", function(match)
    return match:sub(1, 1) .. "_" .. match:sub(2, 2):lower()
  end)
  return cased_option_name
end

local cases = {camel_case, snake_case}
local various_case_options = {}
for option_name, _ in pairs(defaultOptions) do
  for _, case in ipairs(cases) do
    various_case_options[case(option_name)] = option_name
  end
end

local process_options = true
local options = {}
local input_filename
local output_filename
for i = 1, #arg do
  if process_options then
```

After the optional `--` argument has been specified, the remaining arguments are assumed to be input and output filenames. This argument is optional, but encouraged, because it helps resolve ambiguities when deciding whether an option or a filename has been specified.

```
    if arg[i] == "--" then
      process_options = false
      goto continue
```

Unless the `--` argument has been specified before, an argument containing the equals sign (`=`) is assumed to be an option specification in a ⟨*key*⟩`=`⟨*value*⟩ format. The available options are listed in Section 2.1.3.

```
    elseif arg[i]:match("=") then
      local key, value = arg[i]:match("(.-)=(.*)")
      if defaultOptions[key] == nil and
         various_case_options[key] ~= nil then
        key = various_case_options[key]
      end
```

The `defaultOptions` table is consulted to identify whether ⟨*value*⟩ should be parsed as a string, number, table, or boolean.

```
      local default_type = type(defaultOptions[key])
      if default_type == "boolean" then
        options[key] = (value == "true")
      elseif default_type == "number" then
        options[key] = tonumber(value)
      elseif default_type == "table" then
        options[key] = {}
        for item in value:gmatch("[^ ,]+") do
          table.insert(options[key], item)
        end
      else
        if default_type ~= "string" then
          if default_type == "nil" then
            warn('Option "' .. key .. '" not recognized.')
          else
            warn('Option "' .. key .. '" type not recognized, ' ..
                 'please file a report to the package maintainer.')
          end
          warn('Parsing the ' .. 'value "' .. value ..'" of option "' ..
               key .. '" as a string.')
        end
        options[key] = value
      end
      goto continue
```

Unless the `--` argument has been specified before, an argument `--help`, or `-h` causes a brief documentation for how to invoke the program to be printed to the standard output.

```
    elseif arg[i] == "--help" or arg[i] == "-h" then
      print(HELP_STRING)
      os.exit()
```

Unless the `--` argument has been specified before, an argument `--version`, or `-v` causes the program to print information about its name, version, origin and legal status, all on standard output.

```
    elseif arg[i] == "--version" or arg[i] == "-v" then
      print(VERSION_STRING)
      os.exit()
    end
  end
```

The first argument that matches none of the above patterns is assumed to be the input filename. The input filename should correspond to the Markdown document that is going to be converted to a TEX document.

```
  if input_filename == nil then
    input_filename = arg[i]
```

The first argument that matches none of the above patterns is assumed to be the output filename. The output filename should correspond to the TEX document that will result from the conversion.

```
966   elseif output_filename == nil then
967     output_filename = arg[i]
968   else
969     error('Unexpected argument: "' .. arg[i] .. '".')
970   end
971   ::continue::
972 end
```

The command-line Lua interface is implemented by the files `markdown-cli.lua` and `markdown2tex.lua`, which can be invoked from the command line as follows:

```
markdown2tex cacheDir=. -- hello.md hello.tex
```

to convert the Markdown document `hello.md` to a TEX document `hello.tex`. After the Markdown package for our TEX format has been loaded, the converted document can be typeset as follows:

```
\input hello
```

2.2 Plain TEX Interface

The plain TEX interface provides macros for the typesetting of markdown input from within plain TEX, for setting the Lua interface options (see Section 2.1.3) used during the conversion from markdown to plain TEX and for changing the way markdown the tokens are rendered.

```
973 \def\markdownLastModified{(((LASTMODIFIED)))}%
974 \def\markdownVersion{(((VERSION)))}%
```

The plain TEX interface is implemented by the `markdown.tex` file that can be loaded as follows:

```
\input markdown
```

It is expected that the special plain TEX characters have the expected category codes, when `\input`ting the file.

2.2.1 Typesetting Markdown and YAML

The interface exposes the `\markdownBegin`, `\markdownEnd`, `\yamlBegin`, `\yamlEnd`, `\markinline`, `\markdownInput`, `\yamlInput`, and `\markdownEscape` macros.

2.2.1.1 Typesetting Markdown and yaml directly

The \markdownBegin macro marks the beginning of a markdown document fragment and the \markdownEnd macro marks its end.

```
\let\markdownBegin\relax
\let\markdownEnd\relax
```

You may prepend your own code to the \markdownBegin macro and redefine the \markdownEnd macro to produce special effects before and after the markdown block.

There are several limitations to the macros you need to be aware of:

The first limitation concerns the \markdownEnd macro, which must be visible directly from the input line buffer (it may not be produced as a result of input expansion). Otherwise, it will not be recognized as the end of the markdown string. As a corrolary, the \markdownEnd string may not appear anywhere inside the markdown input.

Another limitation concerns spaces at the right end of an input line. In markdown, these are used to produce a forced line break. However, any such spaces are removed before the lines enter the input buffer of TEX [9, p. 46]. As a corrolary, the \markdownBegin macro also ignores them.

The \markdownBegin and \markdownEnd macros will also consume the rest of the lines at which they appear. In the following example plain TEX code, the characters c, e, and f will not appear in the output.

```
\input markdown
a
b \markdownBegin c
d
e \markdownEnd   f
g
\bye
```

Note that you may also not nest the \markdownBegin and \markdownEnd macros.

The following example plain TEX code showcases the usage of the \markdownBegin and \markdownEnd macros:

```
\input markdown
\markdownBegin
_Hello_ **world** ...
\markdownEnd
\bye
```

The \yamlBegin macro marks the beginning of an YAML document fragment and the \yamlEnd macro marks its end.

```
\let\yamlBegin\relax
\def\yamlEnd{\markdownEnd\endgroup}
```

The \yamlBegin and \yamlEnd macros are subject to the same limitations as the \markdownBegin and \markdownEnd macros.

The following example plain TEX code showcases the usage of the \markdownBegin and \markdownEnd macros:

```
\input markdown
\yamlBegin
title: _Hello_ **world** ...
author: John Doe
\yamlEnd
\bye
```

The above code has the same effect as the below code:

```
\input markdown
\yamlSetup{jekyllData, expectJekyllData, ensureJekyllData}
\markdownBegin
title: _Hello_ **world** ...
author: John Doe
\markdownEnd
\bye
```

You can use the \markinline macro to input inline markdown content.

```
\let\markinline\relax
```

The following example plain TEX code showcases the usage of the \markinline macro:

```
\input markdown
\markinline{_Hello_ **world**}
\bye
```

The above code has the same effect as the below code:

```
\input markdown
\markdownSetup{contentLevel=inline}
\markdownBegin
_Hello_ **world**
\markdownEnd
\bye
```

Besides \markinline{⟨*markdown text*⟩}, any other delimiter such as |⟨*markdown text*⟩| can also be used. This allows potentially unbalanced braces to appear in ⟨*markdown text*⟩.

The \markinline macro is subject to the same limitations as the \markdownBegin and \markdownEnd macros.

2.2.1.2 Typesetting Markdown and yaml from external documents

You can use the \markdownInput macro to include markdown documents, similarly to how you might use the \input TEX primitive to include TEX documents. The \markdownInput macro accepts a single parameter with the filename of a markdown document and expands to the result of the conversion of the input markdown document to plain TEX.

```
\let\markdownInput\relax
```

The macro \markdownInput is not subject to the limitations of the \markdownBegin and \markdownEnd macros.

The following example plain TEX code showcases the usage of the \markdownInput macro:

```
\input markdown
\markdownInput{hello.md}
\bye
```

You can use the \yamlInput macro to include YAML documents. similarly to how you might use the \input TEX primitive to include TEX documents. The \yamlInput macro accepts a single parameter with the filename of a YAML document and expands to the result of the conversion of the input YAML document to plain TEX.

```
\def\yamlInput#1{%
  \begingroup
  \yamlSetup{jekyllData, expectJekyllData, ensureJekyllData}%
  \markdownInput{#1}%
  \endgroup
}%
```

The macro \yamlInput is also not subject to the limitations of the \markdownBegin and \markdownEnd macros.

The following example plain TEX code showcases the usage of the \markdownInput macro:

```
\input markdown
\yamlInput{hello.yml}
\bye
```

The above code has the same effect as the below code:

```
\input markdown
\yamlSetup{jekyllData, expectJekyllData, ensureJekyllData}
\markdownInput{hello.yml}
\bye
```

2.2.1.3 Typesetting TeX from inside Markdown and yaml documents

The `\markdownEscape` macro accepts a single parameter with the filename of a TEX document and executes the TEX document in the middle of a markdown document fragment. Unlike the `\input` built-in of TEX, `\markdownEscape` guarantees that the standard catcode regime of your TEX format will be used.

```
\let\markdownEscape\relax
```

2.2.2 Options

The plain TEX options are represented by TEX commands. Some of them map directly to the options recognized by the Lua interface (see Section 2.1.3), while some of them are specific to the plain TEX interface.

To determine whether plain TEX is the top layer or if there are other layers above plain TEX, we take a look on whether the `\c_@@_top_layer_tl` token list has already been defined. If not, we will assume that plain TEX is the top layer.

```
\ExplSyntaxOn
\tl_const:Nn \c_@@_option_layer_plain_tex_tl { plain_tex }
\cs_generate_variant:Nn
  \tl_const:Nn
  { NV }
\tl_if_exist:NF
  \c_@@_top_layer_tl
  {
    \tl_const:NV
      \c_@@_top_layer_tl
      \c_@@_option_layer_plain_tex_tl
  }
```

To enable the enumeration of plain TEX options, we will maintain the `\g_@@_plain_tex_options_seq` sequence.

```
\seq_new:N \g_@@_plain_tex_options_seq
```

To enable the reflection of default/experimental plain TEX options and their types, we will maintain the `\g_@@_default_plain_tex_options_prop`, `\g_@@_experimental_plain_tex_options` and `\g_@@_plain_tex_option_types_prop` property lists and sequences, respectively.

```
\prop_new:N \g_@@_plain_tex_option_types_prop
\prop_new:N \g_@@_default_plain_tex_options_prop
\seq_new:N \g_@@_experimental_plain_tex_options_seq
\seq_gput_right:NV
  \g_@@_option_layers_seq
  \c_@@_option_layer_plain_tex_tl
\cs_new_protected:Nn
  \@@_add_plain_tex_option:nnn
  {
    \@@_add_option:Vnnn
      \c_@@_option_layer_plain_tex_tl
      { #1 }
      { #2 }
```

```
      { #3 }
  }
```

The plain TEX options may be also be specified via the `\markdownSetup` macro. Here, the plain TEX options are represented by a comma-delimited list of ⟨*key*⟩=⟨*value*⟩ pairs. For boolean options, the =⟨*value*⟩ part is optional, and ⟨*key*⟩ will be interpreted as ⟨*key*⟩=`true` if the =⟨*value*⟩ part has been omitted. The `\markdownSetup` macro receives the options to set up as its only argument.

```
\cs_new_protected:Nn
  \@@_setup:n
  {
    \keys_set:nn
      { markdown/options }
      { #1 }
  }
\cs_gset_eq:NN
  \markdownSetup
  \@@_setup:n
```

The command `\yamlSetup` is also available as an alias for the command `\markdownSetup`.

```
\cs_gset_eq:NN
  \yamlSetup
  \markdownSetup
```

The `\markdownIfOption{`⟨*name*⟩`}{`⟨*iftrue*⟩`}{`⟨*iffalse*⟩`}` macro is provided for testing, whether the value of `\markdownOption`⟨*name*⟩ is `true`. If the value is `true`, then ⟨*iftrue*⟩ is expanded, otherwise ⟨*iffalse*⟩ is expanded.

```
\prg_new_protected_conditional:Nnn
  \@@_if_option:n
  { TF, T, F }
  {
    \@@_get_option_type:nN
      { #1 }
      \l_tmpa_tl
    \str_if_eq:NNF
      \l_tmpa_tl
      \c_@@_option_type_boolean_tl
      {
        \msg_error:nnxx
          { markdown }
          { expected-boolean-option }
          { #1 }
          { \l_tmpa_tl }
      }
    \@@_get_option_value:nN
      { #1 }
      \l_tmpa_tl
    \str_if_eq:NNTF
      \l_tmpa_tl
      \c_@@_option_value_true_tl
```

```
      { \prg_return_true: }
      { \prg_return_false: }
  }
\msg_new:nnn
  { markdown }
  { expected-boolean-option }
  {
    Option~#1~has~type~#2,~
    but~a~boolean~was~expected.
  }
\let
  \markdownIfOption
  \@@_if_option:nTF
```

2.2.2.1 Finalizing and Freezing the Cache

The `\markdownOptionFinalizeCache` option corresponds to the Lua interface `finalizeCache` option, which creates an output file `frozenCacheFileName` (frozen cache) that contains a mapping between an enumeration of the markdown documents in the plain TEX document and their auxiliary files cached in the `cacheDir` directory.

The `\markdownOptionFrozenCache` option uses the mapping previously created by the `finalizeCache` option, and uses it to typeset the plain TEX document without invoking Lua. As a result, the plain TEX document becomes more portable, but further changes in the order and the content of markdown documents will not be reflected. It defaults to `false`.

```
\@@_add_plain_tex_option:nnn
  { frozenCache }
  { boolean }
  { false }
```

The standard usage of the above two options is as follows:

1. Remove the `cacheDir` cache directory with stale auxiliary cache files.
2. Enable the `finalizeCache` option.
4. Typeset the plain TEX document to populate and finalize the cache.
5. Enable the `frozenCache` option.
6. Publish the source code of the plain TEX document and the `cacheDir` directory.

2.2.2.2 File and Directory Names

The `\markdownOptionInputTempFileName` macro sets the filename of the temporary input file that is created during the buffering of markdown text from a TEX source. It defaults to `\jobname.markdown.in`.

The expansion of this macro must not contain quotation marks (`"`) or backslash symbols (`\`).

```
\tl_set:Nn
  \l_tmpa_tl
  {
    \str_use:N
```

```
      \g_@@_unquoted_jobname_str
    .markdown.in
  }
\bool_if:NT
  \g_@@_jobname_quoted_bool
  {
    \tl_put_left:Nn
      \l_tmpa_tl
      { " }
    \tl_put_right:Nn
      \l_tmpa_tl
      { " }
  }
\cs_generate_variant:Nn
  \@@_add_plain_tex_option:nnn
  { nnV }
\@@_add_plain_tex_option:nnV
  { inputTempFileName }
  { path }
  \l_tmpa_tl
```

The `\markdownOptionOutputDir` macro sets the path to the directory that will contain the auxiliary cache files produced by the Lua implementation and also the auxiliary files produced by the plain TEX implementation. The option defaults to `.` or, since TEX Live 2024, to the value of the `-output-directory` option of your TEX engine.

In MikTEX, this automatic detection is currently only supported with LuaTEX[36]. If you need to use MikTEX and cannot use LuaTEX, you can either a) fix the automatic detection by setting the environmental variable `TEXMF_OUTPUT_DIRECTORY` manually or by setting the `\markdownOptionOutputDir` option manually.

The path must be set to the same value as the `-output-directory` option of your TEX engine for the package to function correctly. We need this macro to make the Lua implementation aware where it should store the helper files. The same limitations apply here as in the case of the `inputTempFileName` macro.

```
\@@_add_plain_tex_option:nnn
  { outputDir }
  { path }
  { . }
```

2.2.2.3 No default token renderer prototypes

The Markdown package provides default definitions for token renderer prototypes using the `witiko/markdown/defaults` theme (see Section 2.2.3). Although these default definitions provide a useful starting point for authors, they use extra resources, especially with higher-level TEX formats such as LATEX and ConTEXt. Furthermore, the default definitions may change at any time, which may pose a problem for maintainers of Markdown themes and templates who may require a stable output.

[36] See https://github.com/MiKTeX/miktex/issues/1630.

The `\markdownOptionPlain` macro specifies whether higher-level TEX formats should only use the plain TEX default definitions or whether they should also use the format-specific default definitions. Whereas plain TEX default definitions only provide definitions for simple elements such as emphasis, strong emphasis, and paragraph separators, format-specific default definitions add support for more complex elements such as lists, tables, and citations. On the flip side, plain TEX default definitions load no extra resources and are rather stable, whereas format-specific default definitions load extra resources and are subject to a more rapid change.

Here is how you would enable the macro in a LATEX document:

```
\usepackage[plain]{markdown}
```

Here is how you would enable the macro in a ConTEXt document:

```
\def\markdownOptionPlain{true}
\usemodule[t][markdown]
```

The macro must be set before or during the loading of the package. Setting the macro after loading the package has no effect.

```
\@@_add_plain_tex_option:nnn
  { plain }
  { boolean }
  { false }
```

The `\markdownOptionNoDefaults` macro specifies whether we should prevent the loading of default definitions or not. This is useful in contexts, where we want to have total control over how all elements are rendered.

Here is how you would enable the macro in a LATEX document:

```
\usepackage[noDefaults]{markdown}
```

Here is how you would enable the macro in a ConTEXt document:

```
\def\markdownOptionNoDefaults{true}
\usemodule[t][markdown]
```

The macro must be set before or during the loading of the package. Setting the macro after loading the package has no effect.

```
\@@_add_plain_tex_option:nnn
  { noDefaults }
  { boolean }
  { false }
```

2.2.2.4 Miscellaneous Options

The `\markdownOptionStripPercentSigns` macro controls whether a percent sign (`%`) at the beginning of a line will be discarded when buffering Markdown input (see sections 3.2.5 and 3.2.6) or not. Notably, this enables the use of markdown when writing TEX package documentation using the Doc LATEX package [10] or similar. The recognized values of the macro are `true` (discard) and `false` (retain). It defaults to `false`.

```
\seq_gput_right:Nn
  \g_@@_plain_tex_options_seq
  { stripPercentSigns }
\prop_gput:Nnn
  \g_@@_plain_tex_option_types_prop
  { stripPercentSigns }
  { boolean }
\prop_gput:Nnx
  \g_@@_default_plain_tex_options_prop
  { stripPercentSigns }
  { false }
```

2.2.2.5 Generating Plain TEX Option Macros and Key-Values

We define the command `\@@_define_option_commands_and_keyvals:` that defines plain TEX macros and the key–value interface of the `\markdownSetup` macro for the above plain TEX options.

The command also defines macros and key–values that map directly to the options recognized by the Lua interface, such as `\markdownOptionHybrid` for the `hybrid` Lua option (see Section 2.1.3), which are not processed by the plain TEX implementation, only passed along to Lua.

Furthermore, the command also defines options and key–values for subsequently loaded layers that correspond to higher-level TEX formats such as LATEX and ConTEXt.

For the macros that correspond to the non-boolean options recognized by the Lua interface, the same limitations apply here in the case of the `inputTempFileName` macro.

```
\cs_new_protected:Nn
  \@@_define_option_commands_and_keyvals:
  {
    \seq_map_inline:Nn
      \g_@@_option_layers_seq
      {
        \seq_map_inline:cn
          { g_@@_ ##1 _options_seq }
          {
              \@@_define_option_command:n
                { ####1 }
```

To make it easier to copy-and-paste options from Pandoc [7] such as `fancy_lists`, `header_attributes`, and `pipe_tables`, we accept snake_case in addition to camelCase variants of options. As a bonus, studies [8] also show that snake_case is faster to read than camelCase.

```
              \@@_with_various_cases:nn
                { ####1 }
                {
                  \@@_define_option_keyval:nnn
                    { ##1 }
                    { ####1 }
                    { ########1 }
                }
          }
      }
  }
\cs_new_protected:Nn
  \@@_define_option_command:n
  {
```

For experimental options, redirect the option command to the option command `\markdownOptionExperimental`.

```
    \bool_set_false:N
      \l_tmpa_bool
    \seq_map_inline:Nn
      \g_@@_option_layers_seq
      {
        \seq_if_in:cnT
          { g_@@_experimental_ ##1 _options_seq }
          { #1 }
          {
            \bool_set_true:N
              \l_tmpa_bool
            \seq_map_break:
          }
      }
    \bool_if:NTF
      \l_tmpa_bool
      {
        \_@@_option_tl_to_csname:nN
          { #1 }
          \l_tmpa_tl
        \cs_if_exist:cF
          { \l_tmpa_tl }
          {
            \cs_gset:cpn
              { \l_tmpa_tl }
              { \markdownOptionExperimental }
          }
      }
      {
```

Use the lt3luabridge library to determine the default value of the `\markdownOptionOutputDir` macro.

```
        \str_if_eq:nnTF
```

```
          { #1 }
          { outputDir }
          { \@@_define_option_command_output_dir: }
          {
```

Do not override options defined before loading the package.

```
            \@@_option_tl_to_csname:nN
              { #1 }
              \l_tmpa_tl
            \cs_if_exist:cF
              { \l_tmpa_tl }
              {
                \@@_get_default_option_value:nN
                  { #1 }
                  \l_tmpa_tl
                \@@_set_option_value:nV
                  { #1 }
                  \l_tmpa_tl
              }
          }
      }
  }
\ExplSyntaxOff
\input lt3luabridge.tex
```

Use the lt3luabridge library to determine the default value of the `\markdownOptionOutputDir` macro by using one of the following:

1. The `status.output_directory` variable [2, Section 10.2], which is available since LuaTEX 1.18.0 from TeX Live 2024 and in other TEX distributions like MikTEX since ca March 2024. We are only able to read this variable in LuaTEX and not other TEX engines.
2. The `TEXMF_OUTPUT_DIRECTORY` environmental variable, which is available since TEX Live 2024. We are only able to read this variable in TEX Live and not some other TEX distributions like MikTEX.

```
\ExplSyntaxOn
\cs_new:Nn
  \@@_define_option_command_output_dir:
  {
    \cs_if_free:NT
      \markdownOptionOutputDir
      {
        \bool_if:nTF
          {
            \cs_if_exist_p:N
              \luabridge_tl_set:Nn &&
            (
              \int_compare_p:nNn
```

```
                { \g_luabridge_method_int }
                =
                { \c_luabridge_method_directlua_int } ||
              \sys_if_shell_unrestricted_p:
            )
          }
          {
```

Set most catcodes to category 12 (other) to ensure that special characters in the output directory name such as backslashes (\) are not interpreted as control sequences.

```
            \group_begin:
            \cctab_select:N
              \c_str_cctab
            \luabridge_tl_set:Nn
              \l_tmpa_tl
              {
                print(
                  (status.output_directory)
                  or~os.getenv("TEXMF_OUTPUT_DIRECTORY")
                  or~"."
                )
              }
            \tl_gset:NV
              \markdownOptionOutputDir
              \l_tmpa_tl
            \group_end:
          }
          {
            \tl_gset:Nn
              \markdownOptionOutputDir
              { . }
          }
      }
  }
\cs_new_protected:Nn
  \@@_set_option_value:nn
  {
    \@@_define_option:n
      { #1 }
    \@@_get_option_type:nN
      { #1 }
      \l_tmpa_tl
    \str_if_eq:NNTF
      \c_@@_option_type_counter_tl
      \l_tmpa_tl
      {
        \@@_option_tl_to_csname:nN
          { #1 }
          \l_tmpa_tl
```

```
        \int_gset:cn
          { \l_tmpa_tl }
          { #2 }
      }
      {
        \@@_option_tl_to_csname:nN
          { #1 }
          \l_tmpa_tl
        \cs_set:cpn
          { \l_tmpa_tl }
          { #2 }
      }
  }
\cs_new_protected:Nn
  \@@_prepend_option_value:nn
  {
    \@@_get_option_value:nN
      { #1 }
      \l_tmpa_clist
    \clist_put_left:Nn
      \l_tmpa_clist
      { #2 }
    \@@_set_option_value:nV
      { #1 }
      \l_tmpa_clist
  }
\cs_new_protected:Nn
  \@@_append_option_value:nn
  {
    \@@_get_option_value:nN
      { #1 }
      \l_tmpa_clist
    \clist_put_right:Nn
      \l_tmpa_clist
      { #2 }
    \@@_set_option_value:nV
      { #1 }
      \l_tmpa_clist
  }
\cs_generate_variant:Nn
  \@@_set_option_value:nn
  { nV }
\cs_new_protected:Nn
  \@@_define_option:n
  {
    \@@_option_tl_to_csname:nN
      { #1 }
      \l_tmpa_tl
    \cs_if_free:cT
```

```
      { \l_tmpa_tl }
      {
        \@@_get_option_type:nN
          { #1 }
          \l_tmpb_tl
        \str_if_eq:NNT
          \c_@@_option_type_counter_tl
          \l_tmpb_tl
          {
            \@@_option_tl_to_csname:nN
              { #1 }
              \l_tmpa_tl
            \int_new:c
              { \l_tmpa_tl }
          }
      }
  }
\cs_new_protected:Nn
  \@@_define_option_keyval:nnn
  {
    \prop_get:cnN
      { g_@@_ #1 _option_types_prop }
      { #2 }
      \l_tmpa_tl
    \str_if_eq:VVTF
      \l_tmpa_tl
      \c_@@_option_type_boolean_tl
      {
        \keys_define:nn
          { markdown/options }
          {
```

For boolean options, we also accept `yes` as an alias for `true` and `no` as an alias for `false`.

```
            #3 .code:n = {
              \tl_set:Nx
                \l_tmpa_tl
                {
                  \str_case:nnF
                    { ##1 }
                    {
                      { yes } { true }
                      { no } { false }
                    }
                    { ##1 }
                }
              \@@_set_option_value:nV
                { #2 }
                \l_tmpa_tl
            },
            #3 .value_required:n = { false },
```

```
            #3 .default:n = { true },
          }
      }
      {
        \keys_define:nn
          { markdown/options }
          {
            #3 .value_required:n = { true },
            #3 .code:n = {
              \@@_set_option_value:nn
                { #2 }
                { ##1 }
            },
          }
      }
```

For comma-list options, we assume that ⟨*key*⟩ is a regular English noun in plural (such as `extensions`) and we also define the ⟨*singular key*⟩=⟨*value*⟩ interface, where ⟨*singular key*⟩ is ⟨*key*⟩ after stripping the trailing -s (such as `extension`). Rather than setting the option to ⟨*value*⟩, this interface appends ⟨*value*⟩ to the current value as the rightmost item in the list.

```
    \str_if_eq:VVT
      \l_tmpa_tl
      \c_@@_option_type_clist_tl
      {
        \tl_set:Nn
          \l_tmpa_tl
          { #3 }
        \tl_reverse:N
          \l_tmpa_tl
        \str_if_eq:enF
          {
            \tl_head:V
              \l_tmpa_tl
          }
          { s }
          {
            \msg_error:nnn
              { markdown }
              { malformed-name-for-clist-option }
              { #3 }
          }
        \tl_set:Nx
          \l_tmpa_tl
          {
            \tl_tail:V
              \l_tmpa_tl
          }
        \tl_reverse:N
```

```
    \l_tmpa_tl
  \tl_set_eq:NN
    \l_tmpb_tl
    \l_tmpa_tl
  \tl_put_right:Nn
    \l_tmpa_tl
    { .value_required:n = { true } }
  \tl_put_right:Nn
    \l_tmpb_tl
    {
      .code:n = {
        \@@_append_option_value:nn
          { #2 }
          { ##1 }
      }
    }
  \keys_define:nV
    { markdown/options }
    \l_tmpa_tl
  \keys_define:nV
    { markdown/options }
    \l_tmpb_tl
```

To achieve parity with token renderers and renderer prototypes (see sections 2.2.5.48 and 2.2.6.2, respectively) the syntax ⟨*key*⟩`+=`⟨*value*⟩ and ⟨*key*⟩`$=`⟨*value*⟩ with the same appending semantics as ⟨*singular key*⟩`=`⟨*value*⟩ is also supported.

```
  \keys_define:nn
    { markdown/options }
    {
      #3~+ .value_required:n = { true },
      #3~+ .code:n = {
        \@@_append_option_value:nn
          { #2 }
          { ##1 }
      },
      #3 + .value_required:n = { true },
      #3 + .code:n = {
        \@@_append_option_value:nn
          { #2 }
          { ##1 }
      },
      #3~$ .value_required:n = { true },
      #3~$ .code:n = {
        \@@_append_option_value:nn
          { #2 }
          { ##1 }
      },
      #3 $ .value_required:n = { true },
      #3 $ .code:n = {
        \@@_append_option_value:nn
```

```
                { #2 }
                { ##1 }
            },
```

Furthermore, similar to token renderers and renderer prototypes, the syntax ⟨*key*⟩`^=`⟨*value*⟩ is also supported. This syntax prepends ⟨*value*⟩ to the current value as the leftmost item in the list.

```
            #3~^ .value_required:n = { true },
            #3~^ .code:n = {
              \@@_prepend_option_value:nn
                { #2 }
                { ##1 }
            },
            #3 ^ .value_required:n = { true },
            #3 ^ .code:n = {
              \@@_prepend_option_value:nn
                { #2 }
                { ##1 }
            },
          }
      }
  }
\cs_generate_variant:Nn
  \clist_set:Nn
  { NV }
\cs_generate_variant:Nn
  \keys_define:nn
  { nV }
\prg_generate_conditional_variant:Nnn
  \str_if_eq:nn
  { en }
  { p, F }
\msg_new:nnn
  { markdown }
  { malformed-name-for-clist-option }
  {
    Clist~option~name~#1~does~not~end~with~-s.
  }
```

If plain TEX is the top layer, we use the `\@@_define_option_commands_and_keyvals:` macro to define plain TEX option macros and key–values immediately. Otherwise, we postpone the definition until the upper layers have been loaded.

```
\str_if_eq:VVT
  \c_@@_top_layer_tl
  \c_@@_option_layer_plain_tex_tl
  {
    \@@_define_option_commands_and_keyvals:
  }
\ExplSyntaxOff
```

2.2.3 Themes

User-defined themes for the Markdown package provide a domain-specific interpretation of Markdown tokens. Themes allow the authors to achieve a specific look and other high-level goals without low-level programming.

The key–values `theme`=⟨*theme name*⟩ and `import`=⟨*theme name*⟩, optionally followed by `@`⟨*theme version*⟩, load a TEX document (further referred to as *a theme*) named `markdowntheme`⟨*munged theme name*⟩`.tex`, where the *munged theme name* is the *theme name* after the substitution of all forward slashes (`/`) for an underscore (`_`). The theme name must be *qualified* and contain no underscores or at signs (`@`). Themes are inspired by the Beamer LATEX package, which provides similar functionality with its `\usetheme` macro [11, Section 15.1].

A theme name is qualified if and only if it contains at least one forward slash. Theme names must be qualified to minimize naming conflicts between different themes with a similar purpose. The preferred format of a theme name is ⟨*theme author*⟩`/`⟨*theme purpose*⟩`/`⟨*private naming scheme*⟩, where the *private naming scheme* may contain additional forward slashes. For example, a theme by a user `witiko` for the MU theme of the Beamer document class may have the name `witiko/beamer/MU`.

Theme names are munged to allow structure inside theme names without dictating where the themes should be located inside the TEX directory structure. For example, loading a theme named `witiko/beamer/MU` would load a TEX document package named `markdownthemewitiko_beamer_MU.tex`.

If `@`⟨*theme version*⟩ is specified after ⟨*theme name*⟩, then the text *theme version* will be available in the macro `\markdownThemeVersion` when the theme is loaded. If `@`⟨*theme version*⟩ is not specified, the macro `\markdownThemeVersion` will contain the text `latest` [12].

```
\ExplSyntaxOn
\keys_define:nn
  { markdown/options }
  {
    theme .value_required:n = { true },
    theme .code:n = {
      \@@_set_theme:n
        { #1 }
    },
    import .value_required:n = { true },
    import .code:n = {
      \tl_set:Nn
        \l_tmpa_tl
        { #1 }
```

To ensure that keys containing forward slashes get passed correctly, we replace all forward slashes in the input with backslash tokens with category code letter and then undo the replacement. This means that if any unbraced backslash tokens with category code letter exist in the input, they will be replaced with forward slashes. However, this should be extremely rare.

```
      \tl_replace_all:NnV
        \l_tmpa_tl
        { / }
        \c_backslash_str
      \keys_set:nV
        { markdown/options/import }
        \l_tmpa_tl
    },
  }
```

To keep track of the current theme when themes are nested, we will maintain the stacks `\g_@@_theme_names_seq` and `\g_@@_theme_versions_seq` stack of theme names and versions, respectively. For convenience, the name of the current theme and version is also available in the macros `\g_@@_current_theme_tl` and `\markdownThemeVersion`, respectively.

```
\seq_new:N
  \g_@@_theme_names_seq
\seq_new:N
  \g_@@_theme_versions_seq
\tl_new:N
  \g_@@_current_theme_tl
\tl_gset:Nn
  \g_@@_current_theme_tl
  { }
\seq_gput_right:NV
  \g_@@_theme_names_seq
  \g_@@_current_theme_tl
\cs_new:Npn
  \markdownThemeVersion
  { }
\seq_gput_right:NV
  \g_@@_theme_versions_seq
  \g_@@_current_theme_tl
\cs_new_protected:Nn
  \@@_set_theme:n
  {
```

First, we validate the theme name.

```
    \str_if_in:nnF
      { #1 }
      { / }
      {
        \msg_error:nnn
          { markdown }
          { unqualified-theme-name }
          { #1 }
      }
    \str_if_in:nnT
      { #1 }
      { _ }
```

```
      {
        \msg_error:nnn
          { markdown }
          { underscores-in-theme-name }
          { #1 }
      }
```

Next, we extract the theme version.

```
    \str_if_in:nnTF
      { #1 }
      { @ }
      {
        \regex_extract_once:nnN
          { (.*) @ (.*) }
          { #1 }
          \l_tmpa_seq
        \seq_gpop_left:NN
          \l_tmpa_seq
          \l_tmpa_tl
        \seq_gpop_left:NN
          \l_tmpa_seq
          \l_tmpa_tl
        \tl_gset:NV
          \g_@@_current_theme_tl
          \l_tmpa_tl
        \seq_gpop_left:NN
          \l_tmpa_seq
          \l_tmpa_tl
        \cs_gset:Npe
          \markdownThemeVersion
          {
            \tl_use:N
              \l_tmpa_tl
          }
      }
      {
        \tl_gset:Nn
          \g_@@_current_theme_tl
          { #1 }
        \cs_gset:Npn
          \markdownThemeVersion
          { latest }
      }
```

Next, we strip a leading slash, if present, for consistency with snippets, where a leading slash distinguishes absolute snippet names from relative ones. Theme names, however, are currently always absolute, so stripping the slash is only a syntactic normalization and has no semantic effect.

```
    \str_if_eq:enT
      {
```

```
      \tl_head:V
        \g_@@_current_theme_tl
    }
    { / }
    {
      \tl_gset:Ne
        \g_@@_current_theme_tl
        {
          \tl_tail:V
            \g_@@_current_theme_tl
        }
    }
```

Next, we munge the theme name.

```
  \str_set:NV
    \l_tmpa_str
    \g_@@_current_theme_tl
  \str_replace_all:Nnn
    \l_tmpa_str
    { / }
    { _ }
```

Finally, we load the theme. Before loading the theme, we push down the current name and version of the theme on the stack.

```
  \tl_set:NV
    \l_tmpa_tl
    \g_@@_current_theme_tl
  \tl_put_right:Nn
    \g_@@_current_theme_tl
    { / }
  \seq_gput_right:NV
    \g_@@_theme_names_seq
    \g_@@_current_theme_tl
  \seq_gput_right:NV
    \g_@@_theme_versions_seq
    \markdownThemeVersion
  \@@_load_theme:VeV
    \l_tmpa_tl
    { \markdownThemeVersion }
    \l_tmpa_str
```

After the theme has been loaded, we recover the name and version of the previous theme from the stack.

```
  \seq_gpop_right:NN
    \g_@@_theme_names_seq
    \l_tmpa_tl
  \seq_get_right:NN
    \g_@@_theme_names_seq
    \l_tmpa_tl
  \tl_gset:NV
```

```
      \g_@@_current_theme_tl
      \l_tmpa_tl
    \seq_gpop_right:NN
      \g_@@_theme_versions_seq
      \l_tmpa_tl
    \seq_get_right:NN
      \g_@@_theme_versions_seq
      \l_tmpa_tl
    \cs_gset:Npe
      \markdownThemeVersion
      {
        \tl_use:N
          \l_tmpa_tl
      }
  }
\msg_new:nnnn
  { markdown }
  { unqualified-theme-name }
  { Won't~load~theme~with~unqualified~name~#1 }
  { Theme~names~must~contain~at~least~one~forward~slash }
\msg_new:nnnn
  { markdown }
  { underscores-in-theme-name }
  { Won't~load~theme~with~an~underscore~in~its~name~#1 }
  { Theme~names~must~not~contain~underscores~in~their~names }
\cs_generate_variant:Nn
  \tl_replace_all:Nnn
  { NnV }
\cs_generate_variant:Nn
  \cs_gset:Npn
  { Npe }
\prg_generate_conditional_variant:Nnn
  \str_if_eq:nn
  { en }
  { T }
```

We also define the prop `\g_@@_plain_tex_built_in_themes_prop` that contains the code of built-in themes. This is a packaging optimization, so that built-in themes does not need to be distributed in many small files.

```
\prop_new:N
  \g_@@_plain_tex_built_in_themes_prop
```

Built-in plain TEX themes provided with the Markdown package include:

witiko/diagrams A theme that typesets fenced code blocks with the infostrings `dot`, `mermaid`, and `plantuml` as figures with diagrams produced with the command `dot` from Graphviz tools, the command `mmdc` from the npm package `@mermaid-js/mermaid-cli`, and the command `plantuml` from the package PlantUML, respectively.

The key-value attribute `caption` can be used to specify the caption of the figure and for the infostrings `dot` and `plantuml`, the key-value attribute `format` can be used to specify the output image format. The remaining attributes are treated as image attributes.

```
\documentclass{article}
\usepackage[relativeReferences, texComments]{markdown}
\markdownSetup{import=witiko/diagrams@v2}
\begin{document}
\begin{markdown}
``` dot {caption="An example directed graph" %
          format=svg width=12cm #dot}
digraph tree {
  margin = 0;
  rankdir = "LR";

  latex -> pmml;
  latex -> cmml;
  pmml -> slt;
  cmml -> opt;
  cmml -> prefix;
  cmml -> infix;
  pmml -> mterms [style=dashed];
  cmml -> mterms;

  latex [label = "LaTeX"];
  pmml [label = "Presentation MathML"];
  cmml [label = "Content MathML"];
  slt [label = "Symbol Layout Tree"];
  opt [label = "Operator Tree"];
  prefix [label = "Prefix"];
  infix [label = "Infix"];
  mterms [label = "M-Terms"];
}
```

``` mermaid {caption="An example mindmap" %
              width=9cm #mermaid}
mindmap
    root )base-idea(
        sub<br/>idea 1
            ((?))
        sub<br/>idea 2
            ((?))
        sub<br/>idea 3
```
```

```
            ((?))
        sub<br/>idea 4
            ((?))
```

```` plantuml {caption="An example UML sequence diagram" %
               width=7cm #plantuml}
@startuml
' Define participants (actors)
participant "Client" as C
participant "Server" as S
participant "Database" as DB

' Diagram title
title Simple Request-Response Flow

' Messages
C -> S: Send Request
note over S: Process request

alt Request is valid
    S -> DB: Query Data
    DB -> S: Return Data
    S -> C: Respond with Data
else Request is invalid
    S -> C: Return Error
end
@enduml
```

See the diagrams in figures <#dot>, <#mermaid>, and <#plantuml>.
\end{markdown}
\end{document}
````

Typesetting the above document produces the output shown in figures 4, 5, and 6.

The theme requires a Unix-like operating system with GNU Diffutils, Graphviz, the npm package `@mermaid-js/mermaid-cli`, and PlantUML installed. All these packages are already included in the Docker image `witiko/markdown`; consult `Dockerfile` to see how they are installed. The theme also requires shell access unless the `frozenCache` plain TeX option is enabled.

witiko/glossaries A theme that defines snippets with integrations for the LaTeX package glossaries. See Section 2.3.5 for more details.
````

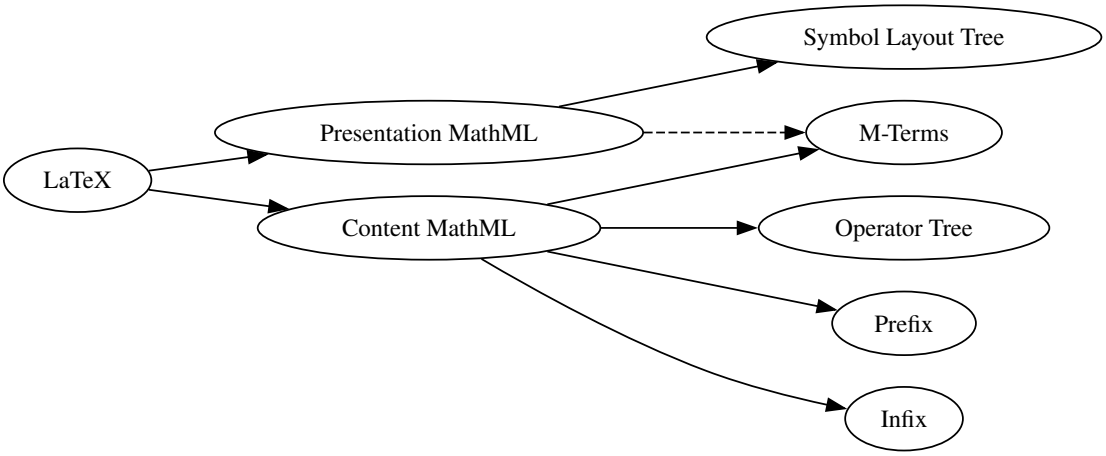


Figure 4: An example directed graph

witiko/graphicx/http A theme that adds support for downloading images whose URL has the HTTP or HTTPS protocol.

```
\documentclass{article}
\usepackage[import=witiko/graphicx/http]{markdown}
\begin{document}
\begin{markdown}
![img](https://github.com/witiko/markdown/raw/main/markdown.png
       "The banner of the Markdown package")
\end{markdown}
\end{document}
```

Typesetting the above document produces the output shown in Figure 7. The theme requires the catchfile LaTeX package and a Unix-like operating system with GNU Coreutils `md5sum` and either GNU Wget or CURL installed. The theme also requires shell access unless the `frozenCache` plain TeX option is enabled.

witiko/tilde A theme that makes tilde (`~`) always typeset the non-breaking space even when the `hybrid` Lua option is disabled.

```
\input markdown
\markdownSetup{import=witiko/tilde}
\markdownBegin
Bartel~Leendert van~der~Waerden
\markdownEnd
\bye
```

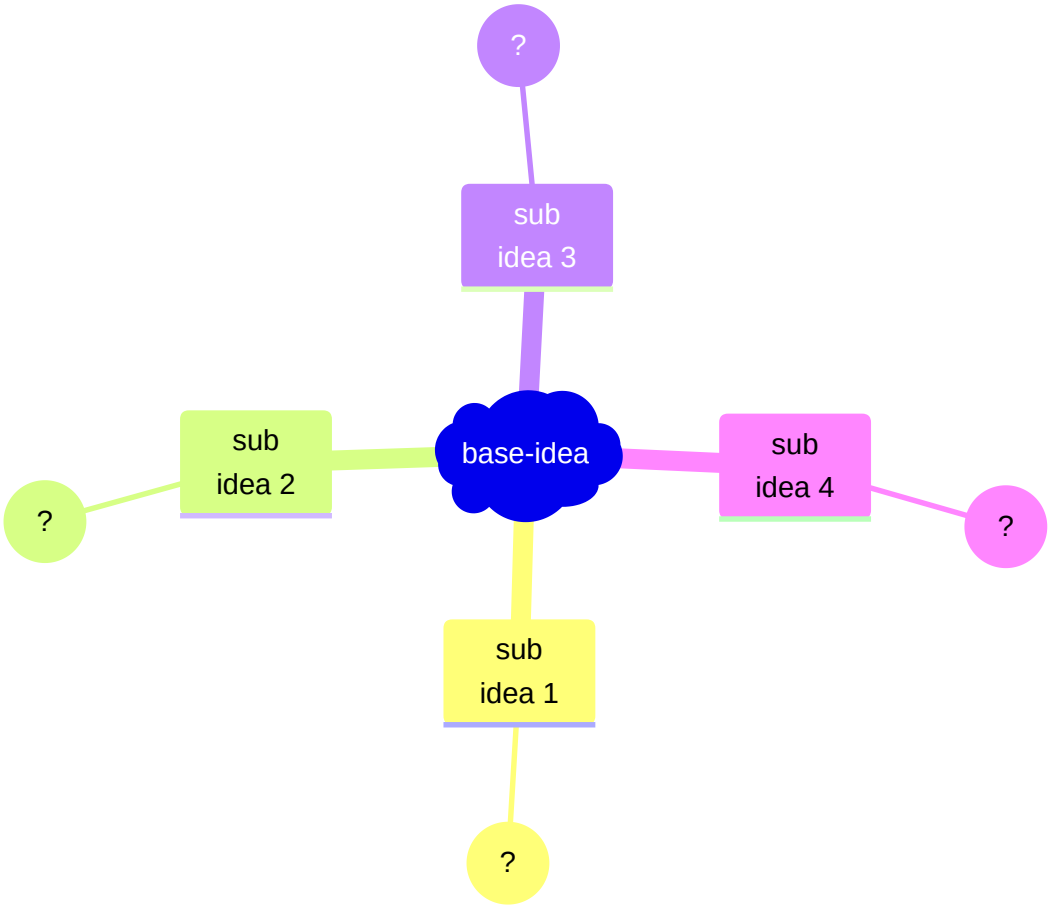


Figure 5: An example mindmap

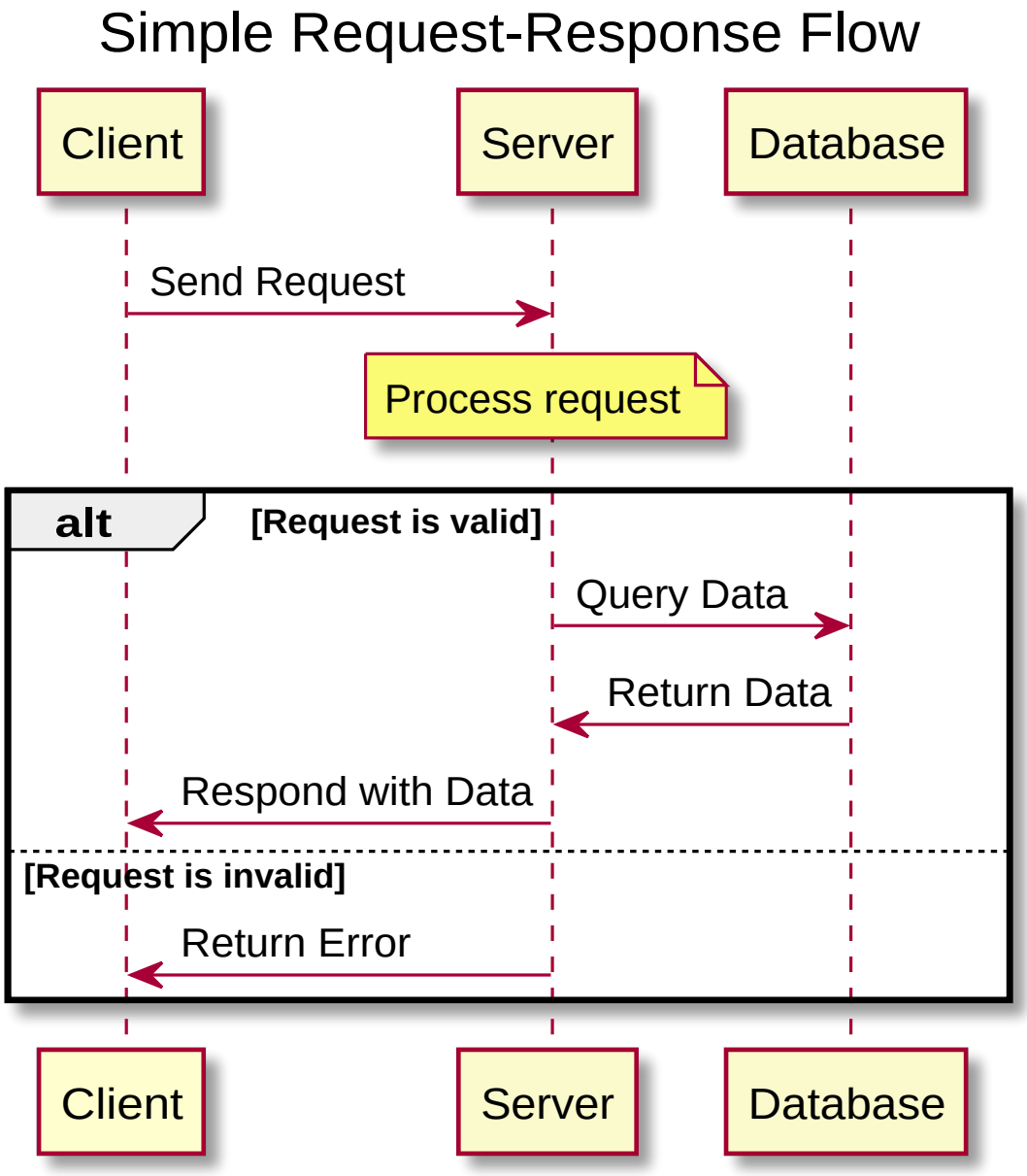


Figure 6: An example UML sequence diagram

```
\documentclass{book}
\usepackage{markdown}
\markdownSetup{pipeTables,tableCaptions}
\begin{document}
\begin{markdown}
Introduction
============
## Section
### Subsection
Hello *Markdown*!

| Right | Left | Default | Center |
|------:|:-----|---------|:------:|
|   12  |  12  |    12   |    12  |
|  123  |  123 |   123   |   123  |
|    1  |    1 |     1   |     1  |

: Table
\end{markdown}
\end{document}
```



Chapter 1

Introduction

1.1 Section

1.1.1 Subsection

Hello *Markdown*!

Right	Left	Default	Center
12	12	12	12
123	123	123	123
1	1	1	1

Table 1.1: Table

Figure 7: The banner of the Markdown package

Typesetting the above document produces the following text: “Bartel Leendert van der Waerden”.

witiko/markdown/defaults A plain TEX theme with the default definitions of token renderer prototypes for plain TEX. This theme is loaded automatically together with the package and explicitly loading it has no effect.

See Section 3.2.2 for implementation details of the built-in plain TEX themes.

2.2.4 Snippets

We may set up options as *snippets* using the `\markdownSetupSnippet` macro and invoke them later. The `\markdownSetupSnippet` macro receives two arguments: the name of the snippet and the options to store.

```
\prop_new:N
  \g_@@_snippets_prop
\cs_new_protected:Nn
  \@@_setup_snippet:nn
  {
    \tl_if_empty:nT
      { #1 }
      {
        \msg_error:nnn
```

```
          { markdown }
          { empty-snippet-name }
          { #1 }
      }
    \@@_resolve_snippet_name:nN
      { #1 }
      \l_tmpa_tl
    \@@_if_snippet_exists:nT
      { #1 }
      {
        \msg_warning:nnV
          { markdown }
          { redefined-snippet }
          \l_tmpa_tl
      }
    \keys_precompile:nnN
      { markdown/options }
      { #2 }
      \l_tmpb_tl
    \prop_gput:NVV
      \g_@@_snippets_prop
      \l_tmpa_tl
      \l_tmpb_tl
  }
\cs_gset_eq:NN
  \markdownSetupSnippet
  \@@_setup_snippet:nn
\msg_new:nnnn
  { markdown }
  { empty-snippet-name }
  { Empty~snippet~name~#1 }
  { Pick~a~non-empty~name~for~your~snippet }
\msg_new:nnn
  { markdown }
  { redefined-snippet }
  { Redefined~snippet~#1 }
```

To decide whether a snippet exists, we can use the `\markdownIfSnippetExists` macro.

```
\tl_new:N
  \l_@@_current_snippet_tl
\prg_new_protected_conditional:Nnn
  \@@_if_snippet_exists:n
  { TF, T }
  {
    \@@_resolve_snippet_name:nN
      { #1 }
      \l_@@_current_snippet_tl
    \prop_if_in:NVTF
      \g_@@_snippets_prop
      \l_@@_current_snippet_tl
```

```
      { \prg_return_true: }
      { \prg_return_false: }
  }
\cs_gset_eq:NN
  \markdownIfSnippetExists
  \@@_if_snippet_exists:nTF
\cs_new_protected:Nn
  \@@_resolve_snippet_name:nN
  {
```

If the provided snippet name starts with a slash (`/`), consider it as *absolute* and take the rest of the name as the full name of the defined snippet, regardless of the currently processed theme.

```
    \str_if_eq:enTF
      {
        \tl_head:n
          { #1 }
      }
      { / }
      {
        \tl_set:Ne
          #2
          {
            \tl_tail:n
              { #1 }
          }
      }
      {
```

Otherwise, consider the provided snippet name as *relative* and prepend the name of the currently processed theme to it, if any. The result is then the full name of the defined snippet.

```
        \tl_set:NV
          #2
          \g_@@_current_theme_tl
        \tl_put_right:Nn
          #2
          { #1 }
      }
  }
\prg_generate_conditional_variant:Nnn
  \str_if_eq:nn
  { en }
  { TF }
```

The option with key `snippet` invokes a snippet named ⟨*value*⟩.

```
\keys_define:nn
  { markdown/options }
  {
    snippet .value_required:n = { true },
    snippet .code:n = {
```

```
      \@@_resolve_snippet_name:nN
        { #1 }
        \l_tmpa_tl
      \@@_if_snippet_exists:nTF
        { #1 }
        {
          \prop_get:NVN
            \g_@@_snippets_prop
            \l_tmpa_tl
            \l_tmpb_tl
          \tl_use:N
            \l_tmpb_tl
        }
        {
          \msg_error:nnV
            { markdown }
            { undefined-snippet }
            \l_tmpa_tl
        }
    },
  }
\msg_new:nnn
  { markdown }
  { undefined-snippet }
  { Can't~invoke~undefined~snippet~#1 }
\ExplSyntaxOff
```

Here is how we can use snippets to store options and invoke them later in LaTeX:

```
\markdownSetupSnippet{romanNumerals}{
  renderers = {
      olItemWithNumber = {\item[\romannumeral#1\relax.]},
  },
}
\begin{markdown}

The following ordered list will be preceded by arabic numerals:

1. wahid
2. aithnayn

\end{markdown}
\begin{markdown}[snippet=romanNumerals]

The following ordered list will be preceded by roman numerals:

3. tres
4. quattuor
```

```
\end{markdown}
```

If the `romanNumerals` snippet were defined in the `jdoe/lists` theme, we could import the `jdoe/lists` theme and use the qualified name `jdoe/lists/romanNumerals` to invoke the snippet:

```
\markdownSetup{import=jdoe/lists}
\begin{markdown}[snippet=jdoe/lists/romanNumerals]

The following ordered list will be preceded by roman numerals:

3. tres
4. quattuor

\end{markdown}
```

Alternatively, we can use the extended variant of the `import` LaTeX option that allows us to import the `romanNumerals` snippet to the current namespace for easier access:

```
\markdownSetup{
  import = {
    jdoe/lists = romanNumerals,
  },
}
\begin{markdown}[snippet=romanNumerals]

The following ordered list will be preceded by roman numerals:

3. tres
4. quattuor

\end{markdown}
```

Furthermore, we can also specify the name of the snippet in the current namespace, which can be different from the name of the snippet in the `jdoe/lists` theme. For example, we can make the snippet `jdoe/lists/romanNumerals` available under the name `roman`.

```
\markdownSetup{
  import = {
    jdoe/lists = romanNumerals as roman,
  },
}
```

```
\begin{markdown}[snippet=roman]

The following ordered list will be preceded by roman numerals:

3. tres
4. quattuor

\end{markdown}
```

Several themes and/or snippets can be loaded at once using the extended variant of the `import` LaTeX option:

```
\markdownSetup{
  import = {
    jdoe/longpackagename/lists = {
      arabic as arabic1,
      roman,
      alphabetic,
    },
    jdoe/anotherlongpackagename/lists = {
      arabic as arabic2,
    },
    jdoe/yetanotherlongpackagename,
  },
}
```

```
\ExplSyntaxOn
\tl_new:N
  \l_@@_import_current_theme_tl
\keys_define:nn
  { markdown/options/import }
  {
```

If a theme name is given without a list of snippets to import, we assume that an empty list was given.

```
    unknown .value_required:n = { false },
    unknown .default:n = {},
    unknown .code:n = {
```

To ensure that keys containing forward slashes get passed correctly, we replace all forward slashes in the input with backslash tokens with category code letter and then undo the replacement. This means that if any unbraced backslash tokens with category code letter exist in the input, they will be replaced with forward slashes. However, this should be extremely rare.

```
      \tl_set_eq:NN
        \l_@@_import_current_theme_tl
```

```
        \l_keys_key_str
      \tl_replace_all:NVn
        \l_@@_import_current_theme_tl
        \c_backslash_str
        { / }
```

Here, we import the snippets.

```
      \clist_map_inline:nn
        { #1 }
        {
          \regex_extract_once:nnNTF
            { ^(.*?)\s+as\s+(.*?)$ }
            { ##1 }
            \l_tmpa_seq
            {
              \seq_pop:NN
                \l_tmpa_seq
                \l_tmpa_tl
              \seq_pop:NN
                \l_tmpa_seq
                \l_tmpa_tl
              \seq_pop:NN
                \l_tmpa_seq
                \l_tmpb_tl
            }
            {
              \tl_set:Nn
                \l_tmpa_tl
                { ##1 }
              \tl_set:Nn
                \l_tmpb_tl
                { ##1 }
            }
          \tl_put_left:Nn
            \l_tmpa_tl
            { / }
          \tl_put_left:NV
            \l_tmpa_tl
            \l_@@_import_current_theme_tl
          \@@_setup_snippet:Vx
            \l_tmpb_tl
            { snippet = { \l_tmpa_tl } }
        }
```

Here, we load the theme.

```
      \@@_set_theme:V
        \l_@@_import_current_theme_tl
    },
  }
\cs_generate_variant:Nn
```

```
  \tl_replace_all:Nnn
  { NVn }
\cs_generate_variant:Nn
  \@@_set_theme:n
  { V }
\cs_generate_variant:Nn
  \@@_setup_snippet:nn
  { Vx }
```

2.2.5 Token Renderers

The following TEX macros may occur inside the output of the converter functions exposed by the Lua interface (see Section 2.1.1) and represent the parsed markdown tokens. These macros are intended to be redefined by the user who is typesetting a document. By default, they point to the corresponding prototypes (see Section 2.2.6).

To enable the enumeration of token renderers, we will maintain the `\g_@@_renderers_seq` sequence.

```
\seq_new:N \g_@@_renderers_seq
```

To enable the reflection of token renderers and their parameters, we will maintain the `\g_@@_renderer_arities_prop` property list.

```
\prop_new:N \g_@@_renderer_arities_prop
\ExplSyntaxOff
```

2.2.5.1 Acronym Renderers

The following macro is only produced when the option `acronyms` is non-empty.

`\markdownRendererAcronym` represents an acronym, initialism, or another all-caps sequence. The macro receives a single attribute that corresponds to the sequence.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererAcronym
  {
    \markdownRendererAcronymPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { acronym }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { acronym }
  { 1 }
\ExplSyntaxOff
```

2.2.5.2 Attribute Renderers

The following macros are only produced, when at least one of the following options for markdown attributes on different elements is enabled:

- `autoIdentifiers`

- `fencedCodeAttributes`
- `gfmAutoIdentifiers`
- `headerAttributes`
- `inlineCodeAttributes`
- `linkAttributes`

`\markdownRendererAttributeIdentifier` represents the ⟨*identifier*⟩ of a markdown element (`id="`⟨*identifier*⟩`"` in HTML and `#`⟨*identifier*⟩ in markdown attributes). The macro receives a single attribute that corresponds to the ⟨*identifier*⟩.

`\markdownRendererAttributeClassName` represents the ⟨*class name*⟩ of a markdown element (`class="`⟨*class name*⟩ ...`"` in HTML and `.`⟨*class name*⟩ in markdown attributes). The macro receives a single attribute that corresponds to the ⟨*class name*⟩.

`\markdownRendererAttributeKeyValue` represents an HTML attribute in the form ⟨*key*⟩=⟨*value*⟩ that is neither an identifier nor a class name. The macro receives two attributes that correspond to the ⟨*key*⟩ and the ⟨*value*⟩, respectively.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererAttributeIdentifier
  {
    \markdownRendererAttributeIdentifierPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { attributeIdentifier }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { attributeIdentifier }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererAttributeClassName
  {
    \markdownRendererAttributeClassNamePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { attributeClassName }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { attributeClassName }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererAttributeKeyValue
  {
    \markdownRendererAttributeKeyValuePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
```

```
  { attributeKeyValue }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { attributeKeyValue }
  { 2 }
\ExplSyntaxOff
```

2.2.5.3 Basic html Renderers

The `\markdownRendererInlineHtmlComment` macro represents the contents of an inline HTML comment. The macro receives a single argument that corresponds to the contents of the HTML comment.

The `\markdownRendererInlineHtmlTag` macro represents an opening, closing, or empty inline HTML tag. The macro receives a single argument that corresponds to the contents of the HTML tag.

The `\markdownRendererInputBlockHtmlElement` macro represents a block HTML element. This macro will only be produced, when the `html` option is enabled. The macro receives a single argument that filename of a file containing the contents of the HTML element.

These macros will only be produced when the `html` option is enabled and the `htmlOutput` option is set to `basic`.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererInlineHtmlComment
  {
    \markdownRendererInlineHtmlCommentPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inlineHtmlComment }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inlineHtmlComment }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererInlineHtmlTag
  {
    \markdownRendererInlineHtmlTagPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inlineHtmlTag }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inlineHtmlTag }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererInputBlockHtmlElement
```

```
  {
    \markdownRendererInputBlockHtmlElementPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inputBlockHtmlElement }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inputBlockHtmlElement }
  { 1 }
\ExplSyntaxOff
```

2.2.5.4 Block Quote Renderers

The \markdownRendererBlockQuoteBegin macro represents the beginning of a block quote. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererBlockQuoteBegin
  {
    \markdownRendererBlockQuoteBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { blockQuoteBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { blockQuoteBegin }
  { 0 }
\ExplSyntaxOff
```

The \markdownRendererBlockQuoteEnd macro represents the end of a block quote. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererBlockQuoteEnd
  {
    \markdownRendererBlockQuoteEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { blockQuoteEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { blockQuoteEnd }
  { 0 }
\ExplSyntaxOff
```

2.2.5.5 Bracketed Spans

The following macros are only produced, when the bracketedSpans option is enabled.

The \markdownRendererBracketedSpan macro represents an inline bracketed span. It receives a single argument that corresponds to the inline bracketed span.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererBracketedSpan
  {
    \markdownRendererBracketedSpanPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { bracketedSpan }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { bracketedSpan }
  { 1 }
\ExplSyntaxOff
```

2.2.5.6 Bracketed Span Attribute Context Renderers

The following macros are only produced, when the bracketedSpans option is enabled.

The \markdownRendererBracketedSpanAttributeContextBegin and \markdownRendererBracke macros represent the beginning and the end of a context in which the attributes of an inline bracketed span apply. The macros receive no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererBracketedSpanAttributeContextBegin
  {
    \markdownRendererBracketedSpanAttributeContextBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { bracketedSpanAttributeContextBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { bracketedSpanAttributeContextBegin }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererBracketedSpanAttributeContextEnd
  {
    \markdownRendererBracketedSpanAttributeContextEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { bracketedSpanAttributeContextEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { bracketedSpanAttributeContextEnd }
```

```
  { 0 }
\ExplSyntaxOff
```

2.2.5.7 Bullet List Renderers

The `\markdownRendererUlBegin` macro represents the beginning of a bulleted list that contains an item with several paragraphs of text (the list is not tight). The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererUlBegin
  {
    \markdownRendererUlBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { ulBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { ulBegin }
  { 0 }
\ExplSyntaxOff
```

The `\markdownRendererUlBeginTight` macro represents the beginning of a bulleted list that contains no item with several paragraphs of text (the list is tight). This macro will only be produced, when the `tightLists` option is disabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererUlBeginTight
  {
    \markdownRendererUlBeginTightPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { ulBeginTight }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { ulBeginTight }
  { 0 }
\ExplSyntaxOff
```

The `\markdownRendererUlItem` macro represents an item in a bulleted list. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererUlItem
  {
```

```
    \markdownRendererUlItemPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { ulItem }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { ulItem }
  { 0 }
\ExplSyntaxOff
```

The `\markdownRendererUlItemEnd` macro represents the end of an item in a bulleted list. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererUlItemEnd
  {
    \markdownRendererUlItemEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { ulItemEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { ulItemEnd }
  { 0 }
\ExplSyntaxOff
```

The `\markdownRendererUlEnd` macro represents the end of a bulleted list that contains an item with several paragraphs of text (the list is not tight). The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererUlEnd
  {
    \markdownRendererUlEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { ulEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { ulEnd }
  { 0 }
\ExplSyntaxOff
```

The `\markdownRendererUlEndTight` macro represents the end of a bulleted list that contains no item with several paragraphs of text (the list is tight). This macro will only be produced, when the `tightLists` option is disabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererUlEndTight
  {
    \markdownRendererUlEndTightPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { ulEndTight }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { ulEndTight }
  { 0 }
\ExplSyntaxOff
```

2.2.5.8 Citation Renderers

The `\markdownRendererCite` macro represents a string of one or more parenthetical citations. This macro will only be produced, when the `citations` option is enabled. The macro receives the parameter `{`⟨*number of citations*⟩`}` followed by ⟨*suppress author*⟩ `{`⟨*prenote*⟩`}{`⟨*postnote*⟩`}{`⟨*name*⟩`}` repeated ⟨*number of citations*⟩ times. The ⟨*suppress author*⟩ parameter is either the token `-`, when the author's name is to be suppressed, or `+` otherwise.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererCite
  {
    \markdownRendererCitePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { cite }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { cite }
  { 1 }
\ExplSyntaxOff
```

The `\markdownRendererTextCite` macro represents a string of one or more text citations. This macro will only be produced, when the `citations` option is enabled. The macro receives parameters in the same format as the `\markdownRendererCite` macro.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererTextCite
  {
    \markdownRendererTextCitePrototype
  }
\seq_gput_right:Nn
```

```
  \g_@@_renderers_seq
  { textCite }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { textCite }
  { 1 }
\ExplSyntaxOff
```

2.2.5.9 Code Block Renderers

The `\markdownRendererInputVerbatim` macro represents a code block. The macro receives a single argument that corresponds to the filename of a file containing the code block contents.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererInputVerbatim
  {
    \markdownRendererInputVerbatimPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inputVerbatim }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inputVerbatim }
  { 1 }
\ExplSyntaxOff
```

The `\markdownRendererInputFencedCode` macro represents a fenced code block. This macro will only be produced, when the `fencedCode` option is enabled. The macro receives three arguments that correspond to the filename of a file containing the code block contents, the fully escaped code fence infostring that can be directly typeset, and the raw code fence infostring that can be used outside typesetting.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererInputFencedCode
  {
    \markdownRendererInputFencedCodePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inputFencedCode }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inputFencedCode }
  { 3 }
\ExplSyntaxOff
```

2.2.5.10 Code Span Renderer

The \markdownRendererCodeSpan macro represents inline code span in the input text. It receives a single argument that corresponds to the inline code span.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererCodeSpan
  {
    \markdownRendererCodeSpanPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { codeSpan }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { codeSpan }
  { 1 }
\ExplSyntaxOff
```

2.2.5.11 Code Span Attribute Context Renderers

The following macros are only produced, when the inlineCodeAttributes option is enabled.

The \markdownRendererCodeSpanAttributeContextBegin and \markdownRendererCodeSpanAtt macros represent the beginning and the end of a context in which the attributes of an inline code span apply. The macros receive no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererCodeSpanAttributeContextBegin
  {
    \markdownRendererCodeSpanAttributeContextBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { codeSpanAttributeContextBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { codeSpanAttributeContextBegin }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererCodeSpanAttributeContextEnd
  {
    \markdownRendererCodeSpanAttributeContextEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { codeSpanAttributeContextEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
```

```
  { codeSpanAttributeContextEnd }
  { 0 }
\ExplSyntaxOff
```

2.2.5.12 CommonMark Block html Renderers

When the `html` option is enabled and `htmlOutput` is set to `commonmark`, the following fine-grained renderers are produced instead of `\markdownRendererInputBlockHtmlElement` to distinguish between different top-level non-terminal elements of CommonMark's grammar for raw HTML[37]:

1. `\markdownRendererInputBlockHtmlCdataElement` – A CDATA block-level HTML element such as `<script>`, `<pre>`, `<style>`, or `<textarea>` that starts on a line of its own
2. `\markdownRendererBlockHtmlComment` – A comment that starts on a line of its own
3. `\markdownRendererInputBlockHtmlProcessingInstruction` – A processing instruction that starts on a line of its own
4. `\markdownRendererInputBlockHtmlDeclaration` – A declaration that starts on a line of its own
5. `\markdownRendererInputBlockHtmlCdataSection` – A CDATA section that starts on a line of its own
6. `\markdownRendererInputBlockHtmlPcdataElement` – A PCDATA block-level HTML element that starts on a line of its own
7. `\markdownRendererBlockHtmlStandaloneTag` – A non-CDATA HTML tag on a line of its own

Each of these macros receive a single argument. For all macros except 2 and 7, it is the filename of a file containing the corresponding HTML text. In contrast, macros 2 and 7 receive the text within the HTML comment and the HTML text, respectively.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererInputBlockHtmlCdataElement
  {
    \markdownRendererInputBlockHtmlCdataElementPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inputBlockHtmlCdataElement }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inputBlockHtmlCdataElement }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererBlockHtmlComment
```

[37] See https://spec.commonmark.org/0.31.2/#html-blocks.

```
  {
    \markdownRendererBlockHtmlCommentPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { blockHtmlComment }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { blockHtmlComment }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererInputBlockHtmlProcessingInstruction
  {
    \markdownRendererInputBlockHtmlProcessingInstructionPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inputBlockHtmlProcessingInstruction }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inputBlockHtmlProcessingInstruction }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererInputBlockHtmlDeclaration
  {
    \markdownRendererInputBlockHtmlDeclarationPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inputBlockHtmlDeclaration }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inputBlockHtmlDeclaration }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererInputBlockHtmlCdataSection
  {
    \markdownRendererInputBlockHtmlCdataSectionPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inputBlockHtmlCdataSection }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inputBlockHtmlCdataSection }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererInputBlockHtmlPcdataElement
  {
```

```
    \markdownRendererInputBlockHtmlPcdataElementPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inputBlockHtmlPcdataElement }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inputBlockHtmlPcdataElement }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererBlockHtmlStandaloneTag
  {
    \markdownRendererBlockHtmlStandaloneTagPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { blockHtmlStandaloneTag }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { blockHtmlStandaloneTag }
  { 1 }
\ExplSyntaxOff
```

2.2.5.13 CommonMark Raw html Renderers

When the `html` option is enabled and `htmlOutput` is set to `commonmark`, the following renderers are produced instead of `\markdownRendererInlineHtmlTag` to distinguish between different top-level non-terminal elements of CommonMark's grammar for raw HTML[38]:

- `\markdownRendererInlineHtmlProcessingInstruction` – A processing instruction
- `\markdownRendererInlineHtmlDeclaration` – A declaration
- `\markdownRendererInlineHtmlCdataSection` – A CDATA section
- `\markdownRendererInlineHtmlOpenTag` – An opening tag
- `\markdownRendererInlineHtmlCloseTag` – A closing tag
- `\markdownRendererInlineHtmlEmptyTag` – An empty tag

Each of these macros receives a single argument with the HTML text.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererInlineHtmlProcessingInstruction
  {
    \markdownRendererInlineHtmlProcessingInstructionPrototype
  }
\seq_gput_right:Nn
```

[38] See https://spec.commonmark.org/0.31.2/#raw-html.

```
  \g_@@_renderers_seq
  { inlineHtmlProcessingInstruction }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inlineHtmlProcessingInstruction }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererInlineHtmlDeclaration
  {
    \markdownRendererInlineHtmlDeclarationPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inlineHtmlDeclaration }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inlineHtmlDeclaration }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererInlineHtmlCdataSection
  {
    \markdownRendererInlineHtmlCdataSectionPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inlineHtmlCdataSection }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inlineHtmlCdataSection }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererInlineHtmlOpenTag
  {
    \markdownRendererInlineHtmlOpenTagPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inlineHtmlOpenTag }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inlineHtmlOpenTag }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererInlineHtmlCloseTag
  {
    \markdownRendererInlineHtmlCloseTagPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
```

```
  { inlineHtmlCloseTag }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inlineHtmlCloseTag }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererInlineHtmlEmptyTag
  {
    \markdownRendererInlineHtmlEmptyTagPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inlineHtmlEmptyTag }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inlineHtmlEmptyTag }
  { 1 }
\ExplSyntaxOff
```

2.2.5.14 Content Block Renderers

The `\markdownRendererContentBlock` macro represents an iA Writer content block. It receives four arguments: the local file or online image filename extension cast to the lower case, the fully escaped URI that can be directly typeset, the raw URI that can be used outside typesetting, and the title of the content block.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererContentBlock
  {
    \markdownRendererContentBlockPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { contentBlock }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { contentBlock }
  { 4 }
\ExplSyntaxOff
```

The `\markdownRendererContentBlockOnlineImage` macro represents an iA Writer online image content block. The macro receives the same arguments as `\markdownRendererContentBlock`

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererContentBlockOnlineImage
  {
    \markdownRendererContentBlockOnlineImagePrototype
  }
\seq_gput_right:Nn
```

```
  \g_@@_renderers_seq
  { contentBlockOnlineImage }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { contentBlockOnlineImage }
  { 4 }
\ExplSyntaxOff
```

The `\markdownRendererContentBlockCode` macro represents an iA Writer content block that was recognized as a file in a known programming language by its filename extension s. If any `markdown-languages.json` file found by kpathsea[39] contains a record (k, v), then a non-online-image content block with the filename extension s, `s:lower()` $= k$ is considered to be in a known programming language v. The macro receives five arguments: the local file name extension s cast to the lower case, the language v, the fully escaped URI that can be directly typeset, the raw URI that can be used outside typesetting, and the title of the content block.

Note that you will need to place place a `markdown-languages.json` file inside your working directory or inside your local TEX directory structure. In this file, you will define a mapping between filename extensions and the language names recognized by your favorite syntax highlighter; there may exist other creative uses beside syntax highlighting. The `Languages.json` file provided by Sotkov [6] is a good starting point.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererContentBlockCode
  {
    \markdownRendererContentBlockCodePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { contentBlockCode }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { contentBlockCode }
  { 5 }
\ExplSyntaxOff
```

2.2.5.15 Definition List Renderers

The following macros are only produced, when the `definitionLists` option is enabled.

The `\markdownRendererDlBegin` macro represents the beginning of a definition list that contains an item with several paragraphs of text (the list is not tight). The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererDlBegin
```

[39] Filenames other than `markdown-languages.json` may be specified using the `contentBlocksLanguageMap` Lua option.

```
  {
    \markdownRendererDlBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { dlBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { dlBegin }
  { 0 }
\ExplSyntaxOff
```

The `\markdownRendererDlBeginTight` macro represents the beginning of a definition list that contains no item with several paragraphs of text (the list is tight). This macro will only be produced, when the `tightLists` option is disabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererDlBeginTight
  {
    \markdownRendererDlBeginTightPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { dlBeginTight }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { dlBeginTight }
  { 0 }
\ExplSyntaxOff
```

The `\markdownRendererDlItem` macro represents a term in a definition list. The macro receives a single argument that corresponds to the term being defined.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererDlItem
  {
    \markdownRendererDlItemPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { dlItem }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { dlItem }
  { 1 }
\ExplSyntaxOff
```

The \markdownRendererDlItemEnd macro represents the end of a list of definitions for a single term.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererDlItemEnd
  {
    \markdownRendererDlItemEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { dlItemEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { dlItemEnd }
  { 0 }
\ExplSyntaxOff
```

The \markdownRendererDlDefinitionBegin macro represents the beginning of a definition in a definition list. There can be several definitions for a single term.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererDlDefinitionBegin
  {
    \markdownRendererDlDefinitionBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { dlDefinitionBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { dlDefinitionBegin }
  { 0 }
\ExplSyntaxOff
```

The \markdownRendererDlDefinitionEnd macro represents the end of a definition in a definition list. There can be several definitions for a single term.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererDlDefinitionEnd
  {
    \markdownRendererDlDefinitionEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { dlDefinitionEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { dlDefinitionEnd }
```

```
  { 0 }
\ExplSyntaxOff
```

The `\markdownRendererDlEnd` macro represents the end of a definition list that contains an item with several paragraphs of text (the list is not tight). The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererDlEnd
  {
    \markdownRendererDlEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { dlEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { dlEnd }
  { 0 }
\ExplSyntaxOff
```

The `\markdownRendererDlEndTight` macro represents the end of a definition list that contains no item with several paragraphs of text (the list is tight). This macro will only be produced, when the `tightLists` option is disabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererDlEndTight
  {
    \markdownRendererDlEndTightPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { dlEndTight }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { dlEndTight }
  { 0 }
\ExplSyntaxOff
```

2.2.5.16 Ellipsis Renderer

The `\markdownRendererEllipsis` macro replaces any occurrence of ASCII ellipses in the input text. This macro will only be produced, when the `smartEllipses` option is enabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererEllipsis
  {
```

```
    \markdownRendererEllipsisPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { ellipsis }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { ellipsis }
  { 0 }
\ExplSyntaxOff
```

2.2.5.17 Emphasis Renderers

The `\markdownRendererEmphasis` macro represents an emphasized span of text. The macro receives a single argument that corresponds to the emphasized span of text.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererEmphasis
  {
    \markdownRendererEmphasisPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { emphasis }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { emphasis }
  { 1 }
\ExplSyntaxOff
```

The `\markdownRendererStrongEmphasis` macro represents a strongly emphasized span of text. The macro receives a single argument that corresponds to the emphasized span of text.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererStrongEmphasis
  {
    \markdownRendererStrongEmphasisPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { strongEmphasis }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { strongEmphasis }
  { 1 }
\ExplSyntaxOff
```

2.2.5.18 Fenced Code Attribute Context Renderers

The following macros are only produced, when the fencedCode and fencedCodeAttributes options are enabled.

The \markdownRendererFencedCodeAttributeContextBegin and \markdownRendererFencedCod macros represent the beginning and the end of a context in which the attributes of a fenced code apply. The macros receive no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererFencedCodeAttributeContextBegin
  {
    \markdownRendererFencedCodeAttributeContextBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { fencedCodeAttributeContextBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { fencedCodeAttributeContextBegin }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererFencedCodeAttributeContextEnd
  {
    \markdownRendererFencedCodeAttributeContextEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { fencedCodeAttributeContextEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { fencedCodeAttributeContextEnd }
  { 0 }
\ExplSyntaxOff
```

2.2.5.19 Fenced Div Attribute Context Renderers

The following macros are only produced, when the fencedDivs option is enabled.

The \markdownRendererFencedDivAttributeContextBegin and \markdownRendererFencedDivA macros represent the beginning and the end of a context in which the attributes of a div apply. The macros receive no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererFencedDivAttributeContextBegin
  {
    \markdownRendererFencedDivAttributeContextBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { fencedDivAttributeContextBegin }
\prop_gput:Nnn
```

```
  \g_@@_renderer_arities_prop
  { fencedDivAttributeContextBegin }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererFencedDivAttributeContextEnd
  {
    \markdownRendererFencedDivAttributeContextEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { fencedDivAttributeContextEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { fencedDivAttributeContextEnd }
  { 0 }
\ExplSyntaxOff
```

2.2.5.20 Header Attribute Context Renderers

The following macros are only produced, when the `autoIdentifiers`, `gfmAutoIdentifiers`, or `headerAttributes` options are enabled.

The `\markdownRendererHeaderAttributeContextBegin` and `\markdownRendererHeaderAttribu` macros represent the beginning and the end of a context in which the attributes of a heading apply. The macros receive no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererHeaderAttributeContextBegin
  {
    \markdownRendererHeaderAttributeContextBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { headerAttributeContextBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { headerAttributeContextBegin }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererHeaderAttributeContextEnd
  {
    \markdownRendererHeaderAttributeContextEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { headerAttributeContextEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { headerAttributeContextEnd }
  { 0 }
```

```
\ExplSyntaxOff
```

2.2.5.21 Heading Renderers

The \markdownRendererHeadingOne macro represents a first level heading. The macro receives a single argument that corresponds to the heading text.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererHeadingOne
  {
    \markdownRendererHeadingOnePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { headingOne }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { headingOne }
  { 1 }
\ExplSyntaxOff
```

The \markdownRendererHeadingTwo macro represents a second level heading. The macro receives a single argument that corresponds to the heading text.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererHeadingTwo
  {
    \markdownRendererHeadingTwoPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { headingTwo }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { headingTwo }
  { 1 }
\ExplSyntaxOff
```

The \markdownRendererHeadingThree macro represents a third level heading. The macro receives a single argument that corresponds to the heading text.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererHeadingThree
  {
    \markdownRendererHeadingThreePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { headingThree }
```

```
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { headingThree }
  { 1 }
\ExplSyntaxOff
```

The \markdownRendererHeadingFour macro represents a fourth level heading. The macro receives a single argument that corresponds to the heading text.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererHeadingFour
  {
    \markdownRendererHeadingFourPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { headingFour }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { headingFour }
  { 1 }
\ExplSyntaxOff
```

The \markdownRendererHeadingFive macro represents a fifth level heading. The macro receives a single argument that corresponds to the heading text.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererHeadingFive
  {
    \markdownRendererHeadingFivePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { headingFive }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { headingFive }
  { 1 }
\ExplSyntaxOff
```

The \markdownRendererHeadingSix macro represents a sixth level heading. The macro receives a single argument that corresponds to the heading text.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererHeadingSix
  {
    \markdownRendererHeadingSixPrototype
  }
\seq_gput_right:Nn
```

```
  \g_@@_renderers_seq
  { headingSix }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { headingSix }
  { 1 }
\ExplSyntaxOff
```

2.2.5.22 Image Renderer

The `\markdownRendererImage` macro represents an image. It receives four arguments: the label, the fully escaped URI that can be directly typeset, the raw URI that can be used outside typesetting, and the title of the link.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererImage
  {
    \markdownRendererImagePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { image }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { image }
  { 4 }
\ExplSyntaxOff
```

2.2.5.23 Image Attribute Context Renderers

The following macros are only produced, when the `linkAttributes` option is enabled.

The `\markdownRendererImageAttributeContextBegin` and `\markdownRendererImageAttribute` macros represent the beginning and the end of a context in which the attributes of an image apply. The macros receive no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererImageAttributeContextBegin
  {
    \markdownRendererImageAttributeContextBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { imageAttributeContextBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { imageAttributeContextBegin }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererImageAttributeContextEnd
```

```
  {
    \markdownRendererImageAttributeContextEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { imageAttributeContextEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { imageAttributeContextEnd }
  { 0 }
\ExplSyntaxOff
```

2.2.5.24 Interblock Separator Renderers

The \markdownRendererInterblockSeparator macro represents an interblock separator between two markdown block elements. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererInterblockSeparator
  {
    \markdownRendererInterblockSeparatorPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { interblockSeparator }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { interblockSeparator }
  { 0 }
\ExplSyntaxOff
```

Users can use more than one blank line to delimit two block to indicate the end of a series of blocks that make up a logical paragraph. This produces a paragraph separator instead of an interblock separator. Between some blocks, such as markdown paragraphs, a paragraph separator is always produced.

The \markdownRendererParagraphSeparator macro represents a paragraph separator. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererParagraphSeparator
  {
    \markdownRendererParagraphSeparatorPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { paragraphSeparator }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { paragraphSeparator }
```

```
  { 0 }
\ExplSyntaxOff
```

2.2.5.25 Line Block Renderers

The following macros are only produced, when the `lineBlocks` option is enabled.

The `\markdownRendererLineBlockBegin` and `\markdownRendererLineBlockEnd` macros represent the beginning and the end of a line block. The macros receive no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererLineBlockBegin
  {
    \markdownRendererLineBlockBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { lineBlockBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { lineBlockBegin }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererLineBlockEnd
  {
    \markdownRendererLineBlockEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { lineBlockEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { lineBlockEnd }
  { 0 }
\ExplSyntaxOff
```

2.2.5.26 Line Break Renderers

The `\markdownRendererSoftLineBreak` macro represents a soft line break. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererSoftLineBreak
  {
    \markdownRendererSoftLineBreakPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { softLineBreak }
```

```
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { softLineBreak }
  { 0 }
\ExplSyntaxOff
```

The \markdownRendererHardLineBreak macro represents a hard line break. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererHardLineBreak
  {
    \markdownRendererHardLineBreakPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { hardLineBreak }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { hardLineBreak }
  { 0 }
\ExplSyntaxOff
```

2.2.5.27 Link Renderer

The \markdownRendererLink macro represents a hyperlink. It receives four arguments: the label, the fully escaped URI that can be directly typeset, the raw URI that can be used outside typesetting, and the title of the link.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererLink
  {
    \markdownRendererLinkPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { link }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { link }
  { 4 }
\ExplSyntaxOff
```

2.2.5.28 Link Attribute Context Renderers

The following macros are only produced, when the linkAttributes option is enabled.

The \markdownRendererLinkAttributeContextBegin and \markdownRendererLinkAttributeCo macros represent the beginning and the end of a context in which the attributes of a hyperlink apply. The macros receive no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererLinkAttributeContextBegin
  {
    \markdownRendererLinkAttributeContextBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { linkAttributeContextBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { linkAttributeContextBegin }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererLinkAttributeContextEnd
  {
    \markdownRendererLinkAttributeContextEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { linkAttributeContextEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { linkAttributeContextEnd }
  { 0 }
\ExplSyntaxOff
```

2.2.5.29 Marked Text Renderer

The following macro is only produced, when the `mark` option is enabled.

The `\markdownRendererMark` macro represents a span of marked or highlighted text. The macro receives a single argument that corresponds to the marked text.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererMark
  {
    \markdownRendererMarkPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { mark }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { mark }
  { 1 }
\ExplSyntaxOff
```

2.2.5.30 Markdown Document Renderers

The \markdownRendererDocumentBegin and \markdownRendererDocumentEnd macros represent the beginning and the end of a *markdown* document. The macros receive no arguments.

A TEX document may contain any number of markdown documents. Additionally, markdown documents may appear not only in a sequence, but several markdown documents may also be *nested*. Redefinitions of the macros should take this into account.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererDocumentBegin
  {
    \markdownRendererDocumentBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { documentBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { documentBegin }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererDocumentEnd
  {
    \markdownRendererDocumentEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { documentEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { documentEnd }
  { 0 }
\ExplSyntaxOff
```

2.2.5.31 Non-Breaking Space Renderer

The \markdownRendererNbsp macro represents a non-breaking space.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererNbsp
  {
    \markdownRendererNbspPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { nbsp }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { nbsp }
```

```
  { 0 }
\ExplSyntaxOff
```

2.2.5.32 Note Renderer

The `\markdownRendererNote` macro represents a note. This macro will only be produced, when the `notes` option is enabled. The macro receives a single argument that corresponds to the note text.

```
\def\markdownRendererNote{%
  \markdownRendererNotePrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { note }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { note }
  { 1 }
\ExplSyntaxOff
```

2.2.5.33 Ordered List Renderers

The `\markdownRendererOlBegin` macro represents the beginning of an ordered list that contains an item with several paragraphs of text (the list is not tight). This macro will only be produced, when the `fancyLists` option is disabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererOlBegin
  {
    \markdownRendererOlBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { olBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { olBegin }
  { 0 }
\ExplSyntaxOff
```

The `\markdownRendererOlBeginTight` macro represents the beginning of an ordered list that contains no item with several paragraphs of text (the list is tight). This macro will only be produced, when the `tightLists` option is enabled and the `fancyLists` option is disabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererOlBeginTight
```

```
  {
    \markdownRendererOlBeginTightPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { olBeginTight }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { olBeginTight }
  { 0 }
\ExplSyntaxOff
```

The `\markdownRendererFancyOlBegin` macro represents the beginning of a fancy ordered list that contains an item with several paragraphs of text (the list is not tight). This macro will only be produced, when the `fancyLists` option is enabled. The macro receives two arguments: the style of the list item labels (`Decimal`, `LowerRoman`, `UpperRoman`, `LowerAlpha`, and `UpperAlpha`), and the style of delimiters between list item labels and texts (`Default`, `OneParen`, and `Period`).

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererFancyOlBegin
  {
    \markdownRendererFancyOlBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { fancyOlBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { fancyOlBegin }
  { 2 }
\ExplSyntaxOff
```

The `\markdownRendererFancyOlBeginTight` macro represents the beginning of a fancy ordered list that contains no item with several paragraphs of text (the list is tight). This macro will only be produced, when the `fancyLists` and `tightLists` options are enabled. The macro receives two arguments: the style of the list item labels, and the style of delimiters between list item labels and texts. See the `\markdownRendererFancyOlBegin` macro for the valid style values.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererFancyOlBeginTight
  {
    \markdownRendererFancyOlBeginTightPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { fancyOlBeginTight }
```

```
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { fancyOlBeginTight }
  { 2 }
\ExplSyntaxOff
```

The \markdownRendererOlItem macro represents an item in an ordered list. This macro will only be produced, when the startNumber option is disabled and the fancyLists option is disabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererOlItem
  {
    \markdownRendererOlItemPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { olItem }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { olItem }
  { 0 }
\ExplSyntaxOff
```

The \markdownRendererOlItemEnd macro represents the end of an item in an ordered list. This macro will only be produced, when the fancyLists option is disabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererOlItemEnd
  {
    \markdownRendererOlItemEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { olItemEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { olItemEnd }
  { 0 }
\ExplSyntaxOff
```

The \markdownRendererOlItemWithNumber macro represents an item in an ordered list. This macro will only be produced, when the startNumber option is enabled and the fancyLists option is disabled. The macro receives a single numeric argument that corresponds to the item number.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
```

```
  \markdownRendererOlItemWithNumber
  {
    \markdownRendererOlItemWithNumberPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { olItemWithNumber }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { olItemWithNumber }
  { 1 }
\ExplSyntaxOff
```

The `\markdownRendererFancyOlItem` macro represents an item in a fancy ordered list. This macro will only be produced, when the `startNumber` option is disabled and the `fancyLists` option is enabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererFancyOlItem
  {
    \markdownRendererFancyOlItemPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { fancyOlItem }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { fancyOlItem }
  { 0 }
\ExplSyntaxOff
```

The `\markdownRendererFancyOlItemEnd` macro represents the end of an item in a fancy ordered list. This macro will only be produced, when the `fancyLists` option is enabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererFancyOlItemEnd
  {
    \markdownRendererFancyOlItemEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { fancyOlItemEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { fancyOlItemEnd }
  { 0 }
\ExplSyntaxOff
```

The \markdownRendererFancyOlItemWithNumber macro represents an item in a fancy ordered list. This macro will only be produced, when the startNumber and fancyLists options are enabled. The macro receives a single numeric argument that corresponds to the item number.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererFancyOlItemWithNumber
  {
    \markdownRendererFancyOlItemWithNumberPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { fancyOlItemWithNumber }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { fancyOlItemWithNumber }
  { 1 }
\ExplSyntaxOff
```

The \markdownRendererOlEnd macro represents the end of an ordered list that contains an item with several paragraphs of text (the list is not tight). This macro will only be produced, when the fancyLists option is disabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererOlEnd
  {
    \markdownRendererOlEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { olEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { olEnd }
  { 0 }
\ExplSyntaxOff
```

The \markdownRendererOlEndTight macro represents the end of an ordered list that contains no item with several paragraphs of text (the list is tight). This macro will only be produced, when the tightLists option is enabled and the fancyLists option is disabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererOlEndTight
  {
    \markdownRendererOlEndTightPrototype
  }
\seq_gput_right:Nn
```

```
  \g_@@_renderers_seq
  { olEndTight }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { olEndTight }
  { 0 }
\ExplSyntaxOff
```

The `\markdownRendererFancyOlEnd` macro represents the end of a fancy ordered list that contains an item with several paragraphs of text (the list is not tight). This macro will only be produced, when the `fancyLists` option is enabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererFancyOlEnd
  {
    \markdownRendererFancyOlEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { fancyOlEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { fancyOlEnd }
  { 0 }
\ExplSyntaxOff
```

The `\markdownRendererFancyOlEndTight` macro represents the end of a fancy ordered list that contains no item with several paragraphs of text (the list is tight). This macro will only be produced, when the `fancyLists` and `tightLists` options are enabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererFancyOlEndTight
  {
    \markdownRendererFancyOlEndTightPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { fancyOlEndTight }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { fancyOlEndTight }
  { 0 }
\ExplSyntaxOff
```

2.2.5.34 Raw Content Renderers

The \markdownRendererInputRawInline macro represents an inline raw span. The macro receives two arguments: the filename of a file containing the inline raw span contents and the raw attribute that designates the format of the inline raw span. This macro will only be produced, when the rawAttribute option is enabled.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererInputRawInline
  {
    \markdownRendererInputRawInlinePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inputRawInline }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inputRawInline }
  { 2 }
\ExplSyntaxOff
```

The \markdownRendererInputRawBlock macro represents a raw block. The macro receives two arguments: the filename of a file containing the raw block and the raw attribute that designates the format of the raw block. This macro will only be produced, when the rawAttribute and fencedCode options are enabled.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererInputRawBlock
  {
    \markdownRendererInputRawBlockPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inputRawBlock }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inputRawBlock }
  { 2 }
\ExplSyntaxOff
```

2.2.5.35 Section Renderers

The \markdownRendererSectionBegin and \markdownRendererSectionEnd macros represent the beginning and the end of a section based on headings.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererSectionBegin
  {
    \markdownRendererSectionBeginPrototype
  }
```

```
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { sectionBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { sectionBegin }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererSectionEnd
  {
    \markdownRendererSectionEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { sectionEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { sectionEnd }
  { 0 }
\ExplSyntaxOff
```

2.2.5.36 Replacement Character Renderers

The `\markdownRendererReplacementCharacter` macro represents the U+0000 and U+FFFD Unicode characters. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererReplacementCharacter
  {
    \markdownRendererReplacementCharacterPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { replacementCharacter }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { replacementCharacter }
  { 0 }
\ExplSyntaxOff
```

2.2.5.37 Special Character Renderers

The following macros replace any special plain TEX characters, including the active pipe character (`|`) of ConTEXt, in the input text. These macros will only be produced, when the `hybrid` option is `false`.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererLeftBrace
  {
```

```
    \markdownRendererLeftBracePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { leftBrace }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { leftBrace }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererRightBrace
  {
    \markdownRendererRightBracePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { rightBrace }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { rightBrace }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererDollarSign
  {
    \markdownRendererDollarSignPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { dollarSign }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { dollarSign }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererPercentSign
  {
    \markdownRendererPercentSignPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { percentSign }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { percentSign }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererAmpersand
  {
    \markdownRendererAmpersandPrototype
```

```
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { ampersand }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { ampersand }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererUnderscore
  {
    \markdownRendererUnderscorePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { underscore }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { underscore }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererHash
  {
    \markdownRendererHashPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { hash }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { hash }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererCircumflex
  {
    \markdownRendererCircumflexPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { circumflex }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { circumflex }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererBackslash
  {
    \markdownRendererBackslashPrototype
  }
```

```
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { backslash }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { backslash }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererTilde
  {
    \markdownRendererTildePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { tilde }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { tilde }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererPipe
  {
    \markdownRendererPipePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { pipe }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { pipe }
  { 0 }
\ExplSyntaxOff
```

2.2.5.38 Strike-Through Renderer

The `\markdownRendererStrikeThrough` macro represents a strike-through span of text. The macro receives a single argument that corresponds to the striked-out span of text. This macro will only be produced, when the `strikeThrough` option is enabled.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererStrikeThrough
  {
    \markdownRendererStrikeThroughPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { strikeThrough }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
```

```
  { strikeThrough }
  { 1 }
\ExplSyntaxOff
```

2.2.5.39 Subscript Renderer

The `\markdownRendererSubscript` macro represents a subscript span of text. The macro receives a single argument that corresponds to the subscript span of text. This macro will only be produced, when the `subscripts` option is enabled.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererSubscript
  {
    \markdownRendererSubscriptPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { subscript }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { subscript }
  { 1 }
```

2.2.5.40 Superscript Renderer

The `\markdownRendererSuperscript` macro represents a superscript span of text. The macro receives a single argument that corresponds to the superscript span of text. This macro will only be produced, when the `superscripts` option is enabled.

```
\cs_gset_protected:Npn
  \markdownRendererSuperscript
  {
    \markdownRendererSuperscriptPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { superscript }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { superscript }
  { 1 }
\ExplSyntaxOff
```

2.2.5.41 Table Attribute Context Renderers

The following macros are only produced, when the `tableCaptions` and `tableAttributes` options are enabled.

The `\markdownRendererTableAttributeContextBegin` and `\markdownRendererTableAttribute` macros represent the beginning and the end of a context in which the attributes of a table apply. The macros receive no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererTableAttributeContextBegin
  {
    \markdownRendererTableAttributeContextBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { tableAttributeContextBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { tableAttributeContextBegin }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererTableAttributeContextEnd
  {
    \markdownRendererTableAttributeContextEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { tableAttributeContextEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { tableAttributeContextEnd }
  { 0 }
\ExplSyntaxOff
```

2.2.5.42 Table Renderer

The `\markdownRendererTable` macro represents a table. This macro will only be produced, when the `pipeTables` option is enabled. The macro receives the parameters `{`⟨*caption*⟩`}{`⟨*number of rows*⟩`}{`⟨*number of columns*⟩`}` followed by `{`⟨*alignments*⟩`}` and then by `{`⟨*row*⟩`}` repeated ⟨*number of rows*⟩ times, where ⟨*row*⟩ is `{`⟨*column*⟩`}` repeated ⟨*number of columns*⟩ times, ⟨*alignments*⟩ is ⟨*alignment*⟩ repeated ⟨*number of columns*⟩ times, and ⟨*alignment*⟩ is one of the following:

- `d` – The corresponding column has an unspecified (default) alignment.
- `l` – The corresponding column is left-aligned.
- `c` – The corresponding column is centered.
- `r` – The corresponding column is right-aligned.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererTable
  {
    \markdownRendererTablePrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
```

```
  { table }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { table }
  { 3 }
\ExplSyntaxOff
```

2.2.5.43 TEX Math Renderers

The `\markdownRendererInlineMath` and `\markdownRendererDisplayMath` macros represent inline and display TEX math. Both macros receive a single argument that corresponds to the TEX math content. These macros will only be produced, when the `texMathDollars`, `texMathSingleBackslash`, or `texMathDoubleBackslash` option are enabled.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererInlineMath
  {
    \markdownRendererInlineMathPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inlineMath }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inlineMath }
  { 1 }
\cs_gset_protected:Npn
  \markdownRendererDisplayMath
  {
    \markdownRendererDisplayMathPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { displayMath }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { displayMath }
  { 1 }
\ExplSyntaxOff
```

2.2.5.44 Thematic Break Renderer

The `\markdownRendererThematicBreak` macro represents a thematic break. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererThematicBreak
  {
```

```
    \markdownRendererThematicBreakPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { thematicBreak }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { thematicBreak }
  { 0 }
\ExplSyntaxOff
```

2.2.5.45 Tickbox Renderers

The macros named `\markdownRendererTickedBox`, `\markdownRendererHalfTickedBox`, and `\markdownRendererUntickedBox` represent ticked and unticked boxes, respectively. These macros will either be produced, when the `taskLists` option is enabled, or when the Ballot Box with X (☒, U+2612), Hourglass (⊡, U+231B) or Ballot Box (▫, U+2610) Unicode characters are encountered in the markdown input, respectively.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererTickedBox
  {
    \markdownRendererTickedBoxPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { tickedBox }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { tickedBox }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererHalfTickedBox
  {
    \markdownRendererHalfTickedBoxPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { halfTickedBox }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { halfTickedBox }
  { 0 }
\cs_gset_protected:Npn
  \markdownRendererUntickedBox
  {
    \markdownRendererUntickedBoxPrototype
  }
\seq_gput_right:Nn
```

```
  \g_@@_renderers_seq
  { untickedBox }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { untickedBox }
  { 0 }
\ExplSyntaxOff
```

2.2.5.46 Warning and Error Renderers

The `\markdownRendererWarning` and `\markdownRendererError` macros represent warnings and errors produced by the markdown parser. Both macros receive four parameters:

1. The fully escaped text of the warning or error that can be directly typeset
2. The raw text of the warning or error that can be used outside typesetting for e.g. logging the warning or error.
3. The fully escaped text with more details about the warning or error that can be directly typeset. Can be empty, unlike the first two parameters.
4. The raw text with more details about the warning or error that can be used outside typesetting for e.g. logging the warning or error. Can be empty, unlike the first two parameters.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererWarning
  {
    \markdownRendererWarningPrototype
  }
\cs_gset_protected:Npn
  \markdownRendererError
  {
    \markdownRendererErrorPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { warning }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { warning }
  { 4 }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { error }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { error }
  { 4 }
\ExplSyntaxOff
```

2.2.5.47 yaml Metadata Renderers

The \markdownRendererJekyllDataBegin macro represents the beginning of a YAML document. This macro will only be produced when the jekyllData option is enabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererJekyllDataBegin
  {
    \markdownRendererJekyllDataBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { jekyllDataBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { jekyllDataBegin }
  { 0 }
\ExplSyntaxOff
```

The \markdownRendererJekyllDataEnd macro represents the end of a YAML document. This macro will only be produced when the jekyllData option is enabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererJekyllDataEnd
  {
    \markdownRendererJekyllDataEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { jekyllDataEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { jekyllDataEnd }
  { 0 }
\ExplSyntaxOff
```

The \markdownRendererJekyllDataMappingBegin macro represents the beginning of a mapping in a YAML document. This macro will only be produced when the jekyllData option is enabled. The macro receives two arguments: the scalar key in the parent structure, cast to a string following YAML serialization rules, and the number of items in the mapping.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererJekyllDataMappingBegin
  {
    \markdownRendererJekyllDataMappingBeginPrototype
  }
```

```
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { jekyllDataMappingBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { jekyllDataMappingBegin }
  { 2 }
\ExplSyntaxOff
```

The `\markdownRendererJekyllDataMappingEnd` macro represents the end of a mapping in a YAML document. This macro will only be produced when the `jekyllData` option is enabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererJekyllDataMappingEnd
  {
    \markdownRendererJekyllDataMappingEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { jekyllDataMappingEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { jekyllDataMappingEnd }
  { 0 }
\ExplSyntaxOff
```

The `\markdownRendererJekyllDataSequenceBegin` macro represents the beginning of a sequence in a YAML document. This macro will only be produced when the `jekyllData` option is enabled. The macro receives two arguments: the scalar key in the parent structure, cast to a string following YAML serialization rules, and the number of items in the sequence.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererJekyllDataSequenceBegin
  {
    \markdownRendererJekyllDataSequenceBeginPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { jekyllDataSequenceBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { jekyllDataSequenceBegin }
  { 2 }
\ExplSyntaxOff
```

The \markdownRendererJekyllDataSequenceEnd macro represents the end of a sequence in a YAML document. This macro will only be produced when the jekyllData option is enabled. The macro receives no arguments.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererJekyllDataSequenceEnd
  {
    \markdownRendererJekyllDataSequenceEndPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { jekyllDataSequenceEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { jekyllDataSequenceEnd }
  { 0 }
\ExplSyntaxOff
```

The \markdownRendererJekyllDataBoolean macro represents a boolean scalar value in a YAML document. This macro will only be produced when the jekyllData option is enabled. The macro receives two arguments: the scalar key in the parent structure, and the scalar value, both cast to a string following YAML serialization rules.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererJekyllDataBoolean
  {
    \markdownRendererJekyllDataBooleanPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { jekyllDataBoolean }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { jekyllDataBoolean }
  { 2 }
\ExplSyntaxOff
```

The \markdownRendererJekyllDataNumber macro represents a numeric scalar value in a YAML document. This macro will only be produced when the jekyllData option is enabled. The macro receives two arguments: the scalar key in the parent structure, and the scalar value, both cast to a string following YAML serialization rules.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererJekyllDataNumber
  {
    \markdownRendererJekyllDataNumberPrototype
  }
\seq_gput_right:Nn
```

```
  \g_@@_renderers_seq
  { jekyllDataNumber }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { jekyllDataNumber }
  { 2 }
\ExplSyntaxOff
```

The \markdownRendererJekyllDataTypographicString and \markdownRendererJekyllDataPro macros represent string scalar values in a YAML document. This macro will only be produced when the jekyllData option is enabled. The macro receives two arguments: the scalar key in the parent structure, cast to a string following YAML serialization rules, and the scalar value.

For each string scalar value, both macros are produced. Whereas \markdownRendererJekyllDataTyp receives the scalar value after all markdown markup and special TEX characters in the string have been replaced by TEX macros, \markdownRendererJekyllDataProgrammaticString receives the raw scalar value. Therefore, whereas the \markdownRendererJekyllDataTypographicStr macro is more appropriate for texts that are supposed to be typeset with TEX, such as document titles, author names, or exam questions, the \markdownRendererJekyllDataProgrammaticStrin macro is more appropriate for identifiers and other programmatic text that won't be typeset by TEX.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererJekyllDataTypographicString
  {
    \markdownRendererJekyllDataTypographicStringPrototype
  }
\cs_gset_protected:Npn
  \markdownRendererJekyllDataProgrammaticString
  {
    \markdownRendererJekyllDataProgrammaticStringPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { jekyllDataTypographicString }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { jekyllDataTypographicString }
  { 2 }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { jekyllDataProgrammaticString }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { jekyllDataProgrammaticString }
  { 2 }
\ExplSyntaxOff
```

Before Markdown 3.7.0, the \markdownRendererJekyllDataTypographicString macro was named \markdownRendererJekyllDataString and the \markdownRendererJekyllDataPr macro was not produced. The \markdownRendererJekyllDataString macro has been deprecated and will be removed in Markdown 4.0.0.

```
\ExplSyntaxOn
\cs_gset:Npn
  \markdownRendererJekyllDataTypographicString
  {
    \cs_if_exist:NTF
      \markdownRendererJekyllDataString
      {
        \@@_if_option:nTF
          { experimental }
          {
            \markdownError
              {
                The~jekyllDataString~renderer~has~been~deprecated,~
                to~be~removed~in~Markdown~4.0.0
              }
          }
          {
            \markdownWarning
              {
                The~jekyllDataString~renderer~has~been~deprecated,~
                to~be~removed~in~Markdown~4.0.0
              }
            \markdownRendererJekyllDataString
          }
      }
      {
        \cs_if_exist:NTF
          \markdownRendererJekyllDataStringPrototype
          {
            \@@_if_option:nTF
              { experimental }
              {
                \markdownError
                  {
                    The~jekyllDataString~renderer~prototype~
                    has~been~deprecated,~
                    to~be~removed~in~Markdown~4.0.0
                  }
              }
              {
                \markdownWarning
                  {
                    The~jekyllDataString~renderer~prototype~
                    has~been~deprecated,~
                    to~be~removed~in~Markdown~4.0.0
```

```
                  }
                \markdownRendererJekyllDataStringPrototype
              }
          }
          {
            \markdownRendererJekyllDataTypographicStringPrototype
          }
      }
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { jekyllDataString }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { jekyllDataString }
  { 2 }
\ExplSyntaxOff
```

The `\markdownRendererJekyllDataEmpty` macro represents an empty scalar value in a YAML document. This macro will only be produced when the `jekyllData` option is enabled. The macro receives one argument: the scalar key in the parent structure, cast to a string following YAML serialization rules.

See also Section 2.2.6.1 for the description of the high-level expl3 interface that you can also use to react to YAML metadata.

```
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererJekyllDataEmpty
  {
    \markdownRendererJekyllDataEmptyPrototype
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { jekyllDataEmpty }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { jekyllDataEmpty }
  { 1 }
\ExplSyntaxOff
```

2.2.5.48 Generating Plain TEX Token Renderer Macros and Key-Values

We define the command `\@@_define_renderers:` that defines plain TEX macros for token renderers. Furthermore, the `\markdownSetup` macro also accepts the `renderers` and `unprotectedRenderers` keys. The value for these keys must be a list of key–values, where the keys correspond to the markdown token renderer macros and the values are new definitions of these token renderers.

Whereas the key `renderers` defines protected functions, which are usually preferable for typesetting, the key `unprotectedRenderers` defines unprotected functions, which are easier to expand and may be preferable for programming.

```
\ExplSyntaxOn
\cs_new_protected:Nn \@@_define_renderers:
  {
    \seq_map_inline:Nn
      \g_@@_renderers_seq
      {
        \@@_define_renderer:n
          { ##1 }
      }
  }
\cs_new_protected:Nn \@@_define_renderer:n
  {
    \@@_renderer_tl_to_csname:nN
      { #1 }
      \l_tmpa_tl
    \prop_get:NnN
      \g_@@_renderer_arities_prop
      { #1 }
      \l_tmpb_tl
    \@@_define_renderer:ncV
      { #1 }
      { \l_tmpa_tl }
      \l_tmpb_tl
  }
\cs_new_protected:Nn \@@_renderer_tl_to_csname:nN
  {
    \tl_set:Nn
      \l_tmpa_tl
      { \str_uppercase:n { #1 } }
    \tl_set:Nx
      #2
      {
        markdownRenderer
        \tl_head:f { \l_tmpa_tl }
        \tl_tail:n { #1 }
      }
  }
\tl_new:N
  \l_@@_renderer_definition_tl
\bool_new:N
  \g_@@_prepending_renderer_bool
\bool_new:N
  \g_@@_appending_renderer_bool
\bool_new:N
  \g_@@_unprotected_renderer_bool
\cs_new_protected:Nn \@@_define_renderer:nNn
```

```
{
  \keys_define:nn
    { markdown/options/renderers }
    {
      #1 .value_required:n = { true },
      #1 .code:n = {
        \tl_set:Nn
          \l_@@_renderer_definition_tl
          { ##1 }
        \regex_replace_all:nnN
          { \cP\#0 }
          { #1 }
          \l_@@_renderer_definition_tl
        \bool_if:nT
          {
            \g_@@_prepending_renderer_bool ||
            \g_@@_appending_renderer_bool
          }
          {
            \@@_tl_set_from_cs:NNn
              \l_tmpa_tl
              #2
              { #3 }
            \bool_if:NTF
              \g_@@_prepending_renderer_bool
              {
                \tl_put_right:NV
                  \l_@@_renderer_definition_tl
                  \l_tmpa_tl
              }
              {
                \tl_put_left:NV
                  \l_@@_renderer_definition_tl
                  \l_tmpa_tl
              }
          }
        \bool_if:NTF
          \g_@@_unprotected_renderer_bool
          {
            \tl_set:Nn
              \l_tmpa_tl
              { \cs_set:Npn }
          }
          {
            \tl_set:Nn
              \l_tmpa_tl
              { \cs_set_protected:Npn }
          }
        \exp_last_unbraced:NNV
```

```
            \cs_generate_from_arg_count:NNnV
            #2
            \l_tmpa_tl
            { #3 }
            \l_@@_renderer_definition_tl
        },
    }
```

If the token renderer macro has been deprecated, we undefine it.

The `\markdownRendererJekyllDataString` macro has been deprecated and will be removed in Markdown 4.0.0.

```
  \str_if_eq:nnT
    { #1 }
    { jekyllDataString }
    {
      \cs_undefine:N
        #2
    }
}
```

We define the function `\@@_tl_set_from_cs:NNn` [13]. The function takes a token list, a control sequence with undelimited parameters, and the number of parameters the control sequence accepts, and locally assigns the replacement text of the control sequence to the token list.

```
\cs_new_protected:Nn
  \@@_tl_set_from_cs:NNn
  {
    \tl_set:Nn
      \l_tmpa_tl
      { #2 }
    \int_step_inline:nn
      { #3 }
      {
        \exp_args:NNc
          \tl_put_right:Nn
          \l_tmpa_tl
          { @@_tl_set_from_cs_parameter_ ##1 }
      }
    \exp_args:NNV
      \tl_set:No
      \l_tmpb_tl
      \l_tmpa_tl
    \regex_replace_all:nnN
      { \cP. }
      { \0\0 }
      \l_tmpb_tl
    \int_step_inline:nn
      { #3 }
      {
        \regex_replace_all:nnN
```

```
          { \c { @@_tl_set_from_cs_parameter_ ##1 } }
          { \cP\# ##1 }
          \l_tmpb_tl
      }
    \tl_set:NV
      #1
      \l_tmpb_tl
  }
\cs_generate_variant:Nn
  \@@_define_renderer:nNn
  { ncV }
\cs_generate_variant:Nn
  \cs_generate_from_arg_count:NNnn
  { NNnV }
\cs_generate_variant:Nn
  \tl_put_left:Nn
  { Nv }
\keys_define:nn
  { markdown/options }
  {
    renderers .value_required:n = { true },
    renderers .code:n = {
      \bool_gset_false:N
        \g_@@_unprotected_renderer_bool
      \keys_set:nn
        { markdown/options/renderers }
        { #1 }
    },
    unprotectedRenderers .value_required:n = { true },
    unprotectedRenderers .code:n = {
      \bool_gset_true:N
        \g_@@_unprotected_renderer_bool
      \keys_set:nn
        { markdown/options/renderers }
        { #1 }
    },
  }
```

The following example code showcases a possible configuration of the `\markdownRendererLink` and `\markdownRendererEmphasis` token renderer macros.

```
\markdownSetup{
  renderers = {
    link = {#4},                    % Render links as the link title.
    emphasis = {{\it #1}},    % Render emphasized text using italics.
  }
}
```

```
\tl_new:N
```

```
  \l_@@_renderer_glob_definition_tl
\seq_new:N
  \l_@@_renderer_glob_results_seq
\regex_const:Nn
  \c_@@_prepending_key_regex
  { \^$ }
\regex_const:Nn
  \c_@@_appending_key_regex
  { [\$+]$ }
\regex_const:Nn
  \c_@@_prepending_or_appending_key_regex
  { [\^\$+]$ }
\keys_define:nn
  { markdown/options/renderers }
  {
    unknown .value_required:n = { true },
    unknown .code:n = {
```

Besides defining renderers at once, we can also define them incrementally using the prepending (`^=`) and appending (`$=` or `+=`) operators. This can be especially useful in defining rules for processing different HTML class names and identifiers:

```
\markdownSetup{
  renderers = {
    % Start with empty renderers.
    headerAttributeContextBegin = \begingroup,
    headerAttributeContextEnd = \endgroup,
    attributeClassName = {},
    attributeIdentifier = {},
    % Define the processing of a single specific HTML class name.
    headerAttributeContextBegin += {
      \markdownSetup{
        renderers = {
          attributeClassName += {...},
        },
      }
    },
    % Define the processing of a single specific HTML identifier.
    headerAttributeContextBegin += {
      \markdownSetup{
        renderers = {
          attributeIdentifier += {...},
        },
      }
    },
  },
```

```
}
```

```
      % TODO: Use `\regex_if_match` in TeX Live 2025.
      \regex_match:NVT
        \c_@@_prepending_key_regex
        \l_keys_key_str
        {
          \bool_gset_true:N
            \g_@@_prepending_renderer_bool
        }
      % TODO: Use `\regex_if_match` in TeX Live 2025.
      \regex_match:NVT
        \c_@@_appending_key_regex
        \l_keys_key_str
        {
          \bool_gset_true:N
            \g_@@_appending_renderer_bool
        }
      % TODO: Use `\regex_if_match` in TeX Live 2025.
      \regex_match:NVTF
        \c_@@_prepending_or_appending_key_regex
        \l_keys_key_str
        {
          \tl_set:NV
            \l_tmpa_tl
            \l_keys_key_str
          \regex_replace_once:NnN
            \c_@@_prepending_or_appending_key_regex
            { }
            \l_tmpa_tl
          \tl_set:Nx
            \l_tmpb_tl
            { { \l_tmpa_tl } = }
          \tl_put_right:Nn
            \l_tmpb_tl
            { { #1 } }
          \keys_set:nV
            { markdown/options/renderers }
            \l_tmpb_tl
          \bool_gset_false:N
            \g_@@_prepending_renderer_bool
          \bool_gset_false:N
            \g_@@_appending_renderer_bool
        }
```

In addition to exact token renderer names, we also support wildcards (`*`) and enumerations (`|`) that match multiple token renderer names:

```
\markdownSetup{
```

```
  renderers = {
    heading* = {{\bf #1}},    % Render headings using the bold face.
    jekyllData(String|Number) = {%  % Render YAML string and numbers
      {\it #2}%                                      % using italics.
    },
  }
}
```

Wildcards and enumerations can be combined:

```
\markdownSetup{
  renderers = {
    *lItem(|End) = {"},           % Quote ordered/bullet list items.
  }
}
```

To determine the current token renderer, you can use the pseudo-parameter `#0`:

```
\markdownSetup{
  renderers = {
    heading* = {#0: #1},      % Render headings as the renderer name
  }                                  % followed by the heading text.
}
```

```
3961          {
3962            \@@_glob_seq:VnN
3963              \l_keys_key_str
3964              { g_@@_renderers_seq }
3965              \l_@@_renderer_glob_results_seq
3966            \seq_if_empty:NTF
3967              \l_@@_renderer_glob_results_seq
3968              {
3969                \msg_error:nnV
3970                  { markdown }
3971                  { undefined-renderer }
3972                  \l_keys_key_str
3973              }
3974              {
3975                \tl_set:Nn
3976                  \l_@@_renderer_glob_definition_tl
3977                  { \exp_not:n { #1 } }
3978                \seq_map_inline:Nn
3979                  \l_@@_renderer_glob_results_seq
3980                  {
3981                    \tl_set:Nn
3982                      \l_tmpa_tl
```

```
                    { { ##1 } = }
                  \tl_put_right:Nx
                    \l_tmpa_tl
                    { { \l_@@_renderer_glob_definition_tl } }
                  \keys_set:nV
                    { markdown/options/renderers }
                    \l_tmpa_tl
                }
            }
        }
    },
  }
\msg_new:nnn
  { markdown }
  { undefined-renderer }
  {
    Renderer~#1~is~undefined.
  }
\cs_generate_variant:Nn
  \@@_glob_seq:nnN
  { VnN }
\cs_generate_variant:Nn
  \cs_generate_from_arg_count:NNnn
  { cNVV }
\cs_generate_variant:Nn
  \msg_error:nnn
  { nnV }
\prg_generate_conditional_variant:Nnn
  % TODO: Use `\regex_if_match` in TeX Live 2025.
  \regex_match:Nn  % noqa: w202
  { NV }
  { T, TF }
\prop_new:N
  \g_@@_glob_cache_prop
\tl_new:N
  \l_@@_current_glob_tl
\cs_new_protected:Nn
  \@@_glob_seq:nnN
  {
    \tl_set:Nn
      \l_@@_current_glob_tl
      { ^ #1 $ }
    \prop_get:NeNTF
      \g_@@_glob_cache_prop
      { #2 / \l_@@_current_glob_tl }
      \l_tmpa_clist
      {
        \seq_set_from_clist:NN
          #3
```

```
          \l_tmpa_clist
      }
      {
        \seq_clear:N
          #3
        \regex_replace_all:nnN
          { \* }
          { .* }
          \l_@@_current_glob_tl
        \regex_set:NV
          \l_tmpa_regex
          \l_@@_current_glob_tl
        \seq_map_inline:cn
          { #2 }
          {
            % TODO: Use `\regex_if_match` in TeX Live 2025.
            \regex_match:NnT  % noqa: w202
              \l_tmpa_regex
              { ##1 }
              {
                \seq_put_right:Nn
                  #3
                  { ##1 }
              }
          }
        \clist_set_from_seq:NN
          \l_tmpa_clist
          #3
        \prop_gput:NeV
          \g_@@_glob_cache_prop
          { #2 / \l_@@_current_glob_tl }
          \l_tmpa_clist
      }
  }
\cs_generate_variant:Nn
  \regex_set:Nn
  { NV }
\cs_generate_variant:Nn
  \prop_gput:Nnn
  { NeV }
```

If plain TEX is the top layer, we use the `\@@_define_renderers:` macro to define plain TEX token renderer macros and key–values immediately. Otherwise, we postpone the definition until the upper layers have been loaded.

```
\str_if_eq:VVT
  \c_@@_top_layer_tl
  \c_@@_option_layer_plain_tex_tl
  {
    \@@_define_renderers:
```

```
  }
\ExplSyntaxOff
```

2.2.6 Token Renderer Prototypes

2.2.6.1 yaml Metadata Renderer Prototypes

For simple YAML metadata, a simple high-level interface is provided that can be programmed by setting the expl3 key–values [3] for the module `markdown/jekyllData`.

```
\ExplSyntaxOn
\keys_define:nn
  { markdown/jekyllData }
  { }
\ExplSyntaxOff
```

The option `jekyllDataRenderers`=⟨*key–values*⟩ can be used to set the ⟨*key–values*⟩ for the module `markdown/jekyllData` without using the expl3 syntax.

```
\ExplSyntaxOn
\@@_with_various_cases:nn
  { jekyllDataRenderers }
  {
    \keys_define:nn
      { markdown/options }
      {
        #1 .value_required:n = { true },
        #1 .code:n = {
          \tl_set:Nn
            \l_tmpa_tl
            { ##1 }
```

To ensure that keys containing forward slashes get passed correctly, we replace all forward slashes in the input with backslash tokens with category code letter and then undo the replacement. This means that if any unbraced backslash tokens with category code letter exist in the input, they will be replaced with forward slashes. However, this should be extremely rare.

```
          \tl_replace_all:NnV
            \l_tmpa_tl
            { / }
            \c_backslash_str
          \keys_set:nV
            { markdown/options/jekyll-data-renderers }
            \l_tmpa_tl
        },
      }
  }
\keys_define:nn
  { markdown/options/jekyll-data-renderers }
  {
    unknown .value_required:n = { true },
    unknown .code:n = {
```

```
      \tl_set_eq:NN
        \l_tmpa_tl
        \l_keys_key_str
      \tl_replace_all:NVn
        \l_tmpa_tl
        \c_backslash_str
        { / }
      \tl_put_right:Nn
        \l_tmpa_tl
        {
          .code:n = { #1 }
        }
      \keys_define:nV
        { markdown/jekyllData }
        \l_tmpa_tl
    }
  }
\ExplSyntaxOff
```

For complex YAML metadata, the option `jekyllDataKeyValue`=⟨*module*⟩ [14] can be used to route the processing of all YAML metadata in the current TEX group to the key–values from ⟨*module*⟩.

2.2.6.2 Generating Plain TEX Token Renderer Prototype Macros and Key-Values

We define the command `\@@_define_renderer_prototypes:` that defines plain TEX macros for token renderer prototypes. Furthermore, the `\markdownSetup` macro also accepts the `rendererPrototypes` and `unprotectedRendererPrototypes` keys. The value for these keys must be a list of key–values, where the keys correspond to the markdown token renderer prototype macros and the values are new definitions of these token renderer prototypes.

Whereas the key `rendererPrototypes` defines protected functions, which are usually preferable for typesetting, the key `unprotectedRendererPrototypes` defines unprotected functions, which are easier to expand and may be preferable for programming.

```
\ExplSyntaxOn
\cs_new_protected:Nn \@@_define_renderer_prototypes:
  {
    \seq_map_inline:Nn
      \g_@@_renderers_seq
      {
        \@@_define_renderer_prototype:n
          { ##1 }
      }
  }
\cs_new_protected:Nn \@@_define_renderer_prototype:n
  {
    \@@_renderer_prototype_tl_to_csname:nN
      { #1 }
      \l_tmpa_tl
```

```
    \prop_get:NnN
      \g_@@_renderer_arities_prop
      { #1 }
      \l_tmpb_tl
    \@@_define_renderer_prototype:ncV
      { #1 }
      { \l_tmpa_tl }
      \l_tmpb_tl
  }
\cs_new_protected:Nn \@@_renderer_prototype_tl_to_csname:nN
  {
    \tl_set:Nn
      \l_tmpa_tl
      { \str_uppercase:n { #1 } }
    \tl_set:Nx
      #2
      {
        markdownRenderer
        \tl_head:f { \l_tmpa_tl }
        \tl_tail:n { #1 }
        Prototype
      }
  }
\tl_new:N
  \l_@@_renderer_prototype_definition_tl
\bool_new:N
  \g_@@_prepending_renderer_prototype_bool
\bool_new:N
  \g_@@_appending_renderer_prototype_bool
\bool_new:N
  \g_@@_unprotected_renderer_prototype_bool
\cs_new_protected:Nn \@@_define_renderer_prototype:nNn
  {
    \keys_define:nn
      { markdown/options/renderer-prototypes }
      {
        #1 .value_required:n = { true },
        #1 .code:n = {
          \tl_set:Nn
            \l_@@_renderer_prototype_definition_tl
            { ##1 }
          \regex_replace_all:nnN
            { \cP\#0 }
            { #1 }
            \l_@@_renderer_prototype_definition_tl
          \bool_if:nT
            {
              \g_@@_prepending_renderer_prototype_bool ||
              \g_@@_appending_renderer_prototype_bool
```

```
      }
      {
        \@@_tl_set_from_cs:NNn
          \l_tmpa_tl
          #2
          { #3 }
        \bool_if:NTF
          \g_@@_prepending_renderer_prototype_bool
          {
            \tl_put_right:NV
              \l_@@_renderer_prototype_definition_tl
              \l_tmpa_tl
          }
          {
            \tl_put_left:NV
              \l_@@_renderer_prototype_definition_tl
              \l_tmpa_tl
          }
      }
    \bool_if:NTF
      \g_@@_unprotected_renderer_prototype_bool
      {
        \tl_set:Nn
          \l_tmpa_tl
          { \cs_set:Npn }
      }
      {
        \tl_set:Nn
          \l_tmpa_tl
          { \cs_set_protected:Npn }
      }
    \exp_last_unbraced:NNV
      \cs_generate_from_arg_count:NNnV
      #2
      \l_tmpa_tl
      { #3 }
      \l_@@_renderer_prototype_definition_tl
  },
}
```

Unless the token renderer prototype macro has already been defined or unless, it has been deprecated, we provide an empty definition.

The `\markdownRendererJekyllDataStringPrototype` macro has been deprecated and will be removed in Markdown 4.0.0.

```
\str_if_eq:nnF
  { #1 }
  { jekyllDataString }
  {
    \cs_if_free:NT
```

```
          #2
          {
            \cs_generate_from_arg_count:NNnn
              #2
              \cs_gset_protected:Npn
              { #3 }
              { }
          }
      }
  }
\cs_generate_variant:Nn
  \@@_define_renderer_prototype:nNn
  { ncV }
```

The following example code showcases a possible configuration of the `\markdownRendererImagePrototy` and `\markdownRendererCodeSpanPrototype` token renderer prototype macros.

```
\markdownSetup{
  rendererPrototypes = {
    image = {\pdfximage{#2}},    % Embed PDF images in the document.
    codeSpan = {{\tt #1}},     % Render inline code using monospace.
  }
}
```

```
\keys_define:nn
  { markdown/options/renderer-prototypes }
  {
    unknown .value_required:n = { true },
    unknown .code:n = {
```

Besides defining renderer prototypes at once, we can also define them incrementally using the prepending (`^=`) and appending (`$=` or `+=`) operators. This can be especially useful in defining rules for processing different HTML class names and identifiers:

```
\markdownSetup{
  rendererPrototypes = {
    % Start with empty renderer prototypes.
    headerAttributeContextBegin = \begingroup,
    headerAttributeContextEnd = \endgroup,
    attributeClassName = {},
    attributeIdentifier = {},
    % Define the processing of a single specific HTML class name.
    headerAttributeContextBegin += {
      \markdownSetup{
        rendererPrototypes = {
          attributeClassName += {...},
        },
```

```
      }
    },
    % Define the processing of a single specific HTML identifier.
    headerAttributeContextBegin += {
      \markdownSetup{
        rendererPrototypes = {
          attributeIdentifier += {...},
        },
      }
    },
  },
}
```

```
4255        % TODO: Use `\regex_if_match` in TeX Live 2025.
4256        \regex_match:NVT
4257          \c_@@_prepending_key_regex
4258          \l_keys_key_str
4259          {
4260            \bool_gset_true:N
4261              \g_@@_prepending_renderer_prototype_bool
4262          }
4263        % TODO: Use `\regex_if_match` in TeX Live 2025.
4264        \regex_match:NVT
4265          \c_@@_appending_key_regex
4266          \l_keys_key_str
4267          {
4268            \bool_gset_true:N
4269              \g_@@_appending_renderer_prototype_bool
4270          }
4271        % TODO: Use `\regex_if_match` in TeX Live 2025.
4272        \regex_match:NVTF
4273          \c_@@_prepending_or_appending_key_regex
4274          \l_keys_key_str
4275          {
4276            \tl_set:NV
4277              \l_tmpa_tl
4278              \l_keys_key_str
4279            \regex_replace_once:NnN
4280              \c_@@_prepending_or_appending_key_regex
4281              { }
4282              \l_tmpa_tl
4283            \tl_set:Nx
4284              \l_tmpb_tl
4285              { { \l_tmpa_tl } = }
4286            \tl_put_right:Nn
4287              \l_tmpb_tl
4288              { { #1 } }
4289            \keys_set:nV
```

```
4290              { markdown/options/renderer-prototypes }
4291              \l_tmpb_tl
4292            \bool_gset_false:N
4293              \g_@@_prepending_renderer_prototype_bool
4294            \bool_gset_false:N
4295              \g_@@_appending_renderer_prototype_bool
4296          }
```

In addition to exact token renderer prototype names, we also support wildcards (`*`) and enumerations (`|`) that match multiple token renderer prototype names:

```
\markdownSetup{
  rendererPrototypes = {
    heading* = {{\bf #1}},    % Render headings using the bold face.
    jekyllData(String|Number) = {   % Render YAML string and numbers
      {\it #2}%                                    % using italics.
    },
  }
}
```

Wildcards and enumerations can be combined:

```
\markdownSetup{
  rendererPrototypes = {
    *lItem(|End) = {"},           % Quote ordered/bullet list items.
  }
}
```

To determine the current token renderer prototype, you can use the pseudo-parameter `#0`:

```
\markdownSetup{
  rendererPrototypes = {
    heading* = {#0: #1}, % Render headings as the renderer prototype
  }                              % name followed by the heading text.
}
```

```
4297          {
4298            \@@_glob_seq:VnN
4299              \l_keys_key_str
4300              { g_@@_renderers_seq }
4301              \l_@@_renderer_glob_results_seq
4302            \seq_if_empty:NTF
4303              \l_@@_renderer_glob_results_seq
4304              {
4305                \msg_error:nnV
```

```
                { markdown }
                { undefined-renderer-prototype }
                \l_keys_key_str
            }
            {
              \tl_set:Nn
                \l_@@_renderer_glob_definition_tl
                { \exp_not:n { #1 } }
              \seq_map_inline:Nn
                \l_@@_renderer_glob_results_seq
                {
                  \tl_set:Nn
                    \l_tmpa_tl
                    { { ##1 } = }
                  \tl_put_right:Nx
                    \l_tmpa_tl
                    { { \l_@@_renderer_glob_definition_tl } }
                  \keys_set:nV
                    { markdown/options/renderer-prototypes }
                    \l_tmpa_tl
                }
            }
        }
    },
  }
\msg_new:nnn
  { markdown }
  { undefined-renderer-prototype }
  {
    Renderer~prototype~#1~is~undefined.
  }
\@@_with_various_cases:nn
  { rendererPrototypes }
  {
    \keys_define:nn
      { markdown/options }
      {
        #1 .value_required:n = { true },
        #1 .code:n = {
          \bool_gset_false:N
            \g_@@_unprotected_renderer_prototype_bool
          \keys_set:nn
            { markdown/options/renderer-prototypes }
            { ##1 }
        },
      }
  }
\@@_with_various_cases:nn
  { unprotectedRendererPrototypes }
```

```
  {
    \keys_define:nn
      { markdown/options }
      {
        #1 .value_required:n = { true },
        #1 .code:n = {
          \bool_gset_true:N
            \g_@@_unprotected_renderer_prototype_bool
          \keys_set:nn
            { markdown/options/renderer-prototypes }
            { ##1 }
        },
      }
  }
```

If plain TEX is the top layer, we use the `\@@_define_renderer_prototypes:` macro to define plain TEX token renderer prototype macros and key–values immediately. Otherwise, we postpone the definition until the upper layers have been loaded.

```
\str_if_eq:VVT
  \c_@@_top_layer_tl
  \c_@@_option_layer_plain_tex_tl
  {
    \@@_define_renderer_prototypes:
  }
\ExplSyntaxOff
```

2.2.7 Logging Facilities

The `\markdownInfo`, `\markdownWarning`, and `\markdownError` macros perform logging for the Markdown package. Their first argument specifies the text of the info, warning, or error message. The `\markdownError` macro receives a second argument that provides a help text. You may redefine these macros to redirect and process the info, warning, and error messages.

The `\markdownInfo`, `\markdownWarning`, and `\markdownError` macros have been deprecated and will be removed in the next major version of the Markdown package.

2.2.8 Miscellanea

The `\markdownMakeOther` macro is used by the package, when a TEX engine that does not support direct Lua access is starting to buffer a text. The plain TEX implementation changes the category code of plain TEX special characters to other, but there may be other active characters that may break the output. This macro should temporarily change the category of these to *other*.

```
\let\markdownMakeOther\relax
```

The `\markdownReadAndConvert` macro implements the `\markdownBegin` and `\yamlBegin` macros. The first argument specifies the token sequence that will terminate the markdown input when the plain TEX special characters have had their

category changed to *other*: `\markdownEnd` for the `\markdownBegin` macro and `\yamlEnd` for the `\yamlBegin` macro. The second argument specifies the token sequence that will actually be inserted into the document, when the ending token sequence has been found.

```
\let\markdownReadAndConvert\relax
\begingroup
```

Locally swap the category code of the backslash symbol (`\`) with the pipe symbol (`|`). This is required in order that all the special symbols in the first argument of the `markdownReadAndConvert` macro have the category code *other*.

```
  \catcode`\|=0\catcode`\\=12%
  |gdef|markdownBegin{%
    |markdownReadAndConvert{\markdownEnd}%
                           {|markdownEnd}}%
  |gdef|yamlBegin{%
    |begingroup
    |yamlSetup{jekyllData, expectJekyllData, ensureJekyllData}%
    |markdownReadAndConvert{\yamlEnd}%
                           {|yamlEnd}}%
|endgroup
```

The macro is exposed in the interface, so that users can create their own markdown environments. Due to the way the arguments are passed to Lua, the first argument may not contain the string `]]` (regardless of the category code of the bracket symbol).

The `code` key, which can be used to immediately expand and execute code.

```
\ExplSyntaxOn
\keys_define:nn
  { markdown/options }
  {
    code .value_required:n = { true },
    code .code:n = { #1 },
  }
\ExplSyntaxOff
```

This can be especially useful in snippets.

2.3 LaTeX Interface

The LaTeX interface provides LaTeX environments for the typesetting of markdown input from within LaTeX, facilities for setting Lua, plain TeX, and LaTeX options used during the conversion from markdown to plain TeX, and facilities for changing the way markdown tokens are rendered. The rest of the interface is inherited from the plain TeX interface (see Section 2.2).

To determine whether LaTeX is the top layer or if there are other layers above LaTeX, we take a look on whether the `\c_@@_top_layer_tl` token list has already been defined. If not, we will assume that LaTeX is the top layer.

```
\ExplSyntaxOn
\tl_const:Nn \c_@@_option_layer_latex_tl { latex }
\cs_generate_variant:Nn
  \tl_const:Nn
```

```
  { NV }
\tl_if_exist:NF
  \c_@@_top_layer_tl
  {
    \tl_const:NV
      \c_@@_top_layer_tl
      \c_@@_option_layer_latex_tl
  }
\ExplSyntaxOff
\input markdown/markdown
```

The LaTeX interface is implemented by the `markdown.sty` file, which can be loaded from the LaTeX document preamble as follows:

```
\usepackage[⟨options⟩]{markdown}
```

where ⟨*options*⟩ are the LaTeX interface options (see Section 2.3.3). Note that ⟨*options*⟩ inside the `\usepackage` macro may not set the `markdownRenderers` (see Section 2.2.5.48) and `markdownRendererPrototypes` (see Section 2.2.6.2) keys. Furthermore, although the base variant of the `import` key that loads a single LaTeX theme (see Section 2.3.4) can be used, the extended variant that can load multiple themes and import snippets from them (see Section 2.2.4) cannot. This limitation is due to the way LaTeX 2_ε parses package options.

2.3.1 Typesetting Markdown and YAML

The interface exposes the `markdown`, `markdown*`, and `yaml` LaTeX environments, and redefines the `\markinline`, `\markdownInput`, and `\yamlInput` commands.

2.3.1.1 Typesetting Markdown and yaml directly

The `markdown` and `markdown*` LaTeX environments are aliases for the macros `\markdownBegin` and `\markdownEnd` exposed by the plain TeX interface.

The `markdown*` environment has been deprecated and will be removed in the next major version of the Markdown package.

```
\newenvironment{markdown}\relax\relax
\newenvironment{markdown*}[1]\relax\relax
```

Furthermore, both environments accept LaTeX interface options (see Section 2.3.3) as the only argument. This argument is optional for the `markdown` environment and mandatory for the `markdown*` environment.

The `markdown` and `markdown*` environments are subject to the same limitations as the `\markdownBegin` and `\markdownEnd` macros.

The following example LaTeX code showcases the usage of the `markdown` and `markdown*` environments:

```
\documentclass{article}
\usepackage{markdown}
\begin{document}
```

```
\documentclass{article}
\usepackage{markdown}
\begin{document}
```

```
\begin{markdown}[smartEllipses]
_Hello_ **world** ...
\end{markdown}
\end{document}
```

```
\begin{markdown*}{smartEllipses}
_Hello_ **world** ...
\end{markdown*}
\end{document}
```

You can't directly extend the `markdown` LaTeX environment by using it in other environments as follows:

```
\newenvironment{foo}%
               {code before \begin{markdown}[some, options]}%
               {\end{markdown} code after}
```

This is because the implementation looks for the literal string `\end{markdown}` to stop scanning the markdown text. However, you can work around this limitation by using the `\markdown` and `\markdownEnd` macros directly in the definition as follows:

```
\newenvironment{foo}%
               {code before \markdown[some, options]}%
               {\markdownEnd code after}
```

Specifically, the `\markdown` macro must appear at the end of the replacement before-text and must be followed by text that has not yet been ingested by TeX's input processor.

Furthermore, using the `\markdownEnd` macro in of after the replacement after-text is optional and only makes a difference if you redefined it to produce special effects before and after the `markdown` LaTeX environment.

Lastly, you can't nest the other environments. For example, the following definition would be incorrect:

```
\newenvironment{bar}{\begin{foo}}{\end{foo}}
```

In this example, you should use the `\markdown` macro directly in the definition of the environment `bar`:

```
\newenvironment{bar}{\markdown[some, options]}{\markdownEnd}
```

The `yaml` LaTeX environment is an alias for the macros `\yamlBegin` and `\yamlEnd` exposed by the plain TeX interface.

```
4413 \newenvironment{yaml}\relax\relax
```

Furthermore, the environment accepts LaTeX interface options (see Section 2.3.3) as the only optional argument.

The `yaml` environment is subject to the same limitations as the `\markdownBegin` and `\markdownEnd` macros.

The following example LaTeX code showcases the usage of the `yaml` environment:

```
\documentclass{article}
\usepackage{markdown}
\begin{document}
\begin{yaml}[smartEllipses]
title: _Hello_ **world** ...
author: John Doe
\end{yaml}
\end{document}
```

The above code has the same effect as the below code:

```
\documentclass{article}
\usepackage{markdown}
\begin{document}
\begin{markdown}[
  jekyllData,
  expectJekyllData,
  ensureJekyllData,
  smartEllipses,
]
title: _Hello_ **world** ...
author: John Doe
\end{markdown}
\end{document}
```

You can't directly extend the `yaml` LaTeX environment by using it in other environments. However, you can work around this limitation by using the `\yaml` and `\yamlEnd` macros directly in the definition, similarly to the `\markdown` and `\markdownEnd` macros described previously. Unlike with the `\markdown` and `\markdownEnd` macros, The `\yamlEnd` macro _must_ be used in or after the replacement after-text.

The `\markinline` macro accepts a single mandatory parameter containing inline markdown content and expands to the result of the conversion of the input markdown document to plain TeX. Unlike the `\markinline` macro provided by the plain TeX interface, this macro also accepts LaTeX interface options (see Section 2.3.3) as its optional argument. These options will only influence this markdown content.

2.3.1.2 Typesetting Markdown and yaml from external documents

The `\markdownInput` macro accepts a single mandatory parameter containing the filename of a markdown document and expands to the result of the conversion of the input markdown document to plain TeX. Unlike the `\markdownInput` macro provided by the plain TeX interface, this macro also accepts LaTeX interface options (see Section 2.3.3) as its optional argument. These options will only influence this markdown document.

The following example LaTeX code showcases the usage of the `\markdownInput` macro:

```
\documentclass{article}
\usepackage{markdown}
\begin{document}
\markdownInput[smartEllipses]{hello.md}
\end{document}
```

The \yamlInput macro accepts a single mandatory parameter containing the filename of a YAML document and expands to the result of the conversion of the input YAML document to plain TEX. Unlike the \yamlInput macro provided by the plain TEX interface, this macro also accepts LATEX interface options (see Section 2.3.3) as its optional argument. These options will only influence this YAML document.

The following example LATEX code showcases the usage of the \yamlInput macro:

```
\documentclass{article}
\usepackage{markdown}
\begin{document}
\yamlInput[smartEllipses]{hello.yml}
\end{document}
```

The above code has the same effect as the below code:

```
\documentclass{article}
\usepackage{markdown}
\begin{document}
\markdownInput[
  jekyllData,
  expectJekyllData,
  ensureJekyllData,
  smartEllipses,
]{hello.yml}
\end{document}
```

2.3.2 Using LATEX hooks with the Markdown package

LATEX provides an intricate hook management system that allows users to insert extra material before and after certain TEX macros and LATEX environments, among other things. [15, Section 3.1.2]

The Markdown package is compatible with hooks and allows the use of hooks to insert extra material before TEX commands and before/after LATEX environments without restriction:

```
\documentclass{article}
\usepackage{markdown}
```

```
\begin{document}
\AddToHook{cmd/markdownRendererEmphasis/before}{emphasis: }
\AddToHook{env/markdown/before}{<markdown>}
\AddToHook{env/markdown/after}{</markdown>}
\begin{markdown}
foo _bar_ baz!
\end{markdown}
\end{document}
```

Processing the above example with LaTeX will produce the text "foo emphasis: _bar_ baz!", as expected.

However, using hooks to insert extra material after TeX commands only works for commands with a fixed number of parameters that don't use currying.

If, in the above example, you explicitly defined the renderer for emphasis using `\markdownSetup` or another method that does not use currying, then you would be able to insert extra material even after the renderer:

```
\documentclass{article}
\usepackage{markdown}
\markdownSetup{renderers={emphasis={\emph{#1}}}}
\begin{document}
\AddToHook{cmd/markdownRendererEmphasis/before}{<emphasis>}
\AddToHook{cmd/markdownRendererEmphasis/after}{</emphasis>}
\AddToHook{env/markdown/before}{<markdown>}
\AddToHook{env/markdown/after}{</markdown>}
\begin{markdown}
foo _bar_ baz!
\end{markdown}
\end{document}
```

Processing the above example with LaTeX will produce the text "foo _bar_ baz!", as expected.

However, the default renderer for emphasis uses currying and calls the renderer prototype in a way that prevents the use of hooks to insert extra material after the renderer, see Section 2.2.5.17. In such a case, you would need to redefine the renderer in a way that does not use currying before you would be able to use hooks to insert extra material after it.

Hooks also cannot be used to insert extra material after renderers with a variable number of parameters such as the renderer for tables, see Section 2.2.5.42.

2.3.3 Options

The LaTeX options are represented by a comma-delimited list of ⟨*key*⟩=⟨*value*⟩ pairs. For boolean options, the =⟨*value*⟩ part is optional, and ⟨*key*⟩ will be interpreted as ⟨*key*⟩=`true` if the =⟨*value*⟩ part has been omitted.

LaTeX options map directly to the options recognized by the plain TeX interface (see Section 2.2.2) and to the markdown token renderers and their prototypes recognized by the plain TeX interface (see Sections 2.2.5 and 2.2.6).

The LaTeX options may be specified when loading the LaTeX package, when using the `markdown*` LaTeX environment or the `\markdownInput` macro (see Section 2.3), or via the `\markdownSetup` macro.

2.3.3.1 Finalizing and Freezing the Cache

To ensure compatibility with the `minted` package [16, Section 5.1], which supports the `finalizecache` and `frozencache` package options with similar semantics to the `finalizeCache` and `frozenCache` plain TeX options, the Markdown package also recognizes these as aliases and accepts them as document class options. By passing `finalizecache` and `frozencache` as document class options, you may conveniently control the behavior of both packages at once:

```
\documentclass[frozencache]{article}
\usepackage{markdown,minted}
\begin{document}
\end{document}
```

We hope that other packages will support the `finalizecache` and `frozencache` package options in the future, so that they can become a standard interface for preparing LaTeX document sources for distribution.

```
\DeclareOption{finalizecache}{\markdownSetup{finalizeCache}}
\DeclareOption{frozencache}{\markdownSetup{frozenCache}}
```

2.3.3.2 Generating Plain TeX Option, Token Renderer, and Token Renderer Prototype Macros and Key-Values

If LaTeX is the top layer, we use the `\@@_define_option_commands_and_keyvals:`, `\@@_define_renderers:`, and `\@@_define_renderer_prototypes:` macro to define plain TeX option, token renderer, and token renderer prototype macros and key–values immediately. Otherwise, we postpone the definition until the upper layers have been loaded.

```
\ExplSyntaxOn
\str_if_eq:VVT
  \c_@@_top_layer_tl
  \c_@@_option_layer_latex_tl
  {
    \@@_define_option_commands_and_keyvals:
    \@@_define_renderers:
    \@@_define_renderer_prototypes:
  }
\ExplSyntaxOff
```

The following example LaTeX code showcases a possible configuration of plain TeX interface options `hybrid`, `smartEllipses`, and `cacheDir`.

```
\markdownSetup{
  hybrid,
  smartEllipses,
  cacheDir = /tmp,
}
```

2.3.4 Themes

In Section 2.2.3, we described the concept of themes. In LaTeX, we expand on the concept of themes by allowing a theme to be a full-blown LaTeX package. Specifically, the key–values `theme`=⟨*theme name*⟩ and `import`=⟨*theme name*⟩ load a LaTeX package named `markdowntheme`⟨*munged theme name*⟩`.sty` if it exists and a TeX document named `markdowntheme`⟨*munged theme name*⟩`.tex` otherwise.

Having the Markdown package automatically load either the generic `.tex` *theme file* or the LaTeX-specific `.sty` theme file allows developers to have a single *theme file*, when the theme is small or the difference between TeX formats is unimportant, and scale up to separate theme files native to different TeX formats for large multi-format themes, where different code is needed for different TeX formats. To enable code reuse, developers can load the `.tex` theme file from the `.sty` theme file using the `\markdownLoadPlainTeXTheme` macro.

If the LaTeX option with keys `theme` or `import` is (repeatedly) specified in the `\usepackage` macro, the loading of the theme(s) will be postponed in first-in-first-out order until after the Markdown LaTeX package has been loaded. Otherwise, the theme(s) will be loaded immediately. For example, the following code would first load the Markdown package, then the theme `witiko/example/foo`, and finally the theme `witiko/example/bar`:

```
\usepackage[
  import=witiko/example/foo,
  import=witiko/example/bar,
]{markdown}
```

```
\newif\ifmarkdownLaTeXLoaded
  \markdownLaTeXLoadedfalse
```

Due to limitations of LaTeX, themes may not be loaded after the beginning of a LaTeX document.

We also define the prop `\g_@@_latex_built_in_themes_prop` that contains the code of built-in themes. This is a packaging optimization, so that built-in themes does not need to be distributed in many small files.

```
\ExplSyntaxOn
\prop_new:N
```

```
  \g_@@_latex_built_in_themes_prop
\ExplSyntaxOff
```

Built-in LaTeX themes provided with the Markdown package include:

witiko/markdown/defaults A LaTeX theme with the default definitions of token renderer prototypes for plain TeX. This theme is loaded automatically together with the package and explicitly loading it has no effect.

```
\AtEndOfPackage{\markdownLaTeXLoadedtrue}
```

At the end of the LaTeX module, we load the `witiko/markdown/defaults` LaTeX theme (see Section 2.2.3) with the default definitions for token renderer prototypes unless the option `noDefaults` has been enabled (see Section 2.2.2.3).

```
\ExplSyntaxOn
\str_if_eq:VVT
  \c_@@_top_layer_tl
  \c_@@_option_layer_latex_tl
  {
    \use:c
      { ExplSyntaxOff }
    \AtEndOfPackage
      {
        \@@_if_option:nF
          { noDefaults }
          {
            \@@_if_option:nTF
              { experimental }
              {
                \@@_setup:n
                  { theme = witiko/markdown/defaults@experimental }
              }
              {
                \@@_setup:n
                  { theme = witiko/markdown/defaults }
              }
          }
      }
    \use:c
      { ExplSyntaxOn }
  }
\ExplSyntaxOff
```

See Section 3.3.2 for implementation details of the built-in LaTeX themes.

2.3.5 Snippets

In Section 2.2.4, we described the concept of snippets.

Built-in LaTeX snippets provided with the Markdown package include:

witiko/glossaries/import-acronyms Imports all acronyms from the LaTeX package glossaries, appends them to the `acronyms` option and updates the corresponding renderers to recognize these acronyms in running text and link them to the corresponding glossary entries.

This snippet is provided by the theme `witiko/glossaries@v1`.

See Section 3.3.3 for implementation details of the built-in LaTeX snippets.

2.4 ConTeXt Interface

To determine whether ConTeXt is the top layer or if there are other layers above ConTeXt, we take a look on whether the `\c_@@_top_layer_tl` token list has already been defined. If not, we will assume that ConTeXt is the top layer.

```
\ExplSyntaxOn
\tl_const:Nn \c_@@_option_layer_context_tl { context }
\cs_generate_variant:Nn
  \tl_const:Nn
  { NV }
\tl_if_exist:NF
  \c_@@_top_layer_tl
  {
    \tl_const:NV
      \c_@@_top_layer_tl
      \c_@@_option_layer_context_tl
  }
\ExplSyntaxOff
```

The ConTeXt interface provides a start-stop macro pair for the typesetting of markdown input from within ConTeXt and facilities for setting Lua, plain TeX, and ConTeXt options used during the conversion from markdown to plain TeX. The rest of the interface is inherited from the plain TeX interface (see Section 2.2).

```
\writestatus{loading}{ConTeXt User Module / markdown}%
\startmodule[markdown]
\def\dospecials{\do\ \do\\\do\{\do\}\do\$\do\&%
  \do\#\do\^\do\_\do\%\do\~}%
\input markdown/markdown
```

The ConTeXt interface is implemented by the `t-markdown.tex` ConTeXt module file that can be loaded as follows:

```
\usemodule[t][markdown]
```

It is expected that the special plain TeX characters have the expected category codes, when `\input`ting the file.

2.4.1 Typesetting Markdown and YAML

The interface exposes the `\startmarkdown`, `\stopmarkdown`, `\startyaml`, `\stopyaml`, `\inputmarkdown`, and `\inputyaml` macros.

2.4.1.1 Typesetting Markdown and yaml directly

The `\startmarkdown` and `\stopmarkdown` macros are aliases for the macros `\markdownBegin` and `\markdownEnd` exposed by the plain TEX interface.

```
\let\startmarkdown\relax
\let\stopmarkdown\relax
```

You may prepend your own code to the `\startmarkdown` macro and redefine the `\stopmarkdown` macro to produce special effects before and after the markdown block.

The macros `\startmarkdown` and `\stopmarkdown` are subject to the same limitations as the `\markdownBegin` and `\markdownEnd` macros.

The following example ConTEXt code showcases the usage of the `\startmarkdown` and `\stopmarkdown` macros:

```
\usemodule[t][markdown]
\starttext
\startmarkdown
_Hello_ **world** ...
\stopmarkdown
\stoptext
```

The `\startyaml` and `\stopyaml` macros are aliases for the macros `\yamlBegin` and `\yamlEnd` exposed by the plain TEX interface.

```
\let\startyaml\relax
\let\stopyaml\relax
```

You may prepend your own code to the `\startyaml` macro and append your own code to the `\stopyaml` macro to produce special effects before and after the YAML document.

The macros `\startyaml` and `\stopyaml` are subject to the same limitations as the `\markdownBegin` and `\markdownEnd` macros.

The following example ConTEXt code showcases the usage of the `\startyaml` and `\stopyaml` macros:

```
\usemodule[t][markdown]
\starttext
\startyaml
title: _Hello_ **world** ...
author: John Doe
\stopyaml
\stoptext
```

The above code has the same effect as the below code:

```
\usemodule[t][markdown]
\starttext
\setupyaml[jekyllData, expectJekyllData, ensureJekyllData]
```

```
\startyaml
title: _Hello_ **world** ...
author: John Doe
\stopyaml
\stoptext
```

2.4.1.2 Typesetting Markdown and yaml from external documents

The `\inputmarkdown` macro aliases the macro `\markdownInput` exposed by the plain TEX interface.

```
4483 \let\inputmarkdown\relax
```

Furthermore, the `\inputmarkdown` macro also accepts ConTEXt interface options (see Section 2.4.2) as its optional argument. These options will only influence this markdown document.

The following example ConTEXt code showcases the usage of the `\inputmarkdown` macro:

```
\usemodule[t][markdown]
\starttext
\inputmarkdown[smartEllipses]{hello.md}
\stoptext
```

The above code has the same effect as the below code:

```
\usemodule[t][markdown]
\starttext
\setupmarkdown[smartEllipses]
\inputmarkdown{hello.md}
\stoptext
```

The `\inputyaml` macro aliases the macro `\yamlInput` exposed by the plain TEX interface.

```
4484 \let\inputyaml\relax
```

Furthermore, the `\inputyaml` macro also accepts ConTEXt interface options (see Section 2.4.2) as its optional argument. These options will only influence this YAML document.

The following example ConTEXt code showcases the usage of the `\inputyaml` macro:

```
\usemodule[t][markdown]
\starttext
\inputyaml[smartEllipses]{hello.yml}
\stoptext
```

The above code has the same effect as the below code:

```
\usemodule[t][markdown]
\starttext
\setupyaml[smartEllipses]
\inputyaml{hello.yml}
\stoptext
```

2.4.2 Options

The ConTEXt options are represented by a comma-delimited list of ⟨*key*⟩=⟨*value*⟩ pairs. For boolean options, the =⟨*value*⟩ part is optional, and ⟨*key*⟩ will be interpreted as ⟨*key*⟩=`true` (or, equivalently, ⟨*key*⟩=`yes`) if the =⟨*value*⟩ part has been omitted.

ConTEXt options map directly to the options recognized by the plain TEX interface (see Section 2.2.2).

The ConTEXt options may be specified when using the `\inputmarkdown` macro (see Section 2.4), via the `\markdownSetup` macro, or via the `\setupmarkdown[#1]` macro, which is an alias for `\markdownSetup{#1}`.

```
\ExplSyntaxOn
\cs_new_protected:Npn
  \setupmarkdown
  [ #1 ]
  {
    \@@_setup:n
      { #1 }
  }
```

The command `\setupyaml` is also available as an alias for the command `\setupmarkdown`.

```
\cs_gset_eq:NN
  \setupyaml
  \setupmarkdown
```

2.4.2.1 Generating Plain TEX Option Macros and Key-Values

Unlike plain TEX, we also accept caseless variants of options in line with the style of ConTEXt.

```
\cs_new_protected:Nn \@@_caseless:N
  {
    \regex_replace_all:nnN
      { ([a-z])([A-Z]) }
      { \1 \c { str_lowercase:n } \cB\{ \2 \cE\} }
      #1
    \tl_set:Nx
      #1
      { #1 }
  }
\seq_gput_right:Nn \g_@@_cases_seq { @@_caseless:N }
```

If ConTEXt is the top layer, we use the `\@@_define_option_commands_and_keyvals:`, `\@@_define_renderers:`, and `\@@_define_renderer_prototypes:` macro to define plain TEX option, token renderer, and token renderer prototype macros and key–values immediately. Otherwise, we postpone the definition until the upper layers have been loaded.

```
\str_if_eq:VVT
  \c_@@_top_layer_tl
  \c_@@_option_layer_context_tl
  {
    \@@_define_option_commands_and_keyvals:
    \@@_define_renderers:
    \@@_define_renderer_prototypes:
  }
```

2.4.3 Themes

In Section 2.2.3, we described the concept of themes. In ConTEXt, we expand on the concept of themes by allowing a theme to be a full-blown ConTEXt module. Specifically, the key–values `theme`=⟨*theme name*⟩ and `import`=⟨*theme name*⟩ load a ConTEXt module named `t-markdowntheme`⟨*munged theme name*⟩`.tex` if it exists and a TEX document named `markdowntheme`⟨*munged theme name*⟩`.tex` otherwise.

Having the Markdown package automatically load either the generic `.tex` *theme file* or the ConTEXt-specific `t-*.tex` theme file allows developers to have a single *theme file*, when the theme is small or the difference between TEX formats is unimportant, and scale up to separate theme files native to different TEX formats for large multi-format themes, where different code is needed for different TEX formats. To enable code reuse, developers can load the `.tex` theme file from the `t-*.tex` theme file using the `\markdownLoadPlainTeXTheme` macro.

For example, to load a theme named `witiko/tilde` in your document:

```
\usemodule[t][markdown]
\setupmarkdown[import=witiko/tilde]
```

We also define the prop `\g_@@_context_built_in_themes_prop` that contains the code of built-in themes. This is a packaging optimization, so that built-in themes does not need to be distributed in many small files.

```
\prop_new:N
  \g_@@_context_built_in_themes_prop
\ExplSyntaxOff
```

Built-in ConTEXt themes provided with the Markdown package include:

witiko/markdown/defaults A ConTEXt theme with the default definitions of token renderer prototypes for plain TEX. This theme is loaded automatically together with the package and explicitly loading it has no effect.

```
\startmodule[markdownthemewitiko_markdown_defaults]
\unprotect
```

See Section 3.4.2 for implementation details of the built-in ConTEXt themes.

3 Implementation

This part of the documentation describes the implementation of the interfaces exposed by the package (see Section 2) and is aimed at the developers of the package, as well as the curious users.

Figure 1 shows the high-level structure of the Markdown package: The translation from markdown to TEX *token renderers* is performed by the Lua layer. The plain TEX layer provides default definitions for the token renderers. The LATEX and ConTEXt layers correct idiosyncrasies of the respective TEX formats, and provide format-specific default definitions for the token renderers.

3.1 Lua Implementation

The Lua implementation implements `writer` and `reader` objects, which provide the conversion from markdown to plain TEX, and `extensions` objects, which provide syntax extensions for the `writer` and `reader` objects.

The Lunamark Lua module implements writers for the conversion to various other formats, such as DocBook, Groff, or HTML. These were stripped from the module and the remaining markdown reader and plain TEX writer were hidden behind the converter functions exposed by the Lua interface (see Section 2.1).

Furthermore, here are some abbreviations that we inherited from the Lunamark library and which are used throughout the Lua implementation.

```
local upper, format, length =
  string.upper, string.format, string.len
local P, R, S, V, C, Cg, Cb, Cmt, Cc, Ct, B, Cs, Cp, any =
  lpeg.P, lpeg.R, lpeg.S, lpeg.V, lpeg.C, lpeg.Cg, lpeg.Cb,
  lpeg.Cmt, lpeg.Cc, lpeg.Ct, lpeg.B, lpeg.Cs, lpeg.Cp, lpeg.P(1)
```

3.1.1 Unicode Support

To start off, we load a Lua file named `markdown-unicode-data.lua` that contains our implementation of various Unicode algorithms.

```
local early_warnings = {}
local unicode_data = require("markdown-unicode-data")
if metadata.version ~= unicode_data.metadata.version then
  table.insert(
    early_warnings,
    "markdown.lua " .. metadata.version .. " used with " ..
    "markdown-unicode-data.lua " .. unicode_data.metadata.version .. "."
  )
end
```

In the following subsections, we'll write a second-order file named `markdown-unicode-data-generator`. The code from this file will be executed during the compilation of the Markdown package and the standard output will be stored in a generated file named `markdown-unicode-data.lua`. First, let's define a couple helper functions.

The function `depth_first_search` performs the depth first search algorithm on a tree with nodes being tables with the key `_type` equal to either `intermediate` or `leaf` and with edges labeled with bytes.

Since the algorithm is implemented using recursion, it should only be used for the traversal of shallow trees to prevent exceeding the maximum recursion depth (usually 100).

```
4534 local function depth_first_search(node, path, visit, leave)
4535   assert(node._type == "intermediate")
4536   visit(node, path)
4537   for label, child in pairs(node) do
4538     if label == "_type" then
4539       goto continue
4540     end
4541     if child._type ~= "intermediate" then
4542       goto continue
4543     end
4544     depth_first_search(child, path .. label, visit, leave)
4545     ::continue::
4546   end
4547   for label, child in pairs(node) do
4548     if label == "_type" then
4549       goto continue
4550     end
4551     if child._type ~= "leaf" then
4552       goto continue
4553     end
4554     visit(child, path)
4555     ::continue::
4556   end
4557   leave(node, path)
4558 end
```

This function is defined in the file `markdown-parser.lua` as well, so that it can be used to define the `extensions.acronyms` built-in syntax extension. The function `serialize_byte_parser` produces the Lua code for a PEG parser that matches a single byte.

```
4559 local function serialize_byte_parser(byte)
4560   if byte == '"' then
4561     return "P('" .. byte .. "')"
4562   elseif byte == "\\" then
4563     return 'P("\\\\")'
4564   else
4565     return 'P("' .. byte .. '")'
4566   end
```

```
4567 end
```

The function `serialize_byte_range_parser` produces the Lua code for a PEG parser that matches a contiguous range of bytes.

```
4568 local function serialize_byte_range_parser(start_byte, end_byte)
4569   assert(start_byte <= end_byte)
4570   if start_byte == "\\" then
4571     start_byte = "\\\\"
4572   end
4573   if end_byte == "\\" then
4574     end_byte = "\\\\"
4575   end
4576   if start_byte == '"' or end_byte == '"' then
4577     return "R('" .. start_byte .. end_byte .. "')"
4578   else
4579     return 'R("' .. start_byte .. end_byte .. '")'
4580   end
4581 end
```

The function `serialize_replacement` produces the Lua code for a string literal with one or more UTF-8-encoded Unicode characters.

```
4582 local function serialize_replacement(codepoints)
4583   assert(#codepoints > 0)
4584   local buffer = {'"'}
4585   for _, codepoint in ipairs(codepoints) do
4586     local code = utf8.char(codepoint)
4587     for i = 1, #code do
4588       local byte = code:sub(i, i)
4589       if byte == '"' then
4590         table.insert(buffer, '\\"')
4591       elseif byte == "\\" then
4592         table.insert(buffer, "\\\\")
4593       else
4594         table.insert(buffer, byte)
4595       end
4596     end
4597   end
4598   table.insert(buffer, '"')
4599   return table.concat(buffer)
4600 end
```

The function `read_decompositions` is an iterator that reads a file `UnicodeData.txt` that has previously been opened for reading and yields all canonical and compatibility decompositions from that file.

```
4601 local function read_decompositions(file)
4602   return function()
4603     local from_codepoint, mapping
4604     for line in file:lines() do
4605       from_codepoint, mapping
4606         = line:match("^(%x+);[^;]*;%a*;%d+;%a*;([<%a>%x ]*)")
```

```
      assert(from_codepoint ~= nil)
      if #mapping > 0 then
        break
      end
    end
    if #mapping == 0 then
      return nil
    end
    from_codepoint = tonumber(from_codepoint, 16)
    local to_codepoints, decomposition_type = {}, "canonical"
    for raw_codepoint in mapping:gmatch("%S+") do
      assert(#raw_codepoint > 0)
      if raw_codepoint:sub(1, 1) == "<" then
        decomposition_type = "compatibility"
      else
        local codepoint = tonumber(raw_codepoint, 16)
        table.insert(to_codepoints, codepoint)
      end
    end
    assert(#to_codepoints > 0)
    return decomposition_type, from_codepoint, to_codepoints
  end
end
```

Next, let's define some aliases in the generated file.

```
print("local P, R, Cc, C = lpeg.P, lpeg.R, lpeg.Cc, lpeg.C")
print("local fail = P(false)")
print("-- luacheck: push no max line length")
```

3.1.1.1 Canonical and Compatibility Decomposition

Low-level parsers that decompose UTF-8-encoded Unicode characters using either the canonical or the compatibility decomposition [17, Section 3.7] are organized in table `unicode_data.decomposition_mapping` based on the number of bytes they occupy after conversion to UTF-8.

First, let's read the file `UnicodeData.txt`.

```
;(function()
  local file = assert(io.open("UnicodeData.txt", "r"),
    [[Could not open file "UnicodeData.txt"]])
```

In order to minimize the size and speed of the parser, we will first construct prefix trees of UTF-8 encodings for all codepoints of a given decomposition type and code length.

```
  local decomposition_types = {"canonical", "compatibility"}
  local prefix_trees = {}
  for _, decomposition_type in ipairs(decomposition_types) do
    prefix_trees[decomposition_type] = {}
    for char_length = 1, 4 do
      prefix_trees[decomposition_type][char_length]
        = {_type = "intermediate"}
    end
```

```
4644  end
4645  for decomposition_type, from_codepoint, to_codepoints
4646      in read_decompositions(file) do
4647    local from_code = utf8.char(from_codepoint)
4648    local node = prefix_trees[decomposition_type][#from_code]
4649    for i = 1, #from_code do
4650      local from_byte = from_code:sub(i, i)
4651      if i < #from_code then
4652        if node[from_byte] == nil then
4653          node[from_byte] = {_type = "intermediate"}
4654        end
4655        node = node[from_byte]
4656      else
4657        table.insert(node, {from_byte, to_codepoints, _type = "leaf"})
4658      end
4659    end
4660  end
4661  assert(file:close())
```

Next, we will construct parsers out of the prefix trees.

```
4662  print("M.decomposition_mapping = {}")
4663  for _, decomposition_type in ipairs(decomposition_types) do
4664    print("M.decomposition_mapping." .. decomposition_type .. " = {}")
4665    for length, prefix_tree in pairs(prefix_trees[decomposition_type])
4666    do
4667      local subparsers = {}
4668      depth_first_search(prefix_tree, "", function(node, path)
4669        if node._type == "leaf" then
4670          local from_byte, to_codepoints = table.unpack(node)
4671          local suffix = serialize_byte_parser(from_byte)
4672            .. " / " .. serialize_replacement(to_codepoints)
4673          if subparsers[path] ~= nil then
4674            subparsers[path] = subparsers[path] .. " + " .. suffix
4675          else
4676            subparsers[path] = suffix
4677          end
4678        end
4679      end, function(_, path)
4680        if #path > 0 then
4681          local byte = path:sub(#path, #path)
4682          local parent_path = path:sub(1, #path-1)
4683          local prefix = serialize_byte_parser(byte)
4684          local suffix
4685          if subparsers[path]:find(" %+ ") then
4686            suffix = prefix .. " * (" .. subparsers[path] .. ")"
4687          else
4688            suffix = prefix .. " * " .. subparsers[path]
4689          end
4690          if subparsers[parent_path] ~= nil then
4691            subparsers[parent_path] = subparsers[parent_path]
```

```
                                    .. " + " .. suffix
          else
            subparsers[parent_path] = suffix
          end
        else
          print(
            "M.decomposition_mapping." .. decomposition_type
            .. "[" .. length .. "] = " .. (subparsers[path] or "fail")
          )
        end
      end)
    end
  end
end)()
```

3.1.1.2 Hangul Syllable Decomposition

Low-level parsers that decompose UTF-8-encoded Unicode characters using the Hangul syllable decomposition [17, Section 3.12.2] are also organized in table `unicode_data.decomposition_mapping`, previously defined in Section 3.1.1.1 based on the number of bytes they occupy after conversion to UTF-8.

First, let's read the file `HangulSyllableType.txt`.

```
;(function()
  local file = assert(io.open("HangulSyllableType.txt", "r"),
    [[Could not open file "HangulSyllableType.txt"]])
```

In order to minimize the size and speed of the parser, we will first construct prefix trees of UTF-8 encodings for all codepoints of a given syllable type and code length.

```
  local syllable_types = {"LV", "LVT"}
  local prefix_trees = {}
  for _, syllable_type in ipairs(syllable_types) do
    prefix_trees[syllable_type] = {}
    for char_length = 1, 4 do
      prefix_trees[syllable_type][char_length]
        = {_type = "intermediate"}
    end
  end
  for line in file:lines() do
    if #line == 0 or line:sub(1, 1) == "#" then
      goto continue
    end
    local codepoint, syllable_type = line:match("^([%x.]+)%s*;%s*(%a*)")
    assert(codepoint ~= nil)
    if prefix_trees[syllable_type] == nil then
      goto continue
    end
    local codepoint_start, codepoint_end
    if codepoint:find("%.%.") then
      codepoint_start, codepoint_end
```

```
        = codepoint:match("^(%x+)%.%.(%x+)$")
    else
      codepoint_start, codepoint_end = codepoint, codepoint
    end
    codepoint_start = tonumber(codepoint_start, 16)
    codepoint_end = tonumber(codepoint_end, 16)
    local prev_code, prev_leaf_node
    for codepoint = codepoint_start, codepoint_end do
      local code = utf8.char(codepoint)
      local node = prefix_trees[syllable_type][#code]
      for i = 1, #code do
        local byte = code:sub(i, i)
        if i < #code then
          if node[byte] == nil then
            node[byte] = {_type = "intermediate"}
          end
          node = node[byte]
        else
          local leaf_node
          if (
                prev_code ~= nil
                and #prev_code == #code
                and code:sub(1, #code - 1)
                  == prev_code:sub(1, #code - 1)
              ) then
            assert(prev_leaf_node ~= nil)
            leaf_node = prev_leaf_node
            leaf_node[2] = byte
          else
            leaf_node = {byte, byte, _type = "leaf"}
            table.insert(node, leaf_node)
          end
          prev_code, prev_leaf_node = code, leaf_node
        end
      end
    end
    ::continue::
  end
  assert(file:close())
```

Next, we will define constants and functions with the Hangul syllable (de)composition algorithm.

```
  print(string.format("local s_base = %d", tonumber("AC00", 16)))
  print(string.format("local l_base = %d", tonumber("1100", 16)))
  print(string.format("local v_base = %d", tonumber("1161", 16)))
  print(string.format("local t_base = %d", tonumber("11A7", 16)))
  print(string.format("local l_count = %d", 19))
  print(string.format("local v_count = %d", 21))
  print(string.format("local t_count = %d", 28))
  print("local n_count = v_count * t_count")
```

```
print("local s_count = l_count * n_count")

print("local function hangul_decompose_LV(byte)")
print("  local s = utf8.codepoint(byte)")
print("  local s_index = s - s_base")
print("  local l_index = s_index // n_count")
print("  local v_index = (s_index % n_count) // t_count")
print("  local l_part = l_base + l_index")
print("  local v_part = v_base + v_index")
print("  return utf8.char(l_part) .. utf8.char(v_part)")
print("end")

print("local function hangul_decompose_LVT(byte)")
print("  local s = utf8.codepoint(byte)")
print("  local s_index = s - s_base")
print("  local lv_index = (s_index // t_count) * t_count")
print("  local t_index = s_index % t_count")
print("  local lv_part = s_base + lv_index")
print("  local t_part = t_base + t_index")
print("  return utf8.char(lv_part) .. utf8.char(t_part)")
print("end")

print("function M.hangul_compose(first_byte, second_byte)")
print("  local last = utf8.codepoint(first_byte)")
print("  local ch = utf8.codepoint(second_byte)")
print("  local l_index = last - l_base")
print("  if 0 <= l_index and l_index < l_count then")
print("    local v_index = ch - v_base")
print("    if 0 <= v_index and v_index < v_count then")
print("      return utf8.char(")
print("        s_base + (l_index * v_count + v_index) * t_count")
print("      )")
print("    end")
print("  end")
print("  local s_index = last - s_base")
print("  if 0 <= s_index and s_index < s_count")
print("      and s_index % t_count == 0 then")
print("    local t_index = ch - t_base")
print("    if 0 < t_index and t_index < t_count then")
print("      return utf8.char(last + t_index)")
print("    end")
print("  end")
print("  return nil")
print("end")
```

Next, we will construct parsers out of the prefix trees.

```
print("M.decomposition_mapping.hangul = {}")
for _, syllable_type in ipairs(syllable_types) do
  print("M.decomposition_mapping.hangul." .. syllable_type .. " = {}")
  for length, prefix_tree in pairs(prefix_trees[syllable_type]) do
```

```
4825      local subparsers = {}
4826      depth_first_search(prefix_tree, "", function(node, path)
4827        if node._type == "leaf" then
4828          local start_byte, end_byte = table.unpack(node)
4829          local suffix
4830          if start_byte == end_byte then
4831            suffix = serialize_byte_parser(start_byte)
4832          else
4833            assert(start_byte < end_byte)
4834            suffix = serialize_byte_range_parser(start_byte, end_byte)
4835          end
4836          if subparsers[path] ~= nil then
4837            subparsers[path] = subparsers[path] .. " + " .. suffix
4838          else
4839            subparsers[path] = suffix
4840          end
4841        end
4842      end, function(_, path)
4843        if #path > 0 then
4844          local byte = path:sub(#path, #path)
4845          local parent_path = path:sub(1, #path-1)
4846          local prefix = serialize_byte_parser(byte)
4847          local suffix
4848          if subparsers[path]:find(" %+ ") then
4849            suffix = prefix .. " * (" .. subparsers[path] .. ")"
4850          else
4851            suffix = prefix .. " * " .. subparsers[path]
4852          end
4853          if subparsers[parent_path] ~= nil then
4854            subparsers[parent_path] = subparsers[parent_path]
4855                                      .. " + " .. suffix
4856          else
4857            subparsers[parent_path] = suffix
4858          end
4859        else
4860          if subparsers[path] then
4861            print(
4862              "M.decomposition_mapping.hangul." .. syllable_type
4863              .. "[" .. length .. "] = C(" .. subparsers[path] .. ")"
4864              .. " / hangul_decompose_" .. syllable_type
4865            )
4866          else
4867            print(
4868              "M.decomposition_mapping.hangul." .. syllable_type
4869              .. "[" .. length .. "] = fail"
4870            )
4871          end
4872        end
4873      end)
```

```
    end
  end
end)()
```

3.1.1.3 Canonical Composition

Low-level parsers that map pairs of UTF-8-encoded Unicode characters from a canonical or compatibility decomposition into their primary composites [17, Section 3.11.6] are organized in table `unicode_data.composition_mapping` based on the number of bytes the characters occupy after conversion to UTF-8.

First, let's read the file `DerivedNormalizationProps.txt` and record all canonical decomposable characters that are not full composition exclusions.

```
;(function()
  local file = assert(io.open("DerivedNormalizationProps.txt", "r"),
    [[Could not open file "DerivedNormalizationProps.txt"]])
  local full_composition_exclusions = {}
  for line in file:lines() do
    if #line == 0 or line:sub(1, 1) == "#" then
      goto continue
    end
    local codepoint, property = line:match("^([%x.]+)%s*;%s*([%a_]+)")
    assert(codepoint ~= nil)
    if property ~= "Full_Composition_Exclusion" then
      goto continue
    end
    local codepoint_start, codepoint_end
    if codepoint:find("%.%.") then
      codepoint_start, codepoint_end
        = codepoint:match("^(%x+)%.%.(%x+)$")
    else
      codepoint_start, codepoint_end = codepoint, codepoint
    end
    codepoint_start = tonumber(codepoint_start, 16)
    codepoint_end = tonumber(codepoint_end, 16)
    for codepoint = codepoint_start, codepoint_end do
      full_composition_exclusions[codepoint] = true
    end
    ::continue::
  end
  assert(file:close())
```

Next, let's also read the file `UnicodeData.txt`.

```
  file = assert(io.open("UnicodeData.txt", "r"),
    [[Could not open file "UnicodeData.txt"]])
```

In order to minimize the size and speed of the parser, we will first construct prefix trees of UTF-8 encodings for all pairs of codepoints of given code lengths.

```
  local prefix_trees = {starters = {}, both = {}}
  for first_char_length = 1, 4 do
    prefix_trees.starters[first_char_length]
```

```
      = {_type = "intermediate"}
    prefix_trees.both[first_char_length] = {}
    for second_char_length = 1, 4 do
      prefix_trees.both[first_char_length][second_char_length]
        = {_type = "intermediate"}
    end
  end
  local seen_starter_codes = {}
  for decomposition_type, to_codepoint, from_codepoints
      in read_decompositions(file) do
    if (
          decomposition_type ~= "canonical"
          or #from_codepoints ~= 2
          or full_composition_exclusions[to_codepoint]
        ) then
      goto continue
    end
    local starter_code = utf8.char(from_codepoints[1])
    local combining_character_code = utf8.char(from_codepoints[2])
    local starter_node = prefix_trees.starters[#starter_code]
    local both_node
      = prefix_trees.both[#starter_code][#combining_character_code]
    for i = 1, #starter_code do
      local from_byte = starter_code:sub(i, i)
      if both_node[from_byte] == nil then
        both_node[from_byte] = {_type = "intermediate"}
      end
      both_node = both_node[from_byte]
      if i < #starter_code then
        if starter_node[from_byte] == nil then
          starter_node[from_byte] = {_type = "intermediate"}
        end
        starter_node = starter_node[from_byte]
      elseif seen_starter_codes[starter_code] == nil then
        seen_starter_codes[starter_code] = true
        table.insert(starter_node, {from_byte, _type = "leaf"})
      end
    end
    for i = 1, #combining_character_code do
      local from_byte = combining_character_code:sub(i, i)
      if i < #combining_character_code then
        if both_node[from_byte] == nil then
          both_node[from_byte] = {_type = "intermediate"}
        end
        both_node = both_node[from_byte]
      else
        table.insert(
          both_node,
          {from_byte, to_codepoint, _type = "leaf"}
```

```
      )
    end
  end
  ::continue::
end
assert(file:close())
```

Next, we will construct parsers out of the prefix trees.

```
print("M.composition_mapping = {starters = {}, both = {}}")
for first_char_length = 1, 4 do
  local prefix_tree = prefix_trees.starters[first_char_length]
  local subparsers = {}
  depth_first_search(prefix_tree, "", function(node, path)
    if node._type == "leaf" then
      local from_byte = table.unpack(node)
      local suffix = serialize_byte_parser(from_byte)
      if subparsers[path] ~= nil then
        subparsers[path] = subparsers[path] .. " + " .. suffix
      else
        subparsers[path] = suffix
      end
    end
  end, function(_, path)
    if #path > 0 then
      local byte = path:sub(#path, #path)
      local parent_path = path:sub(1, #path-1)
      local prefix = serialize_byte_parser(byte)
      local suffix
      if subparsers[path]:find(" %+ ") then
        suffix = prefix .. " * (" .. subparsers[path] .. ")"
      else
        suffix = prefix .. " * " .. subparsers[path]
      end
      if subparsers[parent_path] ~= nil then
        subparsers[parent_path] = subparsers[parent_path]
                                  .. " + " .. suffix
      else
        subparsers[parent_path] = suffix
      end
    else
      print(
        "M.composition_mapping.starters["
        .. first_char_length .. "] = " .. (subparsers[path] or "fail")
      )
    end
  end)
  print(
    string.format(
      "M.composition_mapping.both[%d] = {}",
      first_char_length
```

```
      )
    )
    for second_char_length = 1, 4 do
      prefix_tree
        = prefix_trees.both[first_char_length][second_char_length]
      subparsers = {}
      depth_first_search(prefix_tree, "", function(node, path)
        if node._type == "leaf" then
          local from_byte, to_codepoint = table.unpack(node)
          local suffix = serialize_byte_parser(from_byte)
            .. " / " .. serialize_replacement({to_codepoint})
          if subparsers[path] ~= nil then
            subparsers[path] = subparsers[path] .. " + " .. suffix
          else
            subparsers[path] = suffix
          end
        end
      end, function(_, path)
        if #path > 0 then
          local byte = path:sub(#path, #path)
          local parent_path = path:sub(1, #path-1)
          local prefix = serialize_byte_parser(byte)
          local suffix
          if subparsers[path]:find(" %+ ") then
            suffix = prefix .. " * (" .. subparsers[path] .. ")"
          else
            suffix = prefix .. " * " .. subparsers[path]
          end
          if subparsers[parent_path] ~= nil then
            subparsers[parent_path] = subparsers[parent_path]
                                    .. " + " .. suffix
          else
            subparsers[parent_path] = suffix
          end
        else
          print(
            "M.composition_mapping.both[" .. first_char_length .. "]["
              .. second_char_length .. "] = "
              .. (subparsers[path] or "fail")
          )
        end
      end)
    end
  end
end)()
```

3.1.1.4 Case Folding

Low-level parsers that case-fold UTF-8-encoded Unicode characters using the full map-

ping (C and F) [17, Section 3.13.3] are organized in table `unicode_data.casefold_mapping` based on the number of bytes they occupy after conversion to UTF-8.

First, let's read the file `CaseFolding.txt`.

```
;(function()
  local file = assert(io.open("CaseFolding.txt", "r"),
    [[Could not open file "CaseFolding.txt"]])
```

In order to minimize the size and speed of the parser, we will first construct prefix trees of UTF-8 encodings for all codepoints of a given code length.

```
  local prefix_trees = {}
  for char_length = 1, 4 do
    prefix_trees[char_length] = {_type = "intermediate"}
  end
  for line in file:lines() do
    if #line == 0 or line:sub(1, 1) == "#" then
      goto continue
    end
    local raw_from_codepoint, status, raw_to_codepoints
      = line:match("^(%x+); ([CFST]); ([%x ]+);")
    assert(raw_from_codepoint ~= nil)
    assert(status ~= nil)
    assert(raw_to_codepoints ~= nil)
    if status ~= "C" and status ~= "F" then
      goto continue
    end
    local from_codepoint = tonumber(raw_from_codepoint, 16)
    local to_codepoints = {}
    for raw_codepoint in raw_to_codepoints:gmatch('%x+') do
      local codepoint = tonumber(raw_codepoint, 16)
      table.insert(to_codepoints, codepoint)
    end
    local from_code = utf8.char(from_codepoint)
    local node = prefix_trees[#from_code]
    for i = 1, #from_code do
      local from_byte = from_code:sub(i, i)
      if i < #from_code then
        if node[from_byte] == nil then
          node[from_byte] = {_type = "intermediate"}
        end
        node = node[from_byte]
      else
        table.insert(node, {from_byte, to_codepoints, _type = "leaf"})
      end
    end
    ::continue::
  end
  assert(file:close())
```

Next, we will construct parsers out of the prefix trees.

```
  print("M.casefold_mapping = {}")
```

```
  for length, prefix_tree in pairs(prefix_trees) do
    local subparsers = {}
    depth_first_search(prefix_tree, "", function(node, path)
      if node._type == "leaf" then
        local from_byte, to_codepoints = table.unpack(node)
        local suffix = serialize_byte_parser(from_byte)
          .. " / " .. serialize_replacement(to_codepoints)
        if subparsers[path] ~= nil then
          subparsers[path] = subparsers[path] .. " + " .. suffix
        else
          subparsers[path] = suffix
        end
      end
    end, function(_, path)
      if #path > 0 then
        local byte = path:sub(#path, #path)
        local parent_path = path:sub(1, #path-1)
        local prefix = serialize_byte_parser(byte)
        local suffix
        if subparsers[path]:find(" %+ ") then
          suffix = prefix .. " * (" .. subparsers[path] .. ")"
        else
          suffix = prefix .. " * " .. subparsers[path]
        end
        if subparsers[parent_path] ~= nil then
          subparsers[parent_path] = subparsers[parent_path]
                                  .. " + " .. suffix
        else
          subparsers[parent_path] = suffix
        end
      else
        print(
          "M.casefold_mapping[" .. length .. "] = "
          .. (subparsers[path] or "fail")
        )
      end
    end)
  end
end)()
```

3.1.1.5 Character Categories

Low-level parsers of UTF-8-encoded Unicode characters from different general categories [17, Section 4.5] are organized in table `unicode_data.categories` based on the number of bytes they occupy after conversion to UTF-8.

First, let's read the file `UnicodeData.txt`.

```
;(function()
  local file = assert(io.open("UnicodeData.txt", "r"),
    [[Could not open file "UnicodeData.txt"]])
```

In order to minimize the size and speed of the parser, we will first construct prefix trees of UTF-8 encodings for all codepoints of a given Unicode category and code length.

```
local categories = {"L", "N", "P", "Pc", "S", "Z"}
local prefix_trees = {}
for _, category in ipairs(categories) do
  prefix_trees[category] = {}
  for char_length = 1, 4 do
    prefix_trees[category][char_length] = {_type = "intermediate"}
  end
end
for line in file:lines() do
  local codepoint, full_category = line:match("^(%x+);[^;]*;(%a*)")
  assert(#full_category >= 1)
  local major_category = full_category:sub(1, 1)
  for _, category in ipairs({full_category, major_category}) do
    if prefix_trees[category] == nil then
      goto continue
    end
    local code = utf8.char(tonumber(codepoint, 16))
    local node = prefix_trees[category][#code]
    for i = 1, #code do
      local byte = code:sub(i, i)
      if i < #code then
        if node[byte] == nil then
          node[byte] = {_type = "intermediate"}
        end
        node = node[byte]
      else
        table.insert(node, {byte, _type = "leaf"})
      end
    end
    ::continue::
  end
end
assert(file:close())
```

Next, we will construct parsers out of the prefix trees.

```
print("M.categories = {}")
for _, category in ipairs(categories) do
  print("M.categories." .. category .. " = {}")
  for length, prefix_tree in pairs(prefix_trees[category]) do
    local subparsers = {}
    depth_first_search(prefix_tree, "", function(node, path)
      if node._type == "leaf" then
        local byte = node[1]
        local suffix = serialize_byte_parser(byte)
        if subparsers[path] ~= nil then
          subparsers[path] = subparsers[path] .. " + " .. suffix
        else
```

```
            subparsers[path] = suffix
          end
        end
      end, function(_, path)
        if #path > 0 then
          local byte = path:sub(#path, #path)
          local parent_path = path:sub(1, #path-1)
          local prefix = serialize_byte_parser(byte)
          local suffix
          if subparsers[path]:find(" %+ ") then
            suffix = prefix .. " * (" .. subparsers[path] .. ")"
          else
            suffix = prefix .. " * " .. subparsers[path]
          end
          if subparsers[parent_path] ~= nil then
            subparsers[parent_path] = subparsers[parent_path]
                                      .. " + " .. suffix
          else
            subparsers[parent_path] = suffix
          end
        else
          print(
            "M.categories." .. category .. "[" .. length .. "] = "
            .. (subparsers[path] or "fail")
          )
        end
      end)
    end
  end
end)()
```

3.1.1.6 Canonical Ordering Classes

Low-level parsers of UTF-8-encoded Unicode characters from different character classes [17, Section 3.11] are organized in table `unicode_data.ccc` based on the number of bytes they occupy after conversion to UTF-8.

First, let's read the file `UnicodeData.txt`.

```
;(function()
  local file = assert(io.open("UnicodeData.txt", "r"),
    [[Could not open file "UnicodeData.txt"]])
```

In order to minimize the size and speed of the parser, we will first construct prefix trees of UTF-8 encodings for all codepoints of a given Unicode combining class and code length.

```
  local prefix_trees = {}
  for char_length = 1, 4 do
    prefix_trees[char_length] = {_type = "intermediate"}
  end
  for line in file:lines() do
    local codepoint, combining_class
```

```
      = line:match("^(%x+);[^;]*;%a*;(%d+)")
    combining_class = tonumber(combining_class)
    if combining_class == 0 then
      goto continue
    end
    local code = utf8.char(tonumber(codepoint, 16))
    local node = prefix_trees[#code]
    for i = 1, #code do
      local byte = code:sub(i, i)
      if i < #code then
        if node[byte] == nil then
          node[byte] = {_type = "intermediate"}
        end
        node = node[byte]
      else
        table.insert(node, {byte, combining_class, _type = "leaf"})
      end
    end
    ::continue::
  end
  assert(file:close())
```

Next, we will construct parsers out of the prefix trees.

```
  print("M.ccc = {}")
  for length, prefix_tree in pairs(prefix_trees) do
    local subparsers = {}
    depth_first_search(prefix_tree, "", function(node, path)
      if node._type == "leaf" then
        local byte, combining_class = table.unpack(node)
        local suffix = serialize_byte_parser(byte)
          .. " * Cc(" .. tostring(combining_class) .. ")"
        if subparsers[path] ~= nil then
          subparsers[path] = subparsers[path] .. " + " .. suffix
        else
          subparsers[path] = suffix
        end
      end
    end, function(_, path)
      if #path > 0 then
        local byte = path:sub(#path, #path)
        local parent_path = path:sub(1, #path-1)
        local prefix = serialize_byte_parser(byte)
        local suffix
        if subparsers[path]:find(" %+ ") then
          suffix = prefix .. " * (" .. subparsers[path] .. ")"
        else
          suffix = prefix .. " * " .. subparsers[path]
        end
        if subparsers[parent_path] ~= nil then
          subparsers[parent_path] = subparsers[parent_path]
```

```
                                    .. " + " .. suffix
        else
          subparsers[parent_path] = suffix
        end
      else
        print(
          "M.ccc[" .. length .. "] = " .. (subparsers[path] or "fail")
        )
      end
    end)
  end
end)()
print("-- luacheck: pop")
print("return M")
```

3.1.2 Utility Functions

This section documents the utility functions back in the file `markdown-parser.lua` used by the plain TEX writer and the markdown reader. These functions are encapsulated in the `util` object. The functions were originally located in the `lunamark/util.lua` file in the Lunamark Lua module.

```
local util = {}
```

The `util.err` method prints an error message `msg` and exits. If `exit_code` is provided, it specifies the exit code. Otherwise, the exit code will be 1.

```
function util.err(msg, exit_code)
  io.stderr:write("markdown.lua: " .. msg .. "\n")
  os.exit(exit_code or 1)
end
```

The `util.cache` method used `dir`, `string`, `salt`, and `suffix` to determine a pathname. If a file with such a pathname does not exists, it gets created with `transform(string)` as its content and the result of `transform(string)` is returned as the second return value in case it's useful to the caller. Regardless, the pathname is always returned as the first return value.

```
function util.cache(dir, string, salt, transform, suffix)
  local digest = md5.sumhexa(string .. (salt or ""))
  local name = util.pathname(dir, digest .. suffix)
  local file = io.open(name, "r")
  local result = nil
  if file == nil then -- If no cache entry exists, create a new one.
    file = assert(io.open(name, "w"),
      [[Could not open file "]] .. name .. [[" for writing]])
    result = string
    if transform ~= nil then
      result = transform(result)
    end
    assert(file:write(result))
    assert(file:close())
```

```
  end
  return name, result
end
```

The `util.cache_verbatim` method strips whitespaces from the end of `string` and calls `util.cache` with `dir`, `string`, no salt or transformations, and the `.verbatim` suffix.

```
function util.cache_verbatim(dir, string)
  local name = util.cache(dir, string, nil, nil, ".verbatim")
  return name
end
```

The `util.table_copy` method creates a shallow copy of a table `t` and its metatable.

```
function util.table_copy(t)
  local u = { }
  for k, v in pairs(t) do u[k] = v end
  return setmetatable(u, getmetatable(t))
end
```

The `util.encode_json_string` method encodes a string `s` in JSON.

```
function util.encode_json_string(s)
  s = s:gsub([[\]], [[\\]])
  s = s:gsub([["]], [[\"]])
  return [["]] .. s .. [["]]
end
```

The `util.expand_tabs_in_line` expands tabs in string `s`. If `tabstop` is specified, it is used as the tab stop width. Otherwise, the tab stop width of 4 characters is used. The method is a copy of the tab expansion algorithm from Ierusalimschy [18, Chapter 21].

```
function util.expand_tabs_in_line(s, tabstop)
  local tab = tabstop or 4
  local corr = 0
  return (s:gsub("()\t", function(p)
            local sp = tab - (p - 1 + corr) % tab
            corr = corr - 1 + sp
            return string.rep(" ", sp)
          end))
end
```

The `util.walk` method walks a rope `t`, applying a function `f` to each leaf element in order. A rope is an array whose elements may be ropes, strings, numbers, or functions. If a leaf element is a function, call it and get the return value before proceeding.

```
function util.walk(t, f)
  local typ = type(t)
  if typ == "string" then
    f(t)
  elseif typ == "table" then
    local i = 1
    local n
    n = t[i]
    while n do
      util.walk(n, f)
```

```
      i = i + 1
      n = t[i]
    end
  elseif typ == "function" then
    local ok, val = pcall(t)
    if ok then
      util.walk(val,f)
    end
  else
    f(tostring(t))
  end
end
```

The `util.flatten` method flattens an array `ary` that does not contain cycles and returns the result.

```
function util.flatten(ary)
  local new = {}
  for _,v in ipairs(ary) do
    if type(v) == "table" then
      for _,w in ipairs(util.flatten(v)) do
        new[#new + 1] = w
      end
    else
      new[#new + 1] = v
    end
  end
  return new
end
```

The `util.rope_to_string` method converts a rope `rope` to a string and returns it. For the definition of a rope, see the definition of the `util.walk` method.

```
function util.rope_to_string(rope)
  local buffer = {}
  util.walk(rope, function(x) buffer[#buffer + 1] = x end)
  return table.concat(buffer)
end
```

The `util.rope_last` method retrieves the last item in a rope. For the definition of a rope, see the definition of the `util.walk` method.

```
function util.rope_last(rope)
  if #rope == 0 then
    return nil
  else
    local l = rope[#rope]
    if type(l) == "table" then
      return util.rope_last(l)
    else
      return l
    end
  end
```

```
end
```

Given an array `ary` and a string `x`, the `util.intersperse` method returns an array `new`, such that `ary[i] == new[2*(i-1)+1]` and `new[2*i] == x` for all $1 \leqslant$ `i` $\leqslant$ `#ary`.

```
function util.intersperse(ary, x)
  local new = {}
  local l = #ary
  for i,v in ipairs(ary) do
    local n = #new
    new[n + 1] = v
    if i ~= l then
      new[n + 2] = x
    end
  end
  return new
end
```

Given an array `ary` and a function `f`, the `util.map` method returns an array `new`, such that `new[i] == f(ary[i])` for all $1 \leqslant$ `i` $\leqslant$ `#ary`.

```
function util.map(ary, f)
  local new = {}
  for i,v in ipairs(ary) do
    new[i] = f(v)
  end
  return new
end
```

Given a table `char_escapes` mapping escapable characters to escaped strings and optionally a table `string_escapes` mapping escapable strings to escaped strings, the `util.escaper` method returns an escaper function that escapes all occurrences of escapable strings and characters (in this order).

The method uses LPeg, which is faster than the Lua `string.gsub` built-in method.

```
function util.escaper(char_escapes, string_escapes)
```

Build a string of escapable characters.

```
  local char_escapes_list = ""
  for i,_ in pairs(char_escapes) do
    char_escapes_list = char_escapes_list .. i
  end
```

Create an LPeg capture `escapable` that produces the escaped string corresponding to the matched escapable character.

```
  local escapable = S(char_escapes_list) / char_escapes
```

If `string_escapes` is provided, turn `escapable` into the

$$\sum_{\texttt{(k,v)} \in \texttt{string_escapes}} \texttt{P(k) / v} + \texttt{escapable}$$

capture that replaces any occurrence of the string `k` with the string `v` for each (`k`, `v`) $\in$ `string_escapes`. Note that the pattern summation is not commutative and its operands

are inspected in the summation order during the matching. As a corrolary, the strings always take precedence over the characters.

```
5404    if string_escapes then
5405      for k,v in pairs(string_escapes) do
5406        escapable = P(k) / v + escapable
5407      end
5408    end
```

Create an LPeg capture `escape_string` that captures anything `escapable` does and matches any other unmatched characters.

```
5409    local escape_string = Cs((escapable + any)^0)
```

Return a function that matches the input string `s` against the `escape_string` capture.

```
5410    return function(s)
5411      return lpeg.match(escape_string, s)
5412    end
5413  end
```

The `util.pathname` method produces a pathname out of a directory name `dir` and a filename `file` and returns it.

```
5414  function util.pathname(dir, file)
5415    if #dir == 0 then
5416      return file
5417    else
5418      return dir .. "/" .. file
5419    end
5420  end
```

The `util.salt` method produces cryptographic salt out of a table of options `options`.

```
5421  function util.salt(options)
5422    local opt_string = {}
5423    for k, _ in pairs(defaultOptions) do
5424      local v = options[k]
5425      if type(v) == "table" then
5426        for _, i in ipairs(v) do
5427          opt_string[#opt_string+1] = k .. "=" .. tostring(i)
5428        end
```

The `cacheDir` option is disregarded.

```
5429      elseif k ~= "cacheDir" then
5430        opt_string[#opt_string+1] = k .. "=" .. tostring(v)
5431      end
5432    end
5433    table.sort(opt_string)
5434    local salt = table.concat(opt_string, ",")
5435               .. "," .. metadata.version
5436    return salt
5437  end
```

The `util.warning` method produces a warning `s` that is unrelated to any specific markdown text being processed. For warnings that are specific to a markdown text, use `writer->warning` function.

```
local function warning(s)
  io.stderr:write("Warning: " .. s .. "\n")
end

for _, message in ipairs(early_warnings) do
  warning(message)
end

return warning
```

The `util.casefold` method performs a full case-folding of a UTF-8-encoded Unicode string `s` based on the low-level parsers in `unicode_data.casefold_mapping`, defined in Section 3.1.1.4. Unlike the low-level parsers, the high-level function is invariant to the number of bytes the Unicode characters occupy after conversion to UTF-8.

```
util.casefold = (function()
  local fail, any = P(false), P(1)
  local eof = -any
```

First, define a parser that will case-fold a character.

```
  local fold_character = fail
  for n = 1, 4 do
    fold_character
      = fold_character
      + unicode_data.casefold_mapping[n]
  end
  fold_character
    = fold_character
    + C(any)
```

Next, define a parser that will case-fold a string.

```
  local fold_string = Ct(fold_character^0) * eof
  return function(s, form)
    local result = table.concat(lpeg.match(fold_string, s))
    assert(result ~= nil)
```

For NFD and NFKD normalization forms, normalize the case-folded string and then repeat the fold-and-normalize operation.

```
    if form == "nfd" or form == "nfkd" then
      result = util.normalize(result, form)
      result = table.concat(lpeg.match(fold_string, result))
      assert(result ~= nil)
      result = util.normalize(result, form)
    end
    return result
  end
end)()
```

The `util.canonically_order` method performs a Unicode canonical ordering of a string UTF-8-encoded Unicode `s` based on the low-level parsers in `unicode_data.ccc`, defined in Section 3.1.1.6. Unlike the low-level parsers, the high-level function is invariant to the number of bytes the Unicode characters occupy after conversion to UTF-8.

```
util.canonically_order = (function()
  local fail, any = P(false), P(1)
  local eof = -any
  local cont = R("\128\191")
  local utf8_character
    = R("\0\127")
    + R("\194\223") * cont
    + R("\224\239") * cont * cont
    + R("\240\244") * cont * cont * cont
```

First, define a parser that will determine the combining class of a character.

```
  local classify_character = fail
  for n = 1, 4 do
    classify_character
      = classify_character
      + unicode_data.ccc[n]
  end
  classify_character
    = classify_character
    + utf8_character * Cc(0)
```

Next, define a parser that will determine the combining classes of all characters in a string.

```
  local classify_string = Ct(classify_character^0) * eof
```

When the function is called, first check whether the string is trivially ordered. If it is, return it without any changes.

```
  return function(s)
    local s_len = utf8.len(s)
    if s == false or s_len <= 1 then
      return s
    end
```

Otherwise, determine the combining classes of all characters in the string. If the string cannot be decoded with UTF-8, return it unchanged.

```
    local classes = lpeg.match(classify_string, s)
    if classes == nil then
      return s
    end
    assert(#classes == s_len)
```

Again, check whether the string is trivially ordered. If it is, return it without any changes. Otherwise, construct a list of ranges of non-starter characters that must be ordered.

```
    local non_starter_ranges = {}
    local first_non_starter, last_non_starter = nil, nil
    for i = 1, #classes do
```

```
      if first_non_starter == nil then
        if classes[i] ~= 0 then
          first_non_starter, last_non_starter = i, i
        end
      else
        if classes[i] == 0 then
          table.insert(
            non_starter_ranges,
            {first_non_starter, last_non_starter}
          )
          first_non_starter, last_non_starter = nil, nil
        else
          last_non_starter = i
        end
      end
    end
    if first_non_starter ~= nil then
      table.insert(
        non_starter_ranges,
        {first_non_starter, last_non_starter}
      )
    end
    if #non_starter_ranges == 0 then
      return s
    end
    local max_range_length = 0
    for _, range in ipairs(non_starter_ranges) do
      local range_start, range_end = table.unpack(range)
      local range_length = range_end - range_start + 1
      if range_length > max_range_length then
        max_range_length = range_length
      end
    end
    if max_range_length <= 1 then
      return s
    end
```

Then, construct a buffer of all characters in the string.

```
    local buffer = {}
    for _, code in utf8.codes(s) do
      local char = utf8.char(code)
      table.insert(buffer, char)
    end
    assert(#buffer == s_len)
```

Next, perform a local bubble sort over the ranges of non-starter characters.

```
    for _, range in ipairs(non_starter_ranges) do
      local range_start, range_end = table.unpack(range)
      local range_length = range_end - range_start + 1
      for _ = 1, range_length - 1 do
```

```
        local swapped = false
        for i = range_start, range_end - 1 do
          local j = i + 1
          if classes[i] > classes[j] then
            classes[i], classes[j] = classes[j], classes[i]
            buffer[i], buffer[j] = buffer[j], buffer[i]
            swapped = true
          end
        end
        if not swapped then
          break
        end
      end
    end
```

Finally, concatenate the buffer and return an ordered string.

```
    return table.concat(buffer, "")
  end
end)()
```

The `util.decompose` method performs either the canonical or the compatibility decomposition of a UTF-8-encoded Unicode string `s` based on the low-level parsers in `unicode_data.decomposition_mapping`, defined in sections 3.1.1.1 and 3.1.1.2. Unlike the low-level parsers, the high-level function is invariant to the number of bytes the Unicode characters occupy after conversion to UTF-8.

```
util.decompose = (function()
  local fail, any = P(false), P(1)
  local eof = -any
  local decomposition_types = {"canonical", "compatibility"}
```

First, define parsers that will decompose a character.

```
  local decompose_character = {}
  for _, decomposition_type in ipairs(decomposition_types) do
    decompose_character[decomposition_type] = fail
    for n = 1, 4 do
      decompose_character[decomposition_type]
        = decompose_character[decomposition_type]
        + unicode_data.decomposition_mapping[decomposition_type][n]
    end
    decompose_character[decomposition_type]
      = decompose_character[decomposition_type]
      + C(any)
  end
  local hangul = unicode_data.decomposition_mapping.hangul
  decompose_character.hangul = {}
  for syllable_type, _ in pairs(hangul) do
    decompose_character.hangul[syllable_type] = fail
    for n = 1, 4 do
      decompose_character.hangul[syllable_type]
        = decompose_character.hangul[syllable_type]
```

```
        + hangul[syllable_type][n]
    end
    decompose_character.hangul[syllable_type]
      = decompose_character.hangul[syllable_type]
      + C(any)
  end
```

Next, define a parser that will decompose a string.

```
  local decompose_string = {}
  for _, decomposition_type in ipairs(decomposition_types) do
    decompose_string[decomposition_type]
      = Ct(decompose_character[decomposition_type]^0) * eof
  end
  decompose_string.hangul = {}
  for syllable_type, _ in pairs(hangul) do
    decompose_string.hangul[syllable_type]
      = Ct(decompose_character.hangul[syllable_type]^0) * eof
  end
  local function _decompose(s, parser)
    assert(s ~= nil)
    local result = table.concat(lpeg.match(parser, s), "")
    assert(result ~= nil)
    return result
  end
  return function(s, decomposition_type)
    assert(
      decomposition_type == "canonical"
      or decomposition_type == "compatibility"
    )
    local prev_s
    local next_s = s
    repeat
      prev_s = next_s
      local function decompose(...) next_s = _decompose(next_s, ...) end
      decompose(decompose_string.canonical)
      if decomposition_type == "compatibility" then
        decompose(decompose_string.compatibility)
      end
      decompose(decompose_string.hangul.LVT)
      decompose(decompose_string.hangul.LV)
    until prev_s == next_s
    return util.canonically_order(next_s)
  end
end)()
```

The `util.compose` method performs the canonical composition of a UTF-8-encoded canonically ordered Unicode string `s` based on the low-level parsers in `unicode_data.composition_mapping`, defined in Section 3.1.1.3, and definitions from the Hangul syllable (de)composition algorithm, defined in Section 3.1.1.2. Unlike the

low-level parsers, this high-level function is invariant to the number of bytes the Unicode characters occupy after conversion to UTF-8.

```
util.compose = (function()
  local fail, any = P(false), P(1)
  local eof = -any
  local cont = R("\128\191")
  local utf8_character
    = R("\0\127")
    + R("\194\223") * cont
    + R("\224\239") * cont * cont
    + R("\240\244") * cont * cont * cont
```

First, define a parser that will determine the combining class of a character.

```
  local classify_character = fail
  for n = 1, 4 do
    classify_character
      = classify_character
      + unicode_data.ccc[n]
  end
  classify_character
    = classify_character
    + utf8_character * Cc(0)
```

Next, define a parser that will determine the combining classes of all characters in a string.

```
  local classify_string = Ct(classify_character^0) * eof
```

First, define parsers that will compose a pair of UTF-8-encoded Unicode characters into their primary composite.

```
  local compose_characters = fail
  for m = 1, 4 do
    local starter = #unicode_data.composition_mapping.starters[m]
    local both = fail
    for n = 1, 4 do
      both = (
        both
        + #unicode_data.composition_mapping.both[m][n]
        * unicode_data.composition_mapping.both[m][n]
      )
    end
    compose_characters = compose_characters + starter * both
  end
```

When the function is called, first check whether the string is trivially ordered. If it is, return it without any changes.

```
  return function(s)
    local s_len = utf8.len(s)
    if s == false or s_len <= 1 then
      return s
    end
```

Otherwise, determine the combining classes of all characters in the string. If the string cannot be decoded with UTF-8, return it unchanged.

```
    local classes = lpeg.match(classify_string, s)
    if classes == nil then
      return s
    end
    assert(#classes == s_len)
```

Otherwise, construct a buffer of all characters in the string.

```
    local buffer = {}
    for _, code in utf8.codes(s) do
      local char = utf8.char(code)
      table.insert(buffer, char)
    end
    assert(#buffer == s_len)
```

Finally, implement the composition algorithm.

First, find the first starter character in the string.

```
    local starter = 1
    while starter <= s_len and classes[starter] ~= 0 do
      starter = starter + 1
    end
    local candidate_combining_mark = starter + 1
```

Next, apply the composition rules until we reach the end of the string.

```
    while candidate_combining_mark <= s_len do
      local L = buffer[starter]
      local C = buffer[candidate_combining_mark]
      local P = lpeg.match(compose_characters, L .. C)
      if P ~= nil then
        buffer[starter] = P
        buffer[candidate_combining_mark] = ""
      else
        if classes[candidate_combining_mark] == 0 then
          starter = candidate_combining_mark
        end
        candidate_combining_mark = candidate_combining_mark + 1
      end
      assert(starter <= s_len)
    end
```

Next, iterate over the string once more and compose Hangul syllables.

```
    for i = 1, s_len - 1 do
      local last, ch = buffer[i], buffer[i + 1]
      if last ~= "" and ch ~= "" then
        local composite = unicode_data.hangul_compose(last, ch)
        if composite ~= nil then
          buffer[i] = ""
          buffer[i + 1] = composite
        end
```

```
      end
    end
```

Finally, concatenate the buffer and return an ordered string.

```
    return table.concat(buffer, "")
  end
end)()
```

The `util.normalize` method normalizes a UTF-8-encoded canonically ordered Unicode string `s` using the normalization form `form`.

```
function util.normalize(s, form)
  if form == "nfd" then
    return util.decompose(s, "canonical")
  elseif form == "nfkd" then
    return util.decompose(s, "compatibility")
  elseif form == "nfc" then
    return util.compose(util.decompose(s, "canonical"))
  elseif form == "nfkc" then
    return util.compose(util.decompose(s, "compatibility"))
  else
    error(string.format('Unexpected normal form "%s"', form))
  end
end
```

The `util.find_file` and `util.find_files` method find the first or all locations of a file, respectively, according to either the resolvers API [1, Section 11.5] from the ConTEXt format or the Kpathsea library.

```
function util.find_file(filename)
  if resolvers ~= nil then
    return resolvers.findfile(filename)
  else
    return kpse.find_file(filename)
  end
end
function util.find_files(filename)
  if resolvers ~= nil then
    return resolvers.findfiles(filename)
  else
    return {kpse.lookup(filename, {all=true})}
  end
end
```

3.1.3 HTML Entities

This section documents the HTML entities recognized by the markdown reader. These functions are encapsulated in the `entities` object. The functions were originally located in the `lunamark/entities.lua` file in the Lunamark Lua module.

```
local entities = {}

local character_entities = {
```

```
5743    ["Tab"] = 9,
5744    ["NewLine"] = 10,
5745    ["excl"] = 33,
5746    ["QUOT"] = 34,
5747    ["quot"] = 34,
5748    ["num"] = 35,
5749    ["dollar"] = 36,
5750    ["percnt"] = 37,
5751    ["AMP"] = 38,
5752    ["amp"] = 38,
5753    ["apos"] = 39,
5754    ["lpar"] = 40,
5755    ["rpar"] = 41,
5756    ["ast"] = 42,
5757    ["midast"] = 42,
5758    ["plus"] = 43,
5759    ["comma"] = 44,
5760    ["period"] = 46,
5761    ["sol"] = 47,
5762    ["colon"] = 58,
5763    ["semi"] = 59,
5764    ["LT"] = 60,
5765    ["lt"] = 60,
5766    ["nvlt"] = {60, 8402},
5767    ["bne"] = {61, 8421},
5768    ["equals"] = 61,
5769    ["GT"] = 62,
5770    ["gt"] = 62,
5771    ["nvgt"] = {62, 8402},
5772    ["quest"] = 63,
5773    ["commat"] = 64,
5774    ["lbrack"] = 91,
5775    ["lsqb"] = 91,
5776    ["bsol"] = 92,
5777    ["rbrack"] = 93,
5778    ["rsqb"] = 93,
5779    ["Hat"] = 94,
5780    ["UnderBar"] = 95,
5781    ["lowbar"] = 95,
5782    ["DiacriticalGrave"] = 96,
5783    ["grave"] = 96,
5784    ["fjlig"] = {102, 106},
5785    ["lbrace"] = 123,
5786    ["lcub"] = 123,
5787    ["VerticalLine"] = 124,
5788    ["verbar"] = 124,
5789    ["vert"] = 124,
5790    ["rbrace"] = 125,
5791    ["rcub"] = 125,
```

```
["NonBreakingSpace"] = 160,
["nbsp"] = 160,
["iexcl"] = 161,
["cent"] = 162,
["pound"] = 163,
["curren"] = 164,
["yen"] = 165,
["brvbar"] = 166,
["sect"] = 167,
["Dot"] = 168,
["DoubleDot"] = 168,
["die"] = 168,
["uml"] = 168,
["COPY"] = 169,
["copy"] = 169,
["ordf"] = 170,
["laquo"] = 171,
["not"] = 172,
["shy"] = 173,
["REG"] = 174,
["circledR"] = 174,
["reg"] = 174,
["macr"] = 175,
["strns"] = 175,
["deg"] = 176,
["PlusMinus"] = 177,
["plusmn"] = 177,
["pm"] = 177,
["sup2"] = 178,
["sup3"] = 179,
["DiacriticalAcute"] = 180,
["acute"] = 180,
["micro"] = 181,
["para"] = 182,
["CenterDot"] = 183,
["centerdot"] = 183,
["middot"] = 183,
["Cedilla"] = 184,
["cedil"] = 184,
["sup1"] = 185,
["ordm"] = 186,
["raquo"] = 187,
["frac14"] = 188,
["frac12"] = 189,
["half"] = 189,
["frac34"] = 190,
["iquest"] = 191,
["Agrave"] = 192,
["Aacute"] = 193,
```

```
5841    ["Acirc"] = 194,
5842    ["Atilde"] = 195,
5843    ["Auml"] = 196,
5844    ["Aring"] = 197,
5845    ["angst"] = 197,
5846    ["AElig"] = 198,
5847    ["Ccedil"] = 199,
5848    ["Egrave"] = 200,
5849    ["Eacute"] = 201,
5850    ["Ecirc"] = 202,
5851    ["Euml"] = 203,
5852    ["Igrave"] = 204,
5853    ["Iacute"] = 205,
5854    ["Icirc"] = 206,
5855    ["Iuml"] = 207,
5856    ["ETH"] = 208,
5857    ["Ntilde"] = 209,
5858    ["Ograve"] = 210,
5859    ["Oacute"] = 211,
5860    ["Ocirc"] = 212,
5861    ["Otilde"] = 213,
5862    ["Ouml"] = 214,
5863    ["times"] = 215,
5864    ["Oslash"] = 216,
5865    ["Ugrave"] = 217,
5866    ["Uacute"] = 218,
5867    ["Ucirc"] = 219,
5868    ["Uuml"] = 220,
5869    ["Yacute"] = 221,
5870    ["THORN"] = 222,
5871    ["szlig"] = 223,
5872    ["agrave"] = 224,
5873    ["aacute"] = 225,
5874    ["acirc"] = 226,
5875    ["atilde"] = 227,
5876    ["auml"] = 228,
5877    ["aring"] = 229,
5878    ["aelig"] = 230,
5879    ["ccedil"] = 231,
5880    ["egrave"] = 232,
5881    ["eacute"] = 233,
5882    ["ecirc"] = 234,
5883    ["euml"] = 235,
5884    ["igrave"] = 236,
5885    ["iacute"] = 237,
5886    ["icirc"] = 238,
5887    ["iuml"] = 239,
5888    ["eth"] = 240,
5889    ["ntilde"] = 241,
```

```
5890    ["ograve"] = 242,
5891    ["oacute"] = 243,
5892    ["ocirc"] = 244,
5893    ["otilde"] = 245,
5894    ["ouml"] = 246,
5895    ["div"] = 247,
5896    ["divide"] = 247,
5897    ["oslash"] = 248,
5898    ["ugrave"] = 249,
5899    ["uacute"] = 250,
5900    ["ucirc"] = 251,
5901    ["uuml"] = 252,
5902    ["yacute"] = 253,
5903    ["thorn"] = 254,
5904    ["yuml"] = 255,
5905    ["Amacr"] = 256,
5906    ["amacr"] = 257,
5907    ["Abreve"] = 258,
5908    ["abreve"] = 259,
5909    ["Aogon"] = 260,
5910    ["aogon"] = 261,
5911    ["Cacute"] = 262,
5912    ["cacute"] = 263,
5913    ["Ccirc"] = 264,
5914    ["ccirc"] = 265,
5915    ["Cdot"] = 266,
5916    ["cdot"] = 267,
5917    ["Ccaron"] = 268,
5918    ["ccaron"] = 269,
5919    ["Dcaron"] = 270,
5920    ["dcaron"] = 271,
5921    ["Dstrok"] = 272,
5922    ["dstrok"] = 273,
5923    ["Emacr"] = 274,
5924    ["emacr"] = 275,
5925    ["Edot"] = 278,
5926    ["edot"] = 279,
5927    ["Eogon"] = 280,
5928    ["eogon"] = 281,
5929    ["Ecaron"] = 282,
5930    ["ecaron"] = 283,
5931    ["Gcirc"] = 284,
5932    ["gcirc"] = 285,
5933    ["Gbreve"] = 286,
5934    ["gbreve"] = 287,
5935    ["Gdot"] = 288,
5936    ["gdot"] = 289,
5937    ["Gcedil"] = 290,
5938    ["Hcirc"] = 292,
```

```
5939    ["hcirc"] = 293,
5940    ["Hstrok"] = 294,
5941    ["hstrok"] = 295,
5942    ["Itilde"] = 296,
5943    ["itilde"] = 297,
5944    ["Imacr"] = 298,
5945    ["imacr"] = 299,
5946    ["Iogon"] = 302,
5947    ["iogon"] = 303,
5948    ["Idot"] = 304,
5949    ["imath"] = 305,
5950    ["inodot"] = 305,
5951    ["IJlig"] = 306,
5952    ["ijlig"] = 307,
5953    ["Jcirc"] = 308,
5954    ["jcirc"] = 309,
5955    ["Kcedil"] = 310,
5956    ["kcedil"] = 311,
5957    ["kgreen"] = 312,
5958    ["Lacute"] = 313,
5959    ["lacute"] = 314,
5960    ["Lcedil"] = 315,
5961    ["lcedil"] = 316,
5962    ["Lcaron"] = 317,
5963    ["lcaron"] = 318,
5964    ["Lmidot"] = 319,
5965    ["lmidot"] = 320,
5966    ["Lstrok"] = 321,
5967    ["lstrok"] = 322,
5968    ["Nacute"] = 323,
5969    ["nacute"] = 324,
5970    ["Ncedil"] = 325,
5971    ["ncedil"] = 326,
5972    ["Ncaron"] = 327,
5973    ["ncaron"] = 328,
5974    ["napos"] = 329,
5975    ["ENG"] = 330,
5976    ["eng"] = 331,
5977    ["Omacr"] = 332,
5978    ["omacr"] = 333,
5979    ["Odblac"] = 336,
5980    ["odblac"] = 337,
5981    ["OElig"] = 338,
5982    ["oelig"] = 339,
5983    ["Racute"] = 340,
5984    ["racute"] = 341,
5985    ["Rcedil"] = 342,
5986    ["rcedil"] = 343,
5987    ["Rcaron"] = 344,
```

```
  ["rcaron"] = 345,
  ["Sacute"] = 346,
  ["sacute"] = 347,
  ["Scirc"] = 348,
  ["scirc"] = 349,
  ["Scedil"] = 350,
  ["scedil"] = 351,
  ["Scaron"] = 352,
  ["scaron"] = 353,
  ["Tcedil"] = 354,
  ["tcedil"] = 355,
  ["Tcaron"] = 356,
  ["tcaron"] = 357,
  ["Tstrok"] = 358,
  ["tstrok"] = 359,
  ["Utilde"] = 360,
  ["utilde"] = 361,
  ["Umacr"] = 362,
  ["umacr"] = 363,
  ["Ubreve"] = 364,
  ["ubreve"] = 365,
  ["Uring"] = 366,
  ["uring"] = 367,
  ["Udblac"] = 368,
  ["udblac"] = 369,
  ["Uogon"] = 370,
  ["uogon"] = 371,
  ["Wcirc"] = 372,
  ["wcirc"] = 373,
  ["Ycirc"] = 374,
  ["ycirc"] = 375,
  ["Yuml"] = 376,
  ["Zacute"] = 377,
  ["zacute"] = 378,
  ["Zdot"] = 379,
  ["zdot"] = 380,
  ["Zcaron"] = 381,
  ["zcaron"] = 382,
  ["fnof"] = 402,
  ["imped"] = 437,
  ["gacute"] = 501,
  ["jmath"] = 567,
  ["circ"] = 710,
  ["Hacek"] = 711,
  ["caron"] = 711,
  ["Breve"] = 728,
  ["breve"] = 728,
  ["DiacriticalDot"] = 729,
  ["dot"] = 729,
```

```
6037    ["ring"] = 730,
6038    ["ogon"] = 731,
6039    ["DiacriticalTilde"] = 732,
6040    ["tilde"] = 732,
6041    ["DiacriticalDoubleAcute"] = 733,
6042    ["dblac"] = 733,
6043    ["DownBreve"] = 785,
6044    ["Alpha"] = 913,
6045    ["Beta"] = 914,
6046    ["Gamma"] = 915,
6047    ["Delta"] = 916,
6048    ["Epsilon"] = 917,
6049    ["Zeta"] = 918,
6050    ["Eta"] = 919,
6051    ["Theta"] = 920,
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["asymp"] = 8776,
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6728    ["approxeq"] = 8778,
6729    ["apid"] = 8779,
6730    ["napid"] = {8779, 824},
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6733    ["CupCap"] = 8781,
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6742    ["NotHumpEqual"] = {8783, 824},
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6744    ["bumpeq"] = 8783,
6745    ["nbumpe"] = {8783, 824},
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6754    ["erDot"] = 8787,
6755    ["risingdotseq"] = 8787,
6756    ["Assign"] = 8788,
6757    ["colone"] = 8788,
6758    ["coloneq"] = 8788,
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6761    ["ecir"] = 8790,
6762    ["eqcirc"] = 8790,
6763    ["circeq"] = 8791,
6764    ["cire"] = 8791,
6765    ["wedgeq"] = 8793,
6766    ["veeeq"] = 8794,
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6769    ["equest"] = 8799,
6770    ["questeq"] = 8799,
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6783    ["geq"] = 8805,
6784    ["nvge"] = {8805, 8402},
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6788    ["nlE"] = {8806, 824},
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6793    ["geqq"] = 8807,
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6805    ["NestedLessLess"] = 8810,
6806    ["NotLessLess"] = {8810, 824},
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6808    ["nLt"] = {8810, 8402},
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6812    ["NotGreaterGreater"] = {8811, 824},
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6814    ["nGt"] = {8811, 8402},
6815    ["nGtv"] = {8811, 824},
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6819    ["NotLess"] = 8814,
6820    ["nless"] = 8814,
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6826    ["nle"] = 8816,
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6830    ["ngeq"] = 8817,
6831    ["LessTilde"] = 8818,
6832    ["lesssim"] = 8818,
6833    ["lsim"] = 8818,
6834    ["GreaterTilde"] = 8819,
6835    ["gsim"] = 8819,
6836    ["gtrsim"] = 8819,
6837    ["NotLessTilde"] = 8820,
6838    ["nlsim"] = 8820,
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6842    ["lessgtr"] = 8822,
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6844    ["GreaterLess"] = 8823,
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6849    ["NotGreaterLess"] = 8825,
6850    ["ntgl"] = 8825,
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6855    ["sc"] = 8827,
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6857    ["PrecedesSlantEqual"] = 8828,
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6859    ["preccurlyeq"] = 8828,
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6868    ["scsim"] = 8831,
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6980    ["vartriangleright"] = 8883,
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["RightCeiling"] = 8969,
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["OverParenthesis"] = 9180,
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["elinters"] = 9191,
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["circledS"] = 9416,
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7194    ["boxvL"] = 9569,
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7252    ["EmptySmallSquare"] = 9723,
7253    ["FilledSmallSquare"] = 9724,
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7353    ["tosa"] = 10537,
7354    ["swnwar"] = 10538,
7355    ["nrarrc"] = {10547, 824},
7356    ["rarrc"] = 10547,
7357    ["cudarrr"] = 10549,
7358    ["ldca"] = 10550,
7359    ["rdca"] = 10551,
```

```
["cudarrl"] = 10552,
["larrpl"] = 10553,
["curarrm"] = 10556,
["cularrp"] = 10557,
["rarrpl"] = 10565,
["harrcir"] = 10568,
["Uarrocir"] = 10569,
["lurdshar"] = 10570,
["ldrushar"] = 10571,
["LeftRightVector"] = 10574,
["RightUpDownVector"] = 10575,
["DownLeftRightVector"] = 10576,
["LeftUpDownVector"] = 10577,
["LeftVectorBar"] = 10578,
["RightVectorBar"] = 10579,
["RightUpVectorBar"] = 10580,
["RightDownVectorBar"] = 10581,
["DownLeftVectorBar"] = 10582,
["DownRightVectorBar"] = 10583,
["LeftUpVectorBar"] = 10584,
["LeftDownVectorBar"] = 10585,
["LeftTeeVector"] = 10586,
["RightTeeVector"] = 10587,
["RightUpTeeVector"] = 10588,
["RightDownTeeVector"] = 10589,
["DownLeftTeeVector"] = 10590,
["DownRightTeeVector"] = 10591,
["LeftUpTeeVector"] = 10592,
["LeftDownTeeVector"] = 10593,
["lHar"] = 10594,
["uHar"] = 10595,
["rHar"] = 10596,
["dHar"] = 10597,
["luruhar"] = 10598,
["ldrdhar"] = 10599,
["ruluhar"] = 10600,
["rdldhar"] = 10601,
["lharul"] = 10602,
["llhard"] = 10603,
["rharul"] = 10604,
["lrhard"] = 10605,
["UpEquilibrium"] = 10606,
["udhar"] = 10606,
["ReverseUpEquilibrium"] = 10607,
["duhar"] = 10607,
["RoundImplies"] = 10608,
["erarr"] = 10609,
["simrarr"] = 10610,
["larrsim"] = 10611,
```

```
7409    ["rarrsim"] = 10612,
7410    ["rarrap"] = 10613,
7411    ["ltlarr"] = 10614,
7412    ["gtrarr"] = 10616,
7413    ["subrarr"] = 10617,
7414    ["suplarr"] = 10619,
7415    ["lfisht"] = 10620,
7416    ["rfisht"] = 10621,
7417    ["ufisht"] = 10622,
7418    ["dfisht"] = 10623,
7419    ["lopar"] = 10629,
7420    ["ropar"] = 10630,
7421    ["lbrke"] = 10635,
7422    ["rbrke"] = 10636,
7423    ["lbrkslu"] = 10637,
7424    ["rbrksld"] = 10638,
7425    ["lbrksld"] = 10639,
7426    ["rbrkslu"] = 10640,
7427    ["langd"] = 10641,
7428    ["rangd"] = 10642,
7429    ["lparlt"] = 10643,
7430    ["rpargt"] = 10644,
7431    ["gtlPar"] = 10645,
7432    ["ltrPar"] = 10646,
7433    ["vzigzag"] = 10650,
7434    ["vangrt"] = 10652,
7435    ["angrtvbd"] = 10653,
7436    ["ange"] = 10660,
7437    ["range"] = 10661,
7438    ["dwangle"] = 10662,
7439    ["uwangle"] = 10663,
7440    ["angmsdaa"] = 10664,
7441    ["angmsdab"] = 10665,
7442    ["angmsdac"] = 10666,
7443    ["angmsdad"] = 10667,
7444    ["angmsdae"] = 10668,
7445    ["angmsdaf"] = 10669,
7446    ["angmsdag"] = 10670,
7447    ["angmsdah"] = 10671,
7448    ["bemptyv"] = 10672,
7449    ["demptyv"] = 10673,
7450    ["cemptyv"] = 10674,
7451    ["raemptyv"] = 10675,
7452    ["laemptyv"] = 10676,
7453    ["ohbar"] = 10677,
7454    ["omid"] = 10678,
7455    ["opar"] = 10679,
7456    ["operp"] = 10681,
7457    ["olcross"] = 10683,
```

```
7458    ["odsold"] = 10684,
7459    ["olcir"] = 10686,
7460    ["ofcir"] = 10687,
7461    ["olt"] = 10688,
7462    ["ogt"] = 10689,
7463    ["cirscir"] = 10690,
7464    ["cirE"] = 10691,
7465    ["solb"] = 10692,
7466    ["bsolb"] = 10693,
7467    ["boxbox"] = 10697,
7468    ["trisb"] = 10701,
7469    ["rtriltri"] = 10702,
7470    ["LeftTriangleBar"] = 10703,
7471    ["NotLeftTriangleBar"] = {10703, 824},
7472    ["NotRightTriangleBar"] = {10704, 824},
7473    ["RightTriangleBar"] = 10704,
7474    ["iinfin"] = 10716,
7475    ["infintie"] = 10717,
7476    ["nvinfin"] = 10718,
7477    ["eparsl"] = 10723,
7478    ["smeparsl"] = 10724,
7479    ["eqvparsl"] = 10725,
7480    ["blacklozenge"] = 10731,
7481    ["lozf"] = 10731,
7482    ["RuleDelayed"] = 10740,
7483    ["dsol"] = 10742,
7484    ["bigodot"] = 10752,
7485    ["xodot"] = 10752,
7486    ["bigoplus"] = 10753,
7487    ["xoplus"] = 10753,
7488    ["bigotimes"] = 10754,
7489    ["xotime"] = 10754,
7490    ["biguplus"] = 10756,
7491    ["xuplus"] = 10756,
7492    ["bigsqcup"] = 10758,
7493    ["xsqcup"] = 10758,
7494    ["iiiint"] = 10764,
7495    ["qint"] = 10764,
7496    ["fpartint"] = 10765,
7497    ["cirfnint"] = 10768,
7498    ["awint"] = 10769,
7499    ["rppolint"] = 10770,
7500    ["scpolint"] = 10771,
7501    ["npolint"] = 10772,
7502    ["pointint"] = 10773,
7503    ["quatint"] = 10774,
7504    ["intlarhk"] = 10775,
7505    ["pluscir"] = 10786,
7506    ["plusacir"] = 10787,
```

```
7507    ["simplus"] = 10788,
7508    ["plusdu"] = 10789,
7509    ["plussim"] = 10790,
7510    ["plustwo"] = 10791,
7511    ["mcomma"] = 10793,
7512    ["minusdu"] = 10794,
7513    ["loplus"] = 10797,
7514    ["roplus"] = 10798,
7515    ["Cross"] = 10799,
7516    ["timesd"] = 10800,
7517    ["timesbar"] = 10801,
7518    ["smashp"] = 10803,
7519    ["lotimes"] = 10804,
7520    ["rotimes"] = 10805,
7521    ["otimesas"] = 10806,
7522    ["Otimes"] = 10807,
7523    ["odiv"] = 10808,
7524    ["triplus"] = 10809,
7525    ["triminus"] = 10810,
7526    ["tritime"] = 10811,
7527    ["intprod"] = 10812,
7528    ["iprod"] = 10812,
7529    ["amalg"] = 10815,
7530    ["capdot"] = 10816,
7531    ["ncup"] = 10818,
7532    ["ncap"] = 10819,
7533    ["capand"] = 10820,
7534    ["cupor"] = 10821,
7535    ["cupcap"] = 10822,
7536    ["capcup"] = 10823,
7537    ["cupbrcap"] = 10824,
7538    ["capbrcup"] = 10825,
7539    ["cupcup"] = 10826,
7540    ["capcap"] = 10827,
7541    ["ccups"] = 10828,
7542    ["ccaps"] = 10829,
7543    ["ccupssm"] = 10832,
7544    ["And"] = 10835,
7545    ["Or"] = 10836,
7546    ["andand"] = 10837,
7547    ["oror"] = 10838,
7548    ["orslope"] = 10839,
7549    ["andslope"] = 10840,
7550    ["andv"] = 10842,
7551    ["orv"] = 10843,
7552    ["andd"] = 10844,
7553    ["ord"] = 10845,
7554    ["wedbar"] = 10847,
7555    ["sdote"] = 10854,
```

```
["simdot"] = 10858,
["congdot"] = 10861,
["ncongdot"] = {10861, 824},
["easter"] = 10862,
["apacir"] = 10863,
["apE"] = 10864,
["napE"] = {10864, 824},
["eplus"] = 10865,
["pluse"] = 10866,
["Esim"] = 10867,
["Colone"] = 10868,
["Equal"] = 10869,
["ddotseq"] = 10871,
["eDDot"] = 10871,
["equivDD"] = 10872,
["ltcir"] = 10873,
["gtcir"] = 10874,
["ltquest"] = 10875,
["gtquest"] = 10876,
["LessSlantEqual"] = 10877,
["NotLessSlantEqual"] = {10877, 824},
["leqslant"] = 10877,
["les"] = 10877,
["nleqslant"] = {10877, 824},
["nles"] = {10877, 824},
["GreaterSlantEqual"] = 10878,
["NotGreaterSlantEqual"] = {10878, 824},
["geqslant"] = 10878,
["ges"] = 10878,
["ngeqslant"] = {10878, 824},
["nges"] = {10878, 824},
["lesdot"] = 10879,
["gesdot"] = 10880,
["lesdoto"] = 10881,
["gesdoto"] = 10882,
["lesdotor"] = 10883,
["gesdotol"] = 10884,
["lap"] = 10885,
["lessapprox"] = 10885,
["gap"] = 10886,
["gtrapprox"] = 10886,
["lne"] = 10887,
["lneq"] = 10887,
["gne"] = 10888,
["gneq"] = 10888,
["lnap"] = 10889,
["lnapprox"] = 10889,
["gnap"] = 10890,
["gnapprox"] = 10890,
```

```
7605    ["lEg"] = 10891,
7606    ["lesseqqgtr"] = 10891,
7607    ["gEl"] = 10892,
7608    ["gtreqqless"] = 10892,
7609    ["lsime"] = 10893,
7610    ["gsime"] = 10894,
7611    ["lsimg"] = 10895,
7612    ["gsiml"] = 10896,
7613    ["lgE"] = 10897,
7614    ["glE"] = 10898,
7615    ["lesges"] = 10899,
7616    ["gesles"] = 10900,
7617    ["els"] = 10901,
7618    ["eqslantless"] = 10901,
7619    ["egs"] = 10902,
7620    ["eqslantgtr"] = 10902,
7621    ["elsdot"] = 10903,
7622    ["egsdot"] = 10904,
7623    ["el"] = 10905,
7624    ["eg"] = 10906,
7625    ["siml"] = 10909,
7626    ["simg"] = 10910,
7627    ["simlE"] = 10911,
7628    ["simgE"] = 10912,
7629    ["LessLess"] = 10913,
7630    ["NotNestedLessLess"] = {10913, 824},
7631    ["GreaterGreater"] = 10914,
7632    ["NotNestedGreaterGreater"] = {10914, 824},
7633    ["glj"] = 10916,
7634    ["gla"] = 10917,
7635    ["ltcc"] = 10918,
7636    ["gtcc"] = 10919,
7637    ["lescc"] = 10920,
7638    ["gescc"] = 10921,
7639    ["smt"] = 10922,
7640    ["lat"] = 10923,
7641    ["smte"] = 10924,
7642    ["smtes"] = {10924, 65024},
7643    ["late"] = 10925,
7644    ["lates"] = {10925, 65024},
7645    ["bumpE"] = 10926,
7646    ["NotPrecedesEqual"] = {10927, 824},
7647    ["PrecedesEqual"] = 10927,
7648    ["npre"] = {10927, 824},
7649    ["npreceq"] = {10927, 824},
7650    ["pre"] = 10927,
7651    ["preceq"] = 10927,
7652    ["NotSucceedsEqual"] = {10928, 824},
7653    ["SucceedsEqual"] = 10928,
```

```
["nsce"] = {10928, 824},
["nsucceq"] = {10928, 824},
["sce"] = 10928,
["succeq"] = 10928,
["prE"] = 10931,
["scE"] = 10932,
["precneqq"] = 10933,
["prnE"] = 10933,
["scnE"] = 10934,
["succneqq"] = 10934,
["prap"] = 10935,
["precapprox"] = 10935,
["scap"] = 10936,
["succapprox"] = 10936,
["precnapprox"] = 10937,
["prnap"] = 10937,
["scnap"] = 10938,
["succnapprox"] = 10938,
["Pr"] = 10939,
["Sc"] = 10940,
["subdot"] = 10941,
["supdot"] = 10942,
["subplus"] = 10943,
["supplus"] = 10944,
["submult"] = 10945,
["supmult"] = 10946,
["subedot"] = 10947,
["supedot"] = 10948,
["nsubE"] = {10949, 824},
["nsubseteqq"] = {10949, 824},
["subE"] = 10949,
["subseteqq"] = 10949,
["nsupE"] = {10950, 824},
["nsupseteqq"] = {10950, 824},
["supE"] = 10950,
["supseteqq"] = 10950,
["subsim"] = 10951,
["supsim"] = 10952,
["subnE"] = 10955,
["subsetneqq"] = 10955,
["varsubsetneqq"] = {10955, 65024},
["vsubnE"] = {10955, 65024},
["supnE"] = 10956,
["supsetneqq"] = 10956,
["varsupsetneqq"] = {10956, 65024},
["vsupnE"] = {10956, 65024},
["csub"] = 10959,
["csup"] = 10960,
["csube"] = 10961,
```

```
7703    ["csupe"] = 10962,
7704    ["subsup"] = 10963,
7705    ["supsub"] = 10964,
7706    ["subsub"] = 10965,
7707    ["supsup"] = 10966,
7708    ["suphsub"] = 10967,
7709    ["supdsub"] = 10968,
7710    ["forkv"] = 10969,
7711    ["topfork"] = 10970,
7712    ["mlcp"] = 10971,
7713    ["Dashv"] = 10980,
7714    ["DoubleLeftTee"] = 10980,
7715    ["Vdashl"] = 10982,
7716    ["Barv"] = 10983,
7717    ["vBar"] = 10984,
7718    ["vBarv"] = 10985,
7719    ["Vbar"] = 10987,
7720    ["Not"] = 10988,
7721    ["bNot"] = 10989,
7722    ["rnmid"] = 10990,
7723    ["cirmid"] = 10991,
7724    ["midcir"] = 10992,
7725    ["topcir"] = 10993,
7726    ["nhpar"] = 10994,
7727    ["parsim"] = 10995,
7728    ["nparsl"] = {11005, 8421},
7729    ["parsl"] = 11005,
7730    ["fflig"] = 64256,
7731    ["filig"] = 64257,
7732    ["fllig"] = 64258,
7733    ["ffilig"] = 64259,
7734    ["ffllig"] = 64260,
7735    ["Ascr"] = 119964,
7736    ["Cscr"] = 119966,
7737    ["Dscr"] = 119967,
7738    ["Gscr"] = 119970,
7739    ["Jscr"] = 119973,
7740    ["Kscr"] = 119974,
7741    ["Nscr"] = 119977,
7742    ["Oscr"] = 119978,
7743    ["Pscr"] = 119979,
7744    ["Qscr"] = 119980,
7745    ["Sscr"] = 119982,
7746    ["Tscr"] = 119983,
7747    ["Uscr"] = 119984,
7748    ["Vscr"] = 119985,
7749    ["Wscr"] = 119986,
7750    ["Xscr"] = 119987,
7751    ["Yscr"] = 119988,
```

```
  ["Zscr"] = 119989,
  ["ascr"] = 119990,
  ["bscr"] = 119991,
  ["cscr"] = 119992,
  ["dscr"] = 119993,
  ["fscr"] = 119995,
  ["hscr"] = 119997,
  ["iscr"] = 119998,
  ["jscr"] = 119999,
  ["kscr"] = 120000,
  ["lscr"] = 120001,
  ["mscr"] = 120002,
  ["nscr"] = 120003,
  ["pscr"] = 120005,
  ["qscr"] = 120006,
  ["rscr"] = 120007,
  ["sscr"] = 120008,
  ["tscr"] = 120009,
  ["uscr"] = 120010,
  ["vscr"] = 120011,
  ["wscr"] = 120012,
  ["xscr"] = 120013,
  ["yscr"] = 120014,
  ["zscr"] = 120015,
  ["Afr"] = 120068,
  ["Bfr"] = 120069,
  ["Dfr"] = 120071,
  ["Efr"] = 120072,
  ["Ffr"] = 120073,
  ["Gfr"] = 120074,
  ["Jfr"] = 120077,
  ["Kfr"] = 120078,
  ["Lfr"] = 120079,
  ["Mfr"] = 120080,
  ["Nfr"] = 120081,
  ["Ofr"] = 120082,
  ["Pfr"] = 120083,
  ["Qfr"] = 120084,
  ["Sfr"] = 120086,
  ["Tfr"] = 120087,
  ["Ufr"] = 120088,
  ["Vfr"] = 120089,
  ["Wfr"] = 120090,
  ["Xfr"] = 120091,
  ["Yfr"] = 120092,
  ["afr"] = 120094,
  ["bfr"] = 120095,
  ["cfr"] = 120096,
  ["dfr"] = 120097,
```

```
7801    ["efr"] = 120098,
7802    ["ffr"] = 120099,
7803    ["gfr"] = 120100,
7804    ["hfr"] = 120101,
7805    ["ifr"] = 120102,
7806    ["jfr"] = 120103,
7807    ["kfr"] = 120104,
7808    ["lfr"] = 120105,
7809    ["mfr"] = 120106,
7810    ["nfr"] = 120107,
7811    ["ofr"] = 120108,
7812    ["pfr"] = 120109,
7813    ["qfr"] = 120110,
7814    ["rfr"] = 120111,
7815    ["sfr"] = 120112,
7816    ["tfr"] = 120113,
7817    ["ufr"] = 120114,
7818    ["vfr"] = 120115,
7819    ["wfr"] = 120116,
7820    ["xfr"] = 120117,
7821    ["yfr"] = 120118,
7822    ["zfr"] = 120119,
7823    ["Aopf"] = 120120,
7824    ["Bopf"] = 120121,
7825    ["Dopf"] = 120123,
7826    ["Eopf"] = 120124,
7827    ["Fopf"] = 120125,
7828    ["Gopf"] = 120126,
7829    ["Iopf"] = 120128,
7830    ["Jopf"] = 120129,
7831    ["Kopf"] = 120130,
7832    ["Lopf"] = 120131,
7833    ["Mopf"] = 120132,
7834    ["Oopf"] = 120134,
7835    ["Sopf"] = 120138,
7836    ["Topf"] = 120139,
7837    ["Uopf"] = 120140,
7838    ["Vopf"] = 120141,
7839    ["Wopf"] = 120142,
7840    ["Xopf"] = 120143,
7841    ["Yopf"] = 120144,
7842    ["aopf"] = 120146,
7843    ["bopf"] = 120147,
7844    ["copf"] = 120148,
7845    ["dopf"] = 120149,
7846    ["eopf"] = 120150,
7847    ["fopf"] = 120151,
7848    ["gopf"] = 120152,
7849    ["hopf"] = 120153,
```

```
  ["iopf"] = 120154,
  ["jopf"] = 120155,
  ["kopf"] = 120156,
  ["lopf"] = 120157,
  ["mopf"] = 120158,
  ["nopf"] = 120159,
  ["oopf"] = 120160,
  ["popf"] = 120161,
  ["qopf"] = 120162,
  ["ropf"] = 120163,
  ["sopf"] = 120164,
  ["topf"] = 120165,
  ["uopf"] = 120166,
  ["vopf"] = 120167,
  ["wopf"] = 120168,
  ["xopf"] = 120169,
  ["yopf"] = 120170,
  ["zopf"] = 120171,
}
```

Given a string `s` of decimal digits, the `entities.dec_entity` returns the corresponding UTF8-encoded Unicode codepoint.

```
function entities.dec_entity(s)
  local n = tonumber(s)
  if n == nil then
    return "&#" .. s .. ";"  -- fallback for unknown entities
  end
  return utf8.char(n)
end
```

Given a string `s` of hexadecimal digits, the `entities.hex_entity` returns the corresponding UTF8-encoded Unicode codepoint.

```
function entities.hex_entity(s)
  local n = tonumber("0x"..s)
  if n == nil then
    return "&#x" .. s .. ";"  -- fallback for unknown entities
  end
  return utf8.char(n)
end
```

Given a captured character `x` and a string `s` of hexadecimal digits, the `entities.hex_entity_with_x_c` returns the corresponding UTF8-encoded Unicode codepoint or fallback with the `x` character.

```
function entities.hex_entity_with_x_char(x, s)
  local n = tonumber("0x"..s)
  if n == nil then
    return "&#" .. x .. s .. ";"  -- fallback for unknown entities
  end
  return utf8.char(n)
end
```

Given a character entity name `s` (like `ouml`), the `entities.char_entity` returns the corresponding UTF8-encoded Unicode codepoint.

```
function entities.char_entity(s)
  local code_points = character_entities[s]
  if code_points == nil then
    return "&" .. s .. ";"
  end
  if type(code_points) ~= 'table' then
    code_points = {code_points}
  end
  local char_table = {}
    for _, code_point in ipairs(code_points) do
      table.insert(char_table, utf8.char(code_point))
    end
  return table.concat(char_table)
end
```

3.1.4 Plain TEX Writer

This section documents the `writer` object, which implements the routines for producing the TEX output. The object is an amalgamate of the generic, TEX, LATEX writer objects that were located in the `lunamark/writer/generic.lua`, `lunamark/writer/tex.lua`, and `lunamark/writer/latex.lua` files in the Lunamark Lua module.

Although not specified in the Lua interface (see Section 2.1), the `writer` object is exported, so that the curious user could easily tinker with the methods of the objects produced by the `writer.new` method described below. The user should be aware, however, that the implementation may change in a future revision.

```
M.writer = {}
```

The `writer.new` method creates and returns a new TEX writer object associated with the Lua interface options (see Section 2.1.3) `options`. When `options` are unspecified, it is assumed that an empty table was passed to the method.

The objects produced by the `writer.new` method expose instance methods and variables of their own. As a convention, I will refer to these ⟨*member*⟩s as `writer->`⟨*member*⟩. All member variables are immutable unless explicitly stated otherwise.

```
local parsers
function M.writer.new(options)
  local self = {}
```

Make `options` available as `writer->options`, so that it is accessible from extensions.

```
  self.options = options
```

Define `writer->flatten_inlines`, which indicates whether or not the writer should produce raw text rather than text in the output format for inline elements. The `writer->flatten_inlines` member variable is mutable.

```
  self.flatten_inlines = false
```

3.1.4.1 Slicing

Parse the `slice` option and define `writer->slice_begin`, `writer->slice_end`, and `writer->is_writing`. The `writer->is_writing` member variable is mutable.

```
local slice_specifiers = {}
for specifier in options.slice:gmatch("[^%s]+") do
  table.insert(slice_specifiers, specifier)
end

if #slice_specifiers == 2 then
  self.slice_begin, self.slice_end = table.unpack(slice_specifiers)
  local slice_begin_type = self.slice_begin:sub(1, 1)
  if slice_begin_type ~= "^" and slice_begin_type ~= "$" then
    self.slice_begin = "^" .. self.slice_begin
  end
  local slice_end_type = self.slice_end:sub(1, 1)
  if slice_end_type ~= "^" and slice_end_type ~= "$" then
    self.slice_end = "$" .. self.slice_end
  end
elseif #slice_specifiers == 1 then
  self.slice_begin = "^" .. slice_specifiers[1]
  self.slice_end = "$" .. slice_specifiers[1]
end

self.slice_begin_type = self.slice_begin:sub(1, 1)
self.slice_begin_identifier = self.slice_begin:sub(2) or ""
self.slice_end_type = self.slice_end:sub(1, 1)
self.slice_end_identifier = self.slice_end:sub(2) or ""

if self.slice_begin == "^" and self.slice_end ~= "^" then
  self.is_writing = true
else
  self.is_writing = false
end
```

3.1.4.2 Basic Formatter Variables and Functions

Define `writer->space` as the output format of a space character.

```
self.space = " "
```

Define `writer->nbsp` as the output format of a non-breaking space character.

```
self.nbsp = "\\markdownRendererNbsp{}"
```

Define `writer->plain` as a function that will transform an input plain text block `s` to the output format.

```
function self.plain(s)
  return s
end
```

Define `writer->paragraph` as a function that will transform an input paragraph `s` to the output format.

```
7945  function self.paragraph(s)
7946    if not self.is_writing then return "" end
7947    return s
7948  end
```

Define `writer->interblocksep` as the output format of a block element separator.

```
7949  self.interblocksep_text = "\\markdownRendererInterblockSeparator\n{}"
7950  function self.interblocksep()
7951    if not self.is_writing then return "" end
7952    return self.interblocksep_text
7953  end
```

Define `writer->paragraphsep` as the output format of a paragraph separator. Users can use more than one blank line to delimit two blocks to indicate the end of a series of blocks that make up a paragraph. This produces a paragraph separator instead of an interblock separator.

```
7954  self.paragraphsep_text = "\\markdownRendererParagraphSeparator\n{}"
7955  function self.paragraphsep()
7956    if not self.is_writing then return "" end
7957    return self.paragraphsep_text
7958  end
```

Define `writer->undosep` as a function that will remove the output produced by an immediately preceding block element / paragraph separator.

```
7959  self.undosep_text = "\\markdownRendererUndoSeparator\n{}"
7960  function self.undosep()
7961    if not self.is_writing then return "" end
7962    return self.undosep_text
7963  end
```

Define `writer->soft_line_break` as the output format of a soft line break.

```
7964  self.soft_line_break = function()
7965    if self.flatten_inlines then return "\n" end
7966    return "\\markdownRendererSoftLineBreak\n{}"
7967  end
```

Define `writer->hard_line_break` as the output format of a hard line break.

```
7968  self.hard_line_break = function()
7969    if self.flatten_inlines then return "\n" end
7970    return "\\markdownRendererHardLineBreak\n{}"
7971  end
```

Define `writer->ellipsis` as the output format of an ellipsis.

```
7972  self.ellipsis = "\\markdownRendererEllipsis{}"
```

Define `writer->thematic_break` as the output format of a thematic break.

```
7973  function self.thematic_break()
7974    if not self.is_writing then return "" end
7975    return "\\markdownRendererThematicBreak{}"
7976  end
```

3.1.4.3 Escaping Special Characters

Define tables `writer->escaped_uri_chars` and `writer->escaped_minimal_strings` containing the mapping from special plain characters and character strings that always need to be escaped.

```
self.escaped_uri_chars = {
  ["{"] = "\\markdownRendererLeftBrace{}",
  ["}"] = "\\markdownRendererRightBrace{}",
  ["\\"] = "\\markdownRendererBackslash{}",
  ["\r"] = " ",
  ["\n"] = " ",
}
self.escaped_minimal_strings = {
  ["^^"] = "\\markdownRendererCircumflex"
        .. "\\markdownRendererCircumflex ",
  ["☒"] = "\\markdownRendererTickedBox{}",
  ["⊡"] = "\\markdownRendererHalfTickedBox{}",
  ["▫"] = "\\markdownRendererUntickedBox{}",
  [entities.hex_entity('FFFD')]
    = "\\markdownRendererReplacementCharacter{}",
}
```

Define table `writer->escaped_strings` containing the mapping from character strings that need to be escaped in typeset content.

```
self.escaped_strings = util.table_copy(self.escaped_minimal_strings)
self.escaped_strings[entities.hex_entity('00A0')] = self.nbsp
```

Define a table `writer->escaped_chars` containing the mapping from special plain TEX characters (including the active pipe character (`|`) of ConTEXt) that need to be escaped in typeset content.

```
self.escaped_chars = {
  ["{"] = "\\markdownRendererLeftBrace{}",
  ["}"] = "\\markdownRendererRightBrace{}",
  ["%"] = "\\markdownRendererPercentSign{}",
  ["\\"] = "\\markdownRendererBackslash{}",
  ["#"] = "\\markdownRendererHash{}",
  ["$"] = "\\markdownRendererDollarSign{}",
  ["&"] = "\\markdownRendererAmpersand{}",
  ["_"] = "\\markdownRendererUnderscore{}",
  ["^"] = "\\markdownRendererCircumflex{}",
  ["~"] = "\\markdownRendererTilde{}",
  ["|"] = "\\markdownRendererPipe{}",
  [entities.hex_entity('0000')]
    = "\\markdownRendererReplacementCharacter{}",
}
```

Use the `writer->escaped_chars`, `writer->escaped_uri_chars`, and `writer->escaped_minimal_st` tables to create the `escape_typographic_text`, `escape_programmatic_text`, and `escape_minimal` local escaper functions.

```
local function create_escaper(char_escapes, string_escapes)
```

```
8011      local escape = util.escaper(char_escapes, string_escapes)
8012      return function(s)
8013        if self.flatten_inlines then return s end
8014        return escape(s)
8015      end
8016    end
8017    local escape_typographic_text = create_escaper(
8018      self.escaped_chars, self.escaped_strings)
8019    local escape_programmatic_text = create_escaper(
8020      self.escaped_uri_chars, self.escaped_minimal_strings)
8021    local escape_minimal = create_escaper(
8022      {}, self.escaped_minimal_strings)
```

Define the following semantic aliases for the escaper functions:

- `writer->escape` transforms a text string that should always be made printable.
- `writer->string` transforms a text string that should be made printable only when the `hybrid` Lua option is disabled. When `hybrid` is enabled, the text string should be kept as-is.
- `writer->math` transforms a math span.
- `writer->identifier` transforms an input programmatic identifier.
- `writer->uri` transforms an input URI.
- `writer->infostring` transforms a fence code infostring.

```
8023    self.escape = escape_typographic_text
8024    self.math = escape_minimal
8025    if options.hybrid then
8026      self.identifier = escape_minimal
8027      self.string = escape_minimal
8028      self.uri = escape_minimal
8029      self.infostring = escape_minimal
8030    else
8031      self.identifier = escape_programmatic_text
8032      self.string = escape_typographic_text
8033      self.uri = escape_programmatic_text
8034      self.infostring = escape_programmatic_text
8035    end
```

3.1.4.4 Formatters of Warnings and Errors

Define `writer->warning` as a function that will transform an input warning `t` with optional more warning text `m` to the output format.

```
8036    function self.warning(t, m)
8037      return {"\\markdownRendererWarning{", self.escape(t), "}{",
8038              escape_minimal(t), "}{", self.escape(m or ""), "}{",
8039              escape_minimal(m or ""), "}"}
8040    end
```

Define `writer->error` as a function that will transform an input error text `t` with optional more error text `m` to the output format.

```
function self.error(t, m)
  return {"\\markdownRendererError{", self.escape(t), "}{",
          escape_minimal(t), "}{", self.escape(m or ""), "}{",
          escape_minimal(m or ""), "}"}
end
```

3.1.4.5 Formatter of Code Spans

Define `writer->code` as a function that will transform an input inline code span `s` with optional attributes `attributes` to the output format.

```
function self.code(s, attributes)
  if self.flatten_inlines then return s end
  local buf = {}
  if attributes ~= nil then
    table.insert(buf,
                 "\\markdownRendererCodeSpanAttributeContextBegin\n")
    table.insert(buf, self.attributes(attributes))
  end
  table.insert(buf,
               {"\\markdownRendererCodeSpan{", self.escape(s), "}"})
  if attributes ~= nil then
    table.insert(buf,
                 "\\markdownRendererCodeSpanAttributeContextEnd{}")
  end
  return buf
end
```

3.1.4.6 Formatter of Hyperlinks

Define `writer->link` as a function that will transform an input hyperlink to the output format, where `lab` corresponds to the label, `src` to URI, `tit` to the title of the link, and `attributes` to optional attributes.

```
function self.link(lab, src, tit, attributes)
  if self.flatten_inlines then return lab end
  local buf = {}
  if attributes ~= nil then
    table.insert(buf,
                 "\\markdownRendererLinkAttributeContextBegin\n")
    table.insert(buf, self.attributes(attributes))
  end
  table.insert(buf, {"\\markdownRendererLink{",lab,"}",
                     "{",self.escape(src),"}",
                     "{",self.uri(src),"}",
                     "{",self.string(tit or ""),"}"})
  if attributes ~= nil then
    table.insert(buf,
                 "\\markdownRendererLinkAttributeContextEnd{}")
  end
  return buf
end
```

3.1.4.7 Formatter of Images

Define `writer->image` as a function that will transform an input image to the output format, where `lab` corresponds to the label, `src` to the URL, `tit` to the title of the image, and `attributes` to optional attributes.

```
8080  function self.image(lab, src, tit, attributes)
8081    if self.flatten_inlines then return lab end
8082    local buf = {}
8083    if attributes ~= nil then
8084      table.insert(buf,
8085                   "\\markdownRendererImageAttributeContextBegin\n")
8086      table.insert(buf, self.attributes(attributes))
8087    end
8088    table.insert(buf, {"\\markdownRendererImage{",lab,"}",
8089                       "{",self.string(src),"}",
8090                       "{",self.uri(src),"}",
8091                       "{",tit,"}"})
8092    if attributes ~= nil then
8093      table.insert(buf,
8094                   "\\markdownRendererImageAttributeContextEnd{}")
8095    end
8096    return buf
8097  end
```

3.1.4.8 Formatters of Lists

Define `writer->bulletlist` as a function that will transform an input bulleted list to the output format, where `items` is an array of the list items and `tight` specifies, whether the list is tight or not.

```
8098  function self.bulletlist(items,tight)
8099    if not self.is_writing then return "" end
8100    local buffer = {}
8101    for _,item in ipairs(items) do
8102      if item ~= "" then
8103        buffer[#buffer + 1] = self.bulletitem(item)
8104      end
8105    end
8106    local contents = util.intersperse(buffer,"\n")
8107    if tight and options.tightLists then
8108      return {"\\markdownRendererUlBeginTight\n",contents,
8109        "\n\\markdownRendererUlEndTight "}
8110    else
8111      return {"\\markdownRendererUlBegin\n",contents,
8112        "\n\\markdownRendererUlEnd "}
8113    end
8114  end
```

Define `writer->bulletitem` as a function that will transform an input bulleted list item to the output format, where `s` is the text of the list item.

```
8115  function self.bulletitem(s)
```

```
8116    return {"\\markdownRendererUlItem ",s,
8117            "\\markdownRendererUlItemEnd "}
8118  end
```

Define `writer->orderedlist` as a function that will transform an input ordered list to the output format, where `items` is an array of the list items and `tight` specifies, whether the list is tight or not. If the optional parameter `startnum` is present, it is the number of the first list item.

```
8119  function self.orderedlist(items,tight,startnum)
8120    if not self.is_writing then return "" end
8121    local buffer = {}
8122    local num = startnum
8123    for _,item in ipairs(items) do
8124      if item ~= "" then
8125        buffer[#buffer + 1] = self.ordereditem(item,num)
8126      end
8127      if num ~= nil and item ~= "" then
8128        num = num + 1
8129      end
8130    end
8131    local contents = util.intersperse(buffer,"\n")
8132    if tight and options.tightLists then
8133      return {"\\markdownRendererOlBeginTight\n",contents,
8134              "\n\\markdownRendererOlEndTight "}
8135    else
8136      return {"\\markdownRendererOlBegin\n",contents,
8137              "\n\\markdownRendererOlEnd "}
8138    end
8139  end
```

Define `writer->ordereditem` as a function that will transform an input ordered list item to the output format, where `s` is the text of the list item. If the optional parameter `num` is present, it is the number of the list item.

```
8140  function self.ordereditem(s,num)
8141    if num ~= nil then
8142      return {"\\markdownRendererOlItemWithNumber{",num,"}",s,
8143              "\\markdownRendererOlItemEnd "}
8144    else
8145      return {"\\markdownRendererOlItem ",s,
8146              "\\markdownRendererOlItemEnd "}
8147    end
8148  end
```

3.1.4.9 Formatters of html Tags, Elements, and Comments

Define `writer->inline_html_comment` as a function that will transform the contents of an inline HTML comment, to the output format, where `contents` are the contents of the HTML comment.

```
8149  function self.inline_html_comment(contents)
```

```
8150    if self.flatten_inlines then return contents end
8151    return {"\\markdownRendererInlineHtmlComment{",contents,"}"}
8152  end
```

Define `writer->inline_html_tag` as a function that will transform the contents of an opening, closing, or empty inline HTML tag to the output format, where `contents` are the contents of the HTML tag.

```
8153  function self.inline_html_tag(contents)
8154    if self.flatten_inlines then return contents end
8155    return {"\\markdownRendererInlineHtmlTag{",
8156            self.string(contents),"}"}
8157  end
```

Define `writer->block_html_element` as a function that will transform the contents of a block HTML element to the output format, where `s` are the contents of the HTML element.

```
8158  function self.block_html_element(s)
8159    if not self.is_writing then return "" end
8160    local name = util.cache(options.cacheDir, s, nil, nil, ".verbatim")
8161    return {"\\markdownRendererInputBlockHtmlElement{",name,"}"}
8162  end
```

Define `writer->block_html_cdata_element` as a function that transforms the contents of a block HTML CDATA element such as `<script>`, `<pre>`, `<style>`, or `<textarea>` (CommonMark HTML block type 1) to the output format.

```
8163  function self.block_html_cdata_element(s)
8164    if not self.is_writing then return "" end
8165    local name = util.cache(options.cacheDir, s, nil, nil, ".verbatim")
8166    return {"\\markdownRendererInputBlockHtmlCdataElement{",name,"}"}
8167  end
```

Define `writer->block_html_comment` as a function that transforms the contents of a block HTML comment (CommonMark HTML block type 2) to the output format, where `s` is the full comment text.

```
8168  function self.block_html_comment(contents)
8169    if self.flatten_inlines then return contents end
8170    return {"\\markdownRendererBlockHtmlComment{",contents,"}"}
8171  end
```

Define `writer->block_html_processing_instruction` as a function that transforms the contents of a block HTML processing instruction (CommonMark HTML block type 3) to the output format.

```
8172  function self.block_html_processing_instruction(s)
8173    if not self.is_writing then return "" end
8174    local name = util.cache(options.cacheDir, s, nil, nil, ".verbatim")
8175    return {
8176      "\\markdownRendererInputBlockHtmlProcessingInstruction{",name,"}"}
8177  end
```

Define `writer->block_html_declaration` as a function that transforms the contents of a block HTML declaration (CommonMark HTML block type 4) to the output format.

```
8178  function self.block_html_declaration(s)
8179    if not self.is_writing then return "" end
8180    local name = util.cache(options.cacheDir, s, nil, nil, ".verbatim")
8181    return {
8182      "\\markdownRendererInputBlockHtmlDeclaration{",name,"}"}
8183  end
```

Define `writer->block_html_cdata_section` as a function that transforms the contents of a block HTML CDATA section (CommonMark HTML block type 5) to the output format.

```
8184  function self.block_html_cdata_section(s)
8185    if not self.is_writing then return "" end
8186    local name = util.cache(options.cacheDir, s, nil, nil, ".verbatim")
8187    return {"\\markdownRendererInputBlockHtmlCdataSection{",name,"}"}
8188  end
```

Define `writer->block_html_pcdata_element` as a function that transforms the contents of a block HTML PCDATA element such as `<div>` or `<table>` (CommonMark HTML block type 6) to the output format.

```
8189  function self.block_html_pcdata_element(s)
8190    if not self.is_writing then return "" end
8191    local name = util.cache(options.cacheDir, s, nil, nil, ".verbatim")
8192    return {"\\markdownRendererInputBlockHtmlPcdataElement{",name,"}"}
8193  end
```

Define `writer->block_html_standalone_tag` as a function that transforms the contents of a block HTML element that does not fall into types 1–6 (CommonMark HTML block type 7) to the output format.

```
8194  function self.block_html_standalone_tag(contents)
8195    if self.flatten_inlines then return contents end
8196    return {"\\markdownRendererBlockHtmlStandaloneTag{",
8197            self.string(contents),"}"}
8198  end
```

Define `writer->inline_html_processing_instruction` as a function that transforms the contents of an inline HTML processing instruction to the output format.

```
8199  function self.inline_html_processing_instruction(contents)
8200    if self.flatten_inlines then return contents end
8201    return {"\\markdownRendererInlineHtmlProcessingInstruction{",
8202            self.string(contents),"}"}
8203  end
```

Define `writer->inline_html_declaration` as a function that transforms the contents of an inline HTML declaration to the output format.

```
8204  function self.inline_html_declaration(contents)
8205    if self.flatten_inlines then return contents end
8206    return {"\\markdownRendererInlineHtmlDeclaration{",
8207            self.string(contents),"}"}
8208  end
```

Define `writer->inline_html_cdata_section` as a function that transforms the contents of an inline HTML CDATA section to the output format.

```
function self.inline_html_cdata_section(contents)
  if self.flatten_inlines then return contents end
  return {"\\markdownRendererInlineHtmlCdataSection{",
          self.string(contents),"}"}
end
```

Define `writer->inline_html_open_tag` as a function that transforms the contents of an inline HTML opening tag to the output format.

```
function self.inline_html_open_tag(contents)
  if self.flatten_inlines then return contents end
  return {"\\markdownRendererInlineHtmlOpenTag{",
          self.string(contents),"}"}
end
```

Define `writer->inline_html_close_tag` as a function that transforms the contents of an inline HTML closing tag to the output format.

```
function self.inline_html_close_tag(contents)
  if self.flatten_inlines then return contents end
  return {"\\markdownRendererInlineHtmlCloseTag{",
          self.string(contents),"}"}
end
```

Define `writer->inline_html_empty_tag` as a function that transforms the contents of an inline HTML self-closing (empty) tag to the output format.

```
function self.inline_html_empty_tag(contents)
  if self.flatten_inlines then return contents end
  return {"\\markdownRendererInlineHtmlEmptyTag{",
          self.string(contents),"}"}
end
```

3.1.4.10 Formatter of Emphasis

Define `writer->emphasis` as a function that will transform an emphasized span `s` of input text to the output format.

```
function self.emphasis(s)
  if self.flatten_inlines then return s end
  return {"\\markdownRendererEmphasis{",s,"}"}
end
```

3.1.4.11 Formatter of Strong Emphasis

Define `writer->strong` as a function that will transform a strongly emphasized span `s` of input text to the output format.

```
function self.strong(s)
  if self.flatten_inlines then return s end
  return {"\\markdownRendererStrongEmphasis{",s,"}"}
end
```

3.1.4.12 Formatter of Tickboxes

Define `writer->tickbox` as a function that will transform a number `f` to the output format.

```
function self.tickbox(f)
  if f == 1.0 then
    return "☒ "
  elseif f == 0.0 then
    return "☐ "
  else
    return "⊡ "
  end
end
```

3.1.4.13 Formatter of Blockquotes

Define `writer->blockquote` as a function that will transform an input block quote `s` to the output format.

```
function self.blockquote(s)
  if not self.is_writing then return "" end
  return {"\\markdownRendererBlockQuoteBegin\n",s,
    "\\markdownRendererBlockQuoteEnd "}
end
```

3.1.4.14 Formatter of Code Blocks

Define `writer->verbatim` as a function that will transform an input code block `s` to the output format.

```
function self.verbatim(s)
  if not self.is_writing then return "" end
  s = s:gsub("\n$", "")
  local name = util.cache_verbatim(options.cacheDir, s)
  return {"\\markdownRendererInputVerbatim{",name,"}"}
end
```

3.1.4.15 Formatter of Documents

Define `writer->document` as a function that will transform a document `d` to the output format.

```
function self.document(d)
  local buf = {"\\markdownRendererDocumentBegin\n"}

  -- warn against the `hybrid` option
  if options.hybrid then
    local text = "The `hybrid` option has been soft-deprecated."
    local more = "Consider using one of the following better options "
              .. "for mixing TeX and markdown: `contentBlocks`, "
              .. "`rawAttribute`, `texComments`, `texMathDollars`, "
              .. "`texMathSingleBackslash`, and "
              .. "`texMathDoubleBackslash`. "
```

```
                .. "For more information, see the user manual at "
                .. "<https://witiko.github.io/markdown/>."
      table.insert(buf, self.warning(text, more))
    end

    -- insert the text of the document
    table.insert(buf, d)

    -- pop all attributes
    table.insert(buf, self.pop_attributes())

    table.insert(buf, "\\markdownRendererDocumentEnd")

    return buf
  end
```

3.1.4.16 Formatter of Attributes

Define `writer->attributes` as a function that will transform input attributes `attrs` to the output format.

```
  local seen_identifiers = {}
  local key_value_regex = "([^= ]+)%s*=%s*(.*)"
  local function normalize_attributes(attributes, auto_identifiers)
    -- normalize attributes
    local normalized_attributes = {}
    local has_explicit_identifiers = false
    local key, value
    for _, attribute in ipairs(attributes or {}) do
      if attribute:sub(1, 1) == "#" then
        table.insert(normalized_attributes, attribute)
        has_explicit_identifiers = true
        seen_identifiers[attribute:sub(2)] = true
      elseif attribute:sub(1, 1) == "." then
        table.insert(normalized_attributes, attribute)
      else
        key, value = attribute:match(key_value_regex)
        if key:lower() == "id" then
          table.insert(normalized_attributes, "#" .. value)
        elseif key:lower() == "class" then
          local classes = {}
          for class in value:gmatch("%S+") do
            table.insert(classes, class)
          end
          table.sort(classes)
          for _, class in ipairs(classes) do
            table.insert(normalized_attributes, "." .. class)
          end
        else
          table.insert(normalized_attributes, attribute)
```

```
        end
      end
    end

    -- if no explicit identifiers exist, add auto identifiers
    if not has_explicit_identifiers and auto_identifiers ~= nil then
      local seen_auto_identifiers = {}
      for _, auto_identifier in ipairs(auto_identifiers) do
        if seen_auto_identifiers[auto_identifier] == nil then
          seen_auto_identifiers[auto_identifier] = true
          if seen_identifiers[auto_identifier] == nil then
            seen_identifiers[auto_identifier] = true
            table.insert(normalized_attributes,
                         "#" .. auto_identifier)
          else
            local auto_identifier_number = 1
            while true do
              local numbered_auto_identifier = auto_identifier .. "-"
                                               .. auto_identifier_number
              if seen_identifiers[numbered_auto_identifier] == nil then
                seen_identifiers[numbered_auto_identifier] = true
                table.insert(normalized_attributes,
                             "#" .. numbered_auto_identifier)
                break
              end
              auto_identifier_number = auto_identifier_number + 1
            end
          end
        end
      end
    end

    -- sort and deduplicate normalized attributes
    table.sort(normalized_attributes)
    local seen_normalized_attributes = {}
    local deduplicated_normalized_attributes = {}
    for _, attribute in ipairs(normalized_attributes) do
      if seen_normalized_attributes[attribute] == nil then
        seen_normalized_attributes[attribute] = true
        table.insert(deduplicated_normalized_attributes, attribute)
      end
    end

    return deduplicated_normalized_attributes
  end

  function self.attributes(attributes, should_normalize_attributes)
    local normalized_attributes
    if should_normalize_attributes == false then
```

```
      normalized_attributes = attributes
    else
      normalized_attributes = normalize_attributes(attributes)
    end

    local buf = {}
    local key, value
    for _, attribute in ipairs(normalized_attributes) do
      if attribute:sub(1, 1) == "#" then
        table.insert(buf, {"\\markdownRendererAttributeIdentifier{",
                           attribute:sub(2), "}"})
      elseif attribute:sub(1, 1) == "." then
        table.insert(buf, {"\\markdownRendererAttributeClassName{",
                           attribute:sub(2), "}"})
      else
        key, value = attribute:match(key_value_regex)
        table.insert(buf, {"\\markdownRendererAttributeKeyValue{",
                           key, "}{", value, "}"})
      end
    end

    return buf
  end
```

3.1.4.17 Tracking Active Attributes

Define `writer->active_attributes` as a stack of block-level attributes that are currently active. The `writer->active_attributes` member variable is mutable.

```
  self.active_attributes = {}
```

Define `writer->attribute_type_levels` as a hash table that maps attribute types to the number of attributes of said type in `writer->active_attributes`.

```
  self.attribute_type_levels = {}
  setmetatable(self.attribute_type_levels,
               { __index = function() return 0 end })
```

Define `writer->push_attributes` and `writer->pop_attributes` as functions that will add a new set of active block-level attributes or remove the most current attributes from `writer->active_attributes`.

```
  local function apply_attributes()
    local buf = {}
    for i = 1, #self.active_attributes do
      local start_output = self.active_attributes[i][3]
      if start_output ~= nil then
        table.insert(buf, start_output)
      end
    end
    return buf
  end

```

```
8399  local function tear_down_attributes()
8400    local buf = {}
8401    for i = #self.active_attributes, 1, -1 do
8402      local end_output = self.active_attributes[i][4]
8403      if end_output ~= nil then
8404        table.insert(buf, end_output)
8405      end
8406    end
8407    return buf
8408  end
```

The `writer->push_attributes` method adds `attributes` of type `attribute_type` to `writer->active_attributes`. The `start_output` string is used to construct a rope that will be returned by this function, together with output produced as a result of slicing (see `slice`). The `end_output` string is stored together with `attributes` and is used to construct the return value of the `writer->pop_attributes` method.

```
8409  function self.push_attributes(attribute_type, attributes,
8410                                start_output, end_output)
8411    local attribute_type_level
8412      = self.attribute_type_levels[attribute_type]
8413    self.attribute_type_levels[attribute_type]
8414      = attribute_type_level + 1
8415
8416    -- index attributes in a hash table for easy lookup
8417    attributes = attributes or {}
8418    for i = 1, #attributes do
8419      attributes[attributes[i]] = true
8420    end
8421
8422    local buf = {}
8423    -- handle slicing
8424    if attributes["#" .. self.slice_end_identifier] ~= nil and
8425       self.slice_end_type == "^" then
8426      if self.is_writing then
8427        table.insert(buf, self.undosep())
8428        table.insert(buf, tear_down_attributes())
8429      end
8430      self.is_writing = false
8431    end
8432    if attributes["#" .. self.slice_begin_identifier] ~= nil and
8433       self.slice_begin_type == "^" then
8434      table.insert(buf, apply_attributes())
8435      self.is_writing = true
8436    end
8437    if self.is_writing and start_output ~= nil then
8438      table.insert(buf, start_output)
8439    end
8440    table.insert(self.active_attributes,
8441                 {attribute_type, attributes,
```

```
                  start_output, end_output})
  return buf
end
```

The `writer->pop_attributes` method removes the most current of active block-level attributes from `writer->active_attributes` until attributes of type `attribute_type` have been removed. The method returns a rope constructed from the `end_output` string specified in the calls of `writer->push_attributes` that produced the most current attributes, and also from output produced as a result of slicing (see `slice`).

```
function self.pop_attributes(attribute_type)
  local buf = {}
  -- pop attributes until we find attributes of correct type
  -- or until no attributes remain
  local current_attribute_type = false
  while current_attribute_type ~= attribute_type and
        #self.active_attributes > 0 do
    local attributes, _, end_output
    current_attribute_type, attributes, _, end_output = table.unpack(
      self.active_attributes[#self.active_attributes])
    local attribute_type_level
      = self.attribute_type_levels[current_attribute_type]
    self.attribute_type_levels[current_attribute_type]
      = attribute_type_level - 1
    if self.is_writing and end_output ~= nil then
      table.insert(buf, end_output)
    end
    table.remove(self.active_attributes, #self.active_attributes)
    -- handle slicing
    if attributes["#" .. self.slice_end_identifier] ~= nil
       and self.slice_end_type == "$" then
      if self.is_writing then
        table.insert(buf, self.undosep())
        table.insert(buf, tear_down_attributes())
      end
      self.is_writing = false
    end
    if attributes["#" .. self.slice_begin_identifier] ~= nil and
       self.slice_begin_type == "$" then
      self.is_writing = true
      table.insert(buf, apply_attributes())
    end
  end
  return buf
end
```

3.1.4.18 Automatically Generated Identifiers for Headings

Create an auto identifier string by stripping and converting characters from string `s`.

```
local function create_auto_identifier(s)
  local buffer = {}
  local prev_space = false
  local letter_found = false
  local normalized_s = s
  if not options.unicodeNormalization
     or options.unicodeNormalizationForm ~= "nfc" then
    normalized_s = util.normalize(normalized_s, "nfc")
  end

  for _, code in utf8.codes(normalized_s) do
    local char = utf8.char(code)

    -- Remove everything up to the first letter.
    if not letter_found then
      local is_letter = lpeg.match(
        parsers.unicode.alpha,
        char
      )
      if is_letter then
        letter_found = true
      else
        goto continue
      end
    end

    -- Remove all non-alphanumeric characters, except underscores,
    -- hyphens, and periods.
    if not lpeg.match(
      ( parsers.underscore
      + parsers.dash
      + parsers.period
      + parsers.unicode.word
      + #parsers.unicode.whitespace ),
      char
    ) then
      goto continue
    end

    -- Replace all spaces and newlines with hyphens.
    if lpeg.match(
      ( parsers.newline
      + #parsers.unicode.whitespace ),
      char
    ) then
      char = "-"
      if prev_space then
        goto continue
      else
```

```
          prev_space = true
        end
      else
        -- Case-fold all alphabetic characters.
        local form = nil
        if options.unicodeNormalization then
          form = options.unicodeNormalizationForm
        end
        char = util.casefold(char, form)
        prev_space = false
      end

      table.insert(buffer, char)

      ::continue::
    end

    if prev_space then
      table.remove(buffer)
    end

    local identifier = #buffer == 0 and "section"
                    or table.concat(buffer, "")
    return identifier
  end
```

Create an GitHub-flavored auto identifier string by stripping and converting characters from string s.

```
  local function create_gfm_auto_identifier(s)
    local buffer = {}
    local prev_space = false
    local letter_found = false
    local normalized_s = s
    if not options.unicodeNormalization
       or options.unicodeNormalizationForm ~= "nfc" then
      normalized_s = util.normalize(normalized_s, "nfc")
    end

    for _, code in utf8.codes(normalized_s) do
      local char = utf8.char(code)

      -- Remove everything up to the first non-space.
      if not letter_found then
        local is_letter = not lpeg.match(
          #parsers.unicode.whitespace,
          char
        )
        if is_letter then
          letter_found = true
        else
```

```
8577            goto continue
8578          end
8579        end
8580
8581        -- Remove all non-alphanumeric characters, except underscores
8582        -- and hyphens.
8583        if not lpeg.match(
8584          ( parsers.underscore
8585          + parsers.dash
8586          + parsers.unicode.word
8587          + #parsers.unicode.whitespace ),
8588          char
8589        ) then
8590          prev_space = false
8591          goto continue
8592        end
8593
8594        -- Replace all spaces and newlines with hyphens.
8595        if lpeg.match(
8596          ( parsers.newline
8597          + #parsers.unicode.whitespace ),
8598          char
8599        ) then
8600          char = "-"
8601          if prev_space then
8602            goto continue
8603          else
8604            prev_space = true
8605          end
8606        else
8607          -- Case-fold all alphabetic characters.
8608          local form = nil
8609          if options.unicodeNormalization then
8610            form = options.unicodeNormalizationForm
8611          end
8612          char = util.casefold(char, form)
8613          prev_space = false
8614        end
8615
8616        table.insert(buffer, char)
8617
8618        ::continue::
8619      end
8620
8621      if prev_space then
8622        table.remove(buffer)
8623      end
8624
8625      local identifier = #buffer == 0 and "section"
```

```
                    or table.concat(buffer, "")
  return identifier
end
```

3.1.4.19 Formatter of Headings

Define `writer->heading` as a function that will transform an input heading `s` at level `level` with attributes `attributes` to the output format.

```
self.secbegin_text = "\\markdownRendererSectionBegin\n"
self.secend_text = "\n\\markdownRendererSectionEnd "
function self.heading(s, level, attributes)
  local buf = {}
  local flat_text, inlines = table.unpack(s)

  -- push empty attributes for implied sections
  while self.attribute_type_levels["heading"] < level - 1 do
    table.insert(buf,
                 self.push_attributes("heading",
                                      nil,
                                      self.secbegin_text,
                                      self.secend_text))
  end

  -- pop attributes for sections that have ended
  while self.attribute_type_levels["heading"] >= level do
    table.insert(buf, self.pop_attributes("heading"))
  end

  -- construct attributes for the new section
  local auto_identifiers = {}
  if self.options.autoIdentifiers then
    table.insert(auto_identifiers, create_auto_identifier(flat_text))
  end
  if self.options.gfmAutoIdentifiers then
    table.insert(auto_identifiers,
                 create_gfm_auto_identifier(flat_text))
  end
  local normalized_attributes = normalize_attributes(attributes,
                                                     auto_identifiers)

  -- push attributes for the new section
  local start_output = {}
  local end_output = {}
  table.insert(start_output, self.secbegin_text)
  table.insert(end_output, self.secend_text)

  table.insert(buf, self.push_attributes("heading",
                                         normalized_attributes,
                                         start_output,
```

```
                                          end_output))
  assert(self.attribute_type_levels["heading"] == level)

  -- render the heading and its attributes
  if self.is_writing and #normalized_attributes > 0 then
    table.insert(buf,
                 "\\markdownRendererHeaderAttributeContextBegin\n")
    table.insert(buf, self.attributes(normalized_attributes, false))
  end

  local cmd
  level = level + options.shiftHeadings
  if level <= 1 then
    cmd = "\\markdownRendererHeadingOne"
  elseif level == 2 then
    cmd = "\\markdownRendererHeadingTwo"
  elseif level == 3 then
    cmd = "\\markdownRendererHeadingThree"
  elseif level == 4 then
    cmd = "\\markdownRendererHeadingFour"
  elseif level == 5 then
    cmd = "\\markdownRendererHeadingFive"
  elseif level >= 6 then
    cmd = "\\markdownRendererHeadingSix"
  else
    cmd = ""
  end
  if self.is_writing then
    table.insert(buf, {cmd, "{", inlines, "}"})
  end

  if self.is_writing and #normalized_attributes > 0 then
    table.insert(buf, "\\markdownRendererHeaderAttributeContextEnd{}")
  end

  return buf
end
```

3.1.4.20 Managing State and Deferred Writer Calls

Define `writer->get_state` as a function that returns the current state of the writer, where the state of a writer are its mutable member variables.

```
function self.get_state()
  return {
    is_writing=self.is_writing,
    flatten_inlines=self.flatten_inlines,
    active_attributes={table.unpack(self.active_attributes)},
  }
end
```

Define `writer->set_state` as a function that restores the input state `s` and returns the previous state of the writer.

```
  function self.set_state(s)
    local previous_state = self.get_state()
    for key, value in pairs(s) do
      self[key] = value
    end
    return previous_state
  end
```

Define `writer->defer_call` as a function that will encapsulate the input function `f`, so that `f` is called with the state of the writer at the time of calling `writer->defer_call`.

```
  function self.defer_call(f)
    local previous_state = self.get_state()
    return function(...)
      local state = self.set_state(previous_state)
      local return_value = f(...)
      self.set_state(state)
      return return_value
    end
  end

  return self
end
```

3.1.5 Parsers

The `parsers` hash table stores PEG patterns that are static and can be reused between different `reader` objects.

```
parsers                          = {}
```

3.1.5.1 Basic Parsers

```
parsers.percent                  = P("%")
parsers.at                       = P("@")
parsers.comma                    = P(",")
parsers.asterisk                 = P("*")
parsers.dash                     = P("-")
parsers.plus                     = P("+")
parsers.underscore               = P("_")
parsers.period                   = P(".")
parsers.hash                     = P("#")
parsers.dollar                   = P("$")
parsers.ampersand                = P("&")
parsers.backtick                 = P("`")
parsers.less                     = P("<")
parsers.more                     = P(">")
parsers.space                    = P(" ")
parsers.squote                   = P("'")
```

```
parsers.dquote               = P('"')
parsers.lparent              = P("(")
parsers.rparent              = P(")")
parsers.lbracket             = P("[")
parsers.rbracket             = P("]")
parsers.lbrace               = P("{")
parsers.rbrace               = P("}")
parsers.circumflex           = P("^")
parsers.slash                = P("/")
parsers.equal                = P("=")
parsers.colon                = P(":")
parsers.semicolon            = P(";")
parsers.exclamation          = P("!")
parsers.pipe                 = P("|")
parsers.tilde                = P("~")
parsers.backslash            = P("\\")
parsers.tab                  = P("\t")
parsers.newline              = P("\n")

parsers.digit                = R("09")
parsers.hexdigit             = R("09","af","AF")
parsers.letter               = R("AZ","az")
parsers.alphanumeric         = R("AZ","az","09")
parsers.keyword              = parsers.letter
                             * (parsers.alphanumeric + parsers.dash)^0

parsers.doubleasterisks      = P("**")
parsers.doubleunderscores    = P("__")
parsers.doubletildes         = P("~~")
parsers.fourspaces           = P("    ")

parsers.any                  = P(1)
parsers.eof                  = P(-1)
parsers.succeed              = P(true)
parsers.fail                 = P(false)

parsers.internal_punctuation = S(":;,.?")
parsers.ascii_punctuation    = S("!\"#$%&'()*+,-./:;<=>?@[\\]^_`{|}~")

parsers.escapable            = parsers.ascii_punctuation
parsers.anyescaped           = parsers.backslash / ""
                             * parsers.escapable
                             + parsers.any

parsers.spacechar            = S("\t ")
parsers.spacing              = S(" \n\r\t")
parsers.nonspacechar         = parsers.any - parsers.spacing
parsers.optionalspace        = parsers.spacechar^0

```

```
parsers.normalchar             = parsers.any - (V("SpecialChar")
                                                + parsers.spacing)
parsers.nonindentspace         = parsers.space^-3 * - parsers.spacechar
parsers.indent                 = parsers.space^-3 * parsers.tab
                               + parsers.fourspaces / ""
parsers.linechar               = P(1 - parsers.newline)

parsers.blankline              = parsers.optionalspace
                               * parsers.newline / "\n"
parsers.blanklines             = parsers.blankline^0
parsers.skipblanklines         = ( parsers.optionalspace
                                 * parsers.newline)^0
parsers.indentedline           = parsers.indent    /""
                               * C( parsers.linechar^1
                                  * parsers.newline^-1)
parsers.optionallyindentedline = parsers.indent^-1 /""
                               * C( parsers.linechar^1
                                  * parsers.newline^-1)
parsers.sp                     = parsers.spacing^0
parsers.spnl                   = parsers.optionalspace
                               * ( parsers.newline
                                 * parsers.optionalspace)^-1
parsers.line                   = parsers.linechar^0 * parsers.newline
parsers.nonemptyline           = parsers.line - parsers.blankline

```

3.1.5.2 Parsers for Unicode Character Classes and Categories

We define high-level parsers in table `parsers.unicode` based on the low-level parsers in `unicode_data.categories`, defined in Section 3.1.1.5. Unlike the low-level parsers, the high-level parsers are invariant to the number of bytes the Unicode characters occupy after conversion to UTF-8.

```
parsers.unicode = {}
parsers.unicode.preceding_punctuation = parsers.fail
parsers.unicode.punctuation = parsers.fail
parsers.unicode.alpha = parsers.fail
parsers.unicode.numeric = parsers.fail
parsers.unicode.word = parsers.fail
parsers.unicode.preceding_whitespace = parsers.fail
parsers.unicode.whitespace = parsers.fail
for n = 1, 4 do
```

For punctuation, accept any characters from Unicode categories P (punctuation) and S (symbol), as mandated by the CommonMark standard[40].

```
  local punctuation_of_length_n
    = unicode_data.categories.P[n]
    + unicode_data.categories.S[n]
   parsers.unicode.preceding_punctuation
```

[40] See https://spec.commonmark.org/0.31.2/#unicode-punctuation-character.

```
    = parsers.unicode.preceding_punctuation
    + B(punctuation_of_length_n)
  parsers.unicode.punctuation
    = parsers.unicode.punctuation
    + punctuation_of_length_n
```

For alphabetical characters, accept any characters from Unicode category L (letter), similar to the character class ‘Unicode.

```
  local alpha_of_length_n = unicode_data.categories.L[n]
  parsers.unicode.alpha
    = parsers.unicode.alpha
    + alpha_of_length_n
```

For numeric characters, accept any characters from Unicode category N (number), similar to the character class ‘Unicode.

```
  local numeric_of_length_n = unicode_data.categories.N[n]
  parsers.unicode.numeric
    = parsers.unicode.numeric
    + numeric_of_length_n
```

For word characters, accept any characters from Unicode categories L (letter), N (number), and Pc (connector punctuation), similar to the character class ‘

```
  local word_of_length_n
    = alpha_of_length_n
    + numeric_of_length_n
    + unicode_data.categories.Pc[n]
  parsers.unicode.word
    = parsers.unicode.word
    + word_of_length_n
```

For space characters, accept any characters from Unicode category Z (separator), as well as the ASCII control characters 9 (horizontal tab) through 13 (carriage return), similar to the character class ‘Lua library Selene Unicode.

```
  local whitespace_of_length_n = unicode_data.categories.Z[n]
  if n == 1 then
    whitespace_of_length_n
      = whitespace_of_length_n
      + R("\t\r")
  end
  parsers.unicode.preceding_whitespace
    = parsers.unicode.preceding_whitespace
    + B(whitespace_of_length_n)
  parsers.unicode.whitespace
    = parsers.unicode.whitespace
    + whitespace_of_length_n
end
```

3.1.5.3 Parsers Used for Indentation

```

parsers.leader      = parsers.space^-3
```

Check if a trail exists and is non-empty in the indent table `indent_table`.

```
local function has_trail(indent_table)
  return indent_table ~= nil and
    indent_table.trail ~= nil and
    next(indent_table.trail) ~= nil
end
```

Check if indent table `indent_table` has any indents.

```
local function has_indents(indent_table)
  return indent_table ~= nil and
    indent_table.indents ~= nil and
    next(indent_table.indents) ~= nil
end
```

Add a trail `trail_info` to the indent table `indent_table`.

```
local function add_trail(indent_table, trail_info)
  indent_table.trail = trail_info
  return indent_table
end
```

Remove a trail `trail_info` from the indent table `indent_table`.

```
local function remove_trail(indent_table)
  indent_table.trail = nil
  return indent_table
end
```

Update the indent table `indent_table` by adding or removing a new indent `add`.

```
local function update_indent_table(indent_table, new_indent, add)
  indent_table = remove_trail(indent_table)

  if not has_indents(indent_table) then
    indent_table.indents = {}
  end


  if add then
    indent_table.indents[#indent_table.indents + 1] = new_indent
  else
    if indent_table.indents[#indent_table.indents].name
       == new_indent.name then
      indent_table.indents[#indent_table.indents] = nil
    end
  end

  return indent_table
```

```
end

```

Remove an indent by its name `name`.

```
local function remove_indent(name)
  local remove_indent_level =
    function(s, i, indent_table) -- luacheck: ignore s i
      indent_table = update_indent_table(indent_table, {name=name},
                                         false)
      return true, indent_table
    end

  return Cg(Cmt(Cb("indent_info"), remove_indent_level), "indent_info")
end

```

Process the spacing of a string of spaces and tabs `spacing` with preceding indent width from the start of the line `indent` and strip up to `left_strip_length` spaces. Return the remainder `remainder` and whether there is enough spaces to produce a code `is_code`. Return how many spaces were stripped, as well as if the minimum was met `is_minimum` and what remainder it left `minimum_remainder`.

```
local function process_starter_spacing(indent, spacing,
                                       minimum, left_strip_length)
  left_strip_length = left_strip_length or 0

  local count = 0
  local tab_value = 4 - (indent) % 4

  local code_started, minimum_found = false, false
  local code_start, minimum_remainder = "", ""

  local left_total_stripped = 0
  local full_remainder = ""

  if spacing ~= nil then
    for i = 1, #spacing do
      local character = spacing:sub(i, i)

      if character == "\t" then
        count = count + tab_value
        tab_value = 4
      elseif character == " " then
        count = count + 1
        tab_value = 4 - (1 - tab_value) % 4
      end

      if (left_strip_length ~= 0) then
        local possible_to_strip = math.min(count, left_strip_length)
        count = count - possible_to_strip
        left_strip_length = left_strip_length - possible_to_strip
```

```
        left_total_stripped = left_total_stripped + possible_to_strip
      else
        full_remainder =  full_remainder .. character
      end

      if (minimum_found) then
        minimum_remainder = minimum_remainder .. character
      elseif (count >= minimum) then
        minimum_found = true
        minimum_remainder = minimum_remainder
                          .. string.rep(" ", count - minimum)
      end

      if (code_started) then
        code_start = code_start .. character
      elseif (count >= minimum + 4) then
        code_started = true
        code_start = code_start
                  .. string.rep(" ", count - (minimum + 4))
      end
    end
  end

  local remainder
  if (code_started) then
    remainder = code_start
  else
    remainder = string.rep(" ", count - minimum)
  end

  local is_minimum = count >= minimum
  return {
    is_code = code_started,
    remainder = remainder,
    left_total_stripped = left_total_stripped,
    is_minimum = is_minimum,
    minimum_remainder = minimum_remainder,
    total_length = count,
    full_remainder = full_remainder
  }
end

```

Count the total width of all indents in the indent table `indent_table`.

```
local function count_indent_tab_level(indent_table)
  local count = 0
  if not has_indents(indent_table) then
    return count
  end

```

```
  for i=1, #indent_table.indents do
    count = count + indent_table.indents[i].length
  end
  return count
end

```

Count the total width of a delimiter `delimiter`.

```
local function total_delimiter_length(delimiter)
  local count = 0
  if type(delimiter) == "string" then return #delimiter end
  for _, value in pairs(delimiter) do
    count = count + total_delimiter_length(value)
  end
  return count
end

```

Process the container starter `starter` of a type `indent_type`. Adjust the width of the indent if the delimiter is followed only by whitespaces `is_blank`.

```
local function process_starter_indent(_, _, indent_table, starter,
                                       is_blank, indent_type, breakable)
  local last_trail = starter[1]
  local delimiter = starter[2]
  local raw_new_trail = starter[3]

  if indent_type == "bq" and not breakable then
    indent_table.ignore_blockquote_blank = true
  end

  if has_trail(indent_table) then
    local trail = indent_table.trail
    if trail.is_code then
      return false
    end
    last_trail = trail.remainder
  else
    local sp = process_starter_spacing(0, last_trail, 0, 0)

    if sp.is_code then
      return false
    end
    last_trail = sp.remainder
  end

  local preceding_indentation = count_indent_tab_level(indent_table) % 4
  local last_trail_length = #last_trail
  local delimiter_length = total_delimiter_length(delimiter)

  local total_indent_level = preceding_indentation + last_trail_length
```

```
                            + delimiter_length

  local sp = {}
  if not is_blank then
    sp = process_starter_spacing(total_indent_level, raw_new_trail,
                                 0, 1)
  end

  local del_trail_length = sp.left_total_stripped
  if is_blank then
    del_trail_length = 1
  elseif not sp.is_code then
    del_trail_length = del_trail_length + #sp.remainder
  end

  local indent_length = last_trail_length + delimiter_length
                      + del_trail_length
  local new_indent_info = {name=indent_type, length=indent_length}

  indent_table = update_indent_table(indent_table, new_indent_info,
                                     true)
  indent_table = add_trail(indent_table,
                           {is_code=sp.is_code,
                            remainder=sp.remainder,
                            total_length=sp.total_length,
                            full_remainder=sp.full_remainder})

  return true, indent_table
end

```

Return the pattern corresponding with the indent name `name`.

```
local function decode_pattern(name)
  local delimeter = parsers.succeed
  if name == "bq" then
    delimeter = parsers.more
  end

  return C(parsers.optionalspace) * C(delimeter)
       * C(parsers.optionalspace) * Cp()
end

```

Find the first blank-only indent of the indent table `indent_table` followed by blank-only indents.

```
local function left_blank_starter(indent_table)
  local blank_starter_index

  if not has_indents(indent_table) then
    return
```

```
  end

  for i = #indent_table.indents,1,-1 do
    local value = indent_table.indents[i]
    if value.name == "li" then
      blank_starter_index = i
    else
      break
    end
  end

  return blank_starter_index
end

```

Apply the patterns decoded from the indents of the indent table `indent_table` iteratively starting at position `index` of the string `s`. If the `is_optional` mode is selected, match as many patterns as possible, else match all or fail. With the option `is_blank`, the parsing behaves as optional after the position of a blank-only indent has been surpassed.

```
local function traverse_indent(s, i, indent_table, is_optional,
                               is_blank, current_line_indents)
  local new_index = i

  local preceding_indentation = 0
  local current_trail = {}

  local blank_starter = left_blank_starter(indent_table)

  if current_line_indents == nil then
    current_line_indents = {}
  end

  for index = 1,#indent_table.indents do
    local value = indent_table.indents[index]
    local pattern = decode_pattern(value.name)

    -- match decoded pattern
    local new_indent_info = lpeg.match(Ct(pattern), s, new_index)
    if new_indent_info == nil then
      local blankline_end = lpeg.match(
        Ct(parsers.blankline * Cg(Cp(), "pos")), s, new_index)
      if is_optional or not indent_table.ignore_blockquote_blank
         or not blankline_end then
        return is_optional, new_index, current_trail,
               current_line_indents
      end

      return traverse_indent(s, tonumber(blankline_end.pos),
                             indent_table, is_optional, is_blank,
```

```
                              current_line_indents)
    end

    local raw_last_trail = new_indent_info[1]
    local delimiter = new_indent_info[2]
    local raw_new_trail = new_indent_info[3]
    local next_index = new_indent_info[4]

    local space_only = delimiter == ""

    -- check previous trail
    if not space_only and next(current_trail) == nil then
      local sp = process_starter_spacing(0, raw_last_trail, 0, 0)
      current_trail = {is_code=sp.is_code, remainder=sp.remainder,
                       total_length=sp.total_length,
                       full_remainder=sp.full_remainder}
    end

    if next(current_trail) ~= nil then
      if not space_only and current_trail.is_code then
        return is_optional, new_index, current_trail,
               current_line_indents
      end
      if current_trail.internal_remainder ~= nil then
        raw_last_trail = current_trail.internal_remainder
      end
    end

    local raw_last_trail_length = 0
    local delimiter_length = 0

    if not space_only then
      delimiter_length = #delimiter
      raw_last_trail_length = #raw_last_trail
    end

    local total_indent_level = preceding_indentation
                             + raw_last_trail_length + delimiter_length

    local spacing_to_process
    local minimum = 0
    local left_strip_length = 0

    if not space_only then
      spacing_to_process = raw_new_trail
      left_strip_length = 1
    else
      spacing_to_process = raw_last_trail
      minimum = value.length
```

```
    end

    local sp = process_starter_spacing(total_indent_level,
                                       spacing_to_process, minimum,
                                       left_strip_length)

    if space_only and not sp.is_minimum then
      return is_optional or (is_blank and blank_starter <= index),
             new_index, current_trail, current_line_indents
    end

    local indent_length = raw_last_trail_length + delimiter_length
                        + sp.left_total_stripped

    -- update info for the next pattern
    if not space_only then
      preceding_indentation = preceding_indentation + indent_length
    else
      preceding_indentation = preceding_indentation + value.length
    end

    current_trail = {is_code=sp.is_code, remainder=sp.remainder,
                     internal_remainder=sp.minimum_remainder,
                     total_length=sp.total_length,
                     full_remainder=sp.full_remainder}

    current_line_indents[#current_line_indents + 1] = new_indent_info
    new_index = next_index
  end

  return true, new_index, current_trail, current_line_indents
end

```

Check if a code trail is expected.

```
local function check_trail(expect_code, is_code)
  return (expect_code and is_code) or (not expect_code and not is_code)
end

```

Check if the current trail of the `indent_table` would produce code if it is expected `expect_code` or it would not if it is not. If there is no trail, process and check the current spacing `spacing`.

```
local check_trail_joined =
  function(s, i, indent_table, -- luacheck: ignore s i
           spacing, expect_code, omit_remainder)
    local is_code
    local remainder

    if has_trail(indent_table) then
```

```
      local trail = indent_table.trail
      is_code = trail.is_code
      if is_code then
        remainder = trail.remainder
      else
        remainder = trail.full_remainder
      end
    else
      local sp = process_starter_spacing(0, spacing, 0, 0)
      is_code = sp.is_code
      if is_code then
        remainder = sp.remainder
      else
        remainder = sp.full_remainder
      end
    end

    local result = check_trail(expect_code, is_code)
    if omit_remainder then
      return result
    end
    return result, remainder
  end

```

Check if the current trail of the `indent_table` is of length between `min` and `max`.

```
local check_trail_length =
  function(s, i, indent_table, -- luacheck: ignore s i
           spacing, min, max)
    local trail

    if has_trail(indent_table) then
      trail = indent_table.trail
    else
      trail = process_starter_spacing(0, spacing, 0, 0)
    end

    local total_length = trail.total_length
    if total_length == nil then
      return false
    end

    return min <= total_length and total_length <= max
  end

```

Check the indentation of the continuation line, optionally with the mode `is_optional` selected. Check blank line exclusively with `is_blank`.

```
local function check_continuation_indentation(s, i, indent_table,
                                               is_optional, is_blank)
```

```
  if not has_indents(indent_table) then
    return true
  end

  local passes, new_index, current_trail, current_line_indents =
    traverse_indent(s, i, indent_table, is_optional, is_blank)

  if passes then
    indent_table.current_line_indents = current_line_indents
    indent_table = add_trail(indent_table, current_trail)
    return new_index, indent_table
  end
  return false
end

```

Get name of the last indent from the `indent_table`.

```
local function get_last_indent_name(indent_table)
  if has_indents(indent_table) then
    return indent_table.indents[#indent_table.indents].name
  end
end

```

Remove the remainder altogether if the last indent from the `indent_table` is blank-only.

```
local function remove_remainder_if_blank(indent_table, remainder)
  if get_last_indent_name(indent_table) == "li" then
    return ""
  end
  return remainder
end

```

Take the trail `trail` or create a new one from `spacing` and compare it with the expected `trail_type`. On success return the index `i` and the remainder of the trail.

```
local check_trail_type =
  function(s, i, -- luacheck: ignore s i
           trail, spacing, trail_type)
    if trail == nil then
      trail = process_starter_spacing(0, spacing, 0, 0)
    end

    if trail_type == "non-code" then
      return check_trail(false, trail.is_code)
    end
    if trail_type == "code" then
      return check_trail(true, trail.is_code)
    end
    if trail_type == "full-code" then
      if (trail.is_code) then
        return i, trail.remainder
```

```
      end
      return i, ""
    end
    if trail_type == "full-any" then
      return i, trail.internal_remainder
    end
  end

```

Stores or restores an `is_freezing` trail from indent table `indent_table`.

```
local trail_freezing =
  function(s, i, -- luacheck: ignore s i
           indent_table, is_freezing)
    if is_freezing then
      if indent_table.is_trail_frozen then
        indent_table.trail = indent_table.frozen_trail
      else
        indent_table.frozen_trail = indent_table.trail
        indent_table.is_trail_frozen = true
      end
    else
      indent_table.frozen_trail = nil
      indent_table.is_trail_frozen = false
    end
    return true, indent_table
  end

```

Check the indentation of the continuation line, optionally with the mode `is_optional` selected. Check blank line specifically with `is_blank`. Additionally, also directly check the new trail with a type `trail_type`.

```
local check_continuation_indentation_and_trail =
  function (s, i, indent_table, is_optional, is_blank, trail_type,
            reset_rem, omit_remainder)
    if not has_indents(indent_table) then
      local spacing, new_index = lpeg.match( C(parsers.spacechar^0)
                                           * Cp(), s, i)
      local result, remainder = check_trail_type(s, i,
        indent_table.trail, spacing, trail_type)
      if remainder == nil then
        if result then
          return new_index
        end
        return false
      end
      if result then
        return new_index, remainder
      end
      return false
    end
```

```
9363
9364      local passes, new_index, current_trail = traverse_indent(s, i,
9365        indent_table, is_optional, is_blank)
9366
9367      if passes then
9368        local spacing
9369        if current_trail == nil then
9370          local newer_spacing, newer_index = lpeg.match(
9371            C(parsers.spacechar^0) * Cp(), s, i)
9372          current_trail = process_starter_spacing(0, newer_spacing, 0, 0)
9373          new_index = newer_index
9374          spacing = newer_spacing
9375        else
9376          spacing = current_trail.remainder
9377        end
9378        local result, remainder = check_trail_type(s, new_index,
9379          current_trail, spacing, trail_type)
9380        if remainder == nil or omit_remainder then
9381          if result then
9382            return new_index
9383          end
9384          return false
9385        end
9386
9387        if is_blank and reset_rem then
9388          remainder = remove_remainder_if_blank(indent_table, remainder)
9389        end
9390        if result then
9391          return new_index, remainder
9392        end
9393        return false
9394      end
9395      return false
9396    end
9397
```

The following patterns check whitespace indentation at the start of a block.

```
9398 parsers.check_trail = Cmt( Cb("indent_info") * C(parsers.spacechar^0)
9399                           * Cc(false), check_trail_joined)
9400
9401 parsers.check_trail_no_rem = Cmt( Cb("indent_info")
9402                                 * C(parsers.spacechar^0) * Cc(false)
9403                                 * Cc(true), check_trail_joined)
9404
9405 parsers.check_code_trail  = Cmt( Cb("indent_info")
9406                                * C(parsers.spacechar^0)
9407                                * Cc(true), check_trail_joined)
9408
9409 parsers.check_trail_length_range  = function(min, max)
9410   return Cmt( Cb("indent_info") * C(parsers.spacechar^0) * Cc(min)
```

```
            * Cc(max), check_trail_length)
end

parsers.check_trail_length = function(n)
  return parsers.check_trail_length_range(n, n)
end

```

The following patterns handle trail backup, to prevent a failing pattern to modify it before passing it to the next.

```
parsers.freeze_trail = Cg( Cmt(Cb("indent_info")
                         * Cc(true), trail_freezing), "indent_info")

parsers.unfreeze_trail = Cg(Cmt(Cb("indent_info") * Cc(false),
                            trail_freezing), "indent_info")

```

The following patterns check indentation in continuation lines as defined by the container start.

```
parsers.check_minimal_indent = Cmt(Cb("indent_info") * Cc(false),
                                   check_continuation_indentation)

parsers.check_optional_indent = Cmt(Cb("indent_info") * Cc(true),
                                    check_continuation_indentation)

parsers.check_minimal_blank_indent
  = Cmt( Cb("indent_info") * Cc(false)
       * Cc(true)
       , check_continuation_indentation)

```

The following patterns check indentation in continuation lines as defined by the container start. Additionally the subsequent trail is also directly checked.

```

parsers.check_minimal_indent_and_trail =
  Cmt( Cb("indent_info")
     * Cc(false) * Cc(false) * Cc("non-code") * Cc(true)
     , check_continuation_indentation_and_trail)

parsers.check_minimal_indent_and_code_trail =
  Cmt( Cb("indent_info")
     * Cc(false) * Cc(false) * Cc("code") * Cc(false)
     , check_continuation_indentation_and_trail)

parsers.check_minimal_blank_indent_and_full_code_trail =
  Cmt( Cb("indent_info")
     * Cc(false) * Cc(true) * Cc("full-code") * Cc(true)
     , check_continuation_indentation_and_trail)

parsers.check_minimal_indent_and_any_trail =
```

```
  Cmt( Cb("indent_info")
     * Cc(false) * Cc(false) * Cc("full-any") * Cc(true) * Cc(false)
     , check_continuation_indentation_and_trail)

parsers.check_minimal_blank_indent_and_any_trail =
  Cmt( Cb("indent_info")
     * Cc(false) * Cc(true) * Cc("full-any") * Cc(true) * Cc(false)
     , check_continuation_indentation_and_trail)

parsers.check_minimal_blank_indent_and_any_trail_no_rem =
  Cmt( Cb("indent_info")
     * Cc(false) * Cc(true) * Cc("full-any") * Cc(true) * Cc(true)
     , check_continuation_indentation_and_trail)

parsers.check_optional_indent_and_any_trail =
  Cmt( Cb("indent_info")
     * Cc(true) * Cc(false) * Cc("full-any") * Cc(true) * Cc(false)
     , check_continuation_indentation_and_trail)

parsers.check_optional_blank_indent_and_any_trail =
  Cmt( Cb("indent_info")
     * Cc(true) * Cc(true) * Cc("full-any") * Cc(true) * Cc(false)
     , check_continuation_indentation_and_trail)

```

The following patterns specify behaviour around newlines.

```

parsers.spnlc_noexc = parsers.optionalspace
                    * ( parsers.newline
                      * parsers.check_minimal_indent_and_any_trail)^-1

parsers.spnlc = parsers.optionalspace
              * (V("EndlineNoSub"))^-1

parsers.spnlc_sep  = parsers.optionalspace * V("EndlineNoSub")
                   + parsers.spacechar^1

parsers.only_blank = parsers.spacechar^0
                   * (parsers.newline + parsers.eof)

```

The `parsers.commented_line^1` parser recognizes the regular language of TEX comments, see an equivalent finite automaton in Figure 8.

```
parsers.commented_line_letter  = parsers.linechar
                               + parsers.newline
                               - parsers.backslash
                               - parsers.percent
parsers.commented_line = Cg(Cc(""), "backslashes")
                       * Cg(Cc(true), "pure_comment")
                       * ((#(parsers.commented_line_letter
```

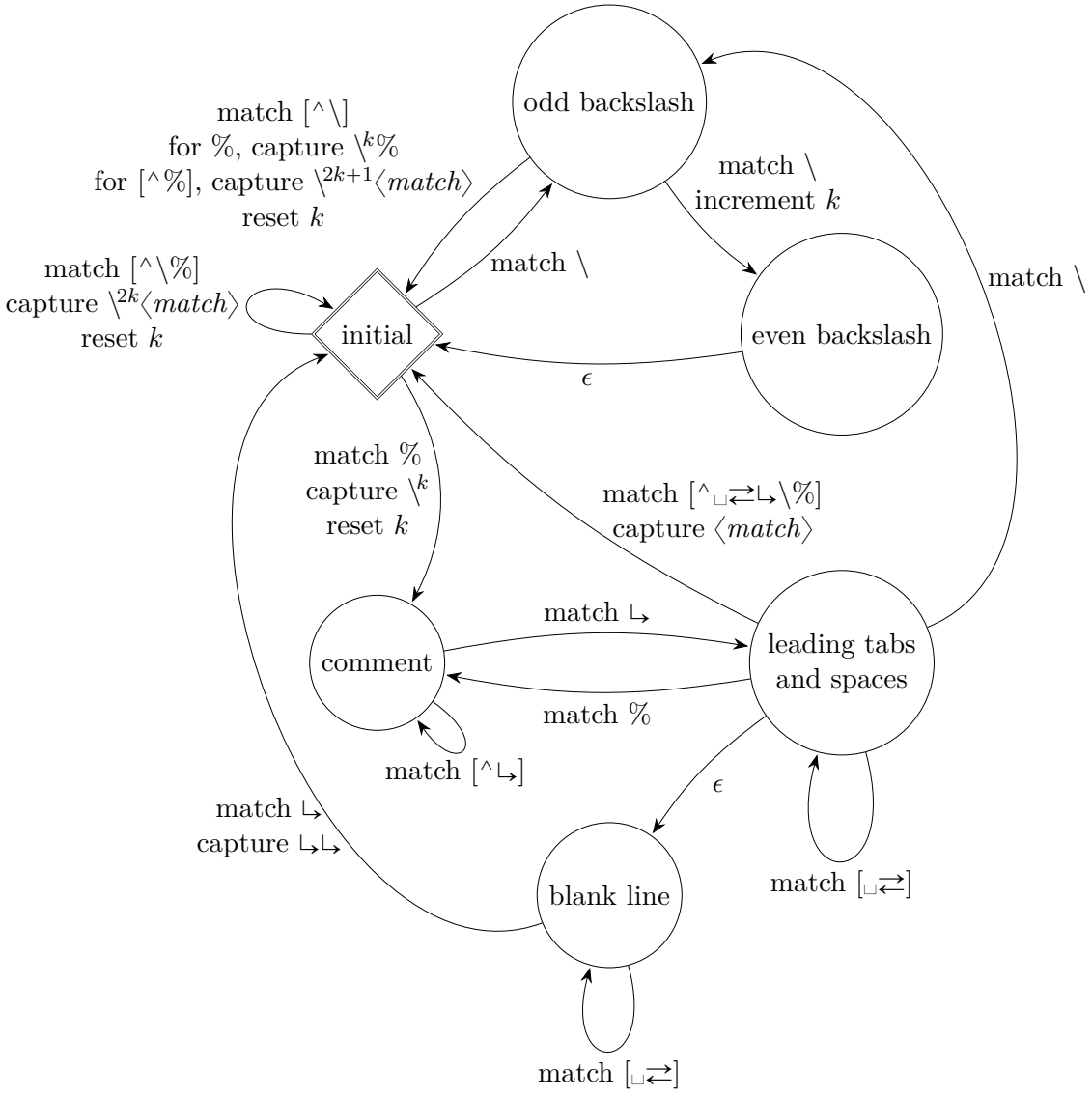


Figure 8: A pushdown automaton that recognizes TEX comments

```
                            - parsers.newline)
                          * Cb("backslashes")
                          * Cs(parsers.commented_line_letter
                            - parsers.newline)^1  -- initial
                          * Cg(Cc(""), "backslashes")
                          * Cg(Cc(false), "pure_comment"))
                         + #( parsers.backslash
                            * (parsers.backslash + parsers.newline))
                         * Cg((parsers.backslash  -- even backslash
                              * ( parsers.backslash
                                + #parsers.newline))^1, "backslashes")
                         * Cg(Cc(false), "pure_comment")
                         + (parsers.backslash
                           * (#parsers.percent
                             * Cb("backslashes")
                             / function(backslashes)
                               return string.rep("\\", #backslashes / 2)
                             end
                             * C(parsers.percent)
                             + #parsers.commented_line_letter
                             * Cb("backslashes")
                             * Cc("\\")
                             * C(parsers.commented_line_letter))
                           * Cg(Cc(""), "backslashes")
                           * Cg(Cc(false), "pure_comment")))^0
                       * (#parsers.percent
                         * Cb("backslashes")
                         / function(backslashes)
                           return string.rep("\\", #backslashes / 2)
                         end
                         * ((Cb("pure_comment")
                            * parsers.percent  -- comment
                            * parsers.line
                            * #parsers.blankline) -- blank line
                           / function(is_pure)
                             return is_pure and "" or "\n"
                           end
                           + parsers.percent  -- comment
                           * parsers.line
                           * parsers.optionalspace)  -- leading spaces
                         + #(parsers.newline)
                         * Cb("backslashes")
                         * C(parsers.newline))

parsers.chunk = parsers.line * (parsers.optionallyindentedline
                                  - parsers.blankline)^0

parsers.attribute_key_char = parsers.unicode.alpha
                           + parsers.unicode.numeric
```

```
                            + S("-_:.")
parsers.attribute_raw_char = parsers.unicode.alpha
                            + parsers.unicode.numeric
                            + S("-_")
parsers.attribute_key = (parsers.attribute_key_char
                        - parsers.dash - parsers.digit)
                      * parsers.attribute_key_char^0
parsers.attribute_value = ( (parsers.dquote / "")
                          * (parsers.anyescaped - parsers.dquote)^0
                          * (parsers.dquote / ""))
                        + ( (parsers.squote / "")
                          * (parsers.anyescaped - parsers.squote)^0
                          * (parsers.squote / ""))
                        + ( parsers.anyescaped
                          - parsers.dquote
                          - parsers.rbrace
                          - parsers.space)^0
parsers.attribute_identifier = parsers.attribute_key_char^1
parsers.attribute_classname = parsers.unicode.alpha
                            * parsers.attribute_key_char^0
parsers.attribute_raw = parsers.attribute_raw_char^1

parsers.attribute = (parsers.dash * Cc(".unnumbered"))
                  + C( parsers.hash
                     * parsers.attribute_identifier)
                  + C( parsers.period
                     * parsers.attribute_classname)
                  + Cs( parsers.attribute_key
                      * parsers.optionalspace
                      * parsers.equal
                      * parsers.optionalspace
                      * parsers.attribute_value)
parsers.attributes = parsers.lbrace
                   * parsers.optionalspace
                   * parsers.attribute
                   * (parsers.spacechar^1
                     * parsers.attribute)^0
                   * parsers.optionalspace
                   * parsers.rbrace

parsers.raw_attribute = parsers.lbrace
                      * parsers.optionalspace
                      * parsers.equal
                      * C(parsers.attribute_raw)
                      * parsers.optionalspace
                      * parsers.rbrace

-- block followed by 0 or more optionally
-- indented blocks with first line indented.
```

```
parsers.indented_blocks = function(bl)
  return Cs( bl
         * ( parsers.blankline^1
           * parsers.indent
           * -parsers.blankline
           * bl)^0
         * (parsers.blankline^1 + parsers.eof) )
end
```

3.1.5.4 Parsers Used for html Entities

```
local function repeat_between(pattern, min, max)
  return -pattern^(max + 1) * pattern^min
end

parsers.hexentity = parsers.ampersand * parsers.hash * C(S("Xx"))
                  * C(repeat_between(parsers.hexdigit, 1, 6))
                  * parsers.semicolon
parsers.decentity = parsers.ampersand * parsers.hash
                  * C(repeat_between(parsers.digit, 1, 7))
                  * parsers.semicolon
parsers.tagentity = parsers.ampersand * C(parsers.alphanumeric^1)
                  * parsers.semicolon

parsers.html_entities
  = parsers.hexentity / entities.hex_entity_with_x_char
  + parsers.decentity / entities.dec_entity
  + parsers.tagentity / entities.char_entity
parsers.html_space_entity_char
  = Cmt(parsers.html_entities, function(_, i, entity)
     return entity == " " and i or nil
    end)
```

3.1.5.5 Parsers Used for Markdown Lists

```
parsers.bullet = function(bullet_char, interrupting)
  local allowed_end
  if interrupting then
    allowed_end = C(parsers.spacechar^1) * #parsers.linechar
  else
    allowed_end = C(parsers.spacechar^1)
                + #(parsers.newline + parsers.eof)
  end
  return parsers.check_trail
        * Ct(C(bullet_char) * Cc(""))
        * allowed_end
end

local function tickbox(interior)
  return parsers.optionalspace * parsers.lbracket
```

```
9639        * interior * parsers.rbracket * parsers.spacechar^1
9640 end
9641
9642 parsers.ticked_box = tickbox(S("xX")) * Cc(1.0)
9643 parsers.halfticked_box = tickbox(S("./")) * Cc(0.5)
9644 parsers.unticked_box = tickbox(parsers.spacechar^1) * Cc(0.0)
9645
```

3.1.5.6 Parsers Used for Markdown Code Spans

```
9646 parsers.openticks   = Cg(parsers.backtick^1, "ticks")
9647
9648 local function captures_equal_length(_,i,a,b)
9649   return #a == #b and i
9650 end
9651
9652 parsers.closeticks  = Cmt(C(parsers.backtick^1)
9653                           * Cb("ticks"), captures_equal_length)
9654
9655 parsers.intickschar = (parsers.any - S("\n\r`"))
9656                     + V("NoSoftLineBreakEndline")
9657                     + (parsers.backtick^1 - parsers.closeticks)
9658
9659 local function process_inticks(s)
9660   s = s:gsub("\n", " ")
9661   s = s:gsub("^ (.*) $", "%1")
9662   return s
9663 end
9664
9665 parsers.inticks = parsers.openticks
9666                 * C(parsers.space^0)
9667                 * parsers.closeticks
9668                 + parsers.openticks
9669                 * Cs(Cs(parsers.intickschar^0) / process_inticks)
9670                 * parsers.closeticks
9671
```

3.1.5.7 Parsers Used for html

```
9672 -- case-insensitive match (we assume s is lowercase)
9673 -- must be single byte encoding
9674 parsers.keyword_exact = function(s)
9675   local parser = P(0)
9676   for i=1,#s do
9677     local c = s:sub(i,i)
9678     local m = c .. upper(c)
9679     parser = parser * S(m)
9680   end
9681   return parser
9682 end
```

```
9683
9684 parsers.special_block_keyword =
9685     parsers.keyword_exact("pre") +
9686     parsers.keyword_exact("script") +
9687     parsers.keyword_exact("style") +
9688     parsers.keyword_exact("textarea")
9689
9690 parsers.block_keyword =
9691     parsers.keyword_exact("address") +
9692     parsers.keyword_exact("article") +
9693     parsers.keyword_exact("aside") +
9694     parsers.keyword_exact("base") +
9695     parsers.keyword_exact("basefont") +
9696     parsers.keyword_exact("blockquote") +
9697     parsers.keyword_exact("body") +
9698     parsers.keyword_exact("caption") +
9699     parsers.keyword_exact("center") +
9700     parsers.keyword_exact("col") +
9701     parsers.keyword_exact("colgroup") +
9702     parsers.keyword_exact("dd") +
9703     parsers.keyword_exact("details") +
9704     parsers.keyword_exact("dialog") +
9705     parsers.keyword_exact("dir") +
9706     parsers.keyword_exact("div") +
9707     parsers.keyword_exact("dl") +
9708     parsers.keyword_exact("dt") +
9709     parsers.keyword_exact("fieldset") +
9710     parsers.keyword_exact("figcaption") +
9711     parsers.keyword_exact("figure") +
9712     parsers.keyword_exact("footer") +
9713     parsers.keyword_exact("form") +
9714     parsers.keyword_exact("frame") +
9715     parsers.keyword_exact("frameset") +
9716     parsers.keyword_exact("h1") +
9717     parsers.keyword_exact("h2") +
9718     parsers.keyword_exact("h3") +
9719     parsers.keyword_exact("h4") +
9720     parsers.keyword_exact("h5") +
9721     parsers.keyword_exact("h6") +
9722     parsers.keyword_exact("head") +
9723     parsers.keyword_exact("header") +
9724     parsers.keyword_exact("hr") +
9725     parsers.keyword_exact("html") +
9726     parsers.keyword_exact("iframe") +
9727     parsers.keyword_exact("legend") +
9728     parsers.keyword_exact("li") +
9729     parsers.keyword_exact("link") +
9730     parsers.keyword_exact("main") +
9731     parsers.keyword_exact("menu") +
```

```
    parsers.keyword_exact("menuitem") +
    parsers.keyword_exact("nav") +
    parsers.keyword_exact("noframes") +
    parsers.keyword_exact("ol") +
    parsers.keyword_exact("optgroup") +
    parsers.keyword_exact("option") +
    parsers.keyword_exact("p") +
    parsers.keyword_exact("param") +
    parsers.keyword_exact("section") +
    parsers.keyword_exact("source") +
    parsers.keyword_exact("summary") +
    parsers.keyword_exact("table") +
    parsers.keyword_exact("tbody") +
    parsers.keyword_exact("td") +
    parsers.keyword_exact("tfoot") +
    parsers.keyword_exact("th") +
    parsers.keyword_exact("thead") +
    parsers.keyword_exact("title") +
    parsers.keyword_exact("tr") +
    parsers.keyword_exact("track") +
    parsers.keyword_exact("ul")

-- end conditions
parsers.html_blankline_end_condition
  = parsers.linechar^0
  * ( parsers.newline
    * (parsers.check_minimal_blank_indent_and_any_trail
      * #parsers.blankline
      + parsers.check_minimal_indent_and_any_trail)
    * parsers.linechar^1)^0
  * (parsers.newline^-1 / "")

local function remove_trailing_blank_lines(s)
  return s:gsub("[\n\r]+%s*$", "")
end

parsers.html_until_end = function(end_marker)
  return (
    Cs(C( parsers.newline
        * (parsers.check_minimal_blank_indent_and_any_trail
          * #parsers.blankline
          + parsers.check_minimal_indent_and_any_trail)
      + parsers.linechar - end_marker)^0)
    * (C(parsers.linechar^0 * parsers.newline^-1)
      / remove_trailing_blank_lines)
  )
end

-- attributes
```

```
parsers.html_attribute_spacing  = parsers.optionalspace
                                * V("NoSoftLineBreakEndline")
                                * parsers.optionalspace
                                + parsers.spacechar^1

parsers.html_attribute_name = ( parsers.letter
                              + parsers.colon
                              + parsers.underscore)
                            * ( parsers.alphanumeric
                              + parsers.colon
                              + parsers.underscore
                            + parsers.period
                            + parsers.dash)^0

parsers.html_attribute_value  = parsers.squote
                              * (parsers.linechar - parsers.squote)^0
                              * parsers.squote
                              + parsers.dquote
                              * (parsers.linechar - parsers.dquote)^0
                              * parsers.dquote
                              + ( parsers.any
                                - parsers.spacechar
                                - parsers.newline
                                - parsers.dquote
                                - parsers.squote
                                - parsers.backtick
                                - parsers.equal
                                - parsers.less
                                - parsers.more)^1

parsers.html_inline_attribute_value = parsers.squote
                                    * (V("NoSoftLineBreakEndline")
                                      + parsers.any
                                      - parsers.blankline^2
                                      - parsers.squote)^0
                                    * parsers.squote
                                    + parsers.dquote
                                    * (V("NoSoftLineBreakEndline")
                                      + parsers.any
                                      - parsers.blankline^2
                                      - parsers.dquote)^0
                                    * parsers.dquote
                                    + (parsers.any
                                      - parsers.spacechar
                                      - parsers.newline
                                      - parsers.dquote
                                      - parsers.squote
                                      - parsers.backtick
                                      - parsers.equal
```

```
                                      - parsers.less
                                      - parsers.more)^1

parsers.html_attribute_value_specification
  = parsers.optionalspace
  * parsers.equal
  * parsers.optionalspace
  * parsers.html_attribute_value

parsers.html_spnl = parsers.optionalspace
                  * (V("NoSoftLineBreakEndline")
                  * parsers.optionalspace)^-1

parsers.html_inline_attribute_value_specification
  = parsers.html_spnl
  * parsers.equal
  * parsers.html_spnl
  * parsers.html_inline_attribute_value

parsers.html_attribute
  = parsers.html_attribute_spacing
  * parsers.html_attribute_name
  * parsers.html_inline_attribute_value_specification^-1

parsers.html_non_newline_attribute
  = parsers.spacechar^1
  * parsers.html_attribute_name
  * parsers.html_attribute_value_specification^-1

parsers.nested_breaking_blank = parsers.newline
                              * parsers.check_minimal_blank_indent
                              * parsers.blankline

parsers.html_comment_start = P("<!--")
                           * parsers.optionalspace

parsers.html_comment_end = parsers.optionalspace
                         * P("-->")

parsers.html_comment
  = parsers.html_comment_start
  * parsers.html_until_end(parsers.html_comment_end)

parsers.html_inline_comment = (parsers.html_comment_start / "")
                            * -P(">") * -P("->")
                            * Cs(( parsers.any
                                 - parsers.nested_breaking_blank
                                 - parsers.html_comment_end)^0)
                            * (parsers.html_comment_end / "")
```

```
9879
9880 parsers.html_cdatasection_start = P("<![CDATA[")
9881
9882 parsers.html_cdatasection_end = P("]]>")
9883
9884 parsers.html_cdatasection
9885   = Cs( parsers.html_cdatasection_start
9886       * parsers.html_until_end(parsers.html_cdatasection_end))
9887   / remove_trailing_blank_lines
9888
9889 parsers.html_inline_cdatasection
9890   = parsers.html_cdatasection_start
9891   * Cs(V("NoSoftLineBreakEndline") + parsers.any
9892       - parsers.nested_breaking_blank - parsers.html_cdatasection_end)^0
9893   * parsers.html_cdatasection_end
9894
9895 parsers.html_declaration_start = P("<!") * parsers.letter
9896
9897 parsers.html_declaration_end = P(">")
9898
9899 parsers.html_declaration
9900   = Cs( parsers.html_declaration_start
9901       * parsers.html_until_end(parsers.html_declaration_end))
9902   / remove_trailing_blank_lines
9903
9904 parsers.html_inline_declaration
9905   = parsers.html_declaration_start
9906   * Cs(V("NoSoftLineBreakEndline") + parsers.any
9907       - parsers.nested_breaking_blank - parsers.html_declaration_end)^0
9908   * parsers.html_declaration_end
9909
9910 parsers.html_instruction_start = P("<?")
9911
9912 parsers.html_instruction_end = P("?>")
9913
9914 parsers.html_instruction
9915   = Cs( parsers.html_instruction_start
9916       * parsers.html_until_end(parsers.html_instruction_end))
9917   / remove_trailing_blank_lines
9918
9919 parsers.html_inline_instruction = parsers.html_instruction_start
9920                                 * Cs( V("NoSoftLineBreakEndline")
9921                                     + parsers.any
9922                                     - parsers.nested_breaking_blank
9923                                     - parsers.html_instruction_end)^0
9924                                 * parsers.html_instruction_end
9925
9926 parsers.html_blankline  = parsers.newline
9927                         * parsers.optionalspace
```

```
                        * parsers.newline

parsers.html_tag_start = parsers.less

parsers.html_tag_closing_start  = parsers.less
                                * parsers.slash

parsers.html_tag_end  = parsers.html_spnl
                      * parsers.more

parsers.html_empty_tag_end  = parsers.html_spnl
                            * parsers.slash
                            * parsers.more

-- opening tags
parsers.html_any_open_inline_tag  = parsers.html_tag_start
                                  * parsers.keyword
                                  * parsers.html_attribute^0
                                  * parsers.html_tag_end

parsers.html_any_open_tag = parsers.html_tag_start
                          * parsers.keyword
                          * parsers.html_non_newline_attribute^0
                          * parsers.html_tag_end

parsers.html_open_tag = parsers.html_tag_start
                      * parsers.block_keyword
                      * parsers.html_attribute^0
                      * parsers.html_tag_end

parsers.html_open_special_tag = parsers.html_tag_start
                              * parsers.special_block_keyword
                              * parsers.html_attribute^0
                              * parsers.html_tag_end

-- incomplete tags
parsers.incomplete_tag_following  = parsers.spacechar
                                  + parsers.more
                                  + parsers.slash * parsers.more
                                  + #(parsers.newline + parsers.eof)

parsers.incomplete_special_tag_following = parsers.spacechar
                                         + parsers.more
                                         + #( parsers.newline
                                            + parsers.eof)

parsers.html_incomplete_open_tag  = parsers.html_tag_start
                                  * parsers.block_keyword
                                  * parsers.incomplete_tag_following
```

```
9977
9978 parsers.html_incomplete_open_special_tag
9979   = parsers.html_tag_start
9980   * parsers.special_block_keyword
9981   * parsers.incomplete_special_tag_following
9982
9983 parsers.html_incomplete_close_tag = parsers.html_tag_closing_start
9984                                   * parsers.block_keyword
9985                                   * parsers.incomplete_tag_following
9986
9987 parsers.html_incomplete_close_special_tag
9988   = parsers.html_tag_closing_start
9989   * parsers.special_block_keyword
9990   * parsers.incomplete_tag_following
9991
9992 -- closing tags
9993 parsers.html_close_tag  = parsers.html_tag_closing_start
9994                         * parsers.block_keyword
9995                         * parsers.html_tag_end
9996
9997 parsers.html_any_close_tag  = parsers.html_tag_closing_start
9998                             * parsers.keyword
9999                             * parsers.html_tag_end
10000
10001 parsers.html_close_special_tag = parsers.html_tag_closing_start
10002                                * parsers.special_block_keyword
10003                                * parsers.html_tag_end
10004
10005 -- empty tags
10006 parsers.html_any_empty_inline_tag = parsers.html_tag_start
10007                                   * parsers.keyword
10008                                   * parsers.html_attribute^0
10009                                   * parsers.html_empty_tag_end
10010
10011 parsers.html_any_empty_tag  = parsers.html_tag_start
10012                             * parsers.keyword
10013                             * parsers.html_non_newline_attribute^0
10014                             * parsers.optionalspace
10015                             * parsers.slash
10016                             * parsers.more
10017
10018 parsers.html_empty_tag  = parsers.html_tag_start
10019                         * parsers.block_keyword
10020                         * parsers.html_attribute^0
10021                         * parsers.html_empty_tag_end
10022
10023 parsers.html_empty_special_tag  = parsers.html_tag_start
10024                                 * parsers.special_block_keyword
10025                                 * parsers.html_attribute^0
```

```
                                * parsers.html_empty_tag_end

parsers.html_incomplete_blocks
  = parsers.html_incomplete_open_tag
  + parsers.html_incomplete_open_special_tag
  + parsers.html_incomplete_close_tag

-- parse special html blocks
parsers.html_blankline_ending_special_block_opening
  = ( parsers.html_close_special_tag
    + parsers.html_empty_special_tag)
  * #( parsers.optionalspace
     * (parsers.newline + parsers.eof))

parsers.html_blankline_ending_special_block
  = parsers.html_blankline_ending_special_block_opening
  * parsers.html_blankline_end_condition

parsers.html_special_block_opening
  = parsers.html_incomplete_open_special_tag
  - parsers.html_empty_special_tag

parsers.html_closing_special_block
  = Cs( parsers.html_special_block_opening
      * parsers.html_until_end(parsers.html_close_special_tag))
  / remove_trailing_blank_lines

parsers.html_special_block
  = parsers.html_blankline_ending_special_block
  + parsers.html_closing_special_block

-- parse html blocks
parsers.html_block_opening  = parsers.html_incomplete_open_tag
                            + parsers.html_incomplete_close_tag

parsers.html_block  = parsers.html_block_opening
                    * parsers.html_blankline_end_condition

-- parse any html blocks
parsers.html_any_block_opening
  = ( parsers.html_any_open_tag
    + parsers.html_any_close_tag
    + parsers.html_any_empty_tag)
  * #(parsers.optionalspace * (parsers.newline + parsers.eof))

parsers.html_any_block  = parsers.html_any_block_opening
                        * parsers.html_blankline_end_condition

parsers.html_inline_comment_full  = parsers.html_comment_start
```

```
                                    * -P(">") * -P("->")
                                    * Cs(( parsers.any - P("--")
                                         - parsers.nested_breaking_blank
                                         - parsers.html_comment_end)^0)
                                    * parsers.html_comment_end

parsers.html_inline_tags  = parsers.html_inline_comment_full
                          + parsers.html_any_empty_inline_tag
                          + parsers.html_inline_instruction
                          + parsers.html_inline_cdatasection
                          + parsers.html_inline_declaration
                          + parsers.html_any_open_inline_tag
                          + parsers.html_any_close_tag

```

3.1.5.8 Parsers Used for Markdown Tags and Links

```
parsers.urlchar = parsers.anyescaped
                - parsers.newline
                - parsers.more

parsers.auto_link_scheme_part = parsers.alphanumeric
                              + parsers.plus
                              + parsers.period
                              + parsers.dash

parsers.auto_link_scheme  = parsers.letter
                          * parsers.auto_link_scheme_part
                          * parsers.auto_link_scheme_part^-30

parsers.absolute_uri  = parsers.auto_link_scheme * parsers.colon
                      * ( parsers.any - parsers.spacing
                        - parsers.less - parsers.more)^0

parsers.printable_characters = S(".!#$%&'*+/=?^_`{|}~-")

parsers.email_address_local_part_char = parsers.alphanumeric
                                      + parsers.printable_characters

parsers.email_address_local_part
  = parsers.email_address_local_part_char^1

parsers.email_address_dns_label = parsers.alphanumeric
                                * ( parsers.alphanumeric
                                  + parsers.dash)^-62
                                * B(parsers.alphanumeric)

parsers.email_address_domain  = parsers.email_address_dns_label
                              * ( parsers.period
                                * parsers.email_address_dns_label)^0
```

```
10122
10123 parsers.email_address = parsers.email_address_local_part
10124                       * parsers.at
10125                       * parsers.email_address_domain
10126
10127 parsers.auto_link_url = parsers.less
10128                       * C(parsers.absolute_uri)
10129                       * parsers.more
10130
10131 parsers.auto_link_email = parsers.less
10132                         * C(parsers.email_address)
10133                         * parsers.more
10134
10135 parsers.auto_link_relative_reference = parsers.less
10136                                      * C(parsers.urlchar^1)
10137                                      * parsers.more
10138
10139 parsers.autolink  = parsers.auto_link_url
10140                   + parsers.auto_link_email
10141
10142 -- content in balanced brackets, parentheses, or quotes:
10143 parsers.bracketed   = P{ parsers.lbracket
10144                        * (( parsers.backslash / "" * parsers.rbracket
10145                           + parsers.any - (parsers.lbracket
10146                                          + parsers.rbracket
10147                                          + parsers.blankline^2)
10148                        ) + V(1))^0
10149                        * parsers.rbracket }
10150
10151 parsers.inparens    = P{ parsers.lparent
10152                        * ((parsers.anyescaped - (parsers.lparent
10153                                                + parsers.rparent
10154                                                + parsers.blankline^2)
10155                        ) + V(1))^0
10156                        * parsers.rparent }
10157
10158 parsers.squoted     = P{ parsers.squote * parsers.alphanumeric
10159                        * ((parsers.anyescaped - (parsers.squote
10160                                                + parsers.blankline^2)
10161                        ) + V(1))^0
10162                        * parsers.squote }
10163
10164 parsers.dquoted     = P{ parsers.dquote * parsers.alphanumeric
10165                        * ((parsers.anyescaped - (parsers.dquote
10166                                                + parsers.blankline^2)
10167                        ) + V(1))^0
10168                        * parsers.dquote }
10169
10170 parsers.link_text  = parsers.lbracket
```

```
                    * Cs((parsers.alphanumeric^1
                        + parsers.bracketed
                        + parsers.inticks
                        + parsers.autolink
                        + V("InlineHtml")
                        + ( parsers.backslash * parsers.backslash)
                        + ( parsers.backslash
                          * ( parsers.lbracket
                            + parsers.rbracket)
                          + V("Space")
                          + V("NoSoftLineBreakEndline")
                          + (parsers.any
                            - ( parsers.newline
                              + parsers.lbracket
                              + parsers.rbracket
                              + parsers.blankline^2))))^0)
                    * parsers.rbracket

parsers.link_label_body = -#(parsers.sp * parsers.rbracket)
                        * #( ( parsers.any
                             - parsers.rbracket)^-999
                           * parsers.rbracket)
                        * Cs((parsers.alphanumeric^1
                            + parsers.inticks
                            + parsers.autolink
                            + V("InlineHtml")
                            + ( parsers.backslash * parsers.backslash)
                            + ( parsers.backslash
                              * ( parsers.lbracket
                                + parsers.rbracket)
                              + V("Space")
                              + V("NoSoftLineBreakEndline")
                              + (parsers.any
                                - ( parsers.newline
                                  + parsers.lbracket
                                  + parsers.rbracket
                                  + parsers.blankline^2))))^1)

parsers.link_label  = parsers.lbracket
                    * parsers.link_label_body
                    * parsers.rbracket

parsers.inparens_url  = P{ parsers.lparent
                         * ((parsers.anyescaped - (parsers.lparent
                                                 + parsers.rparent
                                                 + parsers.spacing)
                           ) + V(1))^0
                         * parsers.rparent }
```

```
-- url for markdown links, allowing nested brackets:
parsers.url         = parsers.less * Cs((parsers.anyescaped
                                       - parsers.newline
                                       - parsers.less
                                       - parsers.more)^0)
                                    * parsers.more
                    + -parsers.less
                    * Cs((parsers.inparens_url + (parsers.anyescaped
                                                  - parsers.spacing
                                                  - parsers.lparent
                                                  - parsers.rparent))^1)

-- quoted text:
parsers.title_s     = parsers.squote
                    * Cs((parsers.html_entities
                         + V("Space")
                         + V("NoSoftLineBreakEndline")
                         + ( parsers.anyescaped
                           - parsers.newline
                           - parsers.squote
                           - parsers.blankline^2))^0)
                    * parsers.squote

parsers.title_d     = parsers.dquote
                    * Cs((parsers.html_entities
                         + V("Space")
                         + V("NoSoftLineBreakEndline")
                         + ( parsers.anyescaped
                           - parsers.newline
                           - parsers.dquote
                           - parsers.blankline^2))^0)
                    * parsers.dquote

parsers.title_p     = parsers.lparent
                    * Cs((parsers.html_entities
                         + V("Space")
                         + V("NoSoftLineBreakEndline")
                         + ( parsers.anyescaped
                           - parsers.newline
                           - parsers.lparent
                           - parsers.rparent
                           - parsers.blankline^2))^0)
                    * parsers.rparent

parsers.title
  = parsers.title_d + parsers.title_s + parsers.title_p

parsers.optionaltitle
  = parsers.spnlc * parsers.title * parsers.spacechar^0 + Cc("")
```

```

```

3.1.5.9 Helpers for Links and Link Reference Definitions

```
-- parse a reference definition:  [foo]: /bar "title"
parsers.define_reference_parser = (parsers.check_trail / "")
                                * parsers.link_label * parsers.colon
                                * parsers.spnlc * parsers.url
                                * ( parsers.spnlc_sep * parsers.title
                                  * parsers.only_blank
                                  + Cc("") * parsers.only_blank)
```

3.1.5.10 Inline Elements

```
parsers.Inline         = V("Inline")

-- parse many p between starter and ender
parsers.between = function(p, starter, ender)
  local ender2 = B(parsers.nonspacechar) * ender
  return ( starter
         * #parsers.nonspacechar
         * Ct(p * (p - ender2)^0)
         * ender2)
end

```

3.1.5.11 Block Elements

```
parsers.lineof = function(c)
    return ( parsers.check_trail_no_rem
           * (P(c) * parsers.optionalspace)^3
           * (parsers.newline + parsers.eof))
end

parsers.thematic_break_lines = parsers.lineof(parsers.asterisk)
                             + parsers.lineof(parsers.dash)
                             + parsers.lineof(parsers.underscore)
```

3.1.5.12 Headings

```
-- parse Atx heading start and return level
parsers.heading_start = #parsers.hash * C(parsers.hash^-6)
                      * -parsers.hash / length

-- parse setext header ending and return level
parsers.heading_level
  = parsers.nonindentspace * parsers.equal^1
  * parsers.optionalspace * #parsers.newline * Cc(1)
  + parsers.nonindentspace * parsers.dash^1
  * parsers.optionalspace * #parsers.newline * Cc(2)

```

```
local function strip_atx_end(s)
  return s:gsub("%s+#*%s*\n$","")
end

parsers.atx_heading = parsers.check_trail_no_rem
                    * Cg(parsers.heading_start, "level")
                    * (C( parsers.optionalspace
                        * parsers.hash^0
                        * parsers.optionalspace
                        * parsers.newline)
                      + parsers.spacechar^1
                      * C(parsers.line))
```

3.1.6 Markdown Reader

This section documents the `reader` object, which implements the routines for parsing the markdown input. The object corresponds to the markdown reader object that was located in the `lunamark/reader/markdown.lua` file in the Lunamark Lua module.

The `reader.new` method creates and returns a new TEX reader object associated with the Lua interface options (see Section 2.1.3) `options` and with a writer object `writer`. When `options` are unspecified, it is assumed that an empty table was passed to the method.

The objects produced by the `reader.new` method expose instance methods and variables of their own. As a convention, I will refer to these ⟨*member*⟩s as `reader->`⟨*member*⟩.

```
M.reader = {}
function M.reader.new(writer, options)
  local self = {}
```

Make the `writer` and `options` parameters available as `reader->writer` and `reader->options`, respectively, so that they are accessible from extensions.

```
  self.writer = writer
  self.options = options
```

Create a `reader->parsers` hash table that stores PEG patterns that depend on the received `options`. Make `reader->parsers` inherit from the global `parsers` table.

```
  self.parsers = {}
  (function(parsers)
    setmetatable(self.parsers, {
      __index = function (_, key)
        return parsers[key]
      end
    })
  end)(parsers)
```

Make `reader->parsers` available as a local `parsers` variable that will shadow the global `parsers` table and will make `reader->parsers` easier to type in the rest of the reader code.

```
  local parsers = self.parsers
```

3.1.6.1 Top-Level Helper Functions

Define `reader->normalize_tag` as a function that normalizes a markdown reference tag by lowercasing it, and by collapsing any adjacent whitespace characters.

```
10334  function self.normalize_tag(tag)
10335    tag = util.rope_to_string(tag)
10336    tag = tag:gsub("[ \n\r\t]+", " ")
10337    tag = tag:gsub("^ ", ""):gsub(" $", "")
10338    local form = nil
10339    if options.unicodeNormalization then
10340      form = options.unicodeNormalizationForm
10341    end
10342    tag = util.casefold(tag, form)
10343    return tag
10344  end
```

Define `iterlines` as a function that iterates over the lines of the input string `s`, transforms them using an input function `f`, and reassembles them into a new string, which it returns.

```
10345  local function iterlines(s, f)
10346    local rope = lpeg.match(Ct((parsers.line / f)^1), s)
10347    return util.rope_to_string(rope)
10348  end
```

Define `expandtabs` either as an identity function, when the `preserveTabs` Lua interface option is enabled, or to a function that expands tabs into spaces otherwise.

```
10349  if options.preserveTabs then
10350    self.expandtabs = function(s) return s end
10351  else
10352    self.expandtabs = function(s)
10353                        if s:find("\t") then
10354                          return iterlines(s, util.expand_tabs_in_line)
10355                        else
10356                          return s
10357                        end
10358                      end
10359  end
```

3.1.6.2 High-Level Parser Functions

Create a `reader->parser_functions` hash table that stores high-level parser functions. Define `reader->create_parser` as a function that will create a high-level parser function `reader->parser_functions.name`, that matches input using grammar `grammar`. If `toplevel` is true, the input is expected to come straight from the user, not from a recursive call, and will be preprocessed.

```
10360  self.parser_functions = {}
10361  self.create_parser = function(name, grammar, toplevel)
10362    self.parser_functions[name] = function(str)
```

If the parser function is top-level and the `stripIndent` Lua option is enabled, we will first expand tabs in the input string `str` into spaces and then we will count the minimum

indent across all lines, skipping blank lines. Next, we will remove the minimum indent from all lines.

```
10363       if toplevel and options.stripIndent then
10364           local min_prefix_length, min_prefix = nil, ''
10365           str = iterlines(str, function(line)
10366               if lpeg.match(parsers.nonemptyline, line) == nil then
10367                   return line
10368               end
10369               line = util.expand_tabs_in_line(line)
10370               local prefix = lpeg.match(C(parsers.optionalspace), line)
10371               local prefix_length = #prefix
10372               local is_shorter = min_prefix_length == nil
10373               if not is_shorter then
10374                 is_shorter = prefix_length < min_prefix_length
10375               end
10376               if is_shorter then
10377                 min_prefix_length, min_prefix = prefix_length, prefix
10378               end
10379               return line
10380           end)
10381           str = str:gsub('^' .. min_prefix, '')
10382       end
```

If the parser is top-level and the `texComments` or `hybrid` Lua options are enabled, we will strip all plain TEX comments from the input string `str` together with the trailing newline characters.

```
10383       if toplevel and (options.texComments or options.hybrid) then
10384         str = lpeg.match(Ct(parsers.commented_line^1), str)
10385         str = util.rope_to_string(str)
10386       end
10387       local res = lpeg.match(grammar(), str)
10388       if res == nil then
10389         return writer.error(
10390           format("Parser `%s` failed to process the input text.", name),
10391           format("Here are the first 20 characters of the remaining "
10392               .. "unprocessed text: `%s`.", str:sub(1,20))
10393         )
10394       else
10395         return res
10396       end
10397     end
10398   end
10399
10400   self.create_parser("parse_blocks",
10401                      function()
10402                        return parsers.blocks
10403                      end, true)
10404
10405   self.create_parser("parse_blocks_nested",
```

```
                    function()
                      return parsers.blocks_nested
                    end, false)

  self.create_parser("parse_inlines",
                    function()
                      return parsers.inlines
                    end, false)

  self.create_parser("parse_inlines_no_inline_note",
                    function()
                      return parsers.inlines_no_inline_note
                    end, false)

  self.create_parser("parse_inlines_no_html",
                    function()
                      return parsers.inlines_no_html
                    end, false)

  self.create_parser("parse_inlines_nbsp",
                    function()
                      return parsers.inlines_nbsp
                    end, false)

  self.create_parser("parse_inlines_no_link_or_emphasis",
                   function()
                     return parsers.inlines_no_link_or_emphasis
                   end, false)

  self.create_parser("parse_inlines_identity",
                   function()
                     return parsers.inlines_identity
                   end, false)

  self.create_parser("parse_inlines_string",
                   function()
                     return parsers.inlines_string
                   end, false)

  self.create_parser("parse_inlines_math",
                   function()
                     return parsers.inlines_math
                   end, false)
```

3.1.6.3 Parsers Used for Indentation (local)

The following patterns represent basic building blocks of indented content.

```
  parsers.minimally_indented_blankline
    = parsers.check_minimal_indent * (parsers.blankline / "")

```

```
parsers.minimally_indented_block
  = parsers.check_minimal_indent * V("Block")

parsers.minimally_indented_block_or_paragraph
  = parsers.check_minimal_indent * V("BlockOrParagraph")

parsers.minimally_indented_paragraph
  = parsers.check_minimal_indent * V("Paragraph")

parsers.minimally_indented_plain
  = parsers.check_minimal_indent * V("Plain")

parsers.minimally_indented_par_or_plain
  = parsers.minimally_indented_paragraph
  + parsers.minimally_indented_plain

parsers.minimally_indented_par_or_plain_no_blank
  = parsers.minimally_indented_par_or_plain
  - parsers.minimally_indented_blankline

parsers.minimally_indented_ref
  = parsers.check_minimal_indent * V("Reference")

parsers.minimally_indented_blank
  = parsers.check_minimal_indent * V("Blank")

parsers.conditionally_indented_blankline
  = parsers.check_minimal_blank_indent * (parsers.blankline / "")

parsers.minimally_indented_ref_or_block
  = parsers.minimally_indented_ref
  + parsers.minimally_indented_block
  - parsers.minimally_indented_blankline

parsers.minimally_indented_ref_or_block_or_par
  = parsers.minimally_indented_ref
  + parsers.minimally_indented_block_or_paragraph
  - parsers.minimally_indented_blankline

```

The following pattern parses the properly indented content that follows the initial container start.

```

function parsers.separator_loop(separated_block, paragraph,
                                block_separator, paragraph_separator)
  return  separated_block
        + block_separator
          * paragraph
          * separated_block
        + paragraph_separator
```

```
10499           * paragraph
10500   end
10501
10502   function parsers.create_loop_body_pair(separated_block, paragraph,
10503                                          block_separator,
10504                                          paragraph_separator)
10505     return {
10506       block = parsers.separator_loop(separated_block, paragraph,
10507                                      block_separator, block_separator),
10508       par = parsers.separator_loop(separated_block, paragraph,
10509                                    block_separator, paragraph_separator)
10510     }
10511   end
10512
10513   parsers.block_sep_group = function(blank)
10514     return  blank^0 * parsers.eof
10515           + ( blank^2 / writer.paragraphsep
10516             + blank^0 / writer.interblocksep
10517             )
10518   end
10519
10520   parsers.par_sep_group = function(blank)
10521     return  blank^0 * parsers.eof
10522           + blank^0 / writer.paragraphsep
10523   end
10524
10525   parsers.sep_group_no_output = function(blank)
10526     return  blank^0 * parsers.eof
10527           + blank^0
10528   end
10529
10530   parsers.content_blank = parsers.minimally_indented_blankline
10531
10532   parsers.ref_or_block_separated
10533     = parsers.sep_group_no_output(parsers.content_blank)
10534     * ( parsers.minimally_indented_ref
10535       - parsers.content_blank)
10536     + parsers.block_sep_group(parsers.content_blank)
10537     * ( parsers.minimally_indented_block
10538       - parsers.content_blank)
10539
10540   parsers.loop_body_pair  =
10541     parsers.create_loop_body_pair(
10542       parsers.ref_or_block_separated,
10543       parsers.minimally_indented_par_or_plain_no_blank,
10544       parsers.block_sep_group(parsers.content_blank),
10545       parsers.par_sep_group(parsers.content_blank))
10546
10547   parsers.content_loop  = ( V("Block")
```

```
                          * parsers.loop_body_pair.block^0
                          + (V("Paragraph") + V("Plain"))
                          * parsers.ref_or_block_separated
                          * parsers.loop_body_pair.block^0
                          + (V("Paragraph") + V("Plain"))
                          * parsers.loop_body_pair.par^0)
                        * parsers.content_blank^0

parsers.indented_content = function()
  return  Ct( (V("Reference") + (parsers.blankline / ""))
            * parsers.content_blank^0
            * parsers.check_minimal_indent
            * parsers.content_loop
            + (V("Reference") + (parsers.blankline / ""))
            * parsers.content_blank^0
            + parsers.content_loop)
end

parsers.add_indent = function(pattern, name, breakable)
  return  Cg(Cmt( Cb("indent_info")
                * Ct(pattern)
                * ( #parsers.linechar  -- check if starter is blank
                  * Cc(false) + Cc(true))
                * Cc(name)
                * Cc(breakable),
              process_starter_indent), "indent_info")
end
```

3.1.6.4 Parsers Used for Markdown Lists (local)

```
if options.hashEnumerators then
  parsers.dig = parsers.digit + parsers.hash
else
  parsers.dig = parsers.digit
end

parsers.enumerator = function(delimiter_type, interrupting)
  local delimiter_range
  local allowed_end
  if interrupting then
    delimiter_range = P("1")
    allowed_end = C(parsers.spacechar^1) * #parsers.linechar
  else
    delimiter_range = parsers.dig * parsers.dig^-8
    allowed_end = C(parsers.spacechar^1)
                + #(parsers.newline + parsers.eof)
  end

  return parsers.check_trail
```

```
            * Ct(C(delimiter_range) * C(delimiter_type))
            * allowed_end
end

parsers.starter = parsers.bullet(parsers.dash)
                + parsers.bullet(parsers.asterisk)
                + parsers.bullet(parsers.plus)
                + parsers.enumerator(parsers.period)
                + parsers.enumerator(parsers.rparent)

```

3.1.6.5 Parsers Used for Blockquotes (local)

```
parsers.blockquote_start
  = parsers.check_trail
  * C(parsers.more)
  * C(parsers.spacechar^0)

parsers.blockquote_body
  = parsers.add_indent(parsers.blockquote_start, "bq", true)
  * parsers.indented_content()
  * remove_indent("bq")

if not options.breakableBlockquotes then
  parsers.blockquote_body
    = parsers.add_indent(parsers.blockquote_start, "bq", false)
    * parsers.indented_content()
    * remove_indent("bq")
end
```

3.1.6.6 Helpers for Emphasis and Strong Emphasis (local)

Parse the content of a table `content_part` with links, images and emphasis disabled.

```
local function parse_content_part(content_part)
  local rope = util.rope_to_string(content_part)
  local parsed
    = self.parser_functions.parse_inlines_no_link_or_emphasis(rope)
  parsed.indent_info = nil
  return parsed
end

```

Collect the content between the `opening_index` and `closing_index` in the delimiter table `t`.

```
local collect_emphasis_content =
  function(t, opening_index, closing_index)
    local content = {}

    local content_part = {}
    for i = opening_index, closing_index do
```

```
10635         local value = t[i]
10636
10637         if value.rendered ~= nil then
10638           content[#content + 1] = parse_content_part(content_part)
10639           content_part = {}
10640           content[#content + 1] = value.rendered
10641           value.rendered = nil
10642         else
10643           if value.warning ~= nil then
10644             if next(content_part) ~= nil then
10645               content[#content + 1] = parse_content_part(content_part)
10646             end
10647             content_part = {}
10648
10649             content[#content + 1] = value.warning
10650             value.warning = nil
10651           end
10652           if value.type == "delimiter"
10653               and value.element == "emphasis" then
10654             if value.is_active then
10655               content_part[#content_part + 1]
10656                 = string.rep(value.character, value.current_count)
10657             end
10658           else
10659             content_part[#content_part + 1] = value.content
10660           end
10661           value.content = ''
10662           value.is_active = false
10663         end
10664       end
10665
10666       if next(content_part) ~= nil then
10667         content[#content + 1] = parse_content_part(content_part)
10668       end
10669
10670       return content
10671     end
10672
```

Render content between the `opening_index` and `closing_index` in the delimiter table `t` as emphasis.

```
10673   local function fill_emph(t, opening_index, closing_index)
10674     local content
10675       = collect_emphasis_content(t, opening_index + 1,
10676                                  closing_index - 1)
10677     t[opening_index + 1].is_active = true
10678     t[opening_index + 1].rendered = writer.emphasis(content)
10679   end
10680
```

Render content between the opening_index and closing_index in the delimiter table t as strong emphasis.

```
local function fill_strong(t, opening_index, closing_index)
  local content
    = collect_emphasis_content(t, opening_index + 1,
                               closing_index - 1)
  t[opening_index + 1].is_active = true
  t[opening_index + 1].rendered = writer.strong(content)
end

```

Check whether the opening delimiter opening_delimiter and closing delimiter closing_delimiter break rule three together.

```
local function breaks_three_rule(opening_delimiter, closing_delimiter)
  return ( opening_delimiter.is_closing
        or closing_delimiter.is_opening)
     and (( opening_delimiter.original_count
          + closing_delimiter.original_count) % 3 == 0)
     and ( opening_delimiter.original_count % 3 ~= 0
        or closing_delimiter.original_count % 3 ~= 0)
end

```

Look for the first potential emphasis opener in the delimiter table t in the range from bottom_index to latest_index that has the same character character as the closing delimiter closing_delimiter.

```
local find_emphasis_opener = function(t, bottom_index, latest_index,
                                      character, closing_delimiter)
  for i = latest_index, bottom_index, -1 do
    local value = t[i]
    if value.is_active and
       value.is_opening and
       value.type == "delimiter" and
       value.element == "emphasis" and
       (value.character == character) and
       (value.current_count > 0) then
      if not breaks_three_rule(value, closing_delimiter) then
        return i
      end
    end
  end
end

```

Iterate over the delimiters in the delimiter table t, producing emphasis or strong emphasis macros.

```
local function process_emphasis(t, opening_index, closing_index)
  for i = opening_index, closing_index do
    local value = t[i]
    if value.type == "delimiter" and value.element == "emphasis" then
```

```
        local delimiter_length = string.len(value.content)
        value.character = string.sub(value.content, 1, 1)
        value.current_count = delimiter_length
        value.original_count = delimiter_length
      end
    end

    local openers_bottom = {
      ['*'] = {
        [true] = {opening_index, opening_index, opening_index},
        [false] = {opening_index, opening_index, opening_index}
      },
      ['_'] = {
        [true] = {opening_index, opening_index, opening_index},
        [false] = {opening_index, opening_index, opening_index}
      }
    }

    local current_position = opening_index
    local max_position = closing_index

    while current_position <= max_position do
      local value = t[current_position]

      if value.type ~= "delimiter" or
        value.element ~= "emphasis" or
        not value.is_active or
        not value.is_closing or
        (value.current_count <= 0) then
        current_position = current_position + 1
        goto continue
      end

      local character = value.character
      local is_opening = value.is_opening
      local closing_length_modulo_three = value.original_count % 3

      local current_openers_bottom
        = openers_bottom[character][is_opening]
                        [closing_length_modulo_three + 1]

      local opener_position
        = find_emphasis_opener(t, current_openers_bottom,
                               current_position - 1, character, value)

      if (opener_position == nil) then
        openers_bottom[character][is_opening]
                      [closing_length_modulo_three + 1]
          = current_position
```

```
10768         current_position = current_position + 1
10769         goto continue
10770       end
10771
10772       local opening_delimiter = t[opener_position]
10773
10774       local current_opening_count = opening_delimiter.current_count
10775       local current_closing_count = t[current_position].current_count
10776
10777       if (current_opening_count >= 2)
10778         and (current_closing_count >= 2) then
10779         opening_delimiter.current_count = current_opening_count - 2
10780         t[current_position].current_count = current_closing_count - 2
10781         fill_strong(t, opener_position, current_position)
10782       else
10783         opening_delimiter.current_count = current_opening_count - 1
10784         t[current_position].current_count = current_closing_count - 1
10785         fill_emph(t, opener_position, current_position)
10786       end
10787
10788       ::continue::
10789     end
10790   end
10791
10792   parsers.delimiter_run = function(character)
10793     return  (B(parsers.backslash * character) + -B(character))
10794           * character^1
10795           * -#character
10796   end
10797
10798   parsers.left_flanking_delimiter_run = function(character)
10799     return  (B( parsers.any)
10800               * ( parsers.unicode.preceding_punctuation
10801                 + parsers.unicode.preceding_whitespace)
10802              + -B(parsers.any))
10803             * parsers.delimiter_run(character)
10804             * #parsers.unicode.punctuation
10805             + parsers.delimiter_run(character)
10806             * -#( #parsers.unicode.punctuation
10807                 + #parsers.unicode.whitespace
10808                 + parsers.eof)
10809   end
10810
10811   parsers.right_flanking_delimiter_run = function(character)
10812     return  parsers.unicode.preceding_punctuation
10813           * parsers.delimiter_run(character)
10814           * ( #parsers.unicode.punctuation
10815             + #parsers.unicode.whitespace
10816             + parsers.eof)
```

```
          + (B(parsers.any)
            * -( parsers.unicode.preceding_punctuation
               + parsers.unicode.preceding_whitespace))
          * parsers.delimiter_run(character)
  end

  if options.underscores then
    parsers.emph_start
      = parsers.left_flanking_delimiter_run(parsers.asterisk)
      + ( -#parsers.right_flanking_delimiter_run(parsers.underscore)
        + ( parsers.unicode.preceding_punctuation
          * #parsers.right_flanking_delimiter_run(parsers.underscore)))
      * parsers.left_flanking_delimiter_run(parsers.underscore)

    parsers.emph_end
      = parsers.right_flanking_delimiter_run(parsers.asterisk)
      + ( -#parsers.left_flanking_delimiter_run(parsers.underscore)
        + #( parsers.left_flanking_delimiter_run(parsers.underscore)
           * #parsers.unicode.punctuation))
      * parsers.right_flanking_delimiter_run(parsers.underscore)
  else
    parsers.emph_start
      = parsers.left_flanking_delimiter_run(parsers.asterisk)

    parsers.emph_end
      = parsers.right_flanking_delimiter_run(parsers.asterisk)
  end

  parsers.emph_capturing_open_and_close
    = #parsers.emph_start * #parsers.emph_end
    * Ct( Cg(Cc("delimiter"), "type")
        * Cg(Cc("emphasis"), "element")
        * Cg(C(parsers.emph_start), "content")
        * Cg(Cc(true), "is_opening")
        * Cg(Cc(true), "is_closing"))

  parsers.emph_capturing_open = Ct( Cg(Cc("delimiter"), "type")
                                  * Cg(Cc("emphasis"), "element")
                                  * Cg(C(parsers.emph_start), "content")
                                  * Cg(Cc(true), "is_opening")
                                  * Cg(Cc(false), "is_closing"))

  parsers.emph_capturing_close = Ct( Cg(Cc("delimiter"), "type")
                                   * Cg(Cc("emphasis"), "element")
                                   * Cg(C(parsers.emph_end), "content")
                                   * Cg(Cc(false), "is_opening")
                                   * Cg(Cc(true), "is_closing"))

  parsers.emph_open_or_close  = parsers.emph_capturing_open_and_close
```

```
                              + parsers.emph_capturing_open
                              + parsers.emph_capturing_close

parsers.emph_open = parsers.emph_capturing_open_and_close
                  + parsers.emph_capturing_open

parsers.emph_close  = parsers.emph_capturing_open_and_close
                    + parsers.emph_capturing_close

```

3.1.6.7 Helpers for Links and Link Reference Definitions (local)

```
-- List of references defined in the document
local references

-- List of note references defined in the document
parsers.rawnotes = {}

```

The `reader->register_link` method registers a link reference, where `tag` is the link label, `url` is the link destination, `title` is the optional link title, and `attributes` are the optional attributes.

```
function self.register_link(_, tag, url, title,
                            attributes)
  local normalized_tag = self.normalize_tag(tag)
  if references[normalized_tag] == nil then
    references[normalized_tag] = {
      url = url,
      title = title,
      attributes = attributes
    }
    return ""
  else
    local text
      = string.format('Multiply defined link reference "%s"', tag)
    local more = string.format("Look for the text `[%s]: ...`.", tag)
    return writer.warning(text, more)
  end
end

```

The `reader->lookup_reference` method looks up a reference with link label `tag`.

```
function self.lookup_reference(tag)
  return references[self.normalize_tag(tag)]
end

```

The `reader->lookup_note_reference` method looks up a note reference with label `tag`.

```
function self.lookup_note_reference(tag)
  return parsers.rawnotes[self.normalize_tag(tag)]
end
```

```
10906
10907   parsers.title_s_direct_ref  = parsers.squote
10908                               * Cs((parsers.html_entities
10909                                   + ( parsers.anyescaped
10910                                     - parsers.squote
10911                                     - parsers.blankline^2))^0)
10912                               * parsers.squote
10913
10914   parsers.title_d_direct_ref  = parsers.dquote
10915                               * Cs((parsers.html_entities
10916                                   + ( parsers.anyescaped
10917                                     - parsers.dquote
10918                                     - parsers.blankline^2))^0)
10919                               * parsers.dquote
10920
10921   parsers.title_p_direct_ref  = parsers.lparent
10922                               * Cs((parsers.html_entities
10923                                   + ( parsers.anyescaped
10924                                     - parsers.lparent
10925                                     - parsers.rparent
10926                                     - parsers.blankline^2))^0)
10927                               * parsers.rparent
10928
10929   parsers.title_direct_ref  = parsers.title_s_direct_ref
10930                             + parsers.title_d_direct_ref
10931                             + parsers.title_p_direct_ref
10932
10933   parsers.inline_direct_ref_inside  = parsers.lparent * parsers.spnl
10934                                     * Cg(parsers.url + Cc(""), "url")
10935                                     * parsers.spnl
10936                                     * Cg( parsers.title_direct_ref
10937                                         + Cc(""), "title")
10938                                     * parsers.spnl * parsers.rparent
10939
10940   parsers.inline_direct_ref = parsers.lparent * parsers.spnlc
10941                             * Cg(parsers.url + Cc(""), "url")
10942                             * parsers.spnlc
10943                             * Cg(parsers.title + Cc(""), "title")
10944                             * parsers.spnlc * parsers.rparent
10945
10946   parsers.empty_link  = parsers.lbracket
10947                       * parsers.rbracket
10948
10949   parsers.inline_link = parsers.link_text
10950                       * parsers.inline_direct_ref
10951
10952   parsers.full_link = parsers.link_text
10953                     * parsers.link_label
10954
```

```
parsers.shortcut_link = parsers.link_label
                      * -(parsers.empty_link + parsers.link_label)

parsers.collapsed_link  = parsers.link_label
                        * parsers.empty_link

parsers.image_opening = #(parsers.exclamation * parsers.inline_link)
                      * Cg(Cc("inline"), "link_type")
                      + #(parsers.exclamation * parsers.full_link)
                      * Cg(Cc("full"), "link_type")
                      + #( parsers.exclamation
                         * parsers.collapsed_link)
                      * Cg(Cc("collapsed"), "link_type")
                      + #(parsers.exclamation * parsers.shortcut_link)
                      * Cg(Cc("shortcut"), "link_type")
                      + #(parsers.exclamation * parsers.empty_link)
                      * Cg(Cc("empty"), "link_type")

parsers.link_opening  = #parsers.inline_link
                      * Cg(Cc("inline"), "link_type")
                      + #parsers.full_link
                      * Cg(Cc("full"), "link_type")
                      + #parsers.collapsed_link
                      * Cg(Cc("collapsed"), "link_type")
                      + #parsers.shortcut_link
                      * Cg(Cc("shortcut"), "link_type")
                      + #parsers.empty_link
                      * Cg(Cc("empty_link"), "link_type")
                      + #parsers.link_text
                      * Cg(Cc("link_text"), "link_type")

parsers.note_opening  = #(parsers.circumflex * parsers.link_text)
                      * Cg(Cc("note_inline"), "link_type")

parsers.raw_note_opening  = #( parsers.lbracket
                             * parsers.circumflex
                             * parsers.link_label_body
                             * parsers.rbracket)
                          * Cg(Cc("raw_note"), "link_type")

local inline_note_element = Cg(Cc("note"), "element")
                          * parsers.note_opening
                          * Cg( parsers.circumflex
                              * parsers.lbracket, "content")

local image_element = Cg(Cc("image"), "element")
                    * parsers.image_opening
                    * Cg( parsers.exclamation
                        * parsers.lbracket, "content")
```

```
11004
11005  local note_element  = Cg(Cc("note"), "element")
11006                      * parsers.raw_note_opening
11007                      * Cg( parsers.lbracket
11008                          * parsers.circumflex, "content")
11009
11010  local link_element  = Cg(Cc("link"), "element")
11011                      * parsers.link_opening
11012                      * Cg(parsers.lbracket, "content")
11013
11014  local opening_elements = parsers.fail
11015
11016  if options.inlineNotes then
11017    opening_elements = opening_elements + inline_note_element
11018  end
11019
11020  opening_elements = opening_elements + image_element
11021
11022  if options.notes then
11023    opening_elements = opening_elements + note_element
11024  end
11025
11026  opening_elements = opening_elements + link_element
11027
11028  parsers.link_image_opening  = Ct( Cg(Cc("delimiter"), "type")
11029                                  * Cg(Cc(true), "is_opening")
11030                                  * Cg(Cc(false), "is_closing")
11031                                  * opening_elements)
11032
11033  parsers.link_image_closing  = Ct( Cg(Cc("delimiter"), "type")
11034                                  * Cg(Cc("link"), "element")
11035                                  * Cg(Cc(false), "is_opening")
11036                                  * Cg(Cc(true), "is_closing")
11037                                  * ( Cg(Cc(true), "is_direct")
11038                                    * Cg( parsers.rbracket
11039                                        * #parsers.inline_direct_ref,
11040                                         "content")
11041                                    + Cg(Cc(false), "is_direct")
11042                                    * Cg(parsers.rbracket, "content")))
11043
11044  parsers.link_image_open_or_close  = parsers.link_image_opening
11045                                    + parsers.link_image_closing
11046
11047  if options.html then
11048    parsers.link_emph_precedence  = parsers.inticks
11049                                  + parsers.autolink
11050                                  + parsers.html_inline_tags
11051  else
11052    parsers.link_emph_precedence  = parsers.inticks
```

```
                                    + parsers.autolink
end

parsers.link_and_emph_endline = parsers.newline
                              * ((parsers.check_minimal_indent
                                * -V("EndlineExceptions")
                                + parsers.check_optional_indent
                                * -V("EndlineExceptions")
                                * -V("ListStarter")) / "")
                              * parsers.spacechar^0 / "\n"

parsers.link_and_emph_content
  = Ct( Cg(Cc("content"), "type")
      * Cg(Cs(( parsers.link_emph_precedence
              + parsers.backslash * parsers.linechar
              + parsers.link_and_emph_endline
              + (parsers.linechar
                - parsers.blankline^2
                - parsers.link_image_open_or_close
                - parsers.emph_open_or_close))^0), "content"))

parsers.link_and_emph_table
  = (parsers.link_image_opening + parsers.emph_open)
  * parsers.link_and_emph_content
  * ((parsers.link_image_open_or_close + parsers.emph_open_or_close)
    * parsers.link_and_emph_content)^1

```

Collect the content between the `opening_index` and `closing_index` in the delimiter table `t`.

```
local function collect_link_content(t, opening_index, closing_index)
  local content = {}
  for i = opening_index, closing_index do
    content[#content + 1] = t[i].content
  end
  return util.rope_to_string(content)
end

```

Look for the closest potential link opener in the delimiter table `t` in the range from `bottom_index` to `latest_index`.

```
local function find_link_opener(t, bottom_index, latest_index)
  for i = latest_index, bottom_index, -1 do
    local value = t[i]
    if value.type == "delimiter" and
       value.is_opening and
       ( value.element == "link"
      or value.element == "image"
      or value.element == "note")
       and not value.removed then
```

```
        if value.is_active then
          return i
        end
        value.removed = true
        return nil
      end
    end
  end

```

Find the position of a delimiter that closes a full link after an an index `latest_index` in the delimiter table `t`.

```
  local function find_next_link_closing_index(t, latest_index)
    for i = latest_index, #t do
      local value = t[i]
      if value.is_closing and
         value.element == "link" and
         not value.removed then
        return i
      end
    end
  end

```

Disable all preceding opening link delimiters by marking them inactive with the `is_active` property to prevent links within links. Images within links are allowed.

```
  local function disable_previous_link_openers(t, opening_index)
    if t[opening_index].element == "image" then
      return
    end

    for i = opening_index, 1, -1 do
      local value = t[i]
      if value.is_active and
         value.type == "delimiter" and
         value.is_opening and
         value.element == "link" then
        value.is_active = false
      end
    end
  end

```

Disable the delimiters between the `opening_index` and `closing_index` in the delimiter table `t` by marking them inactive with the `is_active` property.

```
  local function disable_range(t, opening_index, closing_index)
    for i = opening_index, closing_index do
      local value = t[i]
      if value.is_active then
        value.is_active = false
```

```
        if value.type == "delimiter" then
          value.removed = true
        end
      end
    end
  end

```

Clear the parsed content between the `opening_index` and `closing_index` in the delimiter table `t`.

```
  local delete_parsed_content_in_range =
    function(t, opening_index, closing_index)
      for i = opening_index, closing_index do
        t[i].rendered = nil
      end
    end

```

Clear the content between the `opening_index` and `closing_index` in the delimiter table `t`.

```
  local function empty_content_in_range(t, opening_index, closing_index)
    for i = opening_index, closing_index do
      t[i].content = ''
    end
  end

```

Join the attributes from the link reference definition `reference_attributes` with the link's own attributes `own_attributes`.

```
  local function join_attributes(reference_attributes, own_attributes)
    local merged_attributes = {}
    for _, attribute in ipairs(reference_attributes or {}) do
      table.insert(merged_attributes, attribute)
    end
    for _, attribute in ipairs(own_attributes or {}) do
      table.insert(merged_attributes, attribute)
    end
    if next(merged_attributes) == nil then
      merged_attributes = nil
    end
    return merged_attributes
  end

```

Parse content between two delimiters in the delimiter table `t`. Produce the respective link and image macros.

```
  local render_link_or_image =
    function(t, opening_index, closing_index, content_end_index,
             reference)
      process_emphasis(t, opening_index, content_end_index)
```

```
      local mapped = collect_emphasis_content(t, opening_index + 1,
                                              content_end_index - 1)

      local rendered = {}
      if (t[opening_index].element == "link") then
        rendered = writer.link(mapped, reference.url,
                               reference.title, reference.attributes)
      end

      if (t[opening_index].element == "image") then
        rendered = writer.image(mapped, reference.url,
          self.parser_functions.parse_inlines_string(reference.title),
          reference.attributes)
      end

      if (t[opening_index].element == "note") then
        if (t[opening_index].link_type == "note_inline") then
          rendered = writer.note(mapped)
        end
        if (t[opening_index].link_type == "raw_note") then
          rendered = writer.note(reference)
        end
      end

      t[opening_index].rendered = rendered
      delete_parsed_content_in_range(t, opening_index + 1,
                                     closing_index)
      empty_content_in_range(t, opening_index, closing_index)
      disable_previous_link_openers(t, opening_index)
      disable_range(t, opening_index, closing_index)
    end

```

Match the link destination of an inline link at index `closing_index` in table `t` when `match_reference` is true. Additionally, match attributes when the option `linkAttributes` is enabled.

```
  local resolve_inline_following_content =
    function(t, closing_index, match_reference, match_link_attributes)
      local content = ""
      for i = closing_index + 1, #t do
        content = content .. t[i].content
      end

      local matching_content = parsers.succeed

      if match_reference then
        matching_content = matching_content
                         * parsers.inline_direct_ref_inside
      end

```

```
    if match_link_attributes then
      matching_content = matching_content
                       * Cg(Ct(parsers.attributes^-1), "attributes")
    end

    local matched = lpeg.match(Ct( matching_content
                                 * Cg(Cp(), "end_position")), content)

    local matched_count = matched.end_position - 1
    for i = closing_index + 1, #t do
      local value = t[i]

      local chars_left = matched_count
      matched_count = matched_count - #value.content

      if matched_count <= 0 then
        value.content = value.content:sub(chars_left + 1)
        break
      end

      value.content = ''
      value.is_active = false
    end

    local attributes = matched.attributes
    if attributes == nil or next(attributes) == nil then
      attributes = nil
    end

    return {
      url = matched.url or "",
      title = matched.title or "",
      attributes = attributes
    }
  end

```

Resolve an inline link `[a](b "c")` from the delimiters at `opening_index` and `closing_index` within a delimiter table `t`. Here, compared to other types of links, no reference definition is needed.

```
local function resolve_inline_link(t, opening_index, closing_index)
  local inline_content
    = resolve_inline_following_content(t, closing_index, true,
                                       t.match_link_attributes)
  render_link_or_image(t, opening_index, closing_index,
                       closing_index, inline_content)
end

```

Resolve an inline note `^[a]` from the delimiters at `opening_index` and `closing_index` within a delimiter table `t`.

```
local resolve_note_inline_link =
  function(t, opening_index, closing_index)
    local inline_content
      = resolve_inline_following_content(t, closing_index,
                                         false, false)
    render_link_or_image(t, opening_index, closing_index,
                         closing_index, inline_content)
  end

```

Resolve a shortcut link `[a]` from the delimiters at `opening_index` and `closing_index` within a delimiter table `t`. Continue if a tag `a` is not found in the references.

```
local function resolve_shortcut_link(t, opening_index, closing_index)
  local content
    = collect_link_content(t, opening_index + 1, closing_index - 1)
  local r = self.lookup_reference(content)

  if r then
    local inline_content
      = resolve_inline_following_content(t, closing_index, false,
                                         t.match_link_attributes)
    r.attributes
      = join_attributes(r.attributes, inline_content.attributes)
    render_link_or_image(t, opening_index, closing_index,
                         closing_index, r)
  end
end

```

Resolve a note `[^a]` from the delimiters at `opening_index` and `closing_index` within a delimiter table `t`. Continue if a tag `a` is not found in the rawnotes.

```
local function resolve_raw_note_link(t, opening_index, closing_index)
  local content
    = collect_link_content(t, opening_index + 1, closing_index - 1)
  local r = self.lookup_note_reference(content)

  if r then
    local parsed_ref = self.parser_functions.parse_blocks_nested(r)
    render_link_or_image(t, opening_index, closing_index,
                         closing_index, parsed_ref)
  end
end

```

Resolve a full link `[a][b]` from the delimiters at `opening_index` and `closing_index` within a delimiter table `t`. Continue if a tag `b` is not found in the references.

```
local function resolve_full_link(t, opening_index, closing_index)
  local next_link_closing_index
```

```
      = find_next_link_closing_index(t, closing_index + 4)
    local next_link_content
      = collect_link_content(t, closing_index + 3,
                             next_link_closing_index - 1)
    local r = self.lookup_reference(next_link_content)

    if r then
      local inline_content
        = resolve_inline_following_content(t, next_link_closing_index,
                                           false,
                                           t.match_link_attributes)
      r.attributes
        = join_attributes(r.attributes, inline_content.attributes)
      render_link_or_image(t, opening_index, next_link_closing_index,
                           closing_index, r)
    else
      local text = string.format('Undefined link reference "%s"',
                                 next_link_content)
      local more = string.format("Look for the text `[...][%s]`.",
                                 next_link_content)
      t[opening_index].warning = writer.warning(text, more)
    end
  end

```

Resolve a collapsed link `[a][]` from the delimiters at `opening_index` and `closing_index` within a delimiter table `t`. Continue if a tag `a` is not found in the references.

```
  local function resolve_collapsed_link(t, opening_index, closing_index)
    local next_link_closing_index
      = find_next_link_closing_index(t, closing_index + 4)
    local content
      = collect_link_content(t, opening_index + 1, closing_index - 1)
    local r = self.lookup_reference(content)

    if r then
      local inline_content
        = resolve_inline_following_content(t, closing_index, false,
                                           t.match_link_attributes)
      r.attributes
        = join_attributes(r.attributes, inline_content.attributes)
      render_link_or_image(t, opening_index, next_link_closing_index,
                           closing_index, r)
    else
      local text = string.format('Undefined link reference "%s"',
                                 content)
      local more = string.format("Look for the text `[%s][]`.",
                                 content)
      t[opening_index].warning = writer.warning(text, more)
    end
  end
```

Parse a table of link and emphasis delimiters `t`. First, iterate over the link delimiters and produce either link or image macros. Then run `process_emphasis` over the entire delimiter table, resolving emphasis and strong emphasis and parsing any content outside of closed delimiters.

```
local function process_links_and_emphasis(t)
  for _,value in ipairs(t) do
    value.is_active = true
  end

  for i,value in ipairs(t) do
    if not value.is_closing
        or value.type ~= "delimiter"
        or not ( value.element == "link"
              or value.element == "image"
              or value.element == "note")
        or value.removed then
      goto continue
    end

    local opener_position = find_link_opener(t, 1, i - 1)
    if (opener_position == nil) then
      goto continue
    end

    local opening_delimiter = t[opener_position]
    opening_delimiter.removed = true

    local link_type = opening_delimiter.link_type

    if (link_type == "inline") then
      resolve_inline_link(t, opener_position, i)
    end
    if (link_type == "shortcut") then
      resolve_shortcut_link(t, opener_position, i)
    end
    if (link_type == "full") then
      resolve_full_link(t, opener_position, i)
    end
    if (link_type == "collapsed") then
      resolve_collapsed_link(t, opener_position, i)
    end
    if (link_type == "note_inline") then
      resolve_note_inline_link(t, opener_position, i)
    end
    if (link_type == "raw_note") then
      resolve_raw_note_link(t, opener_position, i)
    end
```

```
11396
11397       ::continue::
11398     end
11399
11400     t[#t].content = t[#t].content:gsub("%s*$","")
11401
11402     process_emphasis(t, 1, #t)
11403     local final_result = collect_emphasis_content(t, 1, #t)
11404     return final_result
11405   end
11406
11407   function self.defer_link_and_emphasis_processing(delimiter_table)
11408     return writer.defer_call(function()
11409       return process_links_and_emphasis(delimiter_table)
11410     end)
11411   end
11412
```

3.1.6.8 Inline Elements (local)

```
11413   parsers.Str      = ( parsers.normalchar
11414                      * (parsers.normalchar + parsers.at)^0)
11415                    / writer.string
11416
11417   parsers.Symbol   = (parsers.backtick^1 + V("SpecialChar"))
11418                    / writer.string
11419
11420   parsers.Ellipsis = P("...") / writer.ellipsis
11421
11422   parsers.Smart    = parsers.Ellipsis
11423
11424   parsers.Code     = parsers.inticks / writer.code
11425
11426   if options.blankBeforeBlockquote then
11427     parsers.bqstart = parsers.fail
11428   else
11429     parsers.bqstart = parsers.blockquote_start
11430   end
11431
11432   if options.blankBeforeHeading then
11433     parsers.headerstart = parsers.fail
11434   else
11435     parsers.headerstart = parsers.atx_heading
11436   end
11437
11438   if options.blankBeforeList then
11439     parsers.interrupting_bullets = parsers.fail
11440     parsers.interrupting_enumerators = parsers.fail
11441   else
11442     parsers.interrupting_bullets
```

```
11443       = parsers.bullet(parsers.dash, true)
11444       + parsers.bullet(parsers.asterisk, true)
11445       + parsers.bullet(parsers.plus, true)
11446
11447     parsers.interrupting_enumerators
11448       = parsers.enumerator(parsers.period, true)
11449       + parsers.enumerator(parsers.rparent, true)
11450   end
11451
11452   if options.html then
11453     parsers.html_interrupting
11454       = parsers.check_trail
11455       * ( parsers.html_incomplete_open_tag
11456         + parsers.html_incomplete_close_tag
11457         + parsers.html_incomplete_open_special_tag
11458         + parsers.html_comment_start
11459         + parsers.html_cdatasection_start
11460         + parsers.html_declaration_start
11461         + parsers.html_instruction_start
11462         - parsers.html_close_special_tag
11463         - parsers.html_empty_special_tag)
11464   else
11465     parsers.html_interrupting = parsers.fail
11466   end
11467
11468   if options.blankBeforeHtmlBlock then
11469     parsers.html_interrupting = parsers.fail
11470   end
11471
11472   parsers.ListStarter = parsers.starter
11473
11474   parsers.EndlineExceptions
11475                       = parsers.blankline -- paragraph break
11476                       + parsers.eof       -- end of document
11477                       + parsers.bqstart
11478                       + parsers.thematic_break_lines
11479                       + parsers.interrupting_bullets
11480                       + parsers.interrupting_enumerators
11481                       + parsers.headerstart
11482                       + parsers.html_interrupting
11483
11484   parsers.NoSoftLineBreakEndlineExceptions = parsers.EndlineExceptions
11485
11486   parsers.endline = parsers.newline
11487                   * (parsers.check_minimal_indent
11488                     * -V("EndlineExceptions")
11489                     + parsers.check_optional_indent
11490                     * -V("EndlineExceptions")
11491                     * -V("ListStarter")) / function(_) return end
```

```
                * parsers.spacechar^0

parsers.Endline = parsers.endline
                / writer.soft_line_break

parsers.EndlineNoSub = parsers.endline

parsers.NoSoftLineBreakEndline
                      = parsers.newline
                      * (parsers.check_minimal_indent
                        * -V("NoSoftLineBreakEndlineExceptions")
                        + parsers.check_optional_indent
                        * -V("NoSoftLineBreakEndlineExceptions")
                        * -V("ListStarter"))
                      * parsers.spacechar^0
                      / writer.space

parsers.EndlineBreak = parsers.backslash * parsers.endline
                                         / writer.hard_line_break

parsers.OptionalIndent
                    = parsers.spacechar^1 / writer.space

parsers.Space       = parsers.spacechar^2 * parsers.endline
                                          / writer.hard_line_break
                    + parsers.spacechar^1
                    * parsers.endline^-1
                    * parsers.eof / self.expandtabs
                    + parsers.spacechar^1 * parsers.endline
                                          / writer.soft_line_break
                    + parsers.spacechar^1
                    * -parsers.newline / self.expandtabs
                    + parsers.spacechar^1
                    + ( parsers.spacechar
                      + parsers.html_space_entity_char)^1
                    * parsers.endline / writer.soft_line_break

parsers.NonbreakingEndline
                    = parsers.endline
                    / writer.nbsp

parsers.NonbreakingSpace
                  = parsers.spacechar^2 * parsers.endline
                                        / writer.nbsp
                  + parsers.spacechar^1
                  * parsers.endline^-1 * parsers.eof / ""
                  + parsers.spacechar^1 * parsers.endline
                                        * parsers.optionalspace
                                        / writer.nbsp
```

```
                  + parsers.spacechar^1 * parsers.optionalspace
                                        / writer.nbsp

```

The `reader->auto_link_url` method produces an autolink to a URL or a relative reference in the output format, where `url` is the link destination and `attributes` are the optional attributes.

```
function self.auto_link_url(url, attributes)
  return writer.link(writer.escape(url),
                     url, nil, attributes)
end
```

The `reader->auto_link_email` method produces an autolink to an e-mail in the output format, where `email` is the email address destination and `attributes` are the optional attributes.

```
function self.auto_link_email(email, attributes)
  return writer.link(writer.escape(email),
                     "mailto:"..email,
                     nil, attributes)
end

  parsers.AutoLinkUrl = parsers.auto_link_url
                      / self.auto_link_url

  parsers.AutoLinkEmail
                      = parsers.auto_link_email
                      / self.auto_link_email

  parsers.AutoLinkRelativeReference
                      = parsers.auto_link_relative_reference
                      / self.auto_link_url

  parsers.LinkAndEmph = Ct(parsers.link_and_emph_table)
                      / self.defer_link_and_emphasis_processing

  parsers.EscapedChar = parsers.backslash
                      * C(parsers.escapable) / writer.string

  if options.htmlOutput == "commonmark" then
    parsers.InlineHtml
      = Cs(parsers.html_inline_comment)
      / self.parser_functions.parse_inlines_no_html
      / writer.inline_html_comment
      + Cs(parsers.html_any_empty_inline_tag)
      / writer.inline_html_empty_tag
      + Cs(parsers.html_inline_instruction)
      / writer.inline_html_processing_instruction
      + Cs(parsers.html_inline_cdatasection)
      / writer.inline_html_cdata_section
      + Cs(parsers.html_inline_declaration)
```

```
      / writer.inline_html_declaration
      + Cs(parsers.html_any_open_inline_tag)
      / writer.inline_html_open_tag
      + Cs(parsers.html_any_close_tag)
      / writer.inline_html_close_tag
  else
    parsers.InlineHtml = Cs(parsers.html_inline_comment)
                       / self.parser_functions.parse_inlines_no_html
                       / writer.inline_html_comment
                       + Cs( parsers.html_any_empty_inline_tag
                           + parsers.html_inline_instruction
                           + parsers.html_inline_cdatasection
                           + parsers.html_inline_declaration
                           + parsers.html_any_open_inline_tag
                           + parsers.html_any_close_tag)
                       / writer.inline_html_tag
  end

  parsers.HtmlEntity = parsers.html_entities / writer.string
```

3.1.6.9 Block Elements (local)

```
  if options.htmlOutput == "commonmark" then
    parsers.DisplayHtml
      = parsers.check_trail
      * ( parsers.html_comment
        / self.parser_functions.parse_blocks_nested
        / writer.block_html_comment)
      + Cs(parsers.check_trail * parsers.html_special_block)
      / writer.block_html_cdata_element
      + Cs(parsers.check_trail * parsers.html_block)
      / writer.block_html_pcdata_element
      + Cs(parsers.check_trail * parsers.html_any_block)
      / writer.block_html_standalone_tag
      + Cs(parsers.check_trail * parsers.html_instruction)
      / writer.block_html_processing_instruction
      + Cs(parsers.check_trail * parsers.html_cdatasection)
      / writer.block_html_cdata_section
      + Cs(parsers.check_trail * parsers.html_declaration)
      / writer.block_html_declaration
  else
    parsers.DisplayHtml = Cs( parsers.check_trail
                            * ( parsers.html_comment
                              + parsers.html_special_block
                              + parsers.html_block
                              + parsers.html_any_block
                              + parsers.html_instruction
                              + parsers.html_cdatasection
                              + parsers.html_declaration))
                        / writer.block_html_element
```

```
11630   end
11631
11632   parsers.indented_non_blank_line = parsers.indentedline
11633                                   - parsers.blankline
11634
11635   parsers.Verbatim
11636     = Cs( parsers.check_code_trail
11637         * (parsers.line - parsers.blankline)
11638         * (( parsers.check_minimal_blank_indent_and_full_code_trail
11639            * parsers.blankline)^0
11640           * ( (parsers.check_minimal_indent / "")
11641             * parsers.check_code_trail
11642             * (parsers.line - parsers.blankline))^1)^0)
11643     / self.expandtabs / writer.verbatim
11644
11645   parsers.Blockquote   = parsers.blockquote_body
11646                        / writer.blockquote
11647
11648   parsers.ThematicBreak = parsers.thematic_break_lines
11649                         / writer.thematic_break
11650
11651   parsers.Reference    = parsers.define_reference_parser
11652                        / self.register_link
11653
11654   parsers.Paragraph    = parsers.freeze_trail
11655                        * (Ct((parsers.Inline)^1)
11656                        * (parsers.newline + parsers.eof)
11657                        * parsers.unfreeze_trail
11658                        / writer.paragraph)
11659
11660   parsers.Plain         = parsers.nonindentspace * Ct(parsers.Inline^1)
11661                         / writer.plain
```

3.1.6.10 Lists (local)

```
11662
11663   if options.taskLists then
11664     parsers.tickbox = ( parsers.ticked_box
11665                       + parsers.halfticked_box
11666                       + parsers.unticked_box
11667                       ) / writer.tickbox
11668   else
11669      parsers.tickbox = parsers.fail
11670   end
11671
11672   parsers.list_blank = parsers.conditionally_indented_blankline
11673
11674   parsers.ref_or_block_list_separated
11675     = parsers.sep_group_no_output(parsers.list_blank)
11676     * parsers.minimally_indented_ref
```

```
    + parsers.block_sep_group(parsers.list_blank)
    * parsers.minimally_indented_block

  parsers.ref_or_block_non_separated
    = parsers.minimally_indented_ref
    + (parsers.succeed / writer.interblocksep)
    * parsers.minimally_indented_block
    - parsers.minimally_indented_blankline

  parsers.tight_list_loop_body_pair =
    parsers.create_loop_body_pair(
      parsers.ref_or_block_non_separated,
      parsers.minimally_indented_par_or_plain_no_blank,
      (parsers.succeed / writer.interblocksep),
      (parsers.succeed / writer.paragraphsep))

  parsers.loose_list_loop_body_pair =
    parsers.create_loop_body_pair(
      parsers.ref_or_block_list_separated,
      parsers.minimally_indented_par_or_plain,
      parsers.block_sep_group(parsers.list_blank),
      parsers.par_sep_group(parsers.list_blank))

  parsers.tight_list_content_loop
    = V("Block")
    * parsers.tight_list_loop_body_pair.block^0
    + (V("Paragraph") + V("Plain"))
    * parsers.ref_or_block_non_separated
    * parsers.tight_list_loop_body_pair.block^0
    +  (V("Paragraph") + V("Plain"))
    * parsers.tight_list_loop_body_pair.par^0

  parsers.loose_list_content_loop
    = V("Block")
    * parsers.loose_list_loop_body_pair.block^0
    + (V("Paragraph") + V("Plain"))
    * parsers.ref_or_block_list_separated
    * parsers.loose_list_loop_body_pair.block^0
    + (V("Paragraph") + V("Plain"))
    * parsers.loose_list_loop_body_pair.par^0

  parsers.list_item_tightness_condition
    = -#( parsers.list_blank^0
        * parsers.minimally_indented_ref_or_block_or_par)
    * remove_indent("li")
    + remove_indent("li")
    * parsers.fail

  parsers.indented_content_tight
```

```
11726     = Ct( (parsers.blankline / "")
11727         * #parsers.list_blank
11728         * remove_indent("li")
11729         + ( (V("Reference") + (parsers.blankline / ""))
11730           * parsers.check_minimal_indent
11731           * parsers.tight_list_content_loop
11732           + (V("Reference") + (parsers.blankline / ""))
11733           + (parsers.tickbox^-1 / writer.escape)
11734           * parsers.tight_list_content_loop
11735           )
11736         * parsers.list_item_tightness_condition)
11737
11738   parsers.indented_content_loose
11739     = Ct( (parsers.blankline / "")
11740         * #parsers.list_blank
11741         + ( (V("Reference") + (parsers.blankline / ""))
11742           * parsers.check_minimal_indent
11743           * parsers.loose_list_content_loop
11744           + (V("Reference") + (parsers.blankline / ""))
11745           + (parsers.tickbox^-1 / writer.escape)
11746           * parsers.loose_list_content_loop))
11747
11748   parsers.TightListItem = function(starter)
11749     return  -parsers.ThematicBreak
11750             * parsers.add_indent(starter, "li")
11751             * parsers.indented_content_tight
11752   end
11753
11754   parsers.LooseListItem = function(starter)
11755     return  -parsers.ThematicBreak
11756             * parsers.add_indent(starter, "li")
11757             * parsers.indented_content_loose
11758             * remove_indent("li")
11759   end
11760
11761   parsers.BulletListOfType = function(bullet_type)
11762     local bullet = parsers.bullet(bullet_type)
11763     return  ( Ct( parsers.TightListItem(bullet)
11764                 * ( (parsers.check_minimal_indent / "")
11765                   * parsers.TightListItem(bullet)
11766                   )^0
11767               )
11768               * Cc(true)
11769               * -#( (parsers.list_blank^0 / "")
11770                   * parsers.check_minimal_indent
11771                   * (bullet - parsers.ThematicBreak)
11772               )
11773               + Ct( parsers.LooseListItem(bullet)
11774                   * ( (parsers.list_blank^0 / "")
```

```
                    * (parsers.check_minimal_indent / "")
                    * parsers.LooseListItem(bullet)
                    )^0
              )
              * Cc(false)
            ) / writer.bulletlist
end

parsers.BulletList = parsers.BulletListOfType(parsers.dash)
                   + parsers.BulletListOfType(parsers.asterisk)
                   + parsers.BulletListOfType(parsers.plus)

local function ordered_list(items,tight,starter)
  local startnum = starter[2][1]
  if options.startNumber then
    startnum = tonumber(startnum) or 1  -- fallback for '#'
    if startnum ~= nil then
      startnum = math.floor(startnum)
    end
  else
    startnum = nil
  end
  return writer.orderedlist(items,tight,startnum)
end

parsers.OrderedListOfType = function(delimiter_type)
  local enumerator = parsers.enumerator(delimiter_type)
  return  Cg(enumerator, "listtype")
        * (Ct( parsers.TightListItem(Cb("listtype"))
            * ( (parsers.check_minimal_indent / "")
              * parsers.TightListItem(enumerator))^0)
        * Cc(true)
        * -#((parsers.list_blank^0 / "")
            * parsers.check_minimal_indent * enumerator)
        + Ct( parsers.LooseListItem(Cb("listtype"))
            * ((parsers.list_blank^0 / "")
              * (parsers.check_minimal_indent / "")
              * parsers.LooseListItem(enumerator))^0)
        * Cc(false)
        ) * Ct(Cb("listtype")) / ordered_list
end

parsers.OrderedList = parsers.OrderedListOfType(parsers.period)
                    + parsers.OrderedListOfType(parsers.rparent)
```

3.1.6.11 Blank (local)

```
parsers.Blank        = parsers.blankline / ""
                     + V("Reference")
```

3.1.6.12 Headings (local)

```
function parsers.parse_heading_text(s)
  local inlines = self.parser_functions.parse_inlines(s)
  local flatten_inlines = self.writer.flatten_inlines
  self.writer.flatten_inlines = true
  local flat_text = self.parser_functions.parse_inlines(s)
  flat_text = util.rope_to_string(flat_text)
  self.writer.flatten_inlines = flatten_inlines
  return {flat_text, inlines}
end

-- parse atx header
parsers.AtxHeading = parsers.check_trail_no_rem
                   * Cg(parsers.heading_start, "level")
                   * ((C( parsers.optionalspace
                        * parsers.hash^0
                        * parsers.optionalspace
                        * parsers.newline)
                      + parsers.spacechar^1
                      * C(parsers.line))
                     / strip_atx_end
                     / parsers.parse_heading_text)
                   * Cb("level")
                   / writer.heading

parsers.heading_line  = parsers.linechar^1
                      - parsers.thematic_break_lines

parsers.heading_text = parsers.heading_line
                     * ( (V("Endline") / "\n")
                       * ( parsers.heading_line
                         - parsers.heading_level))^0
                     * parsers.newline^-1

parsers.SetextHeading = parsers.freeze_trail
                      * parsers.check_trail_no_rem
                      * #( parsers.heading_text
                         * parsers.check_minimal_indent
                         * parsers.check_trail
                         * parsers.heading_level)
                      * Cs(parsers.heading_text)
                      / parsers.parse_heading_text
                      * parsers.check_minimal_indent_and_trail
                      * parsers.heading_level
                      * parsers.newline
                      * parsers.unfreeze_trail
                      / writer.heading

parsers.Heading = parsers.AtxHeading + parsers.SetextHeading
```

3.1.6.13 Syntax Specification

Define `reader->finalize_grammar` as a function that constructs the PEG grammar of markdown, applies syntax extensions `extensions` and returns a conversion function that takes a markdown string and turns it into a plain TEX output.

```
function self.finalize_grammar(extensions)
```

Create a local writable copy of the global read-only `walkable_syntax` hash table. This table can be used by user-defined syntax extensions to insert new PEG patterns into existing rules of the PEG grammar of markdown using the `reader->insert_pattern` method. Furthermore, built-in syntax extensions can use this table to override existing rules using the `reader->update_rule` method.

```
  local walkable_syntax = (function(global_walkable_syntax)
    local local_walkable_syntax = {}
    for lhs, rule in pairs(global_walkable_syntax) do
      local_walkable_syntax[lhs] = util.table_copy(rule)
    end
    return local_walkable_syntax
  end)(walkable_syntax)
```

The `reader->insert_pattern` method adds a pattern to `walkable_syntax[`*left-hand side terminal symbol*`]` before, instead of, or after a right-hand-side terminal symbol.

```
  local current_extension_name = nil
  self.insert_pattern = function(selector, pattern, pattern_name)
    assert(pattern_name == nil or type(pattern_name) == "string")
    local _, _, lhs, pos, rhs
      = selector:find("^(%a+)%s+([%a%s]+%a+)%s+(%a+)$")
    assert(lhs ~= nil,
      [[Expected selector in form ]]
      .. [["LHS (before|after|instead of) RHS", not "]]
      .. selector .. [["]])
    assert(walkable_syntax[lhs] ~= nil,
      [[Rule ]] .. lhs
      .. [[ -> ... does not exist in markdown grammar]])
    assert(pos == "before" or pos == "after" or pos == "instead of",
      [[Expected positional specifier "before", "after", ]]
      .. [[or "instead of", not "]]
      .. pos .. [["]])
    local rule = walkable_syntax[lhs]
    local index = nil
    for current_index, current_rhs in ipairs(rule) do
      if type(current_rhs) == "string" and current_rhs == rhs then
        index = current_index
        if pos == "after" then
          index = index + 1
        end
        break
      end
    end
    assert(index ~= nil,
```

```
        [[Rule ]] .. lhs .. [[ -> ]] .. rhs
          .. [[ does not exist in markdown grammar]])
      local accountable_pattern
      if current_extension_name then
        accountable_pattern
          = {pattern, current_extension_name, pattern_name}
      else
        assert(type(pattern) == "string",
          [[reader->insert_pattern() was called outside ]]
          .. [[an extension with ]]
          .. [[a PEG pattern instead of a rule name]])
        accountable_pattern = pattern
      end
      if pos == "instead of" then
        rule[index] = accountable_pattern
      else
        table.insert(rule, index, accountable_pattern)
      end
      -- TODO: Remove all occurrences of `pattern` after `index`
      --       to improve speed?
    end
    if options.htmlOverLinks then
      self.insert_pattern("Inline before AutoLinkUrl", "InlineHtml")
    end
```

Create a local `syntax` hash table that stores those rules of the PEG grammar of markdown that can't be represented as an ordered choice of terminal symbols.

```
    local syntax =
      { "Blocks",

        Blocks = V("InitializeState")
               * V("ExpectedJekyllData")
               * V("Blank")^0
```

Only create interblock separators between pairs of blocks that are not both paragraphs. Between a pair of paragraphs, any number of blank lines will always produce a paragraph separator.

```
               * ( V("Block")
                 * ( V("Blank")^0 * parsers.eof
                   + ( V("Blank")^2 / writer.paragraphsep
                     + V("Blank")^0 / writer.interblocksep
                     )
                   )
                 + ( V("Paragraph") + V("Plain") )
                 * ( V("Blank")^0 * parsers.eof
                   + ( V("Blank")^2 / writer.paragraphsep
                     + V("Blank")^0 / writer.interblocksep
                     )
                   )
                 * V("Block")
```

```
                * ( V("Blank")^0 * parsers.eof
                  + ( V("Blank")^2 / writer.paragraphsep
                    + V("Blank")^0 / writer.interblocksep
                    )
                  )
                + ( V("Paragraph") + V("Plain") )
                * ( V("Blank")^0 * parsers.eof
                  + V("Blank")^0 / writer.paragraphsep
                  )
                )^0,

        ExpectedJekyllData = parsers.succeed,

        Blank              = parsers.Blank,
        Reference          = parsers.Reference,

        Blockquote         = parsers.Blockquote,
        Verbatim           = parsers.Verbatim,
        ThematicBreak      = parsers.ThematicBreak,
        BulletList         = parsers.BulletList,
        OrderedList        = parsers.OrderedList,
        DisplayHtml        = parsers.DisplayHtml,
        Heading            = parsers.Heading,
        Paragraph          = parsers.Paragraph,
        Plain              = parsers.Plain,

        ListStarter        = parsers.ListStarter,
        EndlineExceptions  = parsers.EndlineExceptions,
        NoSoftLineBreakEndlineExceptions
                           = parsers.NoSoftLineBreakEndlineExceptions,

        Str                = parsers.Str,
        Space              = parsers.Space,
        OptionalIndent     = parsers.OptionalIndent,
        Endline            = parsers.Endline,
        EndlineNoSub       = parsers.EndlineNoSub,
        NoSoftLineBreakEndline
                           = parsers.NoSoftLineBreakEndline,
        EndlineBreak       = parsers.EndlineBreak,
        LinkAndEmph        = parsers.LinkAndEmph,
        Code               = parsers.Code,
        AutoLinkUrl        = parsers.AutoLinkUrl,
        AutoLinkEmail      = parsers.AutoLinkEmail,
        AutoLinkRelativeReference
                           = parsers.AutoLinkRelativeReference,
        InlineHtml         = parsers.InlineHtml,
        HtmlEntity         = parsers.HtmlEntity,
        EscapedChar        = parsers.EscapedChar,
        Smart              = parsers.Smart,
```

```
11997         Symbol             = parsers.Symbol,
11998         SpecialChar        = parsers.fail,
11999         InitializeState    = parsers.succeed,
12000       }
```

Define `reader->update_rule` as a function that receives two arguments: a left-hand side terminal symbol and a function that accepts the current PEG pattern in `walkable_syntax[`left-hand side terminal symbol`]` if defined or `nil` otherwise and returns a PEG pattern that will (re)define `walkable_syntax[`left-hand side terminal symbol`]`.

```
12001     self.update_rule = function(rule_name, get_pattern)
12002       assert(current_extension_name ~= nil)
12003       assert(syntax[rule_name] ~= nil,
12004         [[Rule ]] .. rule_name
12005         .. [[ -> ... does not exist in markdown grammar]])
12006       local previous_pattern
12007       local extension_name
12008       if walkable_syntax[rule_name] then
12009         local previous_accountable_pattern
12010           = walkable_syntax[rule_name][1]
12011         previous_pattern = previous_accountable_pattern[1]
12012         extension_name
12013           = previous_accountable_pattern[2]
12014           .. ", " .. current_extension_name
12015       else
12016         previous_pattern = nil
12017         extension_name = current_extension_name
12018       end
12019       local pattern
```

Instead of a function, a PEG pattern `pattern` may also be supplied with roughly the same effect as supplying the following function, which will define `walkable_syntax[`left-hand side terminal symbol`]` unless it has been previously defined.

```
function(previous_pattern)
  assert(previous_pattern == nil)
  return pattern
end
```

```
12020       if type(get_pattern) == "function" then
12021         pattern = get_pattern(previous_pattern)
12022       else
12023         assert(previous_pattern == nil,
12024                [[Rule ]] .. rule_name ..
12025                [[ has already been updated by ]] .. extension_name)
12026         pattern = get_pattern
12027       end
12028       local accountable_pattern = { pattern, extension_name, rule_name }
12029       walkable_syntax[rule_name] = { accountable_pattern }
12030     end
```

Define a hash table of all characters with special meaning and add method `reader->add_special_character` that extends the hash table and updates the PEG grammar of markdown.

```
12031     local special_characters = {}
12032     self.add_special_character = function(c)
12033       table.insert(special_characters, c)
12034       syntax.SpecialChar = S(table.concat(special_characters, ""))
12035     end
12036
12037     self.add_special_character("*")
12038     self.add_special_character("[")
12039     self.add_special_character("]")
12040     self.add_special_character("<")
12041     self.add_special_character("!")
12042     self.add_special_character("\\")
```

Add method `reader->initialize_named_group` that defines named groups with a default capture value.

```
12043     self.initialize_named_group = function(name, value)
12044       local pattern = Ct("")
12045       if value ~= nil then
12046         pattern = pattern / value
12047       end
12048       syntax.InitializeState = syntax.InitializeState
12049                              * Cg(pattern, name)
12050     end
```

Add a named group for indentation.

```
12051     self.initialize_named_group("indent_info")
```

Apply syntax extensions.

```
12052     for _, extension in ipairs(extensions) do
12053       current_extension_name = extension.name
12054       extension.extend_writer(writer)
12055       extension.extend_reader(self)
12056     end
12057     current_extension_name = nil
```

If the `debugExtensions` option is enabled, serialize `walkable_syntax` to a JSON for debugging purposes.

```
12058     if options.debugExtensions then
12059       local sorted_lhs = {}
12060       for lhs, _ in pairs(walkable_syntax) do
12061         table.insert(sorted_lhs, lhs)
12062       end
12063       table.sort(sorted_lhs)
12064
12065       local output_lines = {"{"}
12066       for lhs_index, lhs in ipairs(sorted_lhs) do
12067         local encoded_lhs = util.encode_json_string(lhs)
```

```
12068         table.insert(output_lines, [[    ]] ..encoded_lhs .. [[: []])
12069         local rule = walkable_syntax[lhs]
12070         for rhs_index, rhs in ipairs(rule) do
12071           local human_readable_rhs
12072           if type(rhs) == "string" then
12073             human_readable_rhs = rhs
12074           else
12075             local pattern_name
12076             if rhs[3] then
12077               pattern_name = rhs[3]
12078             else
12079               pattern_name = "Anonymous Pattern"
12080             end
12081             local extension_name = rhs[2]
12082             human_readable_rhs = pattern_name .. [[ (]]
12083                                  .. extension_name .. [[)]]
12084           end
12085           local encoded_rhs
12086             = util.encode_json_string(human_readable_rhs)
12087           local output_line = [[        ]] .. encoded_rhs
12088           if rhs_index < #rule then
12089             output_line = output_line .. ","
12090           end
12091           table.insert(output_lines, output_line)
12092         end
12093         local output_line = "    ]"
12094         if lhs_index < #sorted_lhs then
12095           output_line = output_line .. ","
12096         end
12097         table.insert(output_lines, output_line)
12098       end
12099       table.insert(output_lines, "}")
12100
12101       local output = table.concat(output_lines, "\n")
12102       local output_filename = options.debugExtensionsFileName
12103       local output_file = assert(io.open(output_filename, "w"),
12104         [[Could not open file "]] .. output_filename
12105         .. [[" for writing]])
12106       assert(output_file:write(output))
12107       assert(output_file:close())
12108     end
```

Materialize `walkable_syntax` and merge it into `syntax` to produce the complete PEG grammar of markdown. Whenever a rule exists in both `walkable_syntax` and `syntax`, the rule from `walkable_syntax` overrides the rule from `syntax`.

```
12109     for lhs, rule in pairs(walkable_syntax) do
12110       syntax[lhs] = parsers.fail
12111       for _, rhs in ipairs(rule) do
12112         local pattern
```

Although the interface of the `reader->insert_pattern` method does not document this (see Section 2.1.2), we allow the `reader->insert_pattern` and `reader->update_rule` methods to insert not just PEG patterns, but also rule names that reference the PEG grammar of Markdown.

```
      if type(rhs) == "string" then
        pattern = V(rhs)
      else
        pattern = rhs[1]
        if type(pattern) == "string" then
          pattern = V(pattern)
        end
      end
      syntax[lhs] = syntax[lhs] + pattern
    end
  end
```

Finalize the parser by reacting to options and by producing special parsers for difficult edge cases such as blocks nested in definition lists or inline content nested in link, note, and image labels.

```
  if options.underscores then
    self.add_special_character("_")
  end

  if not options.codeSpans then
    syntax.Code = parsers.fail
  else
    self.add_special_character("`")
  end

  if not options.html then
    syntax.DisplayHtml = parsers.fail
    syntax.InlineHtml = parsers.fail
    syntax.HtmlEntity  = parsers.fail
  else
    self.add_special_character("&")
  end

  if options.preserveTabs then
    options.stripIndent = false
  end

  if not options.smartEllipses then
    syntax.Smart = parsers.fail
  else
    self.add_special_character(".")
  end

  if not options.relativeReferences then
    syntax.AutoLinkRelativeReference = parsers.fail
```

```
12154     end
12155
12156     if options.contentLevel == "inline" then
12157       syntax[1] = "Inlines"
12158       syntax.Inlines = V("InitializeState")
12159                        * parsers.Inline^0
12160                        * ( parsers.spacing^0
12161                          * parsers.eof / "")
12162       syntax.Space = parsers.Space + parsers.blankline / writer.space
12163     end
12164
12165     local blocks_nested_t = util.table_copy(syntax)
12166     blocks_nested_t.ExpectedJekyllData = parsers.succeed
12167     parsers.blocks_nested = Ct(blocks_nested_t)
12168
12169     parsers.blocks = Ct(syntax)
12170
12171     local inlines_t = util.table_copy(syntax)
12172     inlines_t[1] = "Inlines"
12173     inlines_t.Inlines = V("InitializeState")
12174                         * parsers.Inline^0
12175                         * ( parsers.spacing^0
12176                           * parsers.eof / "")
12177     parsers.inlines = Ct(inlines_t)
12178
12179     local inlines_no_inline_note_t = util.table_copy(inlines_t)
12180     inlines_no_inline_note_t.InlineNote = parsers.fail
12181     parsers.inlines_no_inline_note = Ct(inlines_no_inline_note_t)
12182
12183     local inlines_no_html_t = util.table_copy(inlines_t)
12184     inlines_no_html_t.DisplayHtml = parsers.fail
12185     inlines_no_html_t.InlineHtml = parsers.fail
12186     inlines_no_html_t.HtmlEntity = parsers.fail
12187     parsers.inlines_no_html = Ct(inlines_no_html_t)
12188
12189     local inlines_nbsp_t = util.table_copy(inlines_t)
12190     inlines_nbsp_t.Endline = parsers.NonbreakingEndline
12191     inlines_nbsp_t.Space = parsers.NonbreakingSpace
12192     parsers.inlines_nbsp = Ct(inlines_nbsp_t)
12193
12194     local inlines_identity_t = util.table_copy(inlines_t)
12195     inlines_identity_t.Str = parsers.any / function(s) return s end
12196     parsers.inlines_identity = Ct(inlines_identity_t)
12197
12198     local inlines_string_t = util.table_copy(inlines_t)
12199     inlines_string_t.Str = parsers.any / writer.string
12200     parsers.inlines_string = Ct(inlines_string_t)
12201
12202     local inlines_math_t = util.table_copy(inlines_t)
```

```
12203     inlines_math_t.Str = parsers.any / writer.math
12204     parsers.inlines_math = Ct(inlines_math_t)
12205
12206     local inlines_no_link_or_emphasis_t = util.table_copy(inlines_t)
12207     inlines_no_link_or_emphasis_t.LinkAndEmph = parsers.fail
12208     inlines_no_link_or_emphasis_t.EndlineExceptions
12209       = parsers.EndlineExceptions - parsers.eof
12210     parsers.inlines_no_link_or_emphasis
12211       = Ct(inlines_no_link_or_emphasis_t)
```

Return a function that converts markdown string `input` into a plain TEX output and returns it..

```
12212     return function(input)
```

Normalize the input.

```
12213       if options.unicodeNormalization then
12214         local form = options.unicodeNormalizationForm
12215         input = util.normalize(input, form)
12216       end
```

Since the Lua converter expects UNIX line endings, normalize the input. Also add a line ending at the end of the file in case the input file has none.

```
12217       input = input:gsub("\r\n?", "\n")
12218       if input:sub(-1) ~= "\n" then
12219         input = input .. "\n"
12220       end
```

Clear the table of references.

```
12221       references = {}
12222       local document = self.parser_functions.parse_blocks(input)
12223       local output = util.rope_to_string(writer.document(document))
```

Remove block element / paragraph separators immediately followed by the output of `writer->undosep`, possibly interleaved by section ends. Then, remove any leftover output of `writer->undosep`.

```
12224       local undosep_start, undosep_end
12225       local potential_secend_start, secend_start
12226       local potential_sep_start, sep_start
12227       while true do
12228         -- find a `writer->undosep`
12229         undosep_start, undosep_end
12230           = output:find(writer.undosep_text, 1, true)
12231         if undosep_start == nil then break end
12232         -- skip any preceding section ends
12233         secend_start = undosep_start
12234         while true do
12235           potential_secend_start = secend_start - #writer.secend_text
12236           if potential_secend_start < 1
12237              or output:sub(potential_secend_start,
12238                            secend_start - 1) ~= writer.secend_text
12239              then
```

```
            break
          end
          secend_start = potential_secend_start
        end
        -- find an immediately preceding
        -- block element / paragraph separator
        sep_start = secend_start
        potential_sep_start = sep_start - #writer.interblocksep_text
        if potential_sep_start >= 1
           and output:sub(potential_sep_start,
                          sep_start - 1) == writer.interblocksep_text
           then
          sep_start = potential_sep_start
        else
          potential_sep_start = sep_start - #writer.paragraphsep_text
          if potential_sep_start >= 1
             and output:sub(potential_sep_start,
                            sep_start - 1) == writer.paragraphsep_text
             then
            sep_start = potential_sep_start
          end
        end
        -- remove `writer->undosep` and immediately preceding
        -- block element / paragraph separator
        output = output:sub(1, sep_start - 1)
              .. output:sub(secend_start, undosep_start - 1)
              .. output:sub(undosep_end + 1)
      end
      return output
    end
  end
  return self
end
```

3.1.7 Built-In Syntax Extensions

Create `extensions` hash table that contains built-in syntax extensions. Syntax extensions are functions that produce objects with two methods: `extend_writer` and `extend_reader`. The `extend_writer` object takes a `writer` object as the only parameter and mutates it. Similarly, `extend_reader` takes a `reader` object as the only parameter and mutates it.

```
M.extensions = {}
```

3.1.7.1 Acronyms

The `extensions.acronyms` function recognizes acronyms, initialisms, and other all-caps sequences in markdown text.

```
M.extensions.acronyms = function(acronyms)
  assert(#acronyms > 0)
```

```
  return {
    name = "built-in acronyms syntax extension",
    extend_writer = function(self)
```

Define `writer->acronym` as a function that will transform an input acronym, initialism, or another all-caps sequence to the output format.

```
      function self.acronym(s)
        if self.flatten_inlines then return s end
        return {"\\markdownRendererAcronym{",s,"}"}
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local options = self.options
      local writer = self.writer
```

In order to minimize the size and speed of the parser, we will first construct prefix trees of all registered acronyms, initialisms, and other all-caps sequences.

```
      local prefix_tree = {_type = "intermediate"}
      for _, acronym in ipairs(acronyms) do
        local node = prefix_tree
```

Normalize each acronym, initialism, or another all-caps sequence.

```
        if options.unicodeNormalization then
          local form = options.unicodeNormalizationForm
          acronym = util.normalize(acronym, form)
        end
        for i = 1, #acronym do
          local acronym_byte = acronym:sub(i, i)
          if i < #acronym then
            if node[acronym_byte] == nil then
              node[acronym_byte] = {_type = "intermediate"}
            end
            node = node[acronym_byte]
          else
            table.insert(node, {acronym_byte, _type = "leaf"})
          end
        end
      end
```

Next, we will construct a parser out of the prefix tree.

```
      local subparsers = {}
      depth_first_search(prefix_tree, "", function(node, path)
        if node._type == "leaf" then
          local acronym_byte = table.unpack(node)
          if subparsers[path] == nil then
            subparsers[path] = parsers.fail
          end
          subparsers[path] = subparsers[path] + P(acronym_byte)
        end
      end, function(_, path)
        if #path > 0 then
```

```
          local byte = path:sub(#path, #path)
          local parent_path = path:sub(1, #path-1)
          local prefix = P(byte)
          local suffix = prefix * subparsers[path]
          if subparsers[parent_path] == nil then
            subparsers[parent_path] = parsers.fail
          end
          subparsers[parent_path] = subparsers[parent_path] + suffix
        end
      end)
      assert(subparsers[""] ~= nil)
```

Only match acronyms at word boundaries.

```
      local Acronym = ( parsers.unicode.punctuation
                      - V("SpecialChar")
                      + parsers.unicode.whitespace
                      - V("EndlineExceptions"))^0
                    / writer.string
                    * (
                      subparsers[""]
                      * #(-parsers.normalchar
                         + parsers.unicode.punctuation
                         + parsers.unicode.whitespace
                         + parsers.eof)
                      / writer.acronym)
      self.insert_pattern("Inline before Str", Acronym, "Acronym")
    end
  }
end
%
%#### Bracketed Spans
%
% The \luamdef{extensions.bracketed_spans} function implements the Pandoc
% bracketed span syntax extension.
%
% \end{markdown}
%  \begin{macrocode}
M.extensions.bracketed_spans = function()
  return {
    name = "built-in bracketed_spans syntax extension",
    extend_writer = function(self)
```

Define `writer->span` as a function that will transform an input bracketed span `s` with attributes `attr` to the output format.

```
      function self.span(s, attr)
        if self.flatten_inlines then return s end
        return {"\\markdownRendererBracketedSpanAttributeContextBegin",
                self.attributes(attr),
                "\\markdownRendererBracketedSpan{",s,"}",
                "\\markdownRendererBracketedSpanAttributeContextEnd{}"}
```

```
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local writer = self.writer

      local span_label  = parsers.lbracket
                          * (Cs((parsers.alphanumeric^1
                              + parsers.inticks
                              + parsers.autolink
                              + V("InlineHtml")
                              + ( parsers.backslash * parsers.backslash)
                              + ( parsers.backslash
                                * (parsers.lbracket + parsers.rbracket)
                                + V("Space") + V("Endline")
                                + (parsers.any
                                  - ( parsers.newline
                                    + parsers.lbracket
                                    + parsers.rbracket
                                    + parsers.blankline^2))))^1)
                          / self.parser_functions.parse_inlines)
                          * parsers.rbracket

      local Span = span_label
                  * Ct(parsers.attributes)
                  / writer.span

      self.insert_pattern("Inline before LinkAndEmph",
                          Span, "Span")
    end
  }
end
```

3.1.7.2 Citations

The `extensions.citations` function implements the Pandoc citation syntax extension. When the `citation_nbsps` parameter is enabled, the syntax extension will replace regular spaces with non-breaking spaces inside the prenotes and postnotes of citations.

```
M.extensions.citations = function(citation_nbsps)
  return {
    name = "built-in citations syntax extension",
    extend_writer = function(self)
```

Define `writer->citations` as a function that will transform an input array of citations `cites` to the output format. If `text_cites` is enabled, the citations should be rendered in-text, when applicable. The `cites` array contains tables with the following keys and values:

- `suppress_author` – If the value of the key is true, then the author of the work should be omitted in the citation, when applicable.

- `prenote` – The value of the key is either `nil` or a rope that should be inserted before the citation.
- `postnote` – The value of the key is either `nil` or a rope that should be inserted after the citation.
- `name` – The value of this key is the citation name.

```
12397       function self.citations(text_cites, cites)
12398         local buffer = {}
12399         if self.flatten_inlines then
12400           for _,cite in ipairs(cites) do
12401             if cite.prenote then
12402               table.insert(buffer, {cite.prenote, " "})
12403             end
12404             table.insert(buffer, cite.name)
12405             if cite.postnote then
12406               table.insert(buffer, {" ", cite.postnote})
12407             end
12408           end
12409         else
12410           table.insert(buffer,
12411                        {"\\markdownRenderer",
12412                         text_cites and "TextCite" or "Cite",
12413                         "{", #cites, "}"})
12414           for _,cite in ipairs(cites) do
12415             table.insert(buffer,
12416                          {cite.suppress_author and "-" or "+", "{",
12417                           cite.prenote or "", "}{",
12418                           cite.postnote or "", "}{", cite.name, "}"})
12419           end
12420         end
12421         return buffer
12422       end
12423     end, extend_reader = function(self)
12424       local parsers = self.parsers
12425       local writer = self.writer
12426
12427       local citation_chars
12428                     = parsers.alphanumeric
12429                     + S("#$%&-+<>~/_")
12430
12431       local citation_name
12432                     = Cs(parsers.dash^-1) * parsers.at
12433                     * Cs(citation_chars
12434                         * (((  citation_chars
12435                             + parsers.internal_punctuation
12436                             - parsers.comma - parsers.semicolon)
12437                            * -#(( parsers.internal_punctuation
12438                                 - parsers.comma
```

```
                              - parsers.semicolon)^0
                            * -( citation_chars
                               + parsers.internal_punctuation
                               - parsers.comma
                               - parsers.semicolon)))^0
                        * citation_chars)^-1)

    local citation_body_prenote
                  = Cs((parsers.alphanumeric^1
                       + parsers.bracketed
                       + parsers.inticks
                       + parsers.autolink
                       + V("InlineHtml")
                       + V("Space") + V("EndlineNoSub")
                       + (parsers.anyescaped
                         - ( parsers.newline
                           + parsers.rbracket
                           + parsers.blankline^2))
                       - ( parsers.spnl
                         * parsers.dash^-1
                         * parsers.at))^1)

    local citation_body_postnote
                  = Cs((parsers.alphanumeric^1
                       + parsers.bracketed
                       + parsers.inticks
                       + parsers.autolink
                       + V("InlineHtml")
                       + V("Space") + V("EndlineNoSub")
                       + (parsers.anyescaped
                         - ( parsers.newline
                           + parsers.rbracket
                           + parsers.semicolon
                           + parsers.blankline^2))
                       - (parsers.spnl * parsers.rbracket))^1)

    local citation_body_chunk
                  = ( citation_body_prenote
                    * parsers.spnlc_sep
                    + Cc("")
                    * parsers.spnlc
                  )
                  * citation_name
                  * ( parsers.internal_punctuation
                    - parsers.semicolon)^-1
                  * ( parsers.spnlc / function(_) return end
                    * citation_body_postnote
                    + Cc("")
                    * parsers.spnlc
```

```
                )

    local citation_body
                = citation_body_chunk
                * ( parsers.semicolon
                  * parsers.spnlc
                  * citation_body_chunk
                )^0

    local citation_headless_body_postnote
                = Cs((parsers.alphanumeric^1
                     + parsers.bracketed
                     + parsers.inticks
                     + parsers.autolink
                     + V("InlineHtml")
                     + V("Space") + V("Endline")
                     + (parsers.anyescaped
                       - ( parsers.newline
                         + parsers.rbracket
                         + parsers.at
                         + parsers.semicolon + parsers.blankline^2))
                     - (parsers.spnl * parsers.rbracket))^0)

    local citation_headless_body
                = citation_headless_body_postnote
                * ( parsers.semicolon
                  * parsers.spnlc
                  * citation_body_chunk
                )^0

    local citations
                = function(text_cites, raw_cites)
        local function normalize(str)
            if str == "" then
                str = nil
            else
                str = (citation_nbsps and
                  self.parser_functions.parse_inlines_nbsp or
                  self.parser_functions.parse_inlines)(str)
            end
            return str
        end

        local cites = {}
        for i = 1,#raw_cites,4 do
            cites[#cites+1] = {
                prenote = normalize(raw_cites[i]),
                suppress_author = raw_cites[i+1] == "-",
                name = writer.identifier(raw_cites[i+2]),
```

```
                    postnote = normalize(raw_cites[i+3]),
                }
            end
            return writer.citations(text_cites, cites)
        end

        local TextCitations
                      = Ct((parsers.spnlc
                      * Cc("")
                      * citation_name
                      * ((parsers.spnlc
                          * parsers.lbracket
                          * citation_headless_body
                          * parsers.rbracket) + Cc("")))^1)
                      / function(raw_cites)
                          return citations(true, raw_cites)
                        end

        local ParenthesizedCitations
                      = Ct((parsers.spnlc
                      * parsers.lbracket
                      * citation_body
                      * parsers.rbracket)^1)
                      / function(raw_cites)
                          return citations(false, raw_cites)
                        end

        local Citations = TextCitations + ParenthesizedCitations

        self.insert_pattern("Inline before LinkAndEmph",
                            Citations, "Citations")

        self.add_special_character("@")
        self.add_special_character("-")
      end
    }
end
```

3.1.7.3 Content Blocks

The `extensions.content_blocks` function implements the iA Writer content blocks syntax extension. The `language_map` parameter specifies the filename of the JSON file that maps filename extensions to programming language names.

```
M.extensions.content_blocks = function(language_map)
```

The `languages_json` table maps programming language filename extensions to fence infostrings. All `language_map` files located by the kpathsea library are loaded into a chain of tables. `languages_json` corresponds to the first table and is chained with the rest via Lua metatables.

```
12575   local languages_json = (function()
12576     local base, prev, curr
12577     for _, pathname in ipairs(util.find_files(language_map)) do
12578       local file = io.open(pathname, "r")
12579       if not file then goto continue end
12580       local input = assert(file:read("*a"))
12581       assert(file:close())
12582       local json = input:gsub('("[^\n]-"):','[%1]=')
12583       curr = load("_ENV = {}; return "..json)()
12584       if type(curr) == "table" then
12585         if base == nil then
12586           base = curr
12587         else
12588           setmetatable(prev, { __index = curr })
12589         end
12590         prev = curr
12591       end
12592       ::continue::
12593     end
12594     return base or {}
12595   end)()
12596
12597   return {
12598     name = "built-in content_blocks syntax extension",
12599     extend_writer = function(self)
```

Define `writer->contentblock` as a function that will transform an input iA Writer content block to the output format, where `src` corresponds to the URI prefix, `suf` to the URI extension, `type` to the type of the content block (`localfile` or `onlineimage`), and `tit` to the title of the content block.

```
12600       function self.contentblock(src,suf,type,tit)
12601         if not self.is_writing then return "" end
12602         src = src.."."..suf
12603         suf = suf:lower()
12604         if type == "onlineimage" then
12605           return {"\\markdownRendererContentBlockOnlineImage{",suf,"}",
12606                   "{",self.string(src),"}",
12607                   "{",self.uri(src),"}",
12608                   "{",self.string(tit or ""),"}"}
12609         elseif languages_json[suf] then
12610           return {"\\markdownRendererContentBlockCode{",suf,"}",
12611                   "{",self.string(languages_json[suf]),"}",
12612                   "{",self.string(src),"}",
12613                   "{",self.uri(src),"}",
12614                   "{",self.string(tit or ""),"}"}
12615         else
12616           return {"\\markdownRendererContentBlock{",suf,"}",
12617                   "{",self.string(src),"}",
12618                   "{",self.uri(src),"}",
```

```
                "{",self.string(tit or ""),"}"}
      end
    end
  end, extend_reader = function(self)
    local parsers = self.parsers
    local writer = self.writer

    local contentblock_tail
                = parsers.optionaltitle
                * (parsers.newline + parsers.eof)

    -- case insensitive online image suffix:
    local onlineimagesuffix
                = (function(...)
                    local parser = nil
                    for _, suffix in ipairs({...}) do
                      local pattern=nil
                      for i=1,#suffix do
                        local char=suffix:sub(i,i)
                        char = S(char:lower()..char:upper())
                        if pattern == nil then
                          pattern = char
                        else
                          pattern = pattern * char
                        end
                      end
                      if parser == nil then
                        parser = pattern
                      else
                        parser = parser + pattern
                      end
                    end
                    return parser
                  end)("png", "jpg", "jpeg", "gif", "tif", "tiff")

    -- online image url for iA Writer content blocks with
    -- mandatory suffix, allowing nested brackets:
    local onlineimageurl
                = (parsers.less
                  * Cs((parsers.anyescaped
                       - parsers.more
                       - parsers.spacing
                       - #(parsers.period
                          * onlineimagesuffix
                          * parsers.more
                          * contentblock_tail))^0)
                  * parsers.period
                  * Cs(onlineimagesuffix)
                  * parsers.more
```

```
                      + (Cs((parsers.inparens
                            + (parsers.anyescaped
                              - parsers.spacing
                              - parsers.rparent
                              - #(parsers.period
                                 * onlineimagesuffix
                                 * contentblock_tail)))^0)
                        * parsers.period
                        * Cs(onlineimagesuffix))
                      ) * Cc("onlineimage")

      -- filename for iA Writer content blocks with mandatory suffix:
      local localfilepath
                      = parsers.slash
                      * Cs((parsers.anyescaped
                           - parsers.tab
                           - parsers.newline
                           - #(parsers.period
                              * parsers.alphanumeric^1
                              * contentblock_tail))^1)
                      * parsers.period
                      * Cs(parsers.alphanumeric^1)
                      * Cc("localfile")

      local ContentBlock
                      = parsers.check_trail_no_rem
                      * (localfilepath + onlineimageurl)
                      * contentblock_tail
                      / writer.contentblock

      self.insert_pattern("Block before Blockquote",
                          ContentBlock, "ContentBlock")
    end
  }
end
```

3.1.7.4 Definition Lists

The `extensions.definition_lists` function implements the Pandoc definition list syntax extension. If the `tight_lists` parameter is `true`, tight lists will produce special right item renderers.

```
M.extensions.definition_lists = function(tight_lists)
  return {
    name = "built-in definition_lists syntax extension",
    extend_writer = function(self)
```

Define `writer->definitionlist` as a function that will transform an input definition list to the output format, where `items` is an array of tables, each of the form

`{ term = t, definitions = defs }`, where `t` is a term and `defs` is an array of definitions. `tight` specifies, whether the list is tight or not.

```
12707       local function dlitem(term, defs)
12708         local retVal = {"\\markdownRendererDlItem{",term,"}"}
12709         for _, def in ipairs(defs) do
12710           retVal[#retVal+1]
12711             = {"\\markdownRendererDlDefinitionBegin ",def,
12712                "\\markdownRendererDlDefinitionEnd "}
12713         end
12714         retVal[#retVal+1] = "\\markdownRendererDlItemEnd "
12715         return retVal
12716       end
12717
12718       function self.definitionlist(items,tight)
12719         if not self.is_writing then return "" end
12720         local buffer = {}
12721         for _,item in ipairs(items) do
12722           buffer[#buffer + 1] = dlitem(item.term, item.definitions)
12723         end
12724         if tight and tight_lists then
12725           return {"\\markdownRendererDlBeginTight\n", buffer,
12726             "\n\\markdownRendererDlEndTight"}
12727         else
12728           return {"\\markdownRendererDlBegin\n", buffer,
12729             "\n\\markdownRendererDlEnd"}
12730         end
12731       end
12732     end, extend_reader = function(self)
12733       local parsers = self.parsers
12734       local writer = self.writer
12735
12736       local defstartchar = S("~:")
12737
12738       local defstart
12739         = parsers.check_trail_length(0) * defstartchar
12740         * #parsers.spacing
12741         * (parsers.tab + parsers.space^-3)
12742         + parsers.check_trail_length(1)
12743         * defstartchar * #parsers.spacing
12744         * (parsers.tab + parsers.space^-2)
12745         + parsers.check_trail_length(2)
12746         * defstartchar * #parsers.spacing
12747         * (parsers.tab + parsers.space^-1)
12748         + parsers.check_trail_length(3)
12749         * defstartchar * #parsers.spacing
12750
12751       local indented_line
12752         = (parsers.check_minimal_indent / "")
12753         * parsers.check_code_trail * parsers.line
```

```
12754
12755       local blank
12756         = parsers.check_minimal_blank_indent_and_any_trail
12757         * parsers.optionalspace * parsers.newline
12758
12759       local dlchunk = Cs(parsers.line * (indented_line - blank)^0)
12760
12761       local indented_blocks = function(bl)
12762         return Cs( bl
12763               * (blank^1 * (parsers.check_minimal_indent / "")
12764                 * parsers.check_code_trail * -parsers.blankline * bl)^0
12765               * (blank^1 + parsers.eof))
12766       end
12767
12768       local function definition_list_item(term, defs, _)
12769         return { term = self.parser_functions.parse_inlines(term),
12770                  definitions = defs }
12771       end
12772
12773       local DefinitionListItemLoose
12774         = C(parsers.line) * blank^0
12775         * Ct((parsers.check_minimal_indent * (defstart
12776              * indented_blocks(dlchunk)
12777              / self.parser_functions.parse_blocks_nested))^1)
12778         * Cc(false) / definition_list_item
12779
12780       local DefinitionListItemTight
12781         = C(parsers.line)
12782         * Ct((parsers.check_minimal_indent * (defstart * dlchunk
12783              / self.parser_functions.parse_blocks_nested))^1)
12784         * Cc(true) / definition_list_item
12785
12786       local DefinitionList
12787         = ( Ct(DefinitionListItemLoose^1) * Cc(false)
12788           + Ct(DefinitionListItemTight^1)
12789           * (blank^0
12790             * -DefinitionListItemLoose * Cc(true))
12791           ) / writer.definitionlist
12792
12793       self.insert_pattern("Block after Heading",
12794                           DefinitionList, "DefinitionList")
12795     end
12796   }
12797 end
```

3.1.7.5 Fancy Lists

The `extensions.fancy_lists` function implements the Pandoc fancy list syntax extension.

```
M.extensions.fancy_lists = function()
  return {
    name = "built-in fancy_lists syntax extension",
    extend_writer = function(self)
      local options = self.options

```

Define `writer->fancylist` as a function that will transform an input ordered list to the output format, where:

- `items` is an array of the list items,
- `tight` specifies, whether the list is tight or not,
- `startnum` is the number of the first list item,
- `numstyle` is the style of the list item labels from among the following:
  - `Decimal` – decimal arabic numbers,
  - `LowerRoman` – lower roman numbers,
  - `UpperRoman` – upper roman numbers,
  - `LowerAlpha` – lower ASCII alphabetic characters, and
  - `UpperAlpha` – upper ASCII alphabetic characters, and
- `numdelim` is the style of delimiters between list item labels and texts from among the following:
  - `Default` – default style,
  - `OneParen` – parentheses, and
  - `Period` – periods.

```
    function self.fancylist(items,tight,startnum,numstyle,numdelim)
      if not self.is_writing then return "" end
      local buffer = {}
      local num = startnum
      for _,item in ipairs(items) do
        if item ~= "" then
          buffer[#buffer + 1] = self.fancyitem(item,num)
        end
        if num ~= nil and item ~= "" then
          num = num + 1
        end
      end
      local contents = util.intersperse(buffer,"\n")
      if tight and options.tightLists then
        return {"\\markdownRendererFancyOlBeginTight{",
                numstyle,"}{",numdelim,"}",contents,
                "\n\\markdownRendererFancyOlEndTight "}
      else
        return {"\\markdownRendererFancyOlBegin{",
                numstyle,"}{",numdelim,"}",contents,
                "\n\\markdownRendererFancyOlEnd "}
```

```
12825         end
12826       end
```

Define `writer->fancyitem` as a function that will transform an input fancy ordered list item to the output format, where `s` is the text of the list item. If the optional parameter `num` is present, it is the number of the list item.

```
12827       function self.fancyitem(s,num)
12828         if num ~= nil then
12829           return {"\\markdownRendererFancyOlItemWithNumber{",num,"}",s,
12830                   "\\markdownRendererFancyOlItemEnd "}
12831         else
12832           return {"\\markdownRendererFancyOlItem ",s,
12833                   "\\markdownRendererFancyOlItemEnd "}
12834         end
12835       end
12836     end, extend_reader = function(self)
12837       local parsers = self.parsers
12838       local options = self.options
12839       local writer = self.writer
12840
12841       local function combine_markers_and_delims(markers, delims)
12842         local markers_table = {}
12843         for _,marker in ipairs(markers) do
12844           local start_marker
12845           local continuation_marker
12846           if type(marker) == "table" then
12847             start_marker = marker[1]
12848             continuation_marker = marker[2]
12849           else
12850             start_marker = marker
12851             continuation_marker = marker
12852           end
12853           for _,delim in ipairs(delims) do
12854             table.insert(markers_table,
12855                          {start_marker, continuation_marker, delim})
12856           end
12857         end
12858         return markers_table
12859       end
12860
12861       local function join_table_with_func(func, markers_table)
12862         local pattern = func(table.unpack(markers_table[1]))
12863         for i = 2, #markers_table do
12864           pattern = pattern + func(table.unpack(markers_table[i]))
12865         end
12866         return pattern
12867       end
12868
12869       local lowercase_letter_marker = R("az")
```

```
12870       local uppercase_letter_marker = R("AZ")
12871
12872       local roman_marker = function(chars)
12873         local m, d, c = P(chars[1]), P(chars[2]), P(chars[3])
12874         local l, x, v, i
12875           = P(chars[4]), P(chars[5]), P(chars[6]), P(chars[7])
12876         return  m^-3
12877                 * (c*m + c*d + d^-1 * c^-3)
12878                 * (x*c + x*l + l^-1 * x^-3)
12879                 * (i*x + i*v + v^-1 * i^-3)
12880       end
12881
12882       local lowercase_roman_marker
12883         = roman_marker({"m", "d", "c", "l", "x", "v", "i"})
12884       local uppercase_roman_marker
12885         = roman_marker({"M", "D", "C", "L", "X", "V", "I"})
12886
12887       local lowercase_opening_roman_marker  = P("i")
12888       local uppercase_opening_roman_marker  = P("I")
12889
12890       local digit_marker = parsers.dig * parsers.dig^-8
12891
12892       local markers = {
12893         {lowercase_opening_roman_marker, lowercase_roman_marker},
12894         {uppercase_opening_roman_marker, uppercase_roman_marker},
12895         lowercase_letter_marker,
12896         uppercase_letter_marker,
12897         lowercase_roman_marker,
12898         uppercase_roman_marker,
12899         digit_marker
12900       }
12901
12902       local delims = {
12903         parsers.period,
12904         parsers.rparent
12905       }
12906
12907       local markers_table = combine_markers_and_delims(markers, delims)
12908
12909       local function enumerator(start_marker, _,
12910                                 delimiter_type, interrupting)
12911         local delimiter_range
12912         local allowed_end
12913         if interrupting then
12914           delimiter_range = P("1")
12915           allowed_end = C(parsers.spacechar^1) * #parsers.linechar
12916         else
12917           delimiter_range = start_marker
12918           allowed_end = C(parsers.spacechar^1)
```

```
                    + #(parsers.newline + parsers.eof)
      end

      return parsers.check_trail
              * Ct(C(delimiter_range) * C(delimiter_type))
              * allowed_end
    end

    local starter = join_table_with_func(enumerator, markers_table)

    local TightListItem = function(starter)
      return  parsers.add_indent(starter, "li")
              * parsers.indented_content_tight
    end

    local LooseListItem = function(starter)
      return  parsers.add_indent(starter, "li")
              * parsers.indented_content_loose
              * remove_indent("li")
    end

    local function roman2number(roman)
      local romans = { ["M"] = 1000, ["D"] = 500, ["C"] = 100,
                       ["L"] = 50, ["X"] = 10, ["V"] = 5, ["I"] = 1 }
      local numeral = 0

      local i = 1
      local len = string.len(roman)
      while i < len do
        local z1, z2 = romans[ string.sub(roman, i, i) ],
                       romans[ string.sub(roman, i+1, i+1) ]
        if z1 < z2 then
            numeral = numeral + (z2 - z1)
            i = i + 2
        else
            numeral = numeral + z1
            i = i + 1
        end
      end
      if i <= len then
        numeral = numeral + romans[ string.sub(roman,i,i) ]
      end
      return numeral
    end

    local function sniffstyle(numstr, delimend)
      local numdelim
      if delimend == ")" then
        numdelim = "OneParen"
```

```
12968         elseif delimend == "." then
12969           numdelim = "Period"
12970         else
12971           numdelim = "Default"
12972         end
12973
12974         local num
12975         num = numstr:match("^([I])$")
12976         if num then
12977           return roman2number(num), "UpperRoman", numdelim
12978         end
12979         num = numstr:match("^([i])$")
12980         if num then
12981           return roman2number(string.upper(num)), "LowerRoman", numdelim
12982         end
12983         num = numstr:match("^([A-Z])$")
12984         if num then
12985           return string.byte(num) - string.byte("A") + 1,
12986                  "UpperAlpha", numdelim
12987         end
12988         num = numstr:match("^([a-z])$")
12989         if num then
12990           return string.byte(num) - string.byte("a") + 1,
12991                  "LowerAlpha", numdelim
12992         end
12993         num = numstr:match("^([IVXLCDM]+)")
12994         if num then
12995           return roman2number(num), "UpperRoman", numdelim
12996         end
12997         num = numstr:match("^([ivxlcdm]+)")
12998         if num then
12999           return roman2number(string.upper(num)), "LowerRoman", numdelim
13000         end
13001         return math.floor(tonumber(numstr) or 1), "Decimal", numdelim
13002       end
13003
13004       local function fancylist(items,tight,start)
13005         local startnum, numstyle, numdelim
13006           = sniffstyle(start[2][1], start[2][2])
13007         return writer.fancylist(items,tight,
13008                                 options.startNumber and startnum or 1,
13009                                 numstyle or "Decimal",
13010                                 numdelim or "Default")
13011       end
13012
13013       local FancyListOfType
13014         = function(start_marker, continuation_marker, delimiter_type)
13015           local enumerator_start
13016             = enumerator(start_marker, continuation_marker,
```

```
                          delimiter_type)
          local enumerator_cont
            = enumerator(continuation_marker, continuation_marker,
                          delimiter_type)
          return Cg(enumerator_start, "listtype")
               * (Ct( TightListItem(Cb("listtype"))
                   * ((parsers.check_minimal_indent / "")
                   * TightListItem(enumerator_cont))^0)
               * Cc(true)
               * -#((parsers.conditionally_indented_blankline^0 / "")
                   * parsers.check_minimal_indent * enumerator_cont)
               + Ct( LooseListItem(Cb("listtype"))
                   * ((parsers.conditionally_indented_blankline^0 / "")
                     * (parsers.check_minimal_indent / "")
                     * LooseListItem(enumerator_cont))^0)
               * Cc(false)
               ) * Ct(Cb("listtype")) / fancylist
        end

      local FancyList
        = join_table_with_func(FancyListOfType, markers_table)

      local ListStarter = starter

      self.update_rule("OrderedList", FancyList)
      self.update_rule("ListStarter", ListStarter)
    end
  }
end
```

3.1.7.6 Fenced Code

The `extensions.fenced_code` function implements the CommonMark fenced code block syntax extension. When the `blank_before_code_fence` parameter is `true`, the syntax extension requires a blank line between a paragraph and the following fenced code block.

When the `allow_attributes` option is `true`, the syntax extension permits attributes following the infostring. When the `allow_raw_blocks` option is `true`, the syntax extension permits the specification of raw blocks using the Pandoc raw attribute syntax extension.

```
M.extensions.fenced_code = function(blank_before_code_fence,
                                    allow_attributes,
                                    allow_raw_blocks)
  return {
    name = "built-in fenced_code syntax extension",
    extend_writer = function(self)
      local options = self.options

```

Define `writer->fencedCode` as a function that will transform an input fenced code block `s` with the infostring `i` and optional attributes `attr` to the output format.

```
13054       function self.fencedCode(s, i, attr)
13055         if not self.is_writing then return "" end
13056         s = s:gsub("\n$", "")
13057         local buf = {}
13058         if attr ~= nil then
13059           table.insert(buf,
13060             {"\\markdownRendererFencedCodeAttributeContextBegin",
13061              self.attributes(attr)})
13062         end
13063         local name = util.cache_verbatim(options.cacheDir, s)
13064         table.insert(buf,
13065           {"\\markdownRendererInputFencedCode{",
13066            name,"}{",self.string(i),"}{",self.infostring(i),"}"})
13067         if attr ~= nil then
13068           table.insert(buf,
13069             "\\markdownRendererFencedCodeAttributeContextEnd{}")
13070         end
13071         return buf
13072       end
13073
```

Define `writer->rawBlock` as a function that will transform an input raw block `s` with the raw attribute `attr` to the output format.

```
13074       if allow_raw_blocks then
13075         function self.rawBlock(s, attr)
13076           if not self.is_writing then return "" end
13077           s = s:gsub("\n$", "")
13078           local name = util.cache_verbatim(options.cacheDir, s)
13079           return {"\\markdownRendererInputRawBlock{",
13080                   name,"}{", self.string(attr),"}"}
13081         end
13082       end
13083     end, extend_reader = function(self)
13084       local parsers = self.parsers
13085       local writer = self.writer
13086
13087       local function captures_geq_length(_,i,a,b)
13088         return #a >= #b and i
13089       end
13090
13091       local function strip_enclosing_whitespaces(str)
13092         return str:gsub("^%s*(.-)%s*$", "%1")
13093       end
13094
13095       local tilde_infostring = Cs(Cs((V("HtmlEntity")
13096                                       + parsers.anyescaped
13097                                       - parsers.newline)^0)
```

```
                                / strip_enclosing_whitespaces)

    local backtick_infostring
      = Cs( Cs((V("HtmlEntity")
          + ( -#(parsers.backslash * parsers.backtick)
            * parsers.anyescaped)
            - parsers.newline
            - parsers.backtick)^0)
      / strip_enclosing_whitespaces)

    local fenceindent

    local function has_trail(indent_table)
      return indent_table ~= nil and
        indent_table.trail ~= nil and
        next(indent_table.trail) ~= nil
    end

    local function has_indents(indent_table)
      return indent_table ~= nil and
        indent_table.indents ~= nil and
        next(indent_table.indents) ~= nil
    end

    local function get_last_indent_name(indent_table)
      if has_indents(indent_table) then
        return indent_table.indents[#indent_table.indents].name
      end
    end

    local count_fenced_start_indent =
      function(_, _, indent_table, trail)
        local last_indent_name = get_last_indent_name(indent_table)
        fenceindent = 0
        if last_indent_name ~= "li" then
          fenceindent = #trail
        end
        return true
      end

    local fencehead = function(char, infostring)
      return Cmt( Cb("indent_info")
                * parsers.check_trail, count_fenced_start_indent)
           * Cg(char^3, "fencelength")
           * parsers.optionalspace
           * infostring
           * (parsers.newline + parsers.eof)
    end

```

```
13147       local fencetail = function(char)
13148         return parsers.check_trail_no_rem
13149              * Cmt(C(char^3) * Cb("fencelength"), captures_geq_length)
13150              * parsers.optionalspace * (parsers.newline + parsers.eof)
13151              + parsers.eof
13152       end
13153
13154       local process_fenced_line =
13155         function(s, i, -- luacheck: ignore s i
13156                  indent_table, line_content, is_blank)
13157           local remainder = ""
13158           if has_trail(indent_table) then
13159             remainder = indent_table.trail.internal_remainder
13160           end
13161
13162           if is_blank
13163              and get_last_indent_name(indent_table) == "li" then
13164             remainder = ""
13165           end
13166
13167           local str = remainder .. line_content
13168           local index = 1
13169           local remaining = fenceindent
13170
13171           while true do
13172             local c = str:sub(index, index)
13173             if c == " " and remaining > 0 then
13174               remaining = remaining - 1
13175               index = index + 1
13176             elseif c == "\t" and remaining > 3 then
13177               remaining = remaining - 4
13178               index = index + 1
13179             else
13180               break
13181             end
13182           end
13183
13184           return true, str:sub(index)
13185         end
13186
13187       local fencedline = function(char)
13188         return Cmt( Cb("indent_info")
13189                   * C(parsers.line - fencetail(char))
13190                   * Cc(false), process_fenced_line)
13191       end
13192
13193       local blankfencedline
13194         = Cmt( Cb("indent_info")
13195              * C(parsers.blankline)
```

```
13196         * Cc(true), process_fenced_line)
13197
13198     local TildeFencedCode
13199       = fencehead(parsers.tilde, tilde_infostring)
13200       * Cs(( (parsers.check_minimal_blank_indent / "")
13201           * blankfencedline
13202           + ( parsers.check_minimal_indent / "")
13203             * fencedline(parsers.tilde))^0)
13204       * ( (parsers.check_minimal_indent / "")
13205         * fencetail(parsers.tilde) + parsers.succeed)
13206
13207     local BacktickFencedCode
13208           = fencehead(parsers.backtick, backtick_infostring)
13209           * Cs(( (parsers.check_minimal_blank_indent / "")
13210                * blankfencedline
13211                + (parsers.check_minimal_indent / "")
13212                * fencedline(parsers.backtick))^0)
13213           * ( (parsers.check_minimal_indent / "")
13214             * fencetail(parsers.backtick) + parsers.succeed)
13215
13216     local infostring_with_attributes
13217                       = Ct(C((parsers.linechar
13218                             - ( parsers.optionalspace
13219                               * parsers.attributes))^0)
13220                           * parsers.optionalspace
13221                           * Ct(parsers.attributes))
13222
13223     local FencedCode
13224       = ((TildeFencedCode + BacktickFencedCode)
13225       / function(infostring, code)
13226         local expanded_code = self.expandtabs(code)
13227
13228         if allow_raw_blocks then
13229           local raw_attr = lpeg.match(parsers.raw_attribute,
13230                                       infostring)
13231           if raw_attr then
13232             return writer.rawBlock(expanded_code, raw_attr)
13233           end
13234         end
13235
13236         local attr = nil
13237         if allow_attributes then
13238           local match = lpeg.match(infostring_with_attributes,
13239                                    infostring)
13240           if match then
13241             infostring, attr = table.unpack(match)
13242           end
13243         end
13244         return writer.fencedCode(expanded_code, infostring, attr)
```

```
13245         end)
13246
13247       self.insert_pattern("Block after Verbatim",
13248                           FencedCode, "FencedCode")
13249
13250       local fencestart
13251       if blank_before_code_fence then
13252         fencestart = parsers.fail
13253       else
13254         fencestart = fencehead(parsers.backtick, backtick_infostring)
13255                    + fencehead(parsers.tilde, tilde_infostring)
13256       end
13257
13258       self.update_rule("EndlineExceptions", function(previous_pattern)
13259         if previous_pattern == nil then
13260           previous_pattern = parsers.EndlineExceptions
13261         end
13262         return previous_pattern + fencestart
13263       end)
13264
13265       self.add_special_character("`")
13266       self.add_special_character("~")
13267     end
13268   }
13269 end
```

3.1.7.7 Fenced Divs

The `extensions.fenced_divs` function implements the Pandoc fenced div syntax extension. When the `blank_before_div_fence` parameter is `true`, the syntax extension requires a blank line between a paragraph and the following fenced code block.

```
13270 M.extensions.fenced_divs = function(blank_before_div_fence)
13271   return {
13272     name = "built-in fenced_divs syntax extension",
13273     extend_writer = function(self)
```

Define `writer->div_begin` as a function that will transform the beginning of an input fenced div with with attributes `attributes` to the output format.

```
13274       function self.div_begin(attributes)
13275         local start_output
13276           = {"\\markdownRendererFencedDivAttributeContextBegin\n",
13277              self.attributes(attributes)}
13278         local end_output
13279           = {"\\markdownRendererFencedDivAttributeContextEnd{}"}
13280         return self.push_attributes(
13281           "div", attributes, start_output, end_output)
13282       end
```

Define `writer->div_end` as a function that will produce the end of a fenced div in the output format.

```
13283       function self.div_end()
13284         return self.pop_attributes("div")
13285       end
13286     end, extend_reader = function(self)
13287       local parsers = self.parsers
13288       local writer = self.writer
```

Define basic patterns for matching the opening and the closing tag of a div.

```
13289       local fenced_div_infostring
13290                               = Ct(parsers.attributes)
13291                               + (
13292                                 C( parsers.attribute_classname
13293                                  - parsers.colon)^1
13294                                 / function (infostring)
13295                                   return {"." .. infostring}
13296                                 end
13297                               )
13298
13299       local fenced_div_begin = parsers.nonindentspace
13300                               * parsers.colon^3
13301                               * parsers.optionalspace
13302                               * fenced_div_infostring
13303                               * ( parsers.spacechar^1
13304                                 * parsers.colon^1)^0
13305                               * parsers.optionalspace
13306                               * (parsers.newline + parsers.eof)
13307
13308       local fenced_div_end = parsers.nonindentspace
13309                             * parsers.colon^3
13310                             * parsers.optionalspace
13311                             * (parsers.newline + parsers.eof)
```

Initialize a named group named `fenced_div_level` for tracking how deep we are nested in divs and the named group `fenced_div_num_opening_indents` for tracking the indent of the starting div fence. The former named group is immutable and should roll back properly when we fail to match a fenced div. The latter is mutable and may contain items from unsuccessful matches on top. However, we always know how many items at the head of the latter we can trust by consulting the former.

```
13312       self.initialize_named_group("fenced_div_level", "0")
13313       self.initialize_named_group("fenced_div_num_opening_indents")
13314
13315       local function increment_div_level()
13316         local push_indent_table =
13317           function(s, i, indent_table, -- luacheck: ignore s i
13318                    fenced_div_num_opening_indents, fenced_div_level)
13319             fenced_div_level = tonumber(fenced_div_level) + 1
13320             local num_opening_indents = 0
13321             if indent_table.indents ~= nil then
13322               num_opening_indents = #indent_table.indents
13323             end
```

```
13324           fenced_div_num_opening_indents[fenced_div_level]
13325             = num_opening_indents
13326           return true, fenced_div_num_opening_indents
13327         end
13328
13329       local increment_level =
13330         function(s, i, fenced_div_level) -- luacheck: ignore s i
13331           fenced_div_level = tonumber(fenced_div_level) + 1
13332           return true, tostring(fenced_div_level)
13333         end
13334
13335       return Cg( Cmt( Cb("indent_info")
13336                     * Cb("fenced_div_num_opening_indents")
13337                     * Cb("fenced_div_level"), push_indent_table)
13338                , "fenced_div_num_opening_indents")
13339            * Cg( Cmt( Cb("fenced_div_level"), increment_level)
13340                , "fenced_div_level")
13341     end
13342
13343     local function decrement_div_level()
13344       local pop_indent_table =
13345         function(s, i, -- luacheck: ignore s i
13346                  fenced_div_indent_table, fenced_div_level)
13347           fenced_div_level = tonumber(fenced_div_level)
13348           fenced_div_indent_table[fenced_div_level] = nil
13349           return true, tostring(fenced_div_level - 1)
13350         end
13351
13352       return Cg( Cmt( Cb("fenced_div_num_opening_indents")
13353                     * Cb("fenced_div_level"), pop_indent_table)
13354                , "fenced_div_level")
13355     end
13356
13357
13358     local non_fenced_div_block
13359       = parsers.check_minimal_indent * V("Block")
13360       - parsers.check_minimal_indent_and_trail * fenced_div_end
13361
13362     local non_fenced_div_paragraph
13363       = parsers.check_minimal_indent * V("Paragraph")
13364       - parsers.check_minimal_indent_and_trail * fenced_div_end
13365
13366     local blank = parsers.minimally_indented_blank
13367
13368     local block_separated = parsers.block_sep_group(blank)
13369                           * non_fenced_div_block
13370
13371     local loop_body_pair
13372       = parsers.create_loop_body_pair(block_separated,
```

```
                                      non_fenced_div_paragraph,
                                      parsers.block_sep_group(blank),
                                      parsers.par_sep_group(blank))

    local content_loop  = ( non_fenced_div_block
                          * loop_body_pair.block^0
                          + non_fenced_div_paragraph
                          * block_separated
                          * loop_body_pair.block^0
                          + non_fenced_div_paragraph
                          * loop_body_pair.par^0)
                        * blank^0

    local FencedDiv = fenced_div_begin
                    / writer.div_begin
                    * increment_div_level()
                    * parsers.skipblanklines
                    * Ct(content_loop)
                    * parsers.minimally_indented_blank^0
                    * parsers.check_minimal_indent_and_trail
                    * fenced_div_end
                    * decrement_div_level()
                    * (Cc("") / writer.div_end)

    self.insert_pattern("Block after Verbatim",
                        FencedDiv, "FencedDiv")

    self.add_special_character(":")
```

If the `blank_before_div_fence` parameter is `false`, we will have the closing div at the beginning of a line break the current paragraph if we are currently nested in a div and the indentation matches the opening div fence.

```
    local function is_inside_div()
      local check_div_level =
        function(s, i, fenced_div_level) -- luacheck: ignore s i
          fenced_div_level = tonumber(fenced_div_level)
          return fenced_div_level > 0
        end

      return Cmt(Cb("fenced_div_level"), check_div_level)
    end

    local function check_indent()
      local compare_indent =
        function(s, i, indent_table, -- luacheck: ignore s i
                 fenced_div_num_opening_indents, fenced_div_level)
          fenced_div_level = tonumber(fenced_div_level)
          local num_current_indents
            = ( indent_table.current_line_indents ~= nil and
```

```
                #indent_table.current_line_indents) or 0
            local num_opening_indents
              = fenced_div_num_opening_indents[fenced_div_level]
            return num_current_indents == num_opening_indents
          end

        return Cmt( Cb("indent_info")
                  * Cb("fenced_div_num_opening_indents")
                  * Cb("fenced_div_level"), compare_indent)
      end

      local fencestart = is_inside_div()
                       * fenced_div_end
                       * check_indent()

      if not blank_before_div_fence then
        self.update_rule("EndlineExceptions", function(previous_pattern)
          if previous_pattern == nil then
            previous_pattern = parsers.EndlineExceptions
          end
          return previous_pattern + fencestart
        end)
      end
    end
  }
end
```

3.1.7.8 Header Attributes

The `extensions.header_attributes` function implements the Pandoc header attribute syntax extension.

```
M.extensions.header_attributes = function()
  return {
    name = "built-in header_attributes syntax extension",
    extend_writer = function()
    end, extend_reader = function(self)
      local parsers = self.parsers
      local writer = self.writer

      local function strip_atx_end(s)
        return s:gsub("%s+#*%s*$","")
      end

      local AtxHeading = Cg(parsers.heading_start, "level")
                       * parsers.optionalspace
                       * (C(((parsers.linechar
                              - (parsers.attributes
                                * parsers.optionalspace
                                * parsers.newline))
```

```
                            * (parsers.linechar
                              - parsers.lbrace)^0)^1)
                            / strip_atx_end
                            / parsers.parse_heading_text)
                        * Cg(Ct(parsers.newline
                               + (parsers.attributes
                                 * parsers.optionalspace
                                 * parsers.newline)), "attributes")
                        * Cb("level")
                        * Cb("attributes")
                        / writer.heading

      local function strip_trailing_spaces(s)
        return s:gsub("%s*$","")
      end

      local heading_line  = (parsers.linechar
                            - (parsers.attributes
                              * parsers.optionalspace
                              * parsers.newline))^1
                          - parsers.thematic_break_lines

      local heading_text
        = heading_line
        * ( (V("Endline") / "\n")
          * (heading_line - parsers.heading_level))^0
        * parsers.newline^-1

      local SetextHeading
        = parsers.freeze_trail * parsers.check_trail_no_rem
        * #(heading_text
           * (parsers.attributes
             * parsers.optionalspace
             * parsers.newline)^-1
           * parsers.check_minimal_indent
           * parsers.check_trail
           * parsers.heading_level)
        * Cs(heading_text) / strip_trailing_spaces
        / parsers.parse_heading_text
        * Cg(Ct((parsers.attributes
              * parsers.optionalspace
              * parsers.newline)^-1), "attributes")
        * parsers.check_minimal_indent_and_trail * parsers.heading_level
        * Cb("attributes")
        * parsers.newline
        * parsers.unfreeze_trail
        / writer.heading

      local Heading = AtxHeading + SetextHeading
```

```
13512       self.update_rule("Heading", Heading)
13513     end
13514   }
13515 end
```

3.1.7.9 Inline Code Attributes

The `extensions.inline_code_attributes` function implements the Pandoc inline code attribute syntax extension.

```
13516 M.extensions.inline_code_attributes = function()
13517   return {
13518     name = "built-in inline_code_attributes syntax extension",
13519     extend_writer = function()
13520     end, extend_reader = function(self)
13521       local writer = self.writer
13522
13523       local CodeWithAttributes = parsers.inticks
13524                                * Ct(parsers.attributes)
13525                                / writer.code
13526
13527       self.insert_pattern("Inline before Code",
13528                           CodeWithAttributes,
13529                           "CodeWithAttributes")
13530     end
13531   }
13532 end
```

3.1.7.10 Line Blocks

The `extensions.line_blocks` function implements the Pandoc line block syntax extension.

```
13533 M.extensions.line_blocks = function()
13534   return {
13535     name = "built-in line_blocks syntax extension",
13536     extend_writer = function(self)
```

Define `writer->lineblock` as a function that will transform a line block consisted of `lines` to the output format, with all but the last newline rendered as a line break.

```
13537       function self.lineblock(lines)
13538         if not self.is_writing then return "" end
13539         local buffer = {}
13540         for i = 1, #lines - 1 do
13541           buffer[#buffer + 1] = { lines[i], self.hard_line_break }
13542         end
13543         buffer[#buffer + 1] = lines[#lines]
13544
13545         return {"\\markdownRendererLineBlockBegin\n"
13546                 ,buffer,
13547                 "\n\\markdownRendererLineBlockEnd "}
13548       end
```

```
13549     end, extend_reader = function(self)
13550       local parsers = self.parsers
13551       local writer = self.writer
13552
13553       local LineBlock
13554         = Ct((Cs(( (parsers.pipe * parsers.space) / ""
13555                  * ((parsers.space)/entities.char_entity("nbsp"))^0
13556                  * parsers.linechar^0 * (parsers.newline/""))
13557                  * (-parsers.pipe
13558                    * (parsers.space^1/" ")
13559                    * parsers.linechar^1
13560                    * (parsers.newline/"")
13561                    )^0)
13562               / self.parser_functions.parse_inlines)^1)
13563         / writer.lineblock
13564
13565       self.insert_pattern("Block after Blockquote",
13566                           LineBlock, "LineBlock")
13567     end
13568   }
13569 end
```

3.1.7.11 Marked text

The `extensions.mark` function implements the Pandoc mark syntax extension.

```
13570 M.extensions.mark = function()
13571   return {
13572     name = "built-in mark syntax extension",
13573     extend_writer = function(self)
```

Define `writer->mark` as a function that will transform an input marked text `s` to the output format.

```
13574       function self.mark(s)
13575         if self.flatten_inlines then return s end
13576         return {"\\markdownRendererMark{", s, "}"}
13577       end
13578     end, extend_reader = function(self)
13579       local parsers = self.parsers
13580       local writer = self.writer
13581
13582       local doubleequals = P("==")
13583
13584       local Mark
13585         = parsers.between(V("Inline"), doubleequals, doubleequals)
13586         / function (inlines) return writer.mark(inlines) end
13587
13588       self.add_special_character("=")
13589       self.insert_pattern("Inline before LinkAndEmph",
13590                           Mark, "Mark")
13591     end
```

```
  }
end
```

3.1.7.12 Link Attributes

The `extensions.link_attributes` function implements the Pandoc link attribute syntax extension.

```
M.extensions.link_attributes = function()
  return {
    name = "built-in link_attributes syntax extension",
    extend_writer = function()
    end, extend_reader = function(self)
      local parsers = self.parsers
      local options = self.options
```

The following patterns define link reference definitions with attributes.

```
      local define_reference_parser
        = (parsers.check_trail / "")
        * parsers.link_label
        * parsers.colon
        * parsers.spnlc * parsers.url
        * ( parsers.spnlc_sep * parsers.title
          * (parsers.spnlc * Ct(parsers.attributes))
          * parsers.only_blank
          + parsers.spnlc_sep * parsers.title * parsers.only_blank
          + Cc("") * (parsers.spnlc * Ct(parsers.attributes))
          * parsers.only_blank
          + Cc("") * parsers.only_blank)

      local ReferenceWithAttributes = define_reference_parser
                                    / self.register_link

      self.update_rule("Reference", ReferenceWithAttributes)
```

The following patterns define direct and indirect links with attributes.

```

      local LinkWithAttributesAndEmph
        = Ct(parsers.link_and_emph_table * Cg(Cc(true),
            "match_link_attributes"))
        / self.defer_link_and_emphasis_processing

      self.update_rule("LinkAndEmph", LinkWithAttributesAndEmph)
```

The following patterns define autolinks with attributes.

```
      local AutoLinkUrlWithAttributes
                      = parsers.auto_link_url
                      * Ct(parsers.attributes)
                      / self.auto_link_url
```

```
13632
13633       self.insert_pattern("Inline before AutoLinkUrl",
13634                           AutoLinkUrlWithAttributes,
13635                           "AutoLinkUrlWithAttributes")
13636
13637       local AutoLinkEmailWithAttributes
13638                       = parsers.auto_link_email
13639                       * Ct(parsers.attributes)
13640                       / self.auto_link_email
13641
13642       self.insert_pattern("Inline before AutoLinkEmail",
13643                           AutoLinkEmailWithAttributes,
13644                           "AutoLinkEmailWithAttributes")
13645
13646       if options.relativeReferences then
13647
13648         local AutoLinkRelativeReferenceWithAttributes
13649                         = parsers.auto_link_relative_reference
13650                         * Ct(parsers.attributes)
13651                         / self.auto_link_url
13652
13653         self.insert_pattern(
13654           "Inline before AutoLinkRelativeReference",
13655           AutoLinkRelativeReferenceWithAttributes,
13656           "AutoLinkRelativeReferenceWithAttributes")
13657
13658       end
13659
13660     end
13661   }
13662 end
```

3.1.7.13 Notes

The `extensions.notes` function implements the Pandoc note and inline note syntax extensions. When the `note` parameter is `true`, the Pandoc note syntax extension will be enabled. When the `inline_notes` parameter is `true`, the Pandoc inline note syntax extension will be enabled.

```
13663 M.extensions.notes = function(notes, inline_notes)
13664   assert(notes or inline_notes)
13665   return {
13666     name = "built-in notes syntax extension",
13667     extend_writer = function(self)
```

Define `writer->note` as a function that will transform an input note `s` to the output format.

```
13668       function self.note(s)
13669         if self.flatten_inlines then return "" end
13670         return {"\\markdownRendererNote{",s,"}"}
13671       end
```

```
13672     end, extend_reader = function(self)
13673       local parsers = self.parsers
13674       local writer = self.writer
13675
13676       local rawnotes = parsers.rawnotes
13677
13678       if inline_notes then
13679         local InlineNote
13680           = parsers.circumflex
13681           * ( parsers.link_label
13682             / self.parser_functions.parse_inlines_no_inline_note)
13683           / writer.note
13684
13685         self.insert_pattern("Inline after LinkAndEmph",
13686                             InlineNote, "InlineNote")
13687       end
13688       if notes then
13689         local function strip_first_char(s)
13690           return s:sub(2)
13691         end
13692
13693         local RawNoteRef
13694                       = #(parsers.lbracket * parsers.circumflex)
13695                       * parsers.link_label / strip_first_char
13696
13697         -- like indirect_link
13698         local function lookup_note(ref)
13699           return writer.defer_call(function()
13700             local found = rawnotes[self.normalize_tag(ref)]
13701             if found then
13702               return writer.note(
13703                 self.parser_functions.parse_blocks_nested(found))
13704             else
13705               local text = string.format(
13706                 'Undefined note reference "%s"', ref)
13707               local more = string.format(
13708                 "Look for the text `[^%s]`.", ref)
13709               return {writer.warning(text, more), "[",
13710                 self.parser_functions.parse_inlines("^" .. ref), "]"}
13711             end
13712           end)
13713         end
13714
13715         local function register_note(ref,rawnote)
13716           local normalized_tag = self.normalize_tag(ref)
13717           if rawnotes[normalized_tag] == nil then
13718             rawnotes[normalized_tag] = rawnote
13719             return ""
13720           else
```

```
13721             local text
13722               = string.format('Multiply defined note reference "%s"',
13723                               ref)
13724             local more
13725               = string.format("Look for the text `[^%s]: ...`.", ref)
13726             return writer.warning(text, more)
13727           end
13728         end
13729
13730         local NoteRef = RawNoteRef / lookup_note
13731
13732         local optionally_indented_line
13733           = parsers.check_optional_indent_and_any_trail * parsers.line
13734
13735         local blank
13736           = parsers.check_optional_blank_indent_and_any_trail
13737           * parsers.optionalspace * parsers.newline
13738
13739         local chunk
13740           = Cs(parsers.line
13741           * (optionally_indented_line - blank)^0)
13742
13743         local indented_blocks = function(bl)
13744           return Cs( bl
13745                 * ( blank^1 * (parsers.check_optional_indent / "")
13746                   * parsers.check_code_trail
13747                   * -parsers.blankline * bl)^0)
13748         end
13749
13750         local NoteBlock
13751                     = parsers.check_trail_no_rem
13752                     * RawNoteRef * parsers.colon
13753                     * parsers.spnlc * indented_blocks(chunk)
13754                     / register_note
13755
13756         self.update_rule("Reference", function(previous_pattern)
13757           if previous_pattern == nil then
13758             previous_pattern = parsers.Reference
13759           end
13760           return NoteBlock + previous_pattern
13761         end)
13762
13763         self.insert_pattern("Inline before LinkAndEmph",
13764                             NoteRef, "NoteRef")
13765       end
13766
13767       self.add_special_character("^")
13768     end
13769   }
```

```
13770 end
```

3.1.7.14 Pipe Tables

The `extensions.pipe_table` function implements the PHP Markdown table syntax extension (also known as pipe tables in Pandoc). When the `table_captions` parameter is `true`, the function also implements the Pandoc table caption syntax extension for table captions. When the `table_attributes` parameter is also `true`, the function also allows attributes to be attached to the (possibly empty) table captions.

```
13771 M.extensions.pipe_tables = function(table_captions, table_attributes)
13772
13773   local function make_pipe_table_rectangular(rows)
13774     local num_columns = #rows[2]
13775     local rectangular_rows = {}
13776     for i = 1, #rows do
13777       local row = rows[i]
13778       local rectangular_row = {}
13779       for j = 1, num_columns do
13780         rectangular_row[j] = row[j] or ""
13781       end
13782       table.insert(rectangular_rows, rectangular_row)
13783     end
13784     return rectangular_rows
13785   end
13786
13787   local function pipe_table_row(allow_empty_first_column
13788                                 , nonempty_column
13789                                 , column_separator
13790                                 , column)
13791     local row_beginning
13792     if allow_empty_first_column then
13793       row_beginning = -- empty first column
13794                       #(parsers.spacechar^4
13795                         * column_separator)
13796                     * parsers.optionalspace
13797                     * column
13798                     * parsers.optionalspace
13799                     -- non-empty first column
13800                     + parsers.nonindentspace
13801                     * nonempty_column^-1
13802                     * parsers.optionalspace
13803     else
13804       row_beginning = parsers.nonindentspace
13805                     * nonempty_column^-1
13806                     * parsers.optionalspace
13807     end
13808
13809     return Ct(row_beginning
13810               * (-- single column with no leading pipes
```

```
                #(column_separator
                  * parsers.optionalspace
                  * parsers.newline)
                * column_separator
                * parsers.optionalspace
                -- single column with leading pipes or
                -- more than a single column
                + (column_separator
                  * parsers.optionalspace
                  * column
                  * parsers.optionalspace)^1
                * (column_separator
                  * parsers.optionalspace)^-1))
end

return {
  name = "built-in pipe_tables syntax extension",
  extend_writer = function(self)
```

Define `writer->table` as a function that will transform an input table to the output format, where `rows` is a sequence of columns and a column is a sequence of cell texts.

```
    function self.table(rows, caption, attributes)
      if not self.is_writing then return "" end
      local buffer = {}
      if attributes ~= nil then
        table.insert(buffer,
                     "\\markdownRendererTableAttributeContextBegin\n")
        table.insert(buffer, self.attributes(attributes))
      end
      table.insert(buffer,
                   {"\\markdownRendererTable{",
                    caption or "", "}{", #rows - 1, "}{",
                    #rows[1], "}"})
      local temp = rows[2] -- put alignments on the first row
      rows[2] = rows[1]
      rows[1] = temp
      for i, row in ipairs(rows) do
        table.insert(buffer, "{")
        for _, column in ipairs(row) do
          if i > 1 then -- do not use braces for alignments
            table.insert(buffer, "{")
          end
          table.insert(buffer, column)
          if i > 1 then
            table.insert(buffer, "}")
          end
        end
        table.insert(buffer, "}")
      end
      if attributes ~= nil then
```

```
13858           table.insert(buffer,
13859                        "\\markdownRendererTableAttributeContextEnd{}")
13860         end
13861         return buffer
13862       end
13863     end, extend_reader = function(self)
13864       local parsers = self.parsers
13865       local writer = self.writer
13866
13867       local table_hline_separator = parsers.pipe + parsers.plus
13868
13869       local table_hline_column = (parsers.dash
13870                                   - #(parsers.dash
13871                                      * (parsers.spacechar
13872                                        + table_hline_separator
13873                                        + parsers.newline)))^1
13874                                 * (parsers.colon * Cc("r")
13875                                   + parsers.dash * Cc("d"))
13876                                 + parsers.colon
13877                                 * (parsers.dash
13878                                   - #(parsers.dash
13879                                      * (parsers.spacechar
13880                                        + table_hline_separator
13881                                        + parsers.newline)))^1
13882                                 * (parsers.colon * Cc("c")
13883                                   + parsers.dash * Cc("l"))
13884
13885       local table_hline = pipe_table_row(false
13886                                          , table_hline_column
13887                                          , table_hline_separator
13888                                          , table_hline_column)
13889
13890       local table_caption_beginning
13891         = ( parsers.check_minimal_blank_indent_and_any_trail_no_rem
13892           * parsers.optionalspace * parsers.newline)^0
13893         * parsers.check_minimal_indent_and_trail
13894         * (P("Table")^-1 * parsers.colon)
13895         * parsers.optionalspace
13896
13897       local function strip_trailing_spaces(s)
13898         return s:gsub("%s*$","")
13899       end
13900
13901       local table_row
13902         = pipe_table_row(true
13903                          , (C((parsers.linechar - parsers.pipe)^1)
13904                            / strip_trailing_spaces
13905                            / self.parser_functions.parse_inlines)
13906                          , parsers.pipe
```

```
                      , (C((parsers.linechar - parsers.pipe)^0)
                        / strip_trailing_spaces
                        / self.parser_functions.parse_inlines))

    local table_caption
    if table_captions then
      table_caption = #table_caption_beginning
                    * table_caption_beginning
      if table_attributes then
        table_caption = table_caption
                      * (C(((( parsers.linechar
                             - (parsers.attributes
                               * parsers.optionalspace
                               * parsers.newline
                               * -#( parsers.optionalspace
                                   * parsers.linechar)))
                            + ( parsers.newline
                              * #( parsers.optionalspace
                                 * parsers.linechar)
                              * C(parsers.optionalspace)
                              / writer.space))
                           * (parsers.linechar
                             - parsers.lbrace)^0)^1)
                           / strip_trailing_spaces
                           / self.parser_functions.parse_inlines)
                      * (parsers.newline
                        + ( Ct(parsers.attributes)
                          * parsers.optionalspace
                          * parsers.newline))
      else
        table_caption = table_caption
                      * C(( parsers.linechar
                          + ( parsers.newline
                            * #( parsers.optionalspace
                               * parsers.linechar)
                            * C(parsers.optionalspace)
                            / writer.space))^1)
                      / self.parser_functions.parse_inlines
                      * parsers.newline
      end
    else
      table_caption = parsers.fail
    end

    local PipeTable
      = Ct( table_row * parsers.newline
          * (parsers.check_minimal_indent_and_trail / {})
        * table_hline * parsers.newline
        * ( (parsers.check_minimal_indent / {})
```

```
            * table_row * parsers.newline)^0)
        / make_pipe_table_rectangular
        * table_caption^-1
        / writer.table

      self.insert_pattern("Block after Blockquote",
                          PipeTable, "PipeTable")
    end
  }
end
```

3.1.7.15 Raw Attributes

The `extensions.raw_inline` function implements the Pandoc raw attribute syntax extension for inline code spans.

```
M.extensions.raw_inline = function()
  return {
    name = "built-in raw_inline syntax extension",
    extend_writer = function(self)
      local options = self.options

```

Define `writer->rawInline` as a function that will transform an input inline raw span `s` with the raw attribute `attr` to the output format.

```
      function self.rawInline(s, attr)
        if not self.is_writing then return "" end
        if self.flatten_inlines then return s end
        local name = util.cache_verbatim(options.cacheDir, s)
        return {"\\markdownRendererInputRawInline{",
                name,"}{", self.string(attr),"}"}
      end
    end, extend_reader = function(self)
      local writer = self.writer

      local RawInline = parsers.inticks
                        * parsers.raw_attribute
                        / writer.rawInline

      self.insert_pattern("Inline before Code",
                          RawInline, "RawInline")
    end
  }
end
```

3.1.7.16 Strike-Through

The `extensions.strike_through` function implements the Pandoc strike-through syntax extension.

```
M.extensions.strike_through = function()
  return {
```

```
13993     name = "built-in strike_through syntax extension",
13994     extend_writer = function(self)
```

Define `writer->strike_through` as a function that will transform a strike-through span `s` of input text to the output format.

```
13995       function self.strike_through(s)
13996         if self.flatten_inlines then return s end
13997         return {"\\markdownRendererStrikeThrough{",s,"}"}
13998       end
13999     end, extend_reader = function(self)
14000       local parsers = self.parsers
14001       local writer = self.writer
14002
14003       local StrikeThrough = (
14004         parsers.between(parsers.Inline, parsers.doubletildes,
14005                         parsers.doubletildes)
14006       ) / writer.strike_through
14007
14008       self.insert_pattern("Inline after LinkAndEmph",
14009                           StrikeThrough, "StrikeThrough")
14010
14011       self.add_special_character("~")
14012     end
14013   }
14014 end
```

3.1.7.17 Subscripts

The `extensions.subscripts` function implements the Pandoc subscript syntax extension.

```
14015 M.extensions.subscripts = function()
14016   return {
14017     name = "built-in subscripts syntax extension",
14018     extend_writer = function(self)
```

Define `writer->subscript` as a function that will transform a subscript span `s` of input text to the output format.

```
14019       function self.subscript(s, parsed)
14020         if self.flatten_inlines then return s end
14021         return {"\\markdownRendererSubscript{",parsed,"}"}
14022       end
14023     end, extend_reader = function(self)
14024       local parsers = self.parsers
14025       local writer = self.writer
14026
14027       local Subscript = (
14028         parsers.between(parsers.Str, parsers.tilde, parsers.tilde)
14029       ) / function(s)
14030             return writer.subscript(
14031               s, self.parser_functions.parse_inlines_identity(s[1])
```

```
            )
          end

      self.insert_pattern("Inline after LinkAndEmph",
                          Subscript, "Subscript")

      self.add_special_character("~")
    end
  }
end
```

3.1.7.18 Superscripts

The `extensions.superscripts` function implements the Pandoc superscript syntax extension.

```
M.extensions.superscripts = function()
  return {
    name = "built-in superscripts syntax extension",
    extend_writer = function(self)
```

Define `writer->superscript` as a function that will transform a superscript span `s` of input text to the output format.

```
      function self.superscript(s, parsed)
        if self.flatten_inlines then return s end
        return {"\\markdownRendererSuperscript{",parsed,"}"}
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local writer = self.writer

      local Superscript = (
        parsers.between(parsers.Str, parsers.circumflex,
                        parsers.circumflex)
      ) / function(s)
            return writer.superscript(
              s, self.parser_functions.parse_inlines_identity(s[1])
            )
          end

      self.insert_pattern("Inline after LinkAndEmph",
                          Superscript, "Superscript")

      self.add_special_character("^")
    end
  }
end
```

3.1.7.19 TEX Math

The `extensions.tex_math` function implements the Pandoc math syntax extensions.

```
M.extensions.tex_math = function(tex_math_dollars,
                                 tex_math_single_backslash,
                                 tex_math_double_backslash)
  return {
    name = "built-in tex_math syntax extension",
    extend_writer = function(self)
```

Define `writer->display_math` as a function that will transform a math span `s` of input text to the output format.

```
      function self.display_math(s, parsed)
        if self.flatten_inlines then return s end
        return {"\\markdownRendererDisplayMath{",parsed,"}"}
      end
```

Define `writer->inline_math` as a function that will transform a math span `s` of input text to the output format.

```
      function self.inline_math(s, parsed)
        if self.flatten_inlines then return s end
        return {"\\markdownRendererInlineMath{",parsed,"}"}
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local writer = self.writer

      local function between(p, starter, ender)
        return (starter * Cs(p * (p - ender)^0) * ender)
      end

      local function strip_preceding_whitespaces(str)
        return str:gsub("^%s*(.-)$", "%1")
      end

      local allowed_before_closing
        = B( parsers.backslash * parsers.any
           + parsers.any * (parsers.any - parsers.backslash))

      local allowed_before_closing_no_space
        = B( parsers.backslash * parsers.any
           + parsers.any * (parsers.nonspacechar - parsers.backslash))

```

The following patterns implement the Pandoc dollar math syntax extension.

```
      local dollar_math_content
        = (parsers.newline * (parsers.check_optional_indent / "")
        + parsers.backslash^-1
        * parsers.linechar)
        - parsers.blankline^2
        - parsers.dollar

      local inline_math_opening_dollars = parsers.dollar
```

```
                                        * #(parsers.nonspacechar)

      local inline_math_closing_dollars
        = allowed_before_closing_no_space
        * parsers.dollar
        * -#(parsers.digit)

      local inline_math_dollars = between(Cs( dollar_math_content),
                                          inline_math_opening_dollars,
                                          inline_math_closing_dollars)

      local display_math_opening_dollars  = parsers.dollar
                                          * parsers.dollar

      local display_math_closing_dollars  = parsers.dollar
                                          * parsers.dollar

      local display_math_dollars = between(Cs( dollar_math_content),
                                           display_math_opening_dollars,
                                           display_math_closing_dollars)
```

The following patterns implement the Pandoc single and double backslash math syntax extensions.

```
      local backslash_math_content
        = (parsers.newline * (parsers.check_optional_indent / "")
        + parsers.linechar)
        - parsers.blankline^2
```

The following patterns implement the Pandoc double backslash math syntax extension.

```
      local inline_math_opening_double  = parsers.backslash
                                        * parsers.backslash
                                        * parsers.lparent

      local inline_math_closing_double  = allowed_before_closing
                                        * parsers.spacechar^0
                                        * parsers.backslash
                                        * parsers.backslash
                                        * parsers.rparent

      local inline_math_double  = between(Cs( backslash_math_content),
                                          inline_math_opening_double,
                                          inline_math_closing_double)
                                / strip_preceding_whitespaces

      local display_math_opening_double = parsers.backslash
                                        * parsers.backslash
                                        * parsers.lbracket

      local display_math_closing_double = allowed_before_closing
                                        * parsers.spacechar^0
```

```
                                      * parsers.backslash
                                      * parsers.backslash
                                      * parsers.rbracket

    local display_math_double = between(Cs( backslash_math_content),
                                        display_math_opening_double,
                                        display_math_closing_double)
                              / strip_preceding_whitespaces
```

The following patterns implement the Pandoc single backslash math syntax extension.

```
    local inline_math_opening_single  = parsers.backslash
                                      * parsers.lparent

    local inline_math_closing_single  = allowed_before_closing
                                      * parsers.spacechar^0
                                      * parsers.backslash
                                      * parsers.rparent

    local inline_math_single  = between(Cs( backslash_math_content),
                                        inline_math_opening_single,
                                        inline_math_closing_single)
                              / strip_preceding_whitespaces

    local display_math_opening_single = parsers.backslash
                                      * parsers.lbracket

    local display_math_closing_single = allowed_before_closing
                                      * parsers.spacechar^0
                                      * parsers.backslash
                                      * parsers.rbracket

    local display_math_single = between(Cs( backslash_math_content),
                                        display_math_opening_single,
                                        display_math_closing_single)
                              / strip_preceding_whitespaces

    local display_math = parsers.fail

    local inline_math = parsers.fail

    if tex_math_dollars then
      display_math = display_math + display_math_dollars
      inline_math = inline_math + inline_math_dollars
    end

    if tex_math_double_backslash then
      display_math = display_math + display_math_double
      inline_math = inline_math + inline_math_double
    end

```

```
      if tex_math_single_backslash then
        display_math = display_math + display_math_single
        inline_math = inline_math + inline_math_single
      end

      local TexMath = display_math
                    / function(s)
                        return writer.display_math(
                          s, self.parser_functions.parse_inlines_math(s)
                        )
                      end
                    + inline_math
                    / function(s)
                        return writer.inline_math(
                          s, self.parser_functions.parse_inlines_math(s)
                        )
                      end

      self.insert_pattern("Inline after LinkAndEmph",
                          TexMath, "TexMath")

      if tex_math_dollars then
        self.add_special_character("$")
      end

      if tex_math_single_backslash or tex_math_double_backslash then
        self.add_special_character("\\")
        self.add_special_character("[")
        self.add_special_character("]")
        self.add_special_character(")")
        self.add_special_character("(")
      end
    end
  }
end
```

3.1.7.20 yaml Metadata

The `extensions.jekyll_data` function implements the Pandoc YAML metadata block syntax extension. When the `expect_jekyll_data` parameter is `true`, then a markdown document may begin directly with YAML metadata and may contain nothing but YAML metadata. When both `expect_jekyll_data` and `ensure_jekyll_data` parameters are `true`, then a a markdown document must begin directly with YAML metadata and must contain nothing but YAML metadata.

```
M.extensions.jekyll_data = function(expect_jekyll_data,
                                    ensure_jekyll_data)
  return {
    name = "built-in jekyll_data syntax extension",
    extend_writer = function(self)
```

Define `writer->jekyllData` as a function that will transform an input YAML table `d` to the output format. The table is the value for the key `p` in the parent table; if `p` is nil, then the table has no parent. All scalar keys and values encountered in the table will be cast to a string following YAML serialization rules. String values will also be transformed using the function `t` for the typographic output format used by the `\markdownRendererJekyllDataTypographicString` macro.

```
14245       function self.jekyllData(d, t, p)
14246         if not self.is_writing then return "" end
14247
14248         local buf = {}
14249
14250         local keys = {}
14251         for k, _ in pairs(d) do
14252           table.insert(keys, k)
14253         end
```

For reproducibility, sort the keys. For mixed string-and-numeric keys, sort numeric keys before string keys.

```
14254         table.sort(keys, function(first, second)
14255           if type(first) ~= type(second) then
14256             return type(first) < type(second)
14257           else
14258             return first < second
14259           end
14260         end)
14261
14262         if not p then
14263           table.insert(buf, "\\markdownRendererJekyllDataBegin")
14264         end
14265
14266         local is_sequence = false
14267         if #d > 0 and #d == #keys then
14268           for i=1, #d do
14269             if d[i] == nil then
14270               goto not_a_sequence
14271             end
14272           end
14273           is_sequence = true
14274         end
14275         ::not_a_sequence::
14276
14277         if is_sequence then
14278           table.insert(buf,
14279             "\\markdownRendererJekyllDataSequenceBegin{")
14280           table.insert(buf, self.identifier(p or "null"))
14281           table.insert(buf, "}{")
14282           table.insert(buf, #keys)
14283           table.insert(buf, "}")
14284         else
```

```
14285           table.insert(buf, "\\markdownRendererJekyllDataMappingBegin{")
14286           table.insert(buf, self.identifier(p or "null"))
14287           table.insert(buf, "}{")
14288           table.insert(buf, #keys)
14289           table.insert(buf, "}")
14290         end
14291
14292         for _, k in ipairs(keys) do
14293           local v = d[k]
14294           local typ = type(v)
14295           k = tostring(k or "null")
14296           if typ == "table" and next(v) ~= nil then
14297             table.insert(
14298               buf,
14299               self.jekyllData(v, t, k)
14300             )
14301           else
14302             k = self.identifier(k)
14303             v = tostring(v)
14304             if typ == "boolean" then
14305               table.insert(buf, "\\markdownRendererJekyllDataBoolean{")
14306               table.insert(buf, k)
14307               table.insert(buf, "}{")
14308               table.insert(buf, v)
14309               table.insert(buf, "}")
14310             elseif typ == "number" then
14311               table.insert(buf, "\\markdownRendererJekyllDataNumber{")
14312               table.insert(buf, k)
14313               table.insert(buf, "}{")
14314               table.insert(buf, v)
14315               table.insert(buf, "}")
14316             elseif typ == "string" then
14317               table.insert(buf,
14318                 "\\markdownRendererJekyllDataProgrammaticString{")
14319               table.insert(buf, k)
14320               table.insert(buf, "}{")
14321               table.insert(buf, self.identifier(v))
14322               table.insert(buf, "}")
14323               table.insert(buf,
14324                 "\\markdownRendererJekyllDataTypographicString{")
14325               table.insert(buf, k)
14326               table.insert(buf, "}{")
14327               table.insert(buf, t(v))
14328               table.insert(buf, "}")
14329             elseif typ == "table" then
14330               table.insert(buf, "\\markdownRendererJekyllDataEmpty{")
14331               table.insert(buf, k)
14332               table.insert(buf, "}")
14333             else
```

```
14334               local error = self.error(format(
14335                 "Unexpected type %s for value of "
14336                 .. "YAML key %s.", typ, k))
14337               table.insert(buf, error)
14338             end
14339           end
14340         end
14341
14342         if is_sequence then
14343           table.insert(buf, "\\markdownRendererJekyllDataSequenceEnd")
14344         else
14345           table.insert(buf, "\\markdownRendererJekyllDataMappingEnd")
14346         end
14347
14348         if not p then
14349           table.insert(buf, "\\markdownRendererJekyllDataEnd")
14350         end
14351
14352         return buf
14353       end
14354     end, extend_reader = function(self)
14355       local parsers = self.parsers
14356       local writer = self.writer
14357
14358       local JekyllData
14359         = Cmt( C((parsers.line - P("---") - P("..."))^0)
14360              , function(s, i, text) -- luacheck: ignore s i
14361                  local data
14362                  local ran_ok, _ = pcall(function()
14363                    local tinyyaml = require("tinyyaml")
14364                    data = tinyyaml.parse(text, {timestamps=false})
14365                  end)
14366                  if ran_ok and data ~= nil then
14367                    return true, writer.jekyllData(data, function(s)
14368                      return self.parser_functions.parse_blocks_nested(s)
14369                    end, nil)
14370                  else
14371                    return false
14372                  end
14373                end
14374              )
14375
14376       local UnexpectedJekyllData
14377         = P("---")
14378         * parsers.blankline / 0
14379         -- if followed by blank, it's thematic break
14380         * #(-parsers.blankline)
14381         * JekyllData
14382         * (P("---") + P("..."))
```

```
14383
14384       local ExpectedJekyllData
14385         = ( P("---")
14386           * parsers.blankline / 0
14387           -- if followed by blank, it's thematic break
14388           * #(-parsers.blankline)
14389           )^-1
14390         * JekyllData
14391         * (P("---") + P("..."))^-1
14392
14393       if ensure_jekyll_data then
14394         ExpectedJekyllData = ExpectedJekyllData
14395                            * parsers.eof
14396       else
14397         ExpectedJekyllData = ( ExpectedJekyllData
14398                              * (V("Blank")^0 / writer.interblocksep)
14399                              )^-1
14400       end
14401
14402       self.insert_pattern("Block before Blockquote",
14403                           UnexpectedJekyllData, "UnexpectedJekyllData")
14404       if expect_jekyll_data then
14405         self.update_rule("ExpectedJekyllData", ExpectedJekyllData)
14406       end
14407     end
14408   }
14409 end
```

3.1.8 Conversion from Markdown to Plain TEX

The `new` function of file `markdown.lua` loads file `markdown-parser.lua` and calls its function `new` unless option `eagerCache` or `finalizeCache` has been enabled and a cached conversion output exists, in which case it is returned without loading file `markdown-parser.lua`.

```
14410 function M.new(options)
```

Make the `options` table inherit from the `defaultOptions` and `experimentalOptions` tables.

```
14411   options = options or {}
14412   setmetatable(options, { __index = function (_, key)
14413     return defaultOptions[key] end })
14414   if options.experimental then
14415     setmetatable(options, { __index = function (_, key)
14416       return experimentalOptions[key] end })
14417   end
```

Return a conversion function that tries to produce a cached conversion output exists. If no cached conversion output exists, we load the file `markdown-parser.lua` and use it to convert the input.

```
  local parser_convert = nil
  return function(input, include_flat_output)
    local function convert(input)
      if parser_convert == nil then
```

Lazy-load `markdown-parser.lua` and check that it originates from the same version of the Markdown package.

```
        local parser = require("markdown-parser")
        if metadata.version ~= parser.metadata.version then
          warn("markdown.lua " .. metadata.version .. " used with " ..
               "markdown-parser.lua " .. parser.metadata.version .. ".")
        end
        parser_convert = parser.new(options)
      end
      return parser_convert(input)
    end
```

If we cache markdown documents, produce the cache file and transform its filename to plain TEX output.

When determining the name of the cache file, create salt for the hashing function out of the package version and the passed options recognized by the Lua interface (see Section 2.1.3).

```
    local raw_output, flat_output
    if options.eagerCache or options.finalizeCache then
      local salt = util.salt(options)
      local name, result = util.cache(options.cacheDir, input, salt,
                                      convert, ".md.tex")
      raw_output = [[\input{]] .. name .. [[}\relax]]
      flat_output = function()
        if result == nil then
          local input_file = assert(io.open(name, "r"),
            [[Could not open file "]] .. name .. [[" for reading]])
          result = assert(input_file:read("*a"))
          assert(input_file:close())
        end
        return result
      end
```

Otherwise, return the result of the conversion directly.

```
    else
      raw_output = convert(input)
      flat_output = function()
        return raw_output
      end
    end
```

If the `finalizeCache` option is enabled, populate the frozen cache in the file `frozenCacheFileName` with an entry for markdown document number `frozenCacheCounter`.

```
    if options.finalizeCache then
      local file, mode
```

```
      if options.frozenCacheCounter > 0 then
        mode = "a"
      else
        mode = "w"
      end
      file = assert(io.open(options.frozenCacheFileName, mode),
        [[Could not open file "]] .. options.frozenCacheFileName
        .. [[" for writing]])
      assert(file:write(
        [[\expandafter\global\expandafter\def\csname ]]
        .. [[markdownFrozenCache]] .. options.frozenCacheCounter
        .. [[\endcsname{]] .. raw_output .. [[}]] .. "\n"))
      assert(file:close())
    end
```

Besides the canonical output of the conversion, which may contain cached files behind `\input`, also return a function that always produces a flat output regardless of caching as the second return value.

```
    if include_flat_output then
      return raw_output, flat_output
    else
      return raw_output
    end
  end
end
```

The `new` function from file `markdown-parser.lua` returns a conversion function that takes a markdown string and turns it into a plain TEX output. See Section 2.1.1.

```
function M.new(options)
```

Make the `options` table inherit from the `defaultOptions` and `experimentalOptions` tables.

```
  options = options or {}
  setmetatable(options, { __index = function (_, key)
    return defaultOptions[key] end })
  if options.experimental then
    setmetatable(options, { __index = function (_, key)
      return experimentalOptions[key] end })
  end
```

If the singleton cache contains a conversion function for the same `options`, reuse it.

```
  if options.singletonCache and singletonCache.convert then
    for k, v in pairs(defaultOptions) do
      if type(v) == "table" then
        for i = 1, math.max(#singletonCache.options[k], #options[k]) do
          if singletonCache.options[k][i] ~= options[k][i] then
            goto miss
          end
        end
```

The `cacheDir` option is disregarded.

```
      elseif k ~= "cacheDir"
         and singletonCache.options[k] ~= options[k] then
        goto miss
      end
    end
    return singletonCache.convert
  end
  ::miss::
```

Apply built-in syntax extensions based on `options`.

```
  local extensions = {}

  if #options.acronyms > 0 then
    local acronyms_extension = M.extensions.acronyms(options.acronyms)
    table.insert(extensions, acronyms_extension)
  end

  if options.bracketedSpans then
    local bracketed_spans_extension = M.extensions.bracketed_spans()
    table.insert(extensions, bracketed_spans_extension)
  end

  if options.contentBlocks then
    local content_blocks_extension = M.extensions.content_blocks(
      options.contentBlocksLanguageMap)
    table.insert(extensions, content_blocks_extension)
  end

  if options.definitionLists then
    local definition_lists_extension = M.extensions.definition_lists(
      options.tightLists)
    table.insert(extensions, definition_lists_extension)
  end

  if options.fencedCode then
    local fenced_code_extension = M.extensions.fenced_code(
      options.blankBeforeCodeFence,
      options.fencedCodeAttributes,
      options.rawAttribute)
    table.insert(extensions, fenced_code_extension)
  end

  if options.fencedDivs then
    local fenced_div_extension = M.extensions.fenced_divs(
      options.blankBeforeDivFence)
    table.insert(extensions, fenced_div_extension)
  end

  if options.headerAttributes then
    local header_attributes_extension = M.extensions.header_attributes()
```

```
14539     table.insert(extensions, header_attributes_extension)
14540   end
14541
14542   if options.inlineCodeAttributes then
14543     local inline_code_attributes_extension =
14544       M.extensions.inline_code_attributes()
14545     table.insert(extensions, inline_code_attributes_extension)
14546   end
14547
14548   if options.jekyllData then
14549     local jekyll_data_extension = M.extensions.jekyll_data(
14550       options.expectJekyllData, options.ensureJekyllData)
14551     table.insert(extensions, jekyll_data_extension)
14552   end
14553
14554   if options.linkAttributes then
14555     local link_attributes_extension =
14556       M.extensions.link_attributes()
14557     table.insert(extensions, link_attributes_extension)
14558   end
14559
14560   if options.lineBlocks then
14561     local line_block_extension = M.extensions.line_blocks()
14562     table.insert(extensions, line_block_extension)
14563   end
14564
14565   if options.mark then
14566     local mark_extension = M.extensions.mark()
14567     table.insert(extensions, mark_extension)
14568   end
14569
14570   if options.pipeTables then
14571     local pipe_tables_extension = M.extensions.pipe_tables(
14572       options.tableCaptions, options.tableAttributes)
14573     table.insert(extensions, pipe_tables_extension)
14574   end
14575
14576   if options.rawAttribute then
14577     local raw_inline_extension = M.extensions.raw_inline()
14578     table.insert(extensions, raw_inline_extension)
14579   end
14580
14581   if options.strikeThrough then
14582     local strike_through_extension = M.extensions.strike_through()
14583     table.insert(extensions, strike_through_extension)
14584   end
14585
14586   if options.subscripts then
14587     local subscript_extension = M.extensions.subscripts()
```

```
14588     table.insert(extensions, subscript_extension)
14589   end
14590
14591   if options.superscripts then
14592     local superscript_extension = M.extensions.superscripts()
14593     table.insert(extensions, superscript_extension)
14594   end
14595
14596   if options.texMathDollars or
14597      options.texMathSingleBackslash or
14598      options.texMathDoubleBackslash then
14599     local tex_math_extension = M.extensions.tex_math(
14600       options.texMathDollars,
14601       options.texMathSingleBackslash,
14602       options.texMathDoubleBackslash)
14603     table.insert(extensions, tex_math_extension)
14604   end
14605
14606   if options.notes or options.inlineNotes then
14607     local notes_extension = M.extensions.notes(
14608       options.notes, options.inlineNotes)
14609     table.insert(extensions, notes_extension)
14610   end
14611
14612   if options.citations then
14613     local citations_extension
14614       = M.extensions.citations(options.citationNbsps)
14615     table.insert(extensions, citations_extension)
14616   end
14617
14618   if options.fancyLists then
14619     local fancy_lists_extension = M.extensions.fancy_lists()
14620     table.insert(extensions, fancy_lists_extension)
14621   end
```

Apply user-defined syntax extensions based on `options.extensions`.

```
14622   for _, user_extension_filename in ipairs(options.extensions) do
14623     local user_extension = (function(filename)
```

First, load and compile the contents of the user-defined syntax extension.

```
14624       local pathname = assert(util.find_file(filename),
14625         [[Could not locate user-defined syntax extension "]]
14626         .. filename)
14627       local input_file = assert(io.open(pathname, "r"),
14628         [[Could not open user-defined syntax extension "]]
14629         .. pathname .. [[" for reading]])
14630       local input = assert(input_file:read("*a"))
14631       assert(input_file:close())
14632       local user_extension, err = load([[
14633         local sandbox = {}
```

```
      setmetatable(sandbox, {__index = _G})
      _ENV = sandbox
    ]] .. input)()
    assert(user_extension,
      [[Failed to compile user-defined syntax extension "]]
      .. pathname .. [[": ]] .. (err or [[]]))
```

Then, validate the user-defined syntax extension.

```
    assert(user_extension.api_version ~= nil,
      [[User-defined syntax extension "]] .. pathname
      .. [[" does not specify mandatory field "api_version"]])
    assert(type(user_extension.api_version) == "number",
      [[User-defined syntax extension "]] .. pathname
      .. [[" specifies field "api_version" of type "]]
      .. type(user_extension.api_version)
      .. [[" but "number" was expected]])
    assert(user_extension.api_version > 0
       and user_extension.api_version
        <= metadata.user_extension_api_version,
      [[User-defined syntax extension "]] .. pathname
      .. [[" uses syntax extension API version "]]
      .. user_extension.api_version .. [[ but markdown.lua ]]
      .. metadata.version .. [[ uses API version ]]
      .. metadata.user_extension_api_version
      .. [[, which is incompatible]])

    assert(user_extension.grammar_version ~= nil,
      [[User-defined syntax extension "]] .. pathname
      .. [[" does not specify mandatory field "grammar_version"]])
    assert(type(user_extension.grammar_version) == "number",
      [[User-defined syntax extension "]] .. pathname
      .. [[" specifies field "grammar_version" of type "]]
      .. type(user_extension.grammar_version)
      .. [[" but "number" was expected]])
    assert(user_extension.grammar_version == metadata.grammar_version,
      [[User-defined syntax extension "]] .. pathname
      .. [[" uses grammar version "]]
      .. user_extension.grammar_version
      .. [[ but markdown.lua ]] .. metadata.version
      .. [[ uses grammar version ]] .. metadata.grammar_version
      .. [[, which is incompatible]])

    assert(user_extension.finalize_grammar ~= nil,
      [[User-defined syntax extension "]] .. pathname
      .. [[" does not specify mandatory "finalize_grammar" field]])
    assert(type(user_extension.finalize_grammar) == "function",
      [[User-defined syntax extension "]] .. pathname
      .. [[" specifies field "finalize_grammar" of type "]]
      .. type(user_extension.finalize_grammar)
      .. [[" but "function" was expected]])
```

Finally, cast the user-defined syntax extension to the internal format of user extensions used by the Markdown package (see Section 3.1.7.)

```
      local extension = {
        name = [[user-defined "]] .. pathname .. [[" syntax extension]],
        extend_reader = user_extension.finalize_grammar,
        extend_writer = function() end,
      }
      return extension
    end)(user_extension_filename)
    table.insert(extensions, user_extension)
  end
```

Produce a conversion function from markdown to plain TEX.

```
  local writer = M.writer.new(options)
  local reader = M.reader.new(writer, options)
  local convert = reader.finalize_grammar(extensions)
```

Force garbage collection to reclaim memory for temporary objects created in `writer.new`, `reader.new`, and `reader->finalize_grammar`.

```
  collectgarbage("collect")
```

Update the singleton cache.

```
  if options.singletonCache then
    local singletonCacheOptions = {}
    for k, v in pairs(options) do
      singletonCacheOptions[k] = v
    end
    setmetatable(singletonCacheOptions,
      { __index = function (_, key)
        return defaultOptions[key] end })
    singletonCache.options = singletonCacheOptions
    singletonCache.convert = convert
  end
```

Return the conversion function from markdown to plain TEX.

```
  return convert
end

return M
```

3.1.9 Command-Line Implementation

The command-line implementation provides the actual conversion routine for the command-line interface described in Section 2.1.7.

```

local input
if input_filename then
  local input_file = assert(io.open(input_filename, "r"),
    [[Could not open file "]] .. input_filename .. [[" for reading]])
  input = assert(input_file:read("*a"))
```

```
  assert(input_file:close())
else
  input = assert(io.read("*a"))
end

```

First, ensure that the `options.cacheDir` directory exists.

```
local lfs = require("lfs")
if options.cacheDir and not lfs.isdir(options.cacheDir) then
  assert(lfs.mkdir(options["cacheDir"]))
end
```

If Kpathsea has not been loaded before or if LuaTEX has not yet been initialized, configure Kpathsea on top of loading it.

```
local kpse
(function()
  local should_initialize = package.loaded.kpse == nil
                        or tex.initialize ~= nil
  kpse = require("kpse")
  if should_initialize then
    kpse.set_program_name("luatex")
  end
end)()
local md = require("markdown")
```

Since we are loading the rest of the Lua implementation dynamically, check that both the `markdown` module and the command line implementation are the same version.

```
if metadata.version ~= md.metadata.version then
  warn("markdown-cli.lua " .. metadata.version .. " used with " ..
       "markdown.lua " .. md.metadata.version .. ".")
end

local convert = md.new(options)
local raw_output, flat_output = convert(input, true)
local output
if flat_output == nil then
  if options.eagerCache then
    warn("markdown.lua has not produced flat output, so I am using " ..
         "backwards-compatible raw output instead. This may cause " ..
         'the conversion result to be hidden behind "\\input".')
  end
  output = raw_output
else
  output = flat_output()
end

if output_filename then
  local output_file = assert(io.open(output_filename, "w"),
    [[Could not open file "]] .. output_filename .. [[" for writing]])
  assert(output_file:write(output))
```

```
  assert(output_file:close())
else
  assert(io.write(output))
end
```

Remove the `options.cacheDir` directory if it is empty.

```
if options.cacheDir then
  lfs.rmdir(options.cacheDir)
end
```

3.2 Plain TEX Implementation

The plain TEX implementation provides macros for the interfacing between TEX and Lua and for the buffering of input text. These macros are then used to implement the macros for the conversion from markdown to plain TEX exposed by the plain TEX interface (see Section 2.2).

3.2.1 Logging Facilities

```
\ExplSyntaxOn
\cs_if_free:NT
  \markdownInfo
  {
    \cs_new_protected:Npn
      \markdownInfo #1
      {
        \msg_info:nne
          { markdown }
          { generic-message }
          { #1 }
      }
  }
\cs_if_free:NT
  \markdownWarning
  {
    \cs_new_protected:Npn
      \markdownWarning #1
      {
        \msg_warning:nne
          { markdown }
          { generic-message }
          { #1 }
      }
  }
\cs_if_free:NT
  \markdownError
  {
    \cs_new_protected:Npn
      \markdownError #1 #2
```

```
      {
        \msg_error:nnee
          { markdown }
          { generic-message-with-help-text }
          { #1 }
          { #2 }
      }
  }
\msg_new:nnn
  { markdown }
  { generic-message }
  { #1 }
\msg_new:nnnn
  { markdown }
  { generic-message-with-help-text }
  { #1 }
  { #2 }
\cs_generate_variant:Nn
  \msg_info:nnn
  { nne }
\cs_generate_variant:Nn
  \msg_warning:nnn
  { nne }
\cs_generate_variant:Nn
  \msg_error:nnnn
  { nnee }
\ExplSyntaxOff
```

3.2.2 Themes

This section implements the theme-loading mechanism and the built-in themes provided with the Markdown package. Furthermore, this section also implements the built-in plain TEX themes provided with the Markdown package.

```
\ExplSyntaxOn
\prop_new:N \g_@@_plain_tex_loaded_themes_linenos_prop
\prop_new:N \g_@@_plain_tex_loaded_themes_versions_prop
\cs_new_protected:Nn
  \@@_plain_tex_load_theme:nnn
  {
    \prop_get:NnNTF
      \g_@@_plain_tex_loaded_themes_linenos_prop
      { #1 }
      \l_tmpa_tl
      {
        \prop_get:NnN
          \g_@@_plain_tex_loaded_themes_versions_prop
          { #1 }
          \l_tmpb_tl
        \str_if_eq:nVTF
          { #2 }
```

```
      \l_tmpb_tl
      {
        \msg_warning:nnnVn
          { markdown }
          { repeatedly-loaded-plain-tex-theme }
          { #1 }
          \l_tmpa_tl
          { #2 }
      }
      {
        \msg_error:nnnnVV
          { markdown }
          { different-versions-of-plain-tex-theme }
          { #1 }
          { #2 }
          \l_tmpb_tl
          \l_tmpa_tl
      }
  }
  {
    \prop_gput:Nnx
      \g_@@_plain_tex_loaded_themes_linenos_prop
      { #1 }
      { \tex_the:D \tex_inputlineno:D }  % noqa: W200
    \prop_gput:Nnn
      \g_@@_plain_tex_loaded_themes_versions_prop
      { #1 }
      { #2 }
```

Load built-in plain TEX themes from the prop `\g_@@_plain_tex_built_in_themes_prop` and from the filesystem otherwise.

```
    \prop_if_in:NnTF
      \g_@@_plain_tex_built_in_themes_prop
      { #1 }
      {
        \msg_info:nnnn
          { markdown }
          { loading-built-in-plain-tex-theme }
          { #1 }
          { #2 }
        \prop_item:Nn
          \g_@@_plain_tex_built_in_themes_prop
          { #1 }
      }
      {
        \msg_info:nnnn
          { markdown }
          { loading-plain-tex-theme }
          { #1 }
          { #2 }
```

```
            \file_input:n
              { markdown theme #3 }
          }
      }
  }
\msg_new:nnn
  { markdown }
  { loading-plain-tex-theme }
  { Loading~version~#2~of~plain~TeX~Markdown~theme~#1 }
\msg_new:nnn
  { markdown }
  { loading-built-in-plain-tex-theme }
  { Loading~version~#2~of~built-in~plain~TeX~Markdown~theme~#1 }
\msg_new:nnn
  { markdown }
  { repeatedly-loaded-plain-tex-theme }
  {
    Version~#3~of~plain~TeX~Markdown~theme~#1~was~previously~
    loaded~on~line~#2,~not~loading~it~again
  }
\msg_new:nnn
  { markdown }
  { different-versions-of-plain-tex-theme }
  {
    Tried~to~load~version~#2~of~plain~TeX~Markdown~theme~#1~
    but~version~#3~has~already~been~loaded~on~line~#4
  }
\cs_generate_variant:Nn
  \prop_gput:Nnn
  { Nnx }
\cs_gset_eq:NN
  \@@_load_theme:nnn
  \@@_plain_tex_load_theme:nnn
\cs_generate_variant:Nn
  \@@_load_theme:nnn
  { VeV }
\cs_generate_variant:Nn
  \msg_error:nnnnnn
  { nnnnVV }
\cs_generate_variant:Nn
  \msg_warning:nnnnn
  { nnnVn }
```

Developers can use the `\markdownLoadPlainTeXTheme` macro to load a corresponding plain TeX theme from within themes for higher-level TeX formats such as LaTeX and ConTeXt.

```
\cs_new_protected:Npn
  \markdownLoadPlainTeXTheme
  {
```

First, we extract the name of the current theme from the `\g_@@_current_theme_tl` macro.

```
    \tl_set:NV
      \l_tmpa_tl
      \g_@@_current_theme_tl
    \tl_reverse:N
      \l_tmpa_tl
    \tl_set:Ne
      \l_tmpb_tl
      {
        \tl_tail:V
          \l_tmpa_tl
      }
    \tl_reverse:N
      \l_tmpb_tl
```

Next, we munge the theme name.

```
    \str_set:NV
      \l_tmpa_str
      \l_tmpb_tl
    \str_replace_all:Nnn
      \l_tmpa_str
      { / }
      { _ }
```

Finally, we load the plain TEX theme.

```
    \@@_plain_tex_load_theme:VeV
      \l_tmpb_tl
      { \markdownThemeVersion }
      \l_tmpa_str
  }
\cs_generate_variant:Nn
  \tl_set:Nn
  { Ne }
\cs_generate_variant:Nn
  \@@_plain_tex_load_theme:nnn
  { VeV }
```

The `witiko/dot` theme nags users that they should use the name `witiko/diagrams@v1` instead.

```
\prop_gput:Nnn
  \g_@@_plain_tex_built_in_themes_prop
  { witiko / dot }
  {
    \str_if_eq:enF
      { \markdownThemeVersion }
      { silent }
      {
        \markdownWarning
          {
```

```
            The~theme~name~"witiko/dot"~has~been~soft-deprecated.
            \iow_newline:
            Consider~changing~the~name~to~"witiko/diagrams@v1".
          }
      }
```

We enable the `fencedCode` Lua option.

```
    \markdownSetup { fencedCode }
```

We store the previous definition of the fenced code token renderer prototype:

```
    \cs_set_eq:NN
      \@@_dot_previous_definition:nnn
      \markdownRendererInputFencedCodePrototype
```

If the infostring starts with `dot …`, we redefine the fenced code block token renderer prototype, so that it typesets the code block via Graphviz tools if and only if the `frozenCache` plain TEX option is disabled and the code block has not been previously typeset:

```
    \regex_const:Nn
      \c_@@_dot_infostring_regex
      { ^dot(\s+(.+))? }
    \seq_new:N
      \l_@@_dot_matches_seq
    \markdownSetup {
      rendererPrototypes = {
        inputFencedCode = {
          \regex_extract_once:NnNTF
            \c_@@_dot_infostring_regex
            { #2 }
            \l_@@_dot_matches_seq
            {
              \@@_if_option:nF
                { frozenCache }
                {
                  \sys_shell_now:n
                    {
                      if~!~test~-e~#1.pdf.source~
                      ||~!~diff~#1~#1.pdf.source;
                      then~
                        dot~-Tpdf~-o~#1.pdf~#1;
                        cp~#1~#1.pdf.source;
                      fi
                    }
                }
```

We include the typeset image using the image token renderer:

```
              \exp_args:NNne
                \exp_last_unbraced:No
                \markdownRendererImage
                  {
                    { Graphviz~image }
```

```
                    { #1.pdf }
                    { #1.pdf }
                  }
                  {
                    \seq_item:Nn
                      \l_@@_dot_matches_seq
                      { 3 }
                  }
              }
```

If the infostring does not start with `dot …`, we use the previous definition of the fenced code token renderer prototype:

```
              {
                \@@_dot_previous_definition:nnn
                  { #1 }
                  { #2 }
                  { #3 }
              }
          },
        },
      }
    }
```

The theme `witiko/diagrams` loads either the theme `witiko/dot` for version `v1` or the theme `witiko/diagrams/v2` for version `v2`.

```
\prop_gput:Nnn
  \g_@@_plain_tex_built_in_themes_prop
  { witiko / diagrams }
  {
    \str_case:enF
      { \markdownThemeVersion }
      {
        { latest }
          {
            \msg_warning:nnnn
              { markdown }
              { pin-theme-version }
              { witiko/diagrams }
              { v2 }
            \markdownSetup
              {
                import = witiko/diagrams/v2,
              }
          }
        { v2 }
          {
            \markdownSetup
              {
                import = witiko/diagrams/v2,
              }
```

```
          }
        { v1 }
          {
            \markdownSetup
              {
                import = witiko/dot@silent,
              }
          }
      }
      {
        \msg_error:nnnen
          { markdown }
          { unknown-theme-version }
          { witiko/diagrams }
          { \markdownThemeVersion }
          { v1~and~v2 }
      }
  }
\cs_generate_variant:Nn
  \msg_error:nnnnn
  { nnnen }
\msg_new:nnn
  { markdown }
  { pin-theme-version }
  {
    Write~"#1@#2"~to~pin~version~"#2"~of~the~theme~"#1".
    This~will~keep~your~documents~from~suddenly~breaking
    when~we~have~released~future~versions~of~the~theme
    with~backwards-incompatible~syntax~and~behavior.
  }
\msg_new:nnnn
  { markdown }
  { unknown-theme-version }
  { Unknown~version~"#2"~of~theme~"#1"~has~been~requested. }
  { Known~versions~are:~#3 }
```

Next, we implement the theme witiko/diagrams/v2.

```
\prop_gput:Nnn
  \g_@@_plain_tex_built_in_themes_prop
  { witiko / diagrams / v2 }
  {
```

We enable the fencedCode and fencedCodeAttributes Lua option.

```
    \@@_setup:n
      {
        fencedCode = true,
        fencedCodeAttributes = true,
      }
```

Store the previous fenced code token renderer prototype.

```
    \cs_set_eq:NN
```

```
    \@@_diagrams_previous_fenced_code:nnn
    \markdownRendererInputFencedCodePrototype
```

Store the caption, the desired format, and the command to produce the diagram.

```
  \tl_new:N
    \l_@@_diagrams_caption_tl
  \tl_new:N
    \l_@@_diagrams_format_tl
  \tl_set:Nn
    \l_@@_diagrams_format_tl
    { pdf }
  \tl_new:N
    \l_@@_diagrams_command_tl
  \@@_setup:n
    {
      rendererPrototypes = {
```

Route attributes on fenced code blocks to the image attribute renderer prototypes.

```
        fencedCodeAttributeContextBegin = {
          \group_begin:
          \markdownRendererImageAttributeContextBegin
          \cs_set_eq:NN
            \@@_diagrams_previous_key_value:nn
            \markdownRendererAttributeKeyValuePrototype
          \@@_setup:n
            {
              rendererPrototypes = {
                attributeKeyValue = {
                  \str_case:nnF
                    { ##1 }
                    {
                      { caption }
                        {
                          \tl_set:Nn
                            \l_@@_diagrams_caption_tl
                            { ##2 }
                        }
                      { format }
                        {
                          \tl_set:Nn
                            \l_@@_diagrams_format_tl
                            { ##2 }
                        }
                      { command }
                        {
                          \tl_set:Nn
                            \l_@@_diagrams_command_tl
                            { ##2 }
                        }
                    }
```

```
                    {
                      \@@_diagrams_previous_key_value:nn
                        { ##1 }
                        { ##2 }
                    }
                },
              },
            }
        },
        fencedCodeAttributeContextEnd = {
          \markdownRendererImageAttributeContextEnd
          \group_end:
        },
      },
    }
  \cs_new:Nn
    \@@_diagrams_render_diagram:nnnnn
    {
      \@@_if_option:nF
        { frozenCache }
        {
```

If possible, determine the version of the command used to produce the diagram and extract the major version number to `\l_markdown_diagrams_command_version_tl`. Otherwise, clear the variable.

```
          \tl_clear:N
            \l_markdown_diagrams_command_version_tl
          \tl_if_empty:nF
            { #3 }
            {
              \sys_get_shell:xnN
                { #3 }
                { }
                \l_tmpa_tl
              \regex_extract_once:nVNT
                { ^ \s* \d+ }
                \l_tmpa_tl
                \l_tmpa_seq
                {
                  \tl_set:Nx
                    \l_markdown_diagrams_command_version_tl
                    {
                      \seq_item:Nn
                        \l_tmpa_seq
                        { 1 }
                    }
                }
            }
          \tl_set:Nn
            \l_tmpa_tl
```

```
15192               {
15193                 if~!~test~-e~#2.source~
15194                 ||~!~diff~#1~#2.source;
15195                 then~
15196               }
15197             \tl_put_right:Nx
15198               \l_tmpa_tl
15199               { (#4); }
15200             \tl_put_right:Nn
15201               \l_tmpa_tl
15202               {
15203                   cp~#1~#2.source;
15204                 fi
15205               }
15206             \sys_shell_now:V
15207               \l_tmpa_tl
15208           }
15209           \exp_args:NNnV
15210             \exp_last_unbraced:No
15211             \markdownRendererImage
15212               {
15213                 { #5 }
15214                 { #2 }
15215                 { #2 }
15216               }
15217               \l_@@_diagrams_caption_tl
15218       }
```

Use the prop `\g_markdown_diagrams_infostrings_prop` to determine how the code with a given infostring should be processed and routed to the token renderer prototype(s) for images.

The token list `\l_markdown_diagrams_command_version_tl` should be used to store and pass around the version of the command used to produce the diagram, if necessary.

```
15219     \prop_new:N
15220       \g_markdown_diagrams_infostrings_prop
15221     \tl_new:N
15222       \l_markdown_diagrams_command_version_tl
```

If we know a processing function for a given infostring, use it.

```
15223     \@@_setup:n
15224       {
15225         rendererPrototypes = {
15226           inputFencedCode = {
15227             \prop_get:NnNTF
15228               \g_markdown_diagrams_infostrings_prop
15229               { #2 }
15230               \l_tmpa_tl
15231               {
15232                 \cs_set:NV
15233                   \@@_diagrams_infostrings_current:n
```

```
                \l_tmpa_tl
              \@@_diagrams_infostrings_current:n
                { #1 }
            }
```

Otherwise, use the previous fenced code token renderer prototype.

```
            {
              \@@_diagrams_previous_fenced_code:nnn
                { #1 }
                { #2 }
                { #3 }
            }
        },
      },
    }
  \cs_generate_variant:Nn
    \cs_set:Nn
    { NV }
```

Typeset fenced code with infostring `dot` using the command `dot` from the package Graphviz.

```
  \cs_set:Nn
    \@@_diagrams_infostrings_current:n
    {
      \tl_set:Nn
        \l_tmpb_tl
        { dot~-T }
      \tl_put_right:NV
        \l_tmpb_tl
        \l_@@_diagrams_format_tl
      \tl_put_right:Nn
        \l_tmpb_tl
        { ~-o~#1. }
      \tl_put_right:NV
        \l_tmpb_tl
        \l_@@_diagrams_format_tl
      \tl_put_right:Nn
        \l_tmpb_tl
        { ~#1 }
```

For the SVG format, use Inkscape to convert the resulting image to PDF.

```
      \str_if_eq:VnT
        \l_@@_diagrams_format_tl
        { svg }
        {
          \tl_put_right:Nn
            \l_tmpb_tl
            { ;~inkscape~#1. }
          \tl_put_right:NV
            \l_tmpb_tl
            \l_@@_diagrams_format_tl
```

```
            \tl_put_right:Nn
              \l_tmpb_tl
              { ~--export-area-drawing~--export-dpi=300~-o~#1.pdf }
          }
        \@@_diagrams_render_diagram:nnnVn
          { #1 }
          { #1.pdf }
          { }
          \l_tmpb_tl
          { Graphviz~image }
      }
    \cs_generate_variant:Nn
      \@@_diagrams_render_diagram:nnnnn
      { nnnVn }
    \@@_tl_set_from_cs:NNn
      \l_tmpa_tl
      \@@_diagrams_infostrings_current:n
      { 1 }
    \prop_gput:NnV
      \g_markdown_diagrams_infostrings_prop
      { dot }
      \l_tmpa_tl
```

Typeset fenced code with infostring `mermaid` using the command `mmdc` from the npm package `@mermaid-js/mermaid-cli`. The exact command can be configured by redefining or appending to the `\g_@@_diagrams_mmdc_command_tl` token list, by redefining the `\mmdcCommand` macro, or using the HTML attribute `command` on the fenced code.

Unlike the token list, the macro can be redefined even before loading the Markdown package. Unlike the token list and the macro, the HTML attribute is local to a single fenced code.

```
    \tl_new:N
      \g_@@_diagrams_mmdc_command_tl
    \tl_gset:Nn
      \g_@@_diagrams_mmdc_command_tl
      {
        \tl_if_empty:NTF
          \l_@@_diagrams_command_tl
          { mmdc }
          {
            \tl_use:N
              \l_@@_diagrams_command_tl
          }
      }
    \cs_if_free:NT
      \mmdcCommand
      {
        \cs_new:Npn
          \mmdcCommand
          {
```

```
            \tl_use:N
              \g_@@_diagrams_mmdc_command_tl
          }
      }
    \cs_set:Nn
      \@@_diagrams_infostrings_current:n
      {
        \tl_set:Nx
          \l_tmpb_tl
          { \mmdcCommand }
        \tl_put_right:Nn
          \l_tmpb_tl
          { ~ }
        \@@_diagrams_render_diagram:nnxxn
          { #1 }
          { #1.pdf }
          {
            \tl_use:N
              \l_tmpb_tl
            --version
          }
          {
            \tl_use:N
              \l_tmpb_tl
```

Do not pass the removed `--pdfFit` option to `mmdc` $\geqslant$ 10.0.0, where its previous semantics are now the default.

```
            \tl_if_empty:NF
              \l_markdown_diagrams_command_version_tl
              {
                \int_compare:VNnT
                  \l_markdown_diagrams_command_version_tl
                  <
                  { 10 }
                  { --pdfFit~ }
              }
            -i~#1~-o~#1.pdf
          }
          { Mermaid~image }
      }
    \cs_generate_variant:Nn
      \@@_diagrams_render_diagram:nnnnn
      { nnxxn }
    \@@_tl_set_from_cs:NNn
      \l_tmpa_tl
      \@@_diagrams_infostrings_current:n
      { 1 }
    \prop_gput:NnV
      \g_markdown_diagrams_infostrings_prop
      { mermaid }
```

```
      \l_tmpa_tl
```

Typeset fenced code with infostring `plantuml` using the command `plantuml` from the package PlantUML.

```
    \regex_const:Nn
      \c_@@_diagrams_filename_suffix_regex
      { \.[^.]*$ }
    \cs_set:Nn
      \@@_diagrams_infostrings_current:n
      {
```

Use the output format provided by the user.

```
        \tl_set:Nn
          \l_tmpa_tl
          { #1 }
        \regex_replace_once:NxN
          \c_@@_diagrams_filename_suffix_regex
          {
            .
            \tl_use:N
              \l_@@_diagrams_format_tl
          }
          \l_tmpa_tl
        \tl_set:Nn
          \l_tmpb_tl
          { plantuml~-t }
        \tl_put_right:NV
          \l_tmpb_tl
          \l__markdown_diagrams_format_tl
        \tl_put_right:Nn
          \l_tmpb_tl
          { ~#1 }
```

For the SVG format, use Inkscape to convert the resulting image to PDF.

```
        \str_if_eq:VnT
          \l_@@_diagrams_format_tl
          { svg }
          {
            \tl_put_right:Nn
              \l_tmpb_tl
              { ;~inkscape~ }
            \tl_put_right:NV
              \l_tmpb_tl
              \l_tmpa_tl
            \tl_put_right:Nn
              \l_tmpb_tl
              { ~--export-area-drawing~--export-dpi=300~-o~ }
            \tl_set:Nn
              \l_tmpa_tl
              { #1 }
            \regex_replace_once:NnN
```

```
              \c_@@_diagrams_filename_suffix_regex
              { .pdf }
              \l_tmpa_tl
            \tl_put_right:NV
              \l_tmpb_tl
              \l_tmpa_tl
          }
        \@@_diagrams_render_diagram:nVnVn
          { #1 }
          \l_tmpa_tl
          { }
          \l_tmpb_tl
          { PlantUML~image }
      }
    \cs_generate_variant:Nn
      \@@_diagrams_render_diagram:nnnnn
      { nVnVn }
    \cs_generate_variant:Nn
      \regex_replace_once:NnN
      { NxN }
    \cs_generate_variant:Nn
      \sys_get_shell:nnN
      { xnN }
    \cs_generate_variant:Nn
      \sys_shell_now:n
      { V }
    \prg_generate_conditional_variant:Nnn
      \int_compare:nNn
      { VNn }
      { T }
    \@@_tl_set_from_cs:NNn
      \l_tmpa_tl
      \@@_diagrams_infostrings_current:n
      { 1 }
    \prop_gput:NnV
      \g_markdown_diagrams_infostrings_prop
      { plantuml }
      \l_tmpa_tl
}
```

We locally change the category code of percent signs, so that we can use them in the shell code:

```
\group_begin:
\char_set_catcode_other:N \%
```

The witiko/graphicx/http theme stores the previous definition of the image token renderer prototype:

```
\prop_gput:Nnn
  \g_@@_plain_tex_built_in_themes_prop
  { witiko / graphicx / http }
```

```
{
  \cs_set_eq:NN
    \@@_graphicx_http_previous_definition:nnnn
    \markdownRendererImagePrototype
```

We define variables and functions to enumerate the images for caching and to store the pathname of the file containing the pathname of the downloaded image file.

```
  \int_new:N
    \g_@@_graphicx_http_image_number_int
  \int_gset:Nn
    \g_@@_graphicx_http_image_number_int
    { 0 }
  \cs_new:Nn
    \@@_graphicx_http_filename:
    {
      \markdownOptionCacheDir
      / witiko_graphicx_http .
      \int_use:N
        \g_@@_graphicx_http_image_number_int
    }
```

We define a function that will receive two arguments that correspond to the URL of the online image and to the pathname, where the online image should be downloaded. The function produces a shell command that tries to downloads the online image to the pathname.

```
  \cs_new:Nn
    \@@_graphicx_http_download:nn
    {
      wget~-O~#2~#1~
      ||~curl~--location~-o~#2~#1~
      ||~rm~-f~#2
    }
```

We redefine the image token renderer prototype, so that it tries to download an online image.

```
  \str_new:N
    \l_@@_graphicx_http_filename_str
  \ior_new:N
    \g_@@_graphicx_http_filename_ior
  \markdownSetup {
    rendererPrototypes = {
      image = {
        \@@_if_option:nF
          { frozenCache }
          {
```

The image will be downloaded only if the image URL has the http or https protocols and the `frozenCache` plain TEX option is disabled:

```
            \sys_shell_now:e
              {
```

```
                    mkdir~-p~" \markdownOptionCacheDir ";
                    if~printf~'%s'~"#3"~|~grep~-q~-E~'^https?:';
                    then~
```

The image will be downloaded to the pathname `cacheDir/`⟨*the* MD5 *digest of the image* URL⟩`.`⟨*the suffix of the image* URL⟩:

```
                      OUTPUT_PREFIX=" \markdownOptionCacheDir ";
                      OUTPUT_BODY="$(printf~'%s'~'#3'
                                    |~md5sum~|~cut~-d'~'~-f1)";
                      OUTPUT_SUFFIX="$(printf~'%s'~'#3'
                                    |~sed~'s/.*[.]//')";
                      OUTPUT="$OUTPUT_PREFIX/$OUTPUT_BODY.$OUTPUT_SUFFIX";
```

The image will be downloaded only if it has not already been downloaded:

```
                      if~!~[~-e~"$OUTPUT"~];
                      then~
                        \@@_graphicx_http_download:nn
                          { '#3' }
                          { "$OUTPUT" } ;
                        printf~'%s'~"$OUTPUT"~
                          >~" \@@_graphicx_http_filename: ";
                      fi;
```

If the image does not have the http or https protocols or the image has already been downloaded, the URL will be stored as-is:

```
                    else~
                      printf~'%s'~'#3'~
                        >~" \@@_graphicx_http_filename: ";
                    fi
                  }
                }
```

We load the pathname of the downloaded image and we typeset the image using the previous definition of the image renderer prototype:

```
          \ior_open:Ne
            \g_@@_graphicx_http_filename_ior
            { \@@_graphicx_http_filename: }
          \ior_str_get:NN
            \g_@@_graphicx_http_filename_ior
            \l_@@_graphicx_http_filename_str
          \ior_close:N
            \g_@@_graphicx_http_filename_ior
          \@@_graphicx_http_previous_definition:nnVn
            { #1 }
            { #2 }
            \l_@@_graphicx_http_filename_str
            { #4 }
          \int_gincr:N
            \g_@@_graphicx_http_image_number_int
        }
      }
```

```
    }
    \cs_generate_variant:Nn
      \ior_open:Nn
      { Ne }
    \cs_generate_variant:Nn
      \@@_graphicx_http_previous_definition:nnnn
      { nnVn }
  }
\group_end:
```

The witiko/tilde theme redefines the tilde token renderer prototype, so that it expands to a non-breaking space:

```
\prop_gput:Nnn
  \g_@@_plain_tex_built_in_themes_prop
  { witiko / tilde }
  {
    \markdownSetup {
      rendererPrototypes = {
        tilde = {~},
      },
    }
  }
```

The themes witiko/example/foo and witiko/example/bar are supposed to be used in code examples. They don't do anything.

```
\clist_map_inline:nn
  { foo, bar }
  {
    \prop_gput:Nnn
      \g_@@_plain_tex_built_in_themes_prop
      { witiko / example / #1 }
      {
        \markdownWarning
          {
            The~theme~witiko/example/#1~is~supposed~to~be~used~in~code~
            examples.~Using~it~in~actual~code~has~no~effect,~except~
            this~warning~message,~and~is~usually~a~mistake.
          }
      }
  }
\ExplSyntaxOff
```

The witiko/markdown/defaults plain TEX theme provides default definitions for token renderer prototypes. See Section 3.2.3 for the actual definitions.

3.2.3 Token Renderer Prototypes

The following definitions should be considered placeholder.

```
\def\markdownRendererInterblockSeparatorPrototype{\par}%
\def\markdownRendererParagraphSeparatorPrototype{%
```

```
  \markdownRendererInterblockSeparator}%
\def\markdownRendererHardLineBreakPrototype{\hfil\break}%
\def\markdownRendererSoftLineBreakPrototype{ }%
\let\markdownRendererEllipsisPrototype\dots
\def\markdownRendererNbspPrototype{~}%
\def\markdownRendererLeftBracePrototype{\char`\{}%
\def\markdownRendererRightBracePrototype{\char`\}}%
\def\markdownRendererDollarSignPrototype{\char`$}%
\def\markdownRendererPercentSignPrototype{\char`\%}%
\def\markdownRendererAmpersandPrototype{\&}%
\def\markdownRendererUnderscorePrototype{\char`_}%
\def\markdownRendererHashPrototype{\char`\#}%
\def\markdownRendererCircumflexPrototype{\char`^}%
\def\markdownRendererBackslashPrototype{\char`\\}%
\def\markdownRendererTildePrototype{\char`~}%
\def\markdownRendererPipePrototype{|}%
\def\markdownRendererCodeSpanPrototype#1{{\tt#1}}%
\def\markdownRendererLinkPrototype#1#2#3#4{#2}%
\def\markdownRendererContentBlockPrototype#1#2#3#4{%
  \markdownInput{#3}}%
\def\markdownRendererContentBlockOnlineImagePrototype{%
  \markdownRendererImage}%
\def\markdownRendererContentBlockCodePrototype#1#2#3#4#5{%
  \markdownRendererInputFencedCode{#3}{#2}{#2}}%
\def\markdownRendererImagePrototype#1#2#3#4{#2}%
\def\markdownRendererUlBeginPrototype{}%
\def\markdownRendererUlBeginTightPrototype{}%
\def\markdownRendererUlItemPrototype{}%
\def\markdownRendererUlItemEndPrototype{}%
\def\markdownRendererUlEndPrototype{}%
\def\markdownRendererUlEndTightPrototype{}%
\def\markdownRendererOlBeginPrototype{}%
\def\markdownRendererOlBeginTightPrototype{}%
\def\markdownRendererFancyOlBeginPrototype#1#2{%
  \markdownRendererOlBegin}%
\def\markdownRendererFancyOlBeginTightPrototype#1#2{%
  \markdownRendererOlBeginTight}%
\def\markdownRendererOlItemPrototype{}%
\def\markdownRendererOlItemWithNumberPrototype#1{}%
\def\markdownRendererOlItemEndPrototype{}%
\def\markdownRendererFancyOlItemPrototype{\markdownRendererOlItem}%
\def\markdownRendererFancyOlItemWithNumberPrototype{%
  \markdownRendererOlItemWithNumber}%
\def\markdownRendererFancyOlItemEndPrototype{}%
\def\markdownRendererOlEndPrototype{}%
\def\markdownRendererOlEndTightPrototype{}%
\def\markdownRendererFancyOlEndPrototype{\markdownRendererOlEnd}%
\def\markdownRendererFancyOlEndTightPrototype{%
  \markdownRendererOlEndTight}%
```

```
\def\markdownRendererDlBeginPrototype{}%
\def\markdownRendererDlBeginTightPrototype{}%
\def\markdownRendererDlItemPrototype#1{#1}%
\def\markdownRendererDlItemEndPrototype{}%
\def\markdownRendererDlDefinitionBeginPrototype{}%
\def\markdownRendererDlDefinitionEndPrototype{\par}%
\def\markdownRendererDlEndPrototype{}%
\def\markdownRendererDlEndTightPrototype{}%
\def\markdownRendererEmphasisPrototype#1{{\it#1}}%
\def\markdownRendererStrongEmphasisPrototype#1{{\bf#1}}%
\def\markdownRendererBlockQuoteBeginPrototype{\begingroup\it}%
\def\markdownRendererBlockQuoteEndPrototype{\endgroup\par}%
\def\markdownRendererLineBlockBeginPrototype{\begingroup\parindent=0pt}%
\def\markdownRendererLineBlockEndPrototype{\endgroup}%
\def\markdownRendererInputVerbatimPrototype#1{%
  \par{\tt\input#1\relax{}}\par}%
\def\markdownRendererInputFencedCodePrototype#1#2#3{%
  \markdownRendererInputVerbatim{#1}}%
\def\markdownRendererHeadingOnePrototype#1{#1}%
\def\markdownRendererHeadingTwoPrototype#1{#1}%
\def\markdownRendererHeadingThreePrototype#1{#1}%
\def\markdownRendererHeadingFourPrototype#1{#1}%
\def\markdownRendererHeadingFivePrototype#1{#1}%
\def\markdownRendererHeadingSixPrototype#1{#1}%
\def\markdownRendererThematicBreakPrototype{}%
\def\markdownRendererNotePrototype#1{#1}%
\def\markdownRendererCitePrototype#1{}%
\def\markdownRendererTextCitePrototype#1{}%
\def\markdownRendererTickedBoxPrototype{[X]}%
\def\markdownRendererHalfTickedBoxPrototype{[/]}%
\def\markdownRendererUntickedBoxPrototype{[ ]}%
\def\markdownRendererStrikeThroughPrototype#1{#1}%
\def\markdownRendererSuperscriptPrototype#1{#1}%
\def\markdownRendererSubscriptPrototype#1{#1}%
\def\markdownRendererDisplayMathPrototype#1{$$#1$$}%
\def\markdownRendererInlineMathPrototype#1{$#1$}%
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererHeaderAttributeContextBeginPrototype
  {
    \group_begin:
    \color_group_begin:
  }
\cs_gset_protected:Npn
  \markdownRendererHeaderAttributeContextEndPrototype
  {
    \color_group_end:
    \group_end:
  }
```

```
\cs_gset_eq:NN
  \markdownRendererBracketedSpanAttributeContextBeginPrototype
  \markdownRendererHeaderAttributeContextBeginPrototype
\cs_gset_eq:NN
  \markdownRendererBracketedSpanAttributeContextEndPrototype
  \markdownRendererHeaderAttributeContextEndPrototype
\cs_gset_eq:NN
  \markdownRendererFencedDivAttributeContextBeginPrototype
  \markdownRendererHeaderAttributeContextBeginPrototype
\cs_gset_eq:NN
  \markdownRendererFencedDivAttributeContextEndPrototype
  \markdownRendererHeaderAttributeContextEndPrototype
\cs_gset_eq:NN
  \markdownRendererFencedCodeAttributeContextBeginPrototype
  \markdownRendererHeaderAttributeContextBeginPrototype
\cs_gset_eq:NN
  \markdownRendererFencedCodeAttributeContextEndPrototype
  \markdownRendererHeaderAttributeContextEndPrototype
\cs_gset:Npn
  \markdownRendererReplacementCharacterPrototype
  { \codepoint_str_generate:n { fffd } }
\ExplSyntaxOff
\def\markdownRendererSectionBeginPrototype{}%
\def\markdownRendererSectionEndPrototype{}%
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererWarningPrototype
  #1#2#3#4
  {
    \tl_set:Nn
      \l_tmpa_tl
      { #2 }
    \tl_if_empty:nF
      { #4 }
      {
        \tl_put_right:Nn
          \l_tmpa_tl
          { \iow_newline: #4 }
      }
    \exp_args:NV
      \markdownWarning
      \l_tmpa_tl
  }
\ExplSyntaxOff
\def\markdownRendererErrorPrototype#1#2#3#4{%
  \markdownError{#2}{#4}}%
\def\markdownRendererBracketedSpanPrototype#1{#1}%
```

3.2.3.1 CommonMark Raw html Renderers

The CommonMark raw HTML renderer prototypes (see Section 2.2.5.13) fall back onto the renderer for generic inline HTML tags.

```
\def\markdownRendererInlineHtmlProcessingInstructionPrototype{%
  \markdownRendererInlineHtmlTagPrototype}%
\def\markdownRendererInlineHtmlDeclarationPrototype{%
  \markdownRendererInlineHtmlTagPrototype}%
\def\markdownRendererInlineHtmlCdataSectionPrototype{%
  \markdownRendererInlineHtmlTagPrototype}%
\def\markdownRendererInlineHtmlOpenTagPrototype{%
  \markdownRendererInlineHtmlTagPrototype}%
\def\markdownRendererInlineHtmlCloseTagPrototype{%
  \markdownRendererInlineHtmlTagPrototype}%
\def\markdownRendererInlineHtmlEmptyTagPrototype{%
  \markdownRendererInlineHtmlTagPrototype}%
```

3.2.3.2 CommonMark Block html Renderers

Most CommonMark block HTML renderer prototypes (see Section 2.2.5.12) fall back onto the renderer prototype for generic block HTML elements.

```
\def\markdownRendererInputBlockHtmlCdataElementPrototype{%
  \markdownRendererInputBlockHtmlElementPrototype}%
\def\markdownRendererInputBlockHtmlProcessingInstructionPrototype{%
  \markdownRendererInputBlockHtmlElementPrototype}%
\def\markdownRendererInputBlockHtmlDeclarationPrototype{%
  \markdownRendererInputBlockHtmlElementPrototype}%
\def\markdownRendererInputBlockHtmlCdataSectionPrototype{%
  \markdownRendererInputBlockHtmlElementPrototype}%
\def\markdownRendererInputBlockHtmlPcdataElementPrototype{%
  \markdownRendererInputBlockHtmlElementPrototype}%
```

The block comment HTML renderer (type 2) falls back on the renderer prototype for inline HTML elements.

```
\def\markdownRendererBlockHtmlCommentPrototype{%
  \markdownRendererInlineHtmlCommentPrototype}%
```

The standalone HTML tag renderer (type 7) falls back on the renderer prototype for generic inline HTML tags.

```
\def\markdownRendererBlockHtmlStandaloneTagPrototype{%
  \markdownRendererInlineHtmlTagPrototype}%
```

3.2.3.3 Raw Attributes

In the raw block and inline raw span renderer prototypes, execute the content with TeX when the raw attribute is `tex`, display the content as markdown when the raw attribute is `md`, and ignore the content otherwise.

```
\ExplSyntaxOn
\cs_new:Nn
  \@@_plain_tex_default_input_raw_inline:nn
  {
    \str_case:nn
```

```
      { #2 }
      {
        { md  } { \markdownInput{#1}  }
        { tex } { \markdownEscape{#1} \unskip }
      }
  }
\cs_new:Nn
  \@@_plain_tex_default_input_raw_block:nn
  {
    \str_case:nn
      { #2 }
      {
        { md  } { \markdownInput{#1}  }
        { tex } { \markdownEscape{#1} }
      }
  }
\cs_gset:Npn
  \markdownRendererInputRawInlinePrototype#1#2
  {
    \@@_plain_tex_default_input_raw_inline:nn
      { #1 }
      { #2 }
  }
\cs_gset:Npn
  \markdownRendererInputRawBlockPrototype#1#2
  {
    \@@_plain_tex_default_input_raw_block:nn
      { #1 }
      { #2 }
  }
\ExplSyntaxOff
```

3.2.3.4 Simple yaml Metadata Renderer Prototypes

In this section, we implement the simple high-level interface for processing simple YAML metadata using the key–value `markdown/jekyllData`. See also Section 2.2.6.1.

To keep track of the current type of structure we inhabit when we are traversing a YAML document, we will maintain the `\g_@@_jekyll_data_datatypes_seq` stack. At every step of the traversal, the stack will contain one of the following constants at any position p:

`\c_@@_jekyll_data_sequence_tl` The currently traversed branch of the YAML document contains a sequence at depth p.

`\c_@@_jekyll_data_mapping_tl` The currently traversed branch of the YAML document contains a mapping at depth p.

`\c_@@_jekyll_data_scalar_tl` The currently traversed branch of the YAML document contains a scalar value at depth p.

```
\ExplSyntaxOn
\seq_new:N   \g_@@_jekyll_data_datatypes_seq
\tl_const:Nn \c_@@_jekyll_data_sequence_tl   { sequence }
\tl_const:Nn \c_@@_jekyll_data_mapping_tl    { mapping  }
\tl_const:Nn \c_@@_jekyll_data_scalar_tl     { scalar   }
```

To keep track of our current place when we are traversing a YAML document, we will maintain the `\g_@@_jekyll_data_wildcard_absolute_address_seq` stack of keys using the `\@@_jekyll_data_push_address_segment:n` macro.

```
\seq_new:N \g_@@_jekyll_data_wildcard_absolute_address_seq
\cs_new:Nn \@@_jekyll_data_push_address_segment:n
  {
    \seq_if_empty:NF
      \g_@@_jekyll_data_datatypes_seq
      {
        \seq_get_right:NN
          \g_@@_jekyll_data_datatypes_seq
          \l_tmpa_tl
```

If we are currently in a sequence, we will put an asterisk (`*`) instead of a key into `\g_@@_jekyll_data_wildcard_absolute_address_seq` to make it represent a *wildcard*. Keeping a wildcard instead of a precise address makes it easy for the users to react to *any* item of a sequence regardless of how many there are, which can often be useful.

```
        \str_if_eq:NNTF
          \l_tmpa_tl
          \c_@@_jekyll_data_sequence_tl
          {
            \seq_put_right:Nn
              \g_@@_jekyll_data_wildcard_absolute_address_seq
              { *  }
          }
          {
            \seq_put_right:Nn
              \g_@@_jekyll_data_wildcard_absolute_address_seq
              { #1 }
          }
      }
  }
```

Out of `\g_@@_jekyll_data_wildcard_absolute_address_seq`, we will construct the following two token lists:

`\g_@@_jekyll_data_wildcard_absolute_address_tl` An *absolute wildcard*: The wildcard from the root of the document prefixed with a slash (`/`) with individual keys and asterisks also delimited by slashes. Allows the users to react to complex context-sensitive structures with ease.

For example, the `name` key in the following YAML document would correspond to the `/*/person/name` absolute wildcard:

```
[{person: {name: Elon, surname: Musk}}]
```

`\g_@@_jekyll_data_wildcard_relative_address_tl` A *relative wildcard*: The rightmost segment of the wildcard. Allows the users to react to simple context-free structures.

For example, the `name` key in the following YAML document would correspond to the `name` relative wildcard:

```
[{person: {name: Elon, surname: Musk}}]
```

We will construct `\g_@@_jekyll_data_wildcard_absolute_address_tl` using the `\@@_jekyll_data_concatenate_address:NN` macro and we will construct both token lists using the `\@@_jekyll_data_update_address_tls:` macro.

```
\tl_new:N  \g_@@_jekyll_data_wildcard_absolute_address_tl
\tl_new:N  \g_@@_jekyll_data_wildcard_relative_address_tl
\cs_new_protected:Nn \@@_jekyll_data_concatenate_address:NN
  {
    \seq_pop_left:NN #1 \l_tmpa_tl
    \tl_set:Nx #2 { / \seq_use:Nn #1 { / } }
    \seq_put_left:NV #1 \l_tmpa_tl
  }
\cs_new_protected:Nn \@@_jekyll_data_update_address_tls:
  {
    \@@_jekyll_data_concatenate_address:NN
      \g_@@_jekyll_data_wildcard_absolute_address_seq
      \g_@@_jekyll_data_wildcard_absolute_address_tl
    \seq_get_right:NN
      \g_@@_jekyll_data_wildcard_absolute_address_seq
      \g_@@_jekyll_data_wildcard_relative_address_tl
  }
```

To make sure that the stacks and token lists stay in sync, we will use the `\@@_jekyll_data_push:nN` and `\@@_jekyll_data_pop:` macros.

```
\cs_new_protected:Nn \@@_jekyll_data_push:nN
  {
    \@@_jekyll_data_push_address_segment:n
      { #1 }
    \seq_put_right:NV
     \g_@@_jekyll_data_datatypes_seq
     #2
    \@@_jekyll_data_update_address_tls:
  }
\cs_new_protected:Nn \@@_jekyll_data_pop:
  {
    \seq_pop_right:NN
      \g_@@_jekyll_data_wildcard_absolute_address_seq
```

```
      \l_tmpa_tl
    \seq_pop_right:NN
      \g_@@_jekyll_data_datatypes_seq
      \l_tmpa_tl
    \@@_jekyll_data_update_address_tls:
  }
```

To set a single key–value, we will use the `\@@_jekyll_data_set_keyval_known:nn` macro, ignoring unknown keys. To set key–values for both absolute and relative wildcards, we will use the `\@@_jekyll_data_set_keyvals_known:nn` macro.

```
\cs_new_protected:Nn \@@_jekyll_data_set_keyval_known:nn
  {
    \keys_set_known:nn
      { markdown/jekyllData }
      { { #1 } = { #2 } }
  }
\cs_generate_variant:Nn
  \@@_jekyll_data_set_keyval_known:nn
  { Vn }
\cs_new_protected:Nn \@@_jekyll_data_set_keyvals_known:nn
  {
    \@@_jekyll_data_push:nN
      { #1 }
      \c_@@_jekyll_data_scalar_tl
    \@@_jekyll_data_set_keyval_known:Vn
      \g_@@_jekyll_data_wildcard_absolute_address_tl
      { #2 }
    \@@_jekyll_data_set_keyval_known:Vn
      \g_@@_jekyll_data_wildcard_relative_address_tl
      { #2 }
    \@@_jekyll_data_pop:
  }
```

Finally, we will register our macros as token renderer prototypes to be able to react to the traversal of a YAML document.

```
\cs_gset_protected:Npn
  \markdownRendererJekyllDataSequenceBeginPrototype #1#2
  {
    \@@_jekyll_data_push:nN
      { #1 }
      \c_@@_jekyll_data_sequence_tl
  }
\cs_gset_protected:Npn
  \markdownRendererJekyllDataMappingBeginPrototype #1#2
  {
    \@@_jekyll_data_push:nN
      { #1 }
      \c_@@_jekyll_data_mapping_tl
  }
\cs_gset_protected:Npn
```

```
  \markdownRendererJekyllDataSequenceEndPrototype
  {
    \@@_jekyll_data_pop:
  }
\cs_gset_protected:Npn
  \markdownRendererJekyllDataMappingEndPrototype
  {
    \@@_jekyll_data_pop:
  }
\cs_gset_protected:Npn
  \markdownRendererJekyllDataBooleanPrototype #1#2
  {
    \@@_jekyll_data_set_keyvals_known:nn
      { #1 }
      { #2 }
  }
\def\markdownRendererJekyllDataEmptyPrototype#1{}
\cs_gset_protected:Npn
  \markdownRendererJekyllDataNumberPrototype #1#2
  {
    \@@_jekyll_data_set_keyvals_known:nn
      { #1 }
      { #2 }
  }
```

We will process all string scalar values assuming that they may contain markdown markup and are intended for typesetting.

```
\def\markdownRendererJekyllDataProgrammaticStringPrototype#1#2{}
\cs_gset_protected:Npn
  \markdownRendererJekyllDataTypographicStringPrototype #1#2
  {
    \@@_jekyll_data_set_keyvals_known:nn
      { #1 }
      { #2 }
  }
\ExplSyntaxOff
```

3.2.3.5 Complex yaml Metadata Renderer Prototypes

In this section, we implement the high-level interface for routing complex YAML metadata to expl3 key–values using the option `jekyllDataKeyValue`=⟨*module*⟩. See also Section 2.2.6.1.

```
\ExplSyntaxOn
\@@_with_various_cases:nn
  { jekyllDataKeyValue }
  {
    \keys_define:nn
      { markdown/options }
      {
        #1 .code:n = {
```

```
          \@@_route_jekyll_data_to_key_values:n
            { ##1 }
        },
```

When no ⟨*module*⟩ has been provided, assume that the YAML metadata specify absolute paths to key–values.

```
        #1 .value_required:n = { false },
        #1 .default:n = { },
      }
  }
\seq_new:N
  \l_@@_jekyll_data_current_position_seq
\tl_new:N
  \l_@@_jekyll_data_current_position_tl
\cs_new_protected:Nn
  \@@_route_jekyll_data_to_key_values:n
  {
    \markdownSetup
      {
        renderers = {
          jekyllData(Sequence|Mapping)Begin = {
            \bool_lazy_and:nnTF
              {
                \seq_if_empty_p:N
                  \l_@@_jekyll_data_current_position_seq
              }
              {
                \str_if_eq_p:nn
                  { ##1 }
                  { null }
              }
              {
                \tl_if_empty:nF
                  { #1 }
                  {
                    \seq_put_right:Nn
                      \l_@@_jekyll_data_current_position_seq
                      { #1 }
                  }
              }
              {
                \seq_put_right:Nn
                  \l_@@_jekyll_data_current_position_seq
                  { ##1 }
              }
          },
          jekyllData(Sequence|Mapping)End = {
            \seq_pop_right:NN
              \l_@@_jekyll_data_current_position_seq
              \l_tmpa_tl
```

```
15964           },
```

For every YAML key `path.to.`⟨*key*⟩ with a value of type ⟨*non-string type*⟩, set the key ⟨*non-string type*⟩ of the key–value ⟨*module*⟩`/path/to/`⟨*key*⟩ if it is known and the key ⟨*key*⟩ of the key–value ⟨*module*⟩`/path/to` otherwise. ⟨*Non-string type*⟩ is one of `boolean`, `number`, and `empty`.

```
15965           jekyllDataBoolean = {
15966             \tl_set:Nx
15967               \l_@@_jekyll_data_current_position_tl
15968               {
15969                 \seq_use:Nn
15970                   \l_@@_jekyll_data_current_position_seq
15971                   { / }
15972               }
15973             \keys_if_exist:VnTF
15974               \l_@@_jekyll_data_current_position_tl
15975               { ##1 / boolean }
15976               {
15977                 \@@_keys_set:xn
15978                   {
15979                     \tl_use:N
15980                       \l_@@_jekyll_data_current_position_tl
15981                     / ##1 / boolean
15982                   }
15983                   { ##2 }
15984               }
15985               {
15986                 \@@_keys_set:xn
15987                   {
15988                     \tl_use:N
15989                       \l_@@_jekyll_data_current_position_tl
15990                     / ##1
15991                   }
15992                   { ##2 }
15993               }
15994           },
15995           jekyllDataNumber = {
15996             \tl_set:Nx
15997               \l_@@_jekyll_data_current_position_tl
15998               {
15999                 \seq_use:Nn
16000                   \l_@@_jekyll_data_current_position_seq
16001                   { / }
16002               }
16003             \keys_if_exist:VnTF
16004               \l_@@_jekyll_data_current_position_tl
16005               { ##1 / number }
16006               {
16007                 \@@_keys_set:xn
```

```
                {
                  \tl_use:N
                    \l_@@_jekyll_data_current_position_tl
                  / ##1 / number
                }
                { ##2 }
            }
            {
              \@@_keys_set:xn
                {
                  \tl_use:N
                    \l_@@_jekyll_data_current_position_tl
                  / ##1
                }
                { ##2 }
            }
        },
```

For the ⟨*non-string type*⟩ of `empty`, no value is passed to the key–value. Therefore, a default value should always be defined for nullable keys using the key property `.default:n`.

```
        jekyllDataEmpty = {
          \tl_set:Nx
            \l_@@_jekyll_data_current_position_tl
            {
              \seq_use:Nn
                \l_@@_jekyll_data_current_position_seq
                { / }
            }
          \keys_if_exist:VnTF
            \l_@@_jekyll_data_current_position_tl
            { ##1 / empty }
            {
                \keys_set:xn
                {
                  \tl_use:N
                    \l_@@_jekyll_data_current_position_tl
                  / ##1
                }
                { empty }
            }
            {
              \keys_set:Vn
                \l_@@_jekyll_data_current_position_tl
                { ##1 }
            }
        },
```

For every YAML key `path.to.`⟨*key*⟩ with a value of type `string`, set the keys `typographicString` and `programmaticString` of the key–value ⟨*module*⟩`/path/to/`⟨*key*⟩ if they are known with the typographic and programmatic strings of the value, respec-

tively. Furthermore, set the key ⟨*key*⟩ of the key–value ⟨*module*⟩`/path/to` with the typographic string of the value unless the key `typographicString` is known. If the key `programmaticString` is known, only set the key ⟨*key*⟩ if it is known. In contrast, if neither `typographicString` nor `programmaticString` are known, set ⟨*key*⟩ normally, i.e. regardless of whether it is known or unknown.

```
16051           jekyllDataTypographicString = {
16052             \tl_set:Nx
16053               \l_@@_jekyll_data_current_position_tl
16054               {
16055                 \seq_use:Nn
16056                   \l_@@_jekyll_data_current_position_seq
16057                   { / }
16058               }
16059             \keys_if_exist:VnTF
16060               \l_@@_jekyll_data_current_position_tl
16061               { ##1 / typographicString }
16062               {
16063                 \@@_keys_set:xn
16064                   {
16065                     \tl_use:N
16066                       \l_@@_jekyll_data_current_position_tl
16067                     / ##1 / typographicString
16068                   }
16069                   { ##2 }
16070               }
16071               {
16072                 \keys_if_exist:VnTF
16073                   \l_@@_jekyll_data_current_position_tl
16074                   { ##1 / programmaticString }
16075                   {
16076                     \@@_keys_set_known:xn
16077                       {
16078                         \tl_use:N
16079                           \l_@@_jekyll_data_current_position_tl
16080                         / ##1
16081                       }
16082                       { ##2 }
16083                   }
16084                   {
16085                     \@@_keys_set:xn
16086                       {
16087                         \tl_use:N
16088                           \l_@@_jekyll_data_current_position_tl
16089                         / ##1
16090                       }
16091                       { ##2 }
16092                   }
16093               }
16094           },
```

```
          jekyllDataProgrammaticString = {
            \tl_set:Nx
              \l_@@_jekyll_data_current_position_tl
              {
                \seq_use:Nn
                  \l_@@_jekyll_data_current_position_seq
                  { / }
              }
            \keys_if_exist:VnT
              \l_@@_jekyll_data_current_position_tl
              { ##1 / programmaticString }
              {
                \@@_keys_set:xn
                  {
                    \tl_use:N
                      \l_@@_jekyll_data_current_position_tl
                    / ##1 / programmaticString
                  }
                  { ##2 }
              }
          },
        },
      }
  }
\cs_new_protected:Nn
  \@@_keys_set:nn
  {
    \keys_set:nn
      { }
      { { #1 } = { #2 } }
  }
\cs_new_protected:Nn
  \@@_keys_set_known:nn
  {
    \keys_set_known:nn
      { }
      { { #1 } = { #2 } }
  }
\cs_generate_variant:Nn
  \@@_keys_set:nn
  { xn }
\cs_generate_variant:Nn
  \@@_keys_set_known:nn
  { xn }
\cs_generate_variant:Nn
  \keys_set:nn
  { xn, Vn }
\prg_generate_conditional_variant:Nnn
  \keys_if_exist:nn
```

```
  { Vn }
  { T, TF }
\ExplSyntaxOff
```

If plain TEX is the top layer, we load the `witiko/markdown/defaults` plain TEX theme with the default definitions for token renderer prototypes unless the option `noDefaults` has been enabled (see Section 2.2.2.3).

```
\ExplSyntaxOn
\str_if_eq:VVT
  \c_@@_top_layer_tl
  \c_@@_option_layer_plain_tex_tl
  {
    \use:c
      { ExplSyntaxOff }
    \@@_if_option:nF
      { noDefaults }
      {
        \@@_if_option:nTF
          { experimental }
          {
            \@@_setup:n
              { theme = witiko/markdown/defaults@experimental }
          }
          {
            \@@_setup:n
              { theme = witiko/markdown/defaults }
          }
      }
    \use:c
      { ExplSyntaxOn }
  }
\ExplSyntaxOff
```

3.2.4 Lua Snippets

After the `\markdownPrepareLuaOptions` macro has been fully expanded, the `\markdownLuaOptions` macro will expands to a Lua table that contains the plain TEX options (see Section 2.2.2) in a format recognized by Lua (see Section 2.1.3).

```
\ExplSyntaxOn
\tl_new:N \g_@@_formatted_lua_options_tl
\cs_new_protected:Nn \@@_format_lua_options:
  {
    \tl_gclear:N
      \g_@@_formatted_lua_options_tl
    \seq_map_function:NN
      \g_@@_lua_options_seq
      \@@_format_lua_option:n
  }
\cs_new_protected:Nn \@@_format_lua_option:n
```

```
{
  \@@_typecheck_option:n
    { #1 }
  \@@_get_option_type:nN
    { #1 }
    \l_tmpa_tl
  \bool_case_true:nF
    {
      {
        \str_if_eq_p:VV
          \l_tmpa_tl
          \c_@@_option_type_boolean_tl ||
        \str_if_eq_p:VV
          \l_tmpa_tl
          \c_@@_option_type_number_tl ||
        \str_if_eq_p:VV
          \l_tmpa_tl
          \c_@@_option_type_counter_tl
      }
        {
          \@@_get_option_value:nN
            { #1 }
            \l_tmpa_tl
          \tl_gput_right:Nx
            \g_@@_formatted_lua_options_tl
            { #1~=~ \l_tmpa_tl ,~ }
        }
      {
        \str_if_eq_p:VV
          \l_tmpa_tl
          \c_@@_option_type_clist_tl
      }
        {
          \@@_get_option_value:nN
            { #1 }
            \l_tmpa_tl
          \tl_gput_right:Nx
            \g_@@_formatted_lua_options_tl
            { #1~=~\c_left_brace_str }
          \clist_map_inline:Vn
            \l_tmpa_tl
            {
              \@@_lua_escape:xN
                { ##1 }
                \l_tmpb_tl
              \tl_gput_right:Nn
                \g_@@_formatted_lua_options_tl
                { " }
              \tl_gput_right:NV
```

```
                  \g_@@_formatted_lua_options_tl
                  \l_tmpb_tl
                \tl_gput_right:Nn
                  \g_@@_formatted_lua_options_tl
                  { " ,~ }
              }
            \tl_gput_right:Nx
              \g_@@_formatted_lua_options_tl
              { \c_right_brace_str ,~ }
          }
      }
      {
        \@@_get_option_value:nN
          { #1 }
          \l_tmpa_tl
        \@@_lua_escape:xN
          { \l_tmpa_tl }
          \l_tmpb_tl
        \tl_gput_right:Nn
          \g_@@_formatted_lua_options_tl
          { #1~=~ " }
        \tl_gput_right:NV
          \g_@@_formatted_lua_options_tl
          \l_tmpb_tl
        \tl_gput_right:Nn
          \g_@@_formatted_lua_options_tl
          { " ,~ }
      }
  }
\cs_generate_variant:Nn
  \clist_map_inline:nn
  { Vn }
\let
  \markdownPrepareLuaOptions
  \@@_format_lua_options:
\def
  \markdownLuaOptions
    {
      {
        \g_@@_formatted_lua_options_tl
      }
    }
\sys_if_engine_luatex:TF
  {
    \cs_new_protected:Nn
      \@@_lua_escape:nN
      {
        \tl_set:Nx
          #2
```

```
          {
            \lua_escape:n
              { #1 }
          }
      }
  }
  {
    \regex_const:Nn
      \c_@@_lua_escape_regex
      { [\\"'] }
    \cs_new_protected:Nn
      \@@_lua_escape:nN
      {
        \tl_set:Nn
          #2
          { #1 }
        \regex_replace_all:NnN
          \c_@@_lua_escape_regex
          { \u { c_backslash_str } \0 }
          #2
      }
  }
\cs_generate_variant:Nn
  \@@_lua_escape:nN
  { xN }
```

After the `\markdownPrepareInputFilename` macro has been fully expanded, the `\markdownInputFilename` macro will expands to a Lua string that contains the input filename passed as the first argument.

```
\tl_new:N
  \markdownInputFilename
\cs_new_protected:Npn
  \markdownPrepareInputFilename
  #1
  {
    \@@_lua_escape:xN
      { #1 }
      \markdownInputFilename
    \tl_gset:Nx
      \markdownInputFilename
      { " \markdownInputFilename " }
  }
```

The `\markdownPrepare` macro contains the Lua code that is executed prior to any conversion from markdown to plain TEX. It exposes the `convert` function for the use by any further Lua code.

```
\cs_new:Npn
  \markdownPrepare
  {
```

First, ensure that the cacheDir directory exists.

```
    local~lfs = require("lfs")
    local~options = \markdownLuaOptions
    if~not~lfs.isdir(options.cacheDir) then~
      assert(lfs.mkdir(options.cacheDir))
    end~
```

Next, load the markdown module and create a converter function using the plain TEX options, which were serialized to a Lua table via the \markdownLuaOptions macro.

```
    local~md = require("markdown")
    local~convert = md.new(options)
  }
```

The \markdownConvert macro contains the Lua code that is executed during the conversion from markdown to plain TEX. It opens the input file, converts it, and prints the conversion result.

```
\cs_new:Npn
  \markdownConvert
  {
    local~filename = \markdownInputFilename
    local~file = assert(io.open(filename, "r"),
      [[Could~not~open~file~"]] .. filename .. [["~for~reading]])
    local~input = assert(file:read("*a"))
    assert(file:close())
    print(convert(input))
  }
\ExplSyntaxOff
```

The \markdownCleanup macro contains the Lua code that is executed after any conversion from markdown to plain TEX.

```
\def\markdownCleanup{%
```

Remove the options.cacheDir directory if it is empty.

```
  if options.cacheDir then
    lfs.rmdir(options.cacheDir)
  end
}%
```

3.2.5 Buffering Block-Level Markdown Input

The macros \markdownInputFileStream and \markdownOutputFileStream contain the number of the input and output file streams that will be used for the IO operations of the package.

```
\csname newread\endcsname\markdownInputFileStream
\csname newwrite\endcsname\markdownOutputFileStream
```

The \markdownReadAndConvertTab macro contains the tab character literal.

```
\begingroup
  \catcode`\^^I=12%
  \gdef\markdownReadAndConvertTab{^^I}%
```

```
\endgroup
```

The `\markdownReadAndConvert` macro is largely a rewrite of the LaTeX 2$_\varepsilon$ `\filecontents` macro to plain TeX.

```
\begingroup
```

Make the newline and tab characters active and swap the character codes of the backslash symbol (`\`) and the pipe symbol (`|`), so that we can use the backslash as an ordinary character inside the macro definition. Likewise, swap the character codes of the percent sign (`%`) and the ampersand (`@`), so that we can remove percent signs from the beginning of lines when `stripPercentSigns` is enabled.

```
  \catcode`\^^M=13%
  \catcode`\^^I=13%
  \catcode`|=0%
  \catcode`\\=12%
  |catcode`@=14%
  |catcode`|%=12@
  |gdef|markdownReadAndConvert#1#2{@
    |begingroup@
```

If we are not reading markdown documents from the frozen cache, open the `inputTempFileName` file for writing.

```
      |markdownIfOption{frozenCache}{}{@
        |immediate|openout|markdownOutputFileStream@
          |markdownOptionInputTempFileName|relax@
        |markdownInfo{@
          Buffering block-level markdown input into the temporary @
          input file "|markdownOptionInputTempFileName" and scanning @
          for the closing token sequence "#1"}@
      }@
```

Locally change the category of the special plain TeX characters to *other* in order to prevent unwanted interpretation of the input. Change also the category of the space character, so that we can retrieve it unaltered.

```
      |def|do##1{|catcode`##1=12}|dospecials@
      |catcode`| =12@
      |markdownMakeOther@
```

The `\markdownReadAndConvertStripPercentSigns` macro will process the individual lines of output, stipping away leading percent signs (`%`) when `stripPercentSigns` is enabled. Notice the use of the comments (`@`) to ensure that the entire macro is at a single line and therefore no (active) newline symbols (`^^M`) are produced.

```
      |def|markdownReadAndConvertStripPercentSign##1{@
        |markdownIfOption{stripPercentSigns}{@
          |if##1%@
            |expandafter|expandafter|expandafter@
              |markdownReadAndConvertProcessLine@
          |else@
            |expandafter|expandafter|expandafter@
              |markdownReadAndConvertProcessLine@
```

```
16380             |expandafter|expandafter|expandafter##1@
16381         |fi@
16382       }{@
16383         |expandafter@
16384           |markdownReadAndConvertProcessLine@
16385           |expandafter##1@
16386       }@
16387     }@
```

The `\markdownReadAndConvertProcessLine` macro will process the individual lines of output. Notice the use of the comments (`@`) to ensure that the entire macro is at a single line and therefore no (active) newline symbols (`^^M`) are produced.

```
16388     |def|markdownReadAndConvertProcessLine##1#1##2#1##3|relax{@
```

If we are not reading markdown documents from the frozen cache and the ending token sequence does not appear in the line, store the line in the `inputTempFileName` file. If we are reading markdown documents from the frozen cache and the ending token sequence does not appear in the line, gobble the line.

```
16389       |ifx|relax##3|relax@
16390         |markdownIfOption{frozenCache}{}{@
16391           |immediate|write|markdownOutputFileStream{##1}@
16392         }@
16393       |else@
```

When the ending token sequence appears in the line, make the next newline character close the `inputTempFileName` file, return the character categories back to the former state, convert the `inputTempFileName` file from markdown to plain TEX, `\input` the result of the conversion, and expand the ending control sequence.

```
16394         |def^^M{@
16395           |markdownInfo{The ending token sequence was found}@
16396           |markdownIfOption{frozenCache}{}{@
16397             |immediate|closeout|markdownOutputFileStream@
16398           }@
16399           |endgroup@
16400           |markdownInput{@
16401             |markdownOptionOutputDir@
16402             /|markdownOptionInputTempFileName@
16403           }@
16404           #2}@
16405       |fi@
```

Repeat with the next line.

```
16406       ^^M}@
```

Make the tab character active at expansion time and make it expand to a literal tab character.

```
16407     |catcode`|^^I=13@
16408     |def^^I{|markdownReadAndConvertTab}@
```

Make the newline character active at expansion time and make it consume the rest of the line on expansion. Throw away the rest of the first line and pass the second line to the \markdownReadAndConvertProcessLine macro.

```
    |catcode`|^^M=13@
    |def^^M##1^^M{@
      |def^^M####1^^M{@
        |markdownReadAndConvertStripPercentSign####1#1#1|relax}@
      ^^M}@
    ^^M}@
```

Reset the character categories back to the former state.

```
|endgroup
```

Use the lt3luabridge library to define the \markdownLuaExecute macro, which takes in a Lua scripts and expands to the standard output produced by its execution.

```
\ExplSyntaxOn
\cs_new_protected:Npn
  \markdownLuaExecute
  #1
  {
    \int_compare:nNnT
      { \g_luabridge_method_int }
      =
      { \c_luabridge_method_shell_int }
      {
        \sys_if_shell_unrestricted:F
          {
            \sys_if_shell:TF
              {
                \msg_error:nn
                  { markdown }
                  { restricted-shell-access }
              }
              {
                \msg_error:nn
                  { markdown }
                  { disabled-shell-access }
              }
          }
      }
    \str_gset:NV
      \g_luabridge_output_dirname_str
      \markdownOptionOutputDir
    \luabridge_now:e
      { #1 }
  }
\cs_generate_variant:Nn
  \msg_new:nnnn
  { nnnV }
\tl_set:Nn
```

```
  \l_tmpa_tl
  {
    You~may~need~to~run~TeX~with~the~--shell-escape~or~the~
    --enable-write18~flag,~or~write~shell_escape=t~in~the~
    texmf.cnf~file.
  }
\msg_new:nnnV
  { markdown }
  { restricted-shell-access }
  { Shell~escape~is~restricted }
  \l_tmpa_tl
\msg_new:nnnV
  { markdown }
  { disabled-shell-access }
  { Shell~escape~is~disabled }
  \l_tmpa_tl
\ExplSyntaxOff
```

3.2.6 Buffering Inline Markdown Input

This section describes the implementation of the macro `\markinline`.

```
\ExplSyntaxOn
\tl_new:N
  \g_@@_after_markinline_tl
\tl_gset:Nn
  \g_@@_after_markinline_tl
  { \unskip }
\cs_new_protected:Npn
  \markinline
  {
```

Locally change the category of the special plain TEX characters to *other* in order to prevent unwanted interpretation of the input markdown text as TEX code.

```
    \group_begin:
    \cctab_select:N
      \c_other_cctab
```

Unless we are reading markdown documents from the frozen cache, open the file `inputTempFileName` for writing.

```
    \@@_if_option:nF
      { frozenCache }
      {
        \immediate
          \openout
          \markdownOutputFileStream
          \markdownOptionInputTempFileName
          \relax
        \msg_info:nne
          { markdown }
          { buffering-markinline }
```

```
          { \markdownOptionInputTempFileName }
      }
```

Peek ahead and extract the inline markdown text.

```
    \peek_after:Nw
      \@@_inline_read_markdown_text:
  }
\cs_new_protected:Nn
  \@@_inline_read_markdown_text:
  {
```

Allow both {⟨*markdown text*⟩} but also any other delimiter such as |⟨*markdown text*⟩|.

```
    \bool_if:nTF
      {
        \token_if_group_begin_p:N
          \l_peek_token ||
        \token_if_eq_charcode_p:NN
          \l_peek_token
          \c_group_begin_token
      }
      {
        \regex_set:Nn
          \l_tmpa_regex
          { { (.*?) } }
      }
      {
        \tl_set:Nx
          \l_tmpa_tl
          {
            \text_purify:n
              { \l_peek_token }
          }
        \regex_set:Nn
          \l_tmpa_regex
          {
            \u { l_tmpa_tl }
            (.*?)
            \u { l_tmpa_tl }
          }
      }
    \peek_regex_replace_once:NnF
      \l_tmpa_regex
      {
```

Unless we are reading markdown documents from the frozen cache, store the text in the file `inputTempFileName` and close it.

```
        \c { @@_if_option:nF }
          \cB { frozenCache \cE }
          \cB {
            \c { immediate }
              \c { write }
```

```
              \c { markdownOutputFileStream }
              \cB { \1 \cE }
            \c { immediate }
              \c { closeout }
              \c { markdownOutputFileStream }
          \cE }
```

Reset the category codes and `\input` the result of the conversion.

```
        \c { group_end: }
        \c { group_begin: }
        \c { @@_setup:n }
          \cB { contentLevel = inline \cE }
        \c { markdownInput }
          \cB {
            \c { markdownOptionOutputDir } /
            \c { markdownOptionInputTempFileName }
          \cE }
        \c { group_end: }
        \c { tl_use:N }
          \c { g_@@_after_markinline_tl }
      }
      {
        \msg_error:nn
          { markdown }
          { markinline-peek-failure }
        \group_end:
        \tl_use:N
          \g_@@_after_markinline_tl
      }
  }
\msg_new:nnn
  { markdown }
  { buffering-markinline }
  { Buffering~inline~markdown~input~into~
    the~temporary~input~file~"#1". }
\msg_new:nnnn
  { markdown }
  { markinline-peek-failure }
  { Use~of~\iow_char:N \\ markinline~doesn't~match~its~definition }
  { The~macro~should~be~followed~by~inline~
    markdown~text~in~curly~braces }
\ExplSyntaxOff
```

3.2.7 Typesetting Markdown

The `\markdownInput` macro uses an implementation of the `\markdownLuaExecute` macro to convert the contents of the file whose filename it has received as its single argument from markdown to plain TEX.

```
\ExplSyntaxOn
```

```
\cs_new_protected:Npn
  \markdownInput
  #1
  {
    \@@_if_option:nTF
      { frozenCache }
      {
        \markdownInputRaw
          { #1 }
      }
      {
```

If the file does not exist in the current directory, we will search for it in the directories specified in `\l_file_search_path_seq`. On LaTeX, this also includes the directories specified in `\input@path`.

```
        \tl_set:Nx
          \l_tmpa_tl
          { #1 }
        \file_get_full_name:VNTF
          \l_tmpa_tl
          \l_tmpb_tl
          {
            \exp_args:NV
              \markdownInputRaw
              \l_tmpb_tl
          }
          {
            \msg_error:nnV
              { markdown }
              { markdown-file-does-not-exist }
              \l_tmpa_tl
          }
      }
  }
\msg_new:nnn
  { markdown }
  { markdown-file-does-not-exist }
  {
    Markdown~file~#1~does~not~exist
  }
\ExplSyntaxOff
\begingroup
```

Swap the category code of the backslash symbol and the pipe symbol, so that we may use the backslash symbol freely inside the Lua code. Furthermore, use the ampersand symbol to specify parameters.

```
  \catcode`|=0%
  \catcode`\\=12%
  \catcode`|&=6%
  |gdef|markdownInputRaw#1{%
```

Change the category code of the percent sign (%) to other, so that a user of the hybrid Lua option or a malevolent actor can't produce TeX comments in the plain TeX output of the Markdown package.

```
16618     |begingroup
16619     |catcode`|%=12
```

Furthermore, also change the category code of the hash sign (#) to other, so that it's safe to tokenize the plain TeX output without mistaking hash signs with TeX's parameter numbers.

```
16620     |catcode`|#=12
```

If we are reading from the frozen cache, input it, expand the corresponding \markdownFrozenCache⟨*number*⟩ macro, and increment frozenCacheCounter.

```
16621     |markdownIfOption{frozenCache}{%
16622       |ifnum|markdownOptionFrozenCacheCounter=0|relax
16623         |markdownInfo{Reading frozen cache from
16624           "|markdownOptionFrozenCacheFileName"}%
16625         |input|markdownOptionFrozenCacheFileName|relax
16626       |fi
16627       |markdownInfo{Including markdown document number
16628         "|the|markdownOptionFrozenCacheCounter" from frozen cache}%
16629       |csname markdownFrozenCache%
16630         |the|markdownOptionFrozenCacheCounter|endcsname
16631       |global|advance|markdownOptionFrozenCacheCounter by 1|relax
16632     }{%
16633       |markdownInfo{Including markdown document "&1"}%
```

Attempt to open the markdown document to record it in the .log and .fls files. This allows external programs such as LaTeXMk to track changes to the markdown document.

```
16634       |openin|markdownInputFileStream{&1}%
16635       |closein|markdownInputFileStream
16636       |markdownPrepareLuaOptions
16637       |markdownPrepareInputFilename{&1}%
16638       |markdownLuaExecute{%
16639         |markdownPrepare
16640         |markdownConvert
16641         |markdownCleanup}%
```

If we are finalizing the frozen cache, increment frozenCacheCounter.

```
16642       |markdownIfOption{finalizeCache}{%
16643         |global|advance|markdownOptionFrozenCacheCounter by 1|relax}{}%
16644     }%
16645     |endgroup
16646   }%
16647 |endgroup
```

The \markdownEscape macro resets the category codes of the percent sign and the hash sign back to comment and parameter, respectively, before using the \input built-in of TeX to execute a TeX document in the middle of a markdown document fragment.

```
16648 \gdef\markdownEscape#1{%
```

```
  \catcode`\%=14\relax
  \catcode`\#=6\relax
  \input #1\relax
  \catcode`\%=12\relax
  \catcode`\#=12\relax
}%
```

3.3 LaTeX Implementation

The LaTeX implementation makes use of the fact that, apart from some subtle differences, LaTeX implements the majority of the plain TeX format [19, Section 9]. As a consequence, we can directly reuse the existing plain TeX implementation.

```
\def\markdownVersionSpace{ }%
\ProvidesPackage{markdown}[\markdownLastModified\markdownVersionSpace v%
  \markdownVersion\markdownVersionSpace markdown renderer]%
```

3.3.1 Typesetting Markdown

The `\markinlinePlainTeX` macro is used to store the original plain TeX implementation of the `\markinline` macro. The `\markinline` macro is then redefined to accept an optional argument with options recognized by the LaTeX interface (see Section 2.3.3).

```
\ExplSyntaxOn
\cs_gset_eq:NN
  \markinlinePlainTeX
  \markinline
\cs_gset_protected:Npn
  \markinline
  {
    \peek_regex_replace_once:nn
      { ( \[ (.*?) \] ) ? }
      {
```

Apply the options locally.

```
        \c { group_begin: }
        \c { @@_setup:n }
          \cB { \2 \cE }
        \c { tl_put_right:Nn }
          \c { g_@@_after_markinline_tl }
          \cB { \c { group_end: } \cE }
        \c { markinlinePlainTeX }
      }
  }
\ExplSyntaxOff
```

The `\markdownInputPlainTeX` macro is used to store the original plain TeX implementation of the `\yamlInput` macro. The `\markdownInput` and `\yamlInput` macros are then redefined to accept an optional argument with options recognized by the LaTeX interface (see Section 2.3.3).

```
\let\markdownInputPlainTeX\markdownInput
\renewcommand\markdownInput[2][]{%
  \begingroup
    \markdownSetup{#1}%
    \markdownInputPlainTeX{#2}%
  \endgroup}%
\renewcommand\yamlInput[2][]{%
  \begingroup
    \yamlSetup{jekyllData, expectJekyllData, ensureJekyllData, #1}%
    \markdownInputPlainTeX{#2}%
  \endgroup}%
```

The `markdown`, `markdown*`, and `yaml` LaTeX environments are implemented using the `\markdownReadAndConvert` macro.

```
\ExplSyntaxOn
\renewenvironment
  { markdown }
  {
```

In our implementation of the `markdown` LaTeX environment, we want to distinguish between the following two cases:

```
\begin{markdown} [smartEllipses]
% This is an optional argument ^
% ...
\end{markdown}
```

```
\begin{markdown}
  [smartEllipses]
% ^ This is link
\end{markdown}
```

Therefore, we cannot use the built-in LaTeX support for environments with optional arguments or packages such as xparse. Instead, we must read the optional argument manually and prevent reading past the end of a line.

To prevent reading past the end of a line when looking for the optional argument of the `markdown` LaTeX environment and accidentally tokenizing markdown text, we change the category code of carriage return (`\r`, ASCII character 13 in decimal) from 5 (end of line).

While any category code other than 5 (end of line) would work, we switch to the category 13 (active), which is also used by the `\markdownReadAndConvert` macro. This is necessary if we read until the end of a line, because then the carriage return character will be produced by TeX via the `\endlinechar` plain TeX macro and it needs to have the correct category code, so that `\markdownReadAndConvert` processes it correctly.

```
    \group_begin:
    \char_set_catcode_active:n { 13 }
```

To prevent doubling the hash signs (`#`, ASCII code 35 in decimal), we switch its category from 6 (parameter) to 11 (letter).

```
    \char_set_catcode_letter:n { 35 }
```

After we have matched the opening `[` that begins the optional argument, we accept carriage returns as well.

```
    \peek_regex_replace_once:nnF
      { \ *\[\r*([^]]*)\][^\r]* }
      {
```

After we have matched the optional argument, we switch back the category code of carriage returns and hash signs and we retokenize the content. This will cause single new lines to produce a space token and multiple new lines to produce \par tokens. Furthermore, this will cause hash signs followed by a number to be recognized as parameter numbers, which is necessary when we use the optional argument to redefine token renderers and token renderer prototypes.

```
        \c { group_end: }
        \c { tl_set_rescan:Nnn } \c { l_tmpa_tl } { } { \1 }
```

Then, we pass the retokenized content to the \markdownSetup macro.

```
        \c { @@_setup:V } \c { l_tmpa_tl }
```

Finally, regardless of whether or not we have matched the optional argument, we let the \markdownReadAndConvert macro process the rest of the LaTeX environment.

We also make provision for using the \markdown command as a part of a different LaTeX environment as follows:

```
\newenvironment{foo}%
               {code before \markdown[some, options]}%
               {\markdownEnd code after}
```

```
        \c { exp_args:NV }
          \c { markdownReadAndConvert@ }
          \c { @currenvir }
      }
      {
        \group_end:
        \exp_args:NV
          \markdownReadAndConvert@
          \@currenvir
      }
  }
  { \markdownEnd }
\renewenvironment
  { markdown* }
  [ 1 ]
  {
    \@@_if_option:nTF
      { experimental }
      {
        \msg_error:nn
          { markdown }
          { latex-markdown-star-deprecated }
      }
      {
```

```
        \msg_warning:nn
          { markdown }
          { latex-markdown-star-deprecated }
      }
    \@@_setup:n
      { #1 }
    \markdownReadAndConvert@
      { markdown* }
  }
  { \markdownEnd }
\renewenvironment
  { yaml }
  {
    \group_begin:
    \yamlSetup
      { jekyllData, expectJekyllData, ensureJekyllData }
    \markdown
  }
  { \yamlEnd }
\msg_new:nnn
  { markdown }
  { latex-markdown-star-deprecated }
  {
    The~markdown*~LaTeX~environment~has~been~deprecated~and~will~
    be~removed~in~the~next~major~version~of~the~Markdown~package.
  }
\cs_generate_variant:Nn  % noqa: w402
  \@@_setup:n
  { V }
\ExplSyntaxOff
\begingroup
```

Locally swap the category code of the backslash symbol with the pipe symbol, and of the left ({) and right brace (}) with the less-than (<) and greater-than (>) signs. This is required in order that all the special symbols that appear in the first argument of the `markdownReadAndConvert` macro have the category code *other*.

```
  \catcode`\|=0\catcode`\<=1\catcode`\>=2%
  \catcode`\\=12|catcode`|{=12|catcode`|}=12%
  |gdef|markdownReadAndConvert@#1<%
    |markdownReadAndConvert<\end{#1}>%
                           <|end<#1>>>%
|endgroup
```

3.3.2 Themes

This section overrides the plain TEX implementation of the theme-loading mechanism from Section 3.2.2. Furthermore, this section also implements the built-in LATEX themes provided with the Markdown package.

```
\ExplSyntaxOn
\prop_new:N \g_@@_latex_loaded_themes_linenos_prop
\prop_new:N \g_@@_latex_loaded_themes_versions_prop
\cs_gset_protected:Nn
  \@@_load_theme:nnn
  {
```

If the Markdown package has not yet been loaded, determine whether either this is a built-in theme according to the prop `\g_@@_latex_built_in_themes_prop` or a file named `markdowntheme`⟨*munged theme name*⟩`.sty` exists and whether we are still in the preamble.

```
    \ifmarkdownLaTeXLoaded
      \ifx\@onlypreamble\@notprerr
```

If both conditions are true, end with an error, since we cannot load LaTeX themes after the preamble.

```
        \bool_if:nTF
          {
            \bool_lazy_or_p:nn
              {
                \prop_if_in_p:Nn
                  \g_@@_latex_built_in_themes_prop
                  { #1 }
              }
              {
                \file_if_exist_p:n
                  { markdown theme #3.sty }
              }
          }
          {
            \msg_error:nn
              { markdown }
              { latex-theme-after-preamble }
          }
```

Otherwise, try loading a plain TeX theme instead.

```
          {
            \@@_plain_tex_load_theme:nnn
              { #1 }
              { #2 }
              { #3 }
          }
      \else
```

If the Markdown package has already been loaded but we are still in the preamble, load a LaTeX theme if it exists or load a plain TeX theme otherwise.

```
        \bool_if:nTF
          {
            \bool_lazy_or_p:nn
              {
```

```
      \prop_if_in_p:Nn
        \g_@@_latex_built_in_themes_prop
        { #1 }
    }
    {
      \file_if_exist_p:n
        { markdown theme #3.sty }
    }
}
{
  \prop_get:NnNTF
    \g_@@_latex_loaded_themes_linenos_prop
    { #1 }
    \l_tmpa_tl
    {
      \prop_get:NnN
        \g_@@_latex_loaded_themes_versions_prop
        { #1 }
        \l_tmpb_tl
      \str_if_eq:nVTF
        { #2 }
        \l_tmpb_tl
        {
          \msg_warning:nnnVn
            { markdown }
            { repeatedly-loaded-latex-theme }
            { #1 }
            \l_tmpa_tl
            { #2 }
        }
        {
          \msg_error:nnnnVV
            { markdown }
            { different-versions-of-latex-theme }
            { #1 }
            { #2 }
            \l_tmpb_tl
            \l_tmpa_tl
        }
    }
    {
      \prop_gput:Nnx
        \g_@@_latex_loaded_themes_linenos_prop
        { #1 }
        { \tex_the:D \tex_inputlineno:D }  % noqa: W200
      \prop_gput:Nnn
        \g_@@_latex_loaded_themes_versions_prop
        { #1 }
        { #2 }
```

Load built-in plain TEX themes from the prop \g_@@_latex_built_in_themes_prop and from the filesystem otherwise.

```
                \prop_if_in:NnTF
                  \g_@@_latex_built_in_themes_prop
                  { #1 }
                  {
                    \msg_info:nnnn
                      { markdown }
                      { loading-built-in-latex-theme }
                      { #1 }
                      { #2 }
                    \prop_item:Nn
                      \g_@@_latex_built_in_themes_prop
                      { #1 }
                  }
                  {
                    \msg_info:nnnn
                      { markdown }
                      { loading-latex-theme }
                      { #1 }
                      { #2 }
                    \RequirePackage
                      { markdown theme #3 }
                  }
              }
          }
          {
            \@@_plain_tex_load_theme:nnn
              { #1 }
              { #2 }
              { #3 }
          }
      \fi
    \else
```

If the Markdown package has not yet been loaded, postpone the loading until the Markdown package has finished loading.

```
      \msg_info:nnnn
        { markdown }
        { theme-loading-postponed }
        { #1 }
        { #2 }
      \AtEndOfPackage
        {
          \@@_set_theme:n
            { #1 @ #2 }
        }
    \fi
}
```

```
\msg_new:nnn
  { markdown }
  { theme-loading-postponed }
  {
    Postponing~loading~version~#2~of~Markdown~theme~#1~until~
    Markdown~package~has~finished~loading
  }
\msg_new:nnn
  { markdown }
  { loading-built-in-latex-theme }
  { Loading~version~#2~of~built-in~LaTeX~Markdown~theme~#1 }
\msg_new:nnn
  { markdown }
  { loading-latex-theme }
  { Loading~version~#2~of~LaTeX~Markdown~theme~#1 }
\msg_new:nnn
  { markdown }
  { repeatedly-loaded-latex-theme }
  {
    Version~#3~of~LaTeX~Markdown~theme~#1~was~previously~
    loaded~on~line~#2,~not~loading~it~again
  }
\msg_new:nnn
  { markdown }
  { different-versions-of-latex-theme }
  {
    Tried~to~load~version~#2~of~LaTeX~Markdown~theme~#1~
    but~version~#3~has~already~been~loaded~on~line~#4
  }
\cs_generate_variant:Nn
  \msg_new:nnnn
  { nnVV }
\tl_set:Nn
  \l_tmpa_tl
  { Cannot~load~LaTeX~Markdown~theme~#1~after~ }
\tl_put_right:NV
  \l_tmpa_tl
  \c_backslash_str
\tl_put_right:Nn
  \l_tmpa_tl
  { begin { document } }
\tl_set:Nn
  \l_tmpb_tl
  { Load~Markdown~theme~#1~before~ }
\tl_put_right:NV
  \l_tmpb_tl
  \c_backslash_str
\tl_put_right:Nn
  \l_tmpb_tl
```

```
  { begin { document } }
\msg_new:nnVV
  { markdown }
  { latex-theme-after-preamble }
  \l_tmpa_tl
  \l_tmpb_tl
```

The witiko/dot and witiko/graphicx/http LaTeX themes load the package graphicx, see also Section 1.1.3. Then, they load the corresponding plain TeX themes.

```
\tl_set:Nn
  \l_tmpa_tl
  {
    \RequirePackage
      { graphicx }
    \markdownLoadPlainTeXTheme
  }
\prop_gput:NnV
  \g_@@_latex_built_in_themes_prop
  { witiko / dot }
  \l_tmpa_tl
\prop_gput:NnV
  \g_@@_latex_built_in_themes_prop
  { witiko / graphicx / http }
  \l_tmpa_tl
```

The witiko/glossaries theme first checks that the version is either v1 or latest, issuing a warning for the latter.

```
\prop_gput:Nnn
  \g_@@_latex_built_in_themes_prop
  { witiko / glossaries }
  {
    \str_case:enF
      { \markdownThemeVersion }
      {
        { latest }
          {
            \msg_warning:nnnn
              { markdown }
              { pin-theme-version }
              { witiko/glossaries }
              { v1 }
          }
        { v1 }
          { }
      }
      {
        \msg_error:nnnen
          { markdown }
          { unknown-theme-version }
          { witiko/glossaries }
```

```
          { \markdownThemeVersion }
          { v1 }
      }
  }
\ExplSyntaxOff
```

In Section 3.3.3, we'll continue the implementation of the theme by defining the snippet `witiko/glossaries/import-acronyms`. The `witiko/markdown/defaults` LaTeX theme also loads the corresponding plain TeX theme.

```
\markdownLoadPlainTeXTheme
```

Next, the LaTeX theme overrides some of the plain TeX definitions. See Section 3.3.5 for the actual definitions.

3.3.3 Snippets

This section defines the built-in LaTeX snippet `witiko/glossaries/import-acronyms`.

```
\ExplSyntaxOn
\prop_get:NnN
  \g_@@_latex_built_in_themes_prop
  { witiko / glossaries }
  \l_tmpa_tl
\tl_put_right:Nn
  \l_tmpa_tl
  {
    \cs_new:Nn
      \@@_register_acronym:n
        {
          \@@_setup:n
            {
```

When we register an acronym with the `acronyms` option, enclose it in an extra set of braces in case the acronym contained a comma.

```
              acronyms += {{ #1 }},
            }
        }
    \cs_generate_variant:Nn
      \@@_register_acronym:n
      { V }
    \prop_new:N
      \g_@@_acronyms_to_labels_prop
    \tl_new:N
      \l_@@_acronym_short_tl
```

When we import an acronym from the glossaries package, we receive a ⟨*label*⟩, which doesn't correspond to an acronym. Therefore, we register the short form of the corresponding acronym instead and keep a mapping from these short forms back to the labels when we need to display an acronym in the markdown text.

```
    \cs_new:Nn
      \@@_register_acronym_label:n
```

```
      {
        \tl_set:Nx
          \l_@@_acronym_short_tl
          { \glsentryshort { #1 } }
```

Be idempotent and only import each acronym once.

```
        \prop_if_in:NVF
          \g_@@_acronyms_to_labels_prop
          \l_@@_acronym_short_tl
          {
            \@@_register_acronym:V
              \l_@@_acronym_short_tl
            \prop_gput:NVn
              \g_@@_acronyms_to_labels_prop
              \l_@@_acronym_short_tl
              { #1 }
          }
      }
    \cs_generate_variant:Nn
      \@@_register_acronym_label:n
      { V }
```

When we need to diplay an acronym in the markdown text, first consult our mapping to see if it has been imported from the glossaries package.

```
    \tl_new:N
      \l_@@_acronym_label_tl
    \cs_new:Nn
      \@@_print_acronym:n
      {
        \prop_get:NnNTF
          \g_@@_acronyms_to_labels_prop
          { #1 }
          \l_@@_acronym_label_tl
          {
```

If it has, retrieve the ⟨*label*⟩ and display the acronym using the glossaries package, linking it to the corresponding glossary entry.

```
            \group_begin:
              \cs_set_eq:NN
                \acronymfont
                \markdownRendererAcronymPrototype
              \exp_args:NV
                \acrshort
                \l_@@_acronym_label_tl
            \group_end:
          }
          {
```

Otherwise, just format the acronym using the current renderer prototype.

```
            \markdownRendererAcronymPrototype
              { #1 }
```

```
      }
    }
    \cs_generate_variant:Nn
      \@@_print_acronym:n
      { x }
```

In the snippet witiko/glossaries/import-acronyms, first import all acronyms from the glossaries package and register them with the acronyms option.

```
  \markdownSetupSnippet
    { import-acronyms }
    {
      code = {
        \forglsentries
          [ acronym ]
          \l_@@_acronym_label_tl
          {
            \@@_register_acronym_label:V
              \l_@@_acronym_label_tl
          }
```

Then, redefine the corresponding token renderers to format acronyms that appear in the markdown text.

```
          \@@_setup:n
            {
              renderers = {
                acronym = {
```

Fold nested acronyms.

```
                  \group_begin:
                    \markdownSetup {
                      unprotectedRenderers = {
                        acronym = { ##1 },
                      }
                    }
                    \@@_print_acronym:x
                      { #1 }
                  \group_end:
                }
              }
            }
        }
      }
  }
\prop_gput:NnV
  \g_@@_latex_built_in_themes_prop
  { witiko / glossaries }
  \l_tmpa_tl
\ExplSyntaxOff
```

3.3.4 Options

The supplied package options are processed using the `\markdownSetup` macro.

```
\DeclareOption*{%
  \expandafter\markdownSetup\expandafter{\CurrentOption}}%
\ProcessOptions\relax
```

3.3.5 Token Renderer Prototypes

The following configuration should be considered placeholder. If the option `plain` has been enabled (see Section 2.2.2.3), none of the definitions will take effect.

```
\markdownIfOption{plain}{\iffalse}{\iftrue}
```

3.3.5.1 Acronyms

If the `acronyms` option is non-empty, render acronyms, initialisms, and other all-caps sequences using small caps.

```
\ExplSyntaxOn
\prop_new_linked:N
  \g_@@_recorded_acronyms_prop
\bool_new:N
  \g_@@_record_acronyms_bool
\bool_gset_false:N
  \g_@@_record_acronyms_bool
\cs_new_protected:Nn
  \@@_record_acronym:n
  {
```

For explicitly listed acronyms using the HTML class `acronym` that only contain simple text and not control sequences after cleaning up any potential nested acronyms, record them in the auxiliary file, so that they are applied throughout the document in the next compilation run.

```
    \bool_if:NT
      \g_@@_record_acronyms_bool
      {
        \tl_set:Nn
          \l_tmpa_tl
          { #1 }
        \regex_replace_all:nnN
          { \c { markdownRendererAcronym } | \cB\{ | \cE\} }
          { }
          \l_tmpa_tl
        \prop_if_in:NVF
          \g_@@_recorded_acronyms_prop
          \l_tmpa_tl
          {
            \regex_if_match:nVF
              { \cC. }
              \l_tmpa_tl
```

```
              {
                \prop_gput:NVn
                  \g_@@_recorded_acronyms_prop
                  \l_tmpa_tl
                  { true }
                \tl_gput_right:Nx
                  \markdownOptionAcronyms
                  { , { \tl_use:N \l_tmpa_tl } }
                \tl_set:Nn
                  \l_tmpb_tl
                  {
                    \ExplSyntaxOn
                      \tl_gput_right:Nn
                      \markdownOptionAcronyms
                  }
                \tl_gput_right:Nx
                  \l_tmpb_tl
                  { { , { \tl_use:N \l_tmpa_tl } } }
                \tl_gput_right:Nx
                  \l_tmpb_tl
                  { \ExplSyntaxOff }
                \iow_now:NV
                  \@auxout
                  \l_tmpb_tl
              }
          }
      }
  }
\int_new:N
  \g_@@_heading_nesting_depth_int
\markdownSetup {
  rendererPrototypes = {
    acronym = {
```

Prevent acronyms in headings.

```
      \int_if_zero:nTF
        { \g_@@_heading_nesting_depth_int }
        {
```

Prevent nested acronyms.

```
          \group_begin:
            \markdownSetup {
              unprotectedRenderers = {
                acronym = { ##1 },
              }
            }
            \@@_record_acronym:n
              { #1 }
            \tl_set:Nn
              \l_tmpa_tl
```

```
            { #1 }
```

Render all characters that are neither digits nor ASCII lower case characters in small caps. Ideally, we would also be able to exclude Unicode lower-case characters but that doesn't seem possible with expl3 at the moment [20, Chapter 34 (The l3unicode module)].

```
          \regex_replace_all:nnN
            { [^\d a-z]+ }
            {
              \c{ textsc } \cB\{
                \c{ MakeLowercase } \cB\{ \0 \cE\}
              \cE\}
            }
            \l_tmpa_tl
```

Furthermore, if the current typeface supports it, render all digits using old-style numerals.

```
          \cs_if_exist:NT
            \oldstylenums
            {
              \regex_replace_all:nnN
                { \d+ }
                { \c{ oldstylenums } \cB\{ \0 \cE\} }
                \l_tmpa_tl
            }
```

If the package microtype is loaded, letter-space the small caps.

```
          \@ifpackageloaded
            { microtype }
            {
              \textls
                {
                  \tl_use:N
                    \l_tmpa_tl
                }
            }
            {
              \tl_use:N
                \l_tmpa_tl
            }
        \group_end:
      }
```

Prevent acronyms in headings.

```
      { #1 }
  },
},
}
```

If the package glossaries is loaded with the option `acronym`, use the built-in snippet LaTeX `witiko/glossaries/import-acronyms`.

```
\@ifpackageloaded
  { glossaries }
```

```
  {
    \cs_if_exist:NT
      \@gls@do@acronymsdef
      {
        \markdownSetup {
           import = /witiko/glossaries@v1,
          snippet = /witiko/glossaries/import-acronyms,
        }
      }
  }
  { }
```

3.3.5.2 Lists

If either the `tightLists` or the `fancyLists` option is enabled and the current document class is not beamer, use a package that provides support for tight and fancy lists.

If either the package paralist or the package enumitem have already been loaded, use them. Otherwise, if the option `experimental` or the command `\DocumentMetadata` have been used, use the package enumitem. Otherwise, use the package paralist.

```
\bool_new:N
  \g_@@_tight_or_fancy_lists_bool
\bool_gset_false:N
  \g_@@_tight_or_fancy_lists_bool
\@@_if_option:nTF
  { tightLists }
  {
    \bool_gset_true:N
      \g_@@_tight_or_fancy_lists_bool
  }
  {
    \@@_if_option:nT
      { fancyLists }
      {
        \bool_gset_true:N
          \g_@@_tight_or_fancy_lists_bool
      }
  }
\bool_new:N
  \g_@@_beamer_paralist_or_enumitem_bool
\bool_gset_true:N
  \g_@@_beamer_paralist_or_enumitem_bool
\@ifclassloaded
  { beamer }
  { }
  {
    \@ifpackageloaded
      { paralist }
      { }
      {
```

```
        \@ifpackageloaded
        { enumitem }
        { }
        {
          \bool_gset_false:N
            \g_@@_beamer_paralist_or_enumitem_bool
        }
      }
  }
\bool_new:N
  \g_@@_paralist_bool
\@ifpackageloaded
  { paralist }
  {
    \bool_gset_true:N
      \g_@@_paralist_bool
  }
  {
    \bool_gset_false:N
      \g_@@_paralist_bool
  }
\bool_new:N
  \g_@@_enumitem_bool
\@ifpackageloaded
  { enumitem }
  {
    \bool_gset_true:N
      \g_@@_enumitem_bool
  }
  {
    \bool_gset_false:N
      \g_@@_enumitem_bool
  }
\bool_if:nT
  {
    \g_@@_tight_or_fancy_lists_bool &&
    ! \g_@@_beamer_paralist_or_enumitem_bool
  }
  {
    \str_if_eq:enTF
      { \markdownThemeVersion }
      { experimental }
      {
        \RequirePackage
          { enumitem }
        \bool_gset_true:N
          \g_@@_enumitem_bool
      }
      {
```

```
        \IfDocumentMetadataTF
          {
```

Since LaTeX 2$_\varepsilon$ 2026-06-01, the enumitem package can't be loaded and its interfaces are emulated when tagging is used. [4] Therefore, there is no need to (or point in) trying to load the package and we can just act as though it has already been loaded.

```
            \bool_gset_true:N
              \g_@@_enumitem_bool
          }
          {
            \RequirePackage
              { paralist }
            \bool_gset_true:N
              \g__markdown_paralist_bool
          }
      }
  }
\ExplSyntaxOff
```

If we loaded the enumitem package, define the tight and fancy list renderer prototypes to make use of the capabilities of the package.

```
\ExplSyntaxOn
\cs_new:Nn
  \@@_latex_fancy_list_item_label_number:nn
  {
    \str_case:nn
      { #1 }
      {
        { Decimal } { #2 }
        { LowerRoman } { \int_to_roman:n { #2 } }
        { UpperRoman } { \int_to_Roman:n { #2 } }
        { LowerAlpha } { \int_to_alph:n { #2 } }
        { UpperAlpha } { \int_to_Alph:n { #2 } }
      }
  }
\cs_new:Nn
  \@@_latex_fancy_list_item_label_delimiter:n
  {
    \str_case:nn
      { #1 }
      {
        { Default } { . }
        { OneParen } { ) }
        { Period } { . }
      }
  }
\cs_new:Nn
  \@@_latex_fancy_list_item_label:nnn
  {
    \@@_latex_fancy_list_item_label_number:nn
```

```
      { #1 }
      { #3 }
    \@@_latex_fancy_list_item_label_delimiter:n
      { #2 }
  }
\cs_generate_variant:Nn
  \@@_latex_fancy_list_item_label:nnn
  { VVn }
\tl_new:N
  \l_@@_latex_fancy_list_item_label_number_style_tl
\tl_new:N
  \l_@@_latex_fancy_list_item_label_delimiter_style_tl
\bool_if:NTF \g_@@_enumitem_bool {
  \markdownSetup { rendererPrototypes = {
```

First, let's define the tight list item renderer prototypes.

```
    ulBeginTight = {
      \begin
        { itemize }
        [ noitemsep ]
    },
    ulEndTight = {
      \end
        { itemize }
    },
    olBeginTight = {
      \begin
        { enumerate }
        [ noitemsep ]
    },
    olEndTight = {
      \end
        { enumerate }
    },
    dlBeginTight = {
      \begin
        { description }
        [ noitemsep ]
    },
    dlEndTight = {
      \end
        { description }
    },
```

Second, let's define the fancy list item renderer prototypes.

```
    fancyOlBegin = {
      \group_begin:
      \tl_set:Nn
        \l_@@_latex_fancy_list_item_label_number_style_tl
        { #1 }
```

```
      \tl_set:Nn
        \l_@@_latex_fancy_list_item_label_delimiter_style_tl
        { #2 }
      \begin
        { enumerate }
    },
    fancyOlBeginTight = {
      \group_begin:
      \tl_set:Nn
        \l_@@_latex_fancy_list_item_label_number_style_tl
        { #1 }
      \tl_set:Nn
        \l_@@_latex_fancy_list_item_label_delimiter_style_tl
        { #2 }
      \begin
        { enumerate }
        [ noitemsep ]
    },
    fancyOlEnd(|Tight) = {
      \end { enumerate }
      \group_end:
    },
    fancyOlItemWithNumber = {
      \item
        [
          \@@_latex_fancy_list_item_label:VVn
            \l_@@_latex_fancy_list_item_label_number_style_tl
            \l_@@_latex_fancy_list_item_label_delimiter_style_tl
            { #1 }
        ]
    },
  } }
```

Otherwise, if we loaded the paralist package, define the tight and fancy list renderer prototypes to make use of the capabilities of the package.

```
}
{ \bool_if:NTF \g_@@_paralist_bool {
  \markdownSetup { rendererPrototypes = {
```

Make tight bullet lists a little less compact by adding extra vertical space above and below them.

```
    ulBeginTight = {
      \group_begin:
      \pltopsep=\topsep
      \plpartopsep=\partopsep
      \begin { compactitem }
    },
    ulEndTight = {
      \end { compactitem }
      \group_end:
```

```
    },
    fancyOlBegin = {
      \group_begin:
      \tl_set:Nn
        \l_@@_latex_fancy_list_item_label_number_style_tl
        { #1 }
      \tl_set:Nn
        \l_@@_latex_fancy_list_item_label_delimiter_style_tl
        { #2 }
      \begin { enumerate }
    },
    fancyOlEnd = {
      \end { enumerate }
      \group_end:
    },
```

Make tight ordered lists a little less compact by adding extra vertical space above and below them.

```
    olBeginTight = {
      \group_begin:
      \plpartopsep=\partopsep
      \pltopsep=\topsep
      \begin { compactenum }
    },
    olEndTight = {
      \end { compactenum }
      \group_end:
    },
    fancyOlBeginTight = {
      \group_begin:
      \tl_set:Nn
        \l_@@_latex_fancy_list_item_label_number_style_tl
        { #1 }
      \tl_set:Nn
        \l_@@_latex_fancy_list_item_label_delimiter_style_tl
        { #2 }
      \plpartopsep=\partopsep
      \pltopsep=\topsep
      \begin { compactenum }
    },
    fancyOlEndTight = {
      \end { compactenum }
      \group_end:
    },
    fancyOlItemWithNumber = {
      \item
        [
          \@@_latex_fancy_list_item_label:VVn
            \l_@@_latex_fancy_list_item_label_number_style_tl
            \l_@@_latex_fancy_list_item_label_delimiter_style_tl
```

```
            { #1 }
        ]
    },
```

Make tight definition lists a little less compact by adding extra vertical space above and below them.

```
    dlBeginTight = {
      \group_begin:
      \plpartopsep=\partopsep
      \pltopsep=\topsep
      \begin { compactdesc }
    },
    dlEndTight = {
      \end { compactdesc }
      \group_end:
    }
  } }
}
{
```

Otherwise, if we loaded neither the enumitem package nor the paralist package, define the tight and fancy list renderer prototypes to fall back on the corresponding renderers for the non-tight lists.

```
  \markdownSetup
    {
      rendererPrototypes = {
        ulBeginTight = \markdownRendererUlBegin,
        ulEndTight = \markdownRendererUlEnd,
        fancyOlBegin = \markdownRendererOlBegin,
        fancyOlEnd = \markdownRendererOlEnd,
        olBeginTight = \markdownRendererOlBegin,
        olEndTight = \markdownRendererOlEnd,
        fancyOlBeginTight = \markdownRendererOlBegin,
        fancyOlEndTight = \markdownRendererOlEnd,
        dlBeginTight = \markdownRendererDlBegin,
        dlEndTight = \markdownRendererDlEnd,
      },
    }
} }
\ExplSyntaxOff
\RequirePackage{amsmath}
```

Unless the unicode-math package has been loaded, load the amssymb package with symbols to be used for tickboxes.

```
\@ifpackageloaded{unicode-math}{
  \markdownSetup{rendererPrototypes={
    untickedBox = {$\mdlgwhtsquare$},
  }}
}{
  \RequirePackage{amssymb}
```

```
  \markdownSetup{rendererPrototypes={
    untickedBox = {$\square$},
  }}
}
\RequirePackage{csvsimple}
\RequirePackage{fancyvrb}
\RequirePackage{graphicx}
\markdownSetup{rendererPrototypes={
  hardLineBreak = {\\},
  leftBrace = {\textbraceleft},
  rightBrace = {\textbraceright},
  dollarSign = {\textdollar},
  underscore = {\textunderscore},
  circumflex = {\textasciicircum},
  backslash = {\textbackslash},
  tilde = {\textasciitilde},
  pipe = {\textbar},
```

We can capitalize on the fact that the expansion of renderers is performed by TEX during the typesetting. Therefore, even if we don't know whether a span of text is part of math formula or not when we are parsing markdown,[41] we can reliably detect math mode inside the renderer.

Here, we will redefine the code span renderer prototype to typeset upright text in math formulae and typewriter text outside math formulae.

```
  codeSpan = {%
    \ifmmode
      \text{#1}%
    \else
      \texttt{#1}%
    \fi
  }}}
```

3.3.5.3 Content Blocks

In content block renderer prototypes, display the content as a table using the package csvsimple when the raw attribute is `csv`, display the content using the default templates of the package luaxml when the raw attribute is `html`, execute the content with TeX when the raw attribute is `tex`, and display the content as markdown otherwise.

```
\ExplSyntaxOn
\markdownSetup{
  rendererPrototypes = {
    contentBlock = {
      \str_case:nnF
        { #1 }
        {
```

[41] This property may actually be undecidable. Suppose a span of text is a part of a macro definition. Then, whether the span of text is part of a math formula or not depends on where the macro is later used, which may easily be *both* inside and outside a math formula.

```
          { csv }
            {
              \begin { table }
                \begin { center }
                  \csvautotabular { #3 }
                \end{ center }
                \tl_if_empty:nF
                  { #4 }
                  { \caption { #4 } }
              \end { table }
            }
          { html }
            {
```

If we are using TEX4ht[42], we will pass HTML elements to the output HTML document unchanged.

```
              \cs_if_exist:NTF
                \HCode
                {
                  \if_mode_vertical:
                    \IgnorePar
                  \fi:
                  \EndP
                  \special
                    { t4ht* < #3 }
                  \par
                  \ShowPar
                }
                {
                  \@@_luaxml_print_html:n
                    { #3 }
                }
            }
          { tex }
            {
              \markdownEscape
                { #3 }
            }
        }
        {
          \markdownInput
            { #3 }
        }
    },
  },
}
\ExplSyntaxOff
\markdownSetup{rendererPrototypes={
```

[42] See https://tug.org/tex4ht/.

```
  ulBegin = {\begin{itemize}},
  ulEnd = {\end{itemize}},
  olBegin = {\begin{enumerate}},
  olItem = {\item{}},
  olItemWithNumber = {\item[#1.]},
  olEnd = {\end{enumerate}},
  dlBegin = {\begin{description}},
  dlItem = {\item[#1]},
  dlEnd = {\end{description}},
  emphasis = {\emph{#1}},
  tickedBox = {$\boxtimes$},
  halfTickedBox = {$\boxdot$}}}
```

If HTML identifiers appear after a heading, we make them produce `\label` macros.

```
\ExplSyntaxOn
\seq_new:N
  \g_@@_header_identifiers_seq
\markdownSetup
  {
    rendererPrototypes = {
      headerAttributeContextBegin = {
        \markdownSetup
          {
            rendererPrototypes = {
              attributeIdentifier = {
                \seq_gput_right:Nn
                  \g_@@_header_identifiers_seq
                  { ##1 }
              },
            },
          }
      },
      headerAttributeContextEnd = {
        \seq_map_inline:Nn
          \g_@@_header_identifiers_seq
          { \label { ##1 } }
        \seq_gclear:N
          \g_@@_header_identifiers_seq
      },
    },
  }
```

If the `unnumbered` HTML class (or the `{-}` shorthand) appears after a heading the heading and all its subheadings will be unnumbered.

```
\bool_new:N
  \l_@@_header_unnumbered_bool
\markdownSetup
  {
    rendererPrototypes = {
      headerAttributeContextBegin += {
```

```
        \markdownSetup
          {
            rendererPrototypes = {
              attributeClassName = {
                \bool_if:nT
                  {
                    \str_if_eq_p:nn
                      { ##1 }
                      { unnumbered } &&
                    ! \l_@@_header_unnumbered_bool
                  }
                  {
                    \group_begin:
                    \bool_set_true:N
                      \l_@@_header_unnumbered_bool
                    \c@secnumdepth = -2
                    \markdownSetup
                      {
                        rendererPrototypes = {
                          sectionBegin = {
                            \group_begin:
                          },
                          sectionEnd = {
                            \group_end:
                          },
                        },
                      }
                  }
              },
            },
          }
      },
    },
  }
\ExplSyntaxOff
\markdownSetup{rendererPrototypes={
  superscript = {\textsuperscript{#1}},
  subscript = {\textsubscript{#1}},
  blockQuoteBegin = {\begin{quotation}},
  blockQuoteEnd = {\end{quotation}},
  inputVerbatim = {\VerbatimInput{#1}},
  thematicBreak = {\noindent\rule[0.5ex]{\linewidth}{1pt}},
  note = {\footnote{#1}}}}
```

3.3.5.4 Fenced Code

When no infostring has been specified, default to the indented code block renderer.

```
\RequirePackage{ltxcmds}
\ExplSyntaxOn
\cs_gset_protected:Npn
```

```
  \markdownRendererInputFencedCodePrototype#1#2#3
  {
    \tl_if_empty:nTF
      { #2 }
      { \markdownRendererInputVerbatim{#1} }
```

Otherwise, extract the first word of the infostring and treat it as the name of the programming language in which the code block is written.

```
      {
        \regex_extract_once:nnN
          { \w* }
          { #2 }
          \l_tmpa_seq
        \seq_pop_left:NN
          \l_tmpa_seq
          \l_tmpa_tl
```

When the minted package is loaded, use it for syntax highlighting.

```
        \ltx@ifpackageloaded
          { minted }
          {
            \catcode`\%=14\relax
            \catcode`\#=6\relax
            \exp_args:NV
              \inputminted
              \l_tmpa_tl
              { #1 }
            \catcode`\%=12\relax
            \catcode`\#=12\relax
          }
          {
```

When the listings package is loaded, use it for syntax highlighting.

```
            \ltx@ifpackageloaded
              { listings }
              { \lstinputlisting [ language = \l_tmpa_tl ] { #1 } }
```

When neither the listings package nor the minted package is loaded, act as though no infostring were given.

```
              { \markdownRendererInputFencedCode { #1 } { } { } }
          }
      }
  }
\ExplSyntaxOff
```

Support the nesting of strong emphasis.

```
\ExplSyntaxOn
\cs_new_protected:Npn
  \markdownLaTeXStrongEmphasis #1
  {
    \str_if_in:NnTF
```

```
      \f@series
      { b }
      { \textnormal{#1} }
      { \textbf{#1} }
  }
\ExplSyntaxOff
\markdownSetup{rendererPrototypes={strongEmphasis={%
  \protect\markdownLATEXStrongEmphasis{#1}}}}
```

Support LaTeX document classes that do not provide chapters.

```
\@ifundefined{chapter}{%
  \markdownSetup{rendererPrototypes = {
    headingOne = {\section{#1}},
    headingTwo = {\subsection{#1}},
    headingThree = {\subsubsection{#1}},
    headingFour = {\paragraph{#1}},
    headingFive = {\subparagraph{#1}}}}
}{%
  \markdownSetup{rendererPrototypes = {
    headingOne = {\chapter{#1}},
    headingTwo = {\section{#1}},
    headingThree = {\subsection{#1}},
    headingFour = {\subsubsection{#1}},
    headingFive = {\paragraph{#1}},
    headingSix = {\subparagraph{#1}}}}
}%
```

Prevent acronyms in headings.

```
\ExplSyntaxOn
\markdownSetup {
  rendererPrototypes = {
    heading* ^= {
      \int_gincr:N
        \g_@@_heading_nesting_depth_int
    },
    heading* $= {
      \int_gdecr:N
        \g_@@_heading_nesting_depth_int
    }
  }
}
\ExplSyntaxOff
```

3.3.5.5 Tickboxes

If the `taskLists` option is enabled, we will hide bullets in unordered list items with tickboxes.

```
\markdownSetup{
  rendererPrototypes = {
    ulItem = {%
```

```
      \futurelet\markdownLaTeXCheckbox\markdownLaTeXUlItem
    },
  },
}
\def\markdownLaTeXUlItem{%
  \ifx\markdownLaTeXCheckbox\markdownRendererTickedBox
    \item[\markdownLaTeXCheckbox]%
    \expandafter\@gobble
  \else
    \ifx\markdownLaTeXCheckbox\markdownRendererHalfTickedBox
      \item[\markdownLaTeXCheckbox]%
      \expandafter\expandafter\expandafter\@gobble
    \else
      \ifx\markdownLaTeXCheckbox\markdownRendererUntickedBox
        \item[\markdownLaTeXCheckbox]%
        \expandafter\expandafter\expandafter\expandafter
          \expandafter\expandafter\expandafter\@gobble
      \else
        \item{}%
      \fi
    \fi
  \fi
}
```

3.3.5.6 html elements

If the `html` option is enabled and we are using TEX4ht[43], we will pass HTML elements to the output HTML document unchanged.

```
\@ifundefined{HCode}{}{
  \markdownSetup{
    rendererPrototypes = {
      inlineHtmlTag = {%
        \ifvmode
          \IgnorePar
          \EndP
        \fi
        \HCode{#1}%
      },
      inputBlockHtmlElement = {%
        \ifvmode
          \IgnorePar
        \fi
        \EndP
        \special{t4ht*<#1}%
        \par
        \ShowPar
      },
    },
```

[43] See https://tug.org/tex4ht/.

```
  }
}
```

3.3.5.7 Citations

Here is a basic implementation for citations that uses the LaTeX `\cite` macro. There are also implementations that use the natbib `\citep`, and `\citet` macros, and the BibLaTeX `\autocites` and `\textcites` macros. These implementations will be used, when the respective packages are loaded.

```
\newcount\markdownLaTeXCitationsCounter

% Basic implementation
\long\def\@gobblethree#1#2#3{}%
\def\markdownLaTeXBasicCitations#1#2#3#4#5#6{%
  \advance\markdownLaTeXCitationsCounter by 1\relax
  \ifx\relax#4\relax
    \ifx\relax#5\relax
      \ifnum\markdownLaTeXCitationsCounter>\markdownLaTeXCitationsTotal
        \relax
        \cite{#1#2#6}%  No prenotes/postnotes, just accumulate cites
        \expandafter\expandafter\expandafter
        \expandafter\expandafter\expandafter\expandafter
        \@gobblethree
      \fi
    \else%  Before a postnote (#5), dump the accumulator
      \ifx\relax#1\relax\else
        \cite{#1}%
      \fi
      \cite[#5]{#6}%
      \ifnum\markdownLaTeXCitationsCounter>\markdownLaTeXCitationsTotal
      \relax
      \else
        \expandafter\expandafter\expandafter
        \expandafter\expandafter\expandafter\expandafter
        \expandafter\expandafter\expandafter
        \expandafter\expandafter\expandafter\expandafter
        \markdownLaTeXBasicCitations
      \fi
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter{%
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter}%
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter{%
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter}%
      \expandafter\expandafter\expandafter
      \@gobblethree
    \fi
```

```
  \else%  Before a prenote (#4), dump the accumulator
    \ifx\relax#1\relax\else
      \cite{#1}%
    \fi
    \ifnum\markdownLaTeXCitationsCounter>1\relax
      \space  % Insert a space before the prenote in later citations
    \fi
    #4~\expandafter\cite\ifx\relax#5\relax{#6}\else[#5]{#6}\fi
    \ifnum\markdownLaTeXCitationsCounter>\markdownLaTeXCitationsTotal
    \relax
    \else
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter
      \markdownLaTeXBasicCitations
    \fi
    \expandafter\expandafter\expandafter{%
    \expandafter\expandafter\expandafter}%
    \expandafter\expandafter\expandafter{%
    \expandafter\expandafter\expandafter}%
    \expandafter
    \@gobblethree
  \fi\markdownLaTeXBasicCitations{#1#2#6},}
\let\markdownLaTeXBasicTextCitations\markdownLaTeXBasicCitations

% Natbib implementation
\def\markdownLaTeXNatbibCitations#1#2#3#4#5{%
  \advance\markdownLaTeXCitationsCounter by 1\relax
  \ifx\relax#3\relax
    \ifx\relax#4\relax
      \ifnum\markdownLaTeXCitationsCounter>\markdownLaTeXCitationsTotal
      \relax
        \citep{#1,#5}%  No prenotes/postnotes, just accumulate cites
        \expandafter\expandafter\expandafter
        \expandafter\expandafter\expandafter\expandafter
        \@gobbletwo
      \fi
    \else%  Before a postnote (#4), dump the accumulator
      \ifx\relax#1\relax\else
        \citep{#1}%
      \fi
      \citep[][#4]{#5}%
      \ifnum\markdownLaTeXCitationsCounter>\markdownLaTeXCitationsTotal
      \relax
      \else
        \expandafter\expandafter\expandafter
        \expandafter\expandafter\expandafter\expandafter
        \expandafter\expandafter\expandafter
        \expandafter\expandafter\expandafter\expandafter
        \markdownLaTeXNatbibCitations
```

```
      \fi
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter{%
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter}%
      \expandafter\expandafter\expandafter
      \@gobbletwo
    \fi
  \else%  Before a prenote (#3), dump the accumulator
    \ifx\relax#1\relax\relax\else
      \citep{#1}%
    \fi
    \citep[#3][#4]{#5}%
    \ifnum\markdownLaTeXCitationsCounter>\markdownLaTeXCitationsTotal
    \relax
    \else
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter
      \markdownLaTeXNatbibCitations
    \fi
    \expandafter\expandafter\expandafter{%
    \expandafter\expandafter\expandafter}%
    \expandafter
    \@gobbletwo
  \fi\markdownLaTeXNatbibCitations{#1,#5}}
\def\markdownLaTeXNatbibTextCitations#1#2#3#4#5{%
  \advance\markdownLaTeXCitationsCounter by 1\relax
  \ifx\relax#3\relax
    \ifx\relax#4\relax
      \ifnum\markdownLaTeXCitationsCounter>\markdownLaTeXCitationsTotal
      \relax
        \citet{#1,#5}%  No prenotes/postnotes, just accumulate cites
        \expandafter\expandafter\expandafter
        \expandafter\expandafter\expandafter\expandafter
        \@gobbletwo
      \fi
    \else%  After a prenote or a postnote, dump the accumulator
      \ifx\relax#1\relax\else
        \citet{#1}%
      \fi
      , \citet[#3][#4]{#5}%
      \ifnum\markdownLaTeXCitationsCounter<\markdownLaTeXCitationsTotal
      \relax
        ,
      \else
        \ifnum
        \markdownLaTeXCitationsCounter=\markdownLaTeXCitationsTotal
        \relax
          ,
```

```
        \fi
      \fi
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter
      \markdownLaTeXNatbibTextCitations
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter{%
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter}%
      \expandafter\expandafter\expandafter
      \@gobbletwo
    \fi
  \else%  After a prenote or a postnote, dump the accumulator
    \ifx\relax#1\relax\relax\else
      \citet{#1}%
    \fi
    , \citet[#3][#4]{#5}%
    \ifnum\markdownLaTeXCitationsCounter<\markdownLaTeXCitationsTotal
    \relax
      ,
    \else
      \ifnum
      \markdownLaTeXCitationsCounter=\markdownLaTeXCitationsTotal
      \relax
        ,
      \fi
    \fi
    \expandafter\expandafter\expandafter
    \markdownLaTeXNatbibTextCitations
    \expandafter\expandafter\expandafter{%
    \expandafter\expandafter\expandafter}%
    \expandafter
    \@gobbletwo
  \fi\markdownLaTeXNatbibTextCitations{#1,#5}}

% BibLaTeX implementation
\def\markdownLaTeXBibLaTeXCitations#1#2#3#4#5{%
  \advance\markdownLaTeXCitationsCounter by 1\relax
  \ifnum\markdownLaTeXCitationsCounter>\markdownLaTeXCitationsTotal
  \relax
    \autocites#1[#3][#4]{#5}%
    \expandafter\@gobbletwo
  \fi\markdownLaTeXBibLaTeXCitations{#1[#3][#4]{#5}}}
\def\markdownLaTeXBibLaTeXTextCitations#1#2#3#4#5{%
  \advance\markdownLaTeXCitationsCounter by 1\relax
  \ifnum\markdownLaTeXCitationsCounter>\markdownLaTeXCitationsTotal
  \relax
    \textcites#1[#3][#4]{#5}%
    \expandafter\@gobbletwo
```

```
  \fi\markdownLaTeXBibLaTeXTextCitations{#1[#3][#4]{#5}}}

\markdownSetup{rendererPrototypes = {
  cite = {%
    \markdownLaTeXCitationsCounter=1%
    \def\markdownLaTeXCitationsTotal{#1}%
    \@ifundefined{autocites}{%
      \@ifundefined{citep}{%
        \expandafter\expandafter\expandafter
        \markdownLaTeXBasicCitations
        \expandafter\expandafter\expandafter{%
        \expandafter\expandafter\expandafter}%
        \expandafter\expandafter\expandafter{%
        \expandafter\expandafter\expandafter}%
      }{%
        \expandafter\expandafter\expandafter
        \markdownLaTeXNatbibCitations
        \expandafter\expandafter\expandafter{%
        \expandafter\expandafter\expandafter}%
      }%
    }{%
      \expandafter\expandafter\expandafter
      \markdownLaTeXBibLaTeXCitations
      \expandafter{\expandafter}%
    }},
  textCite = {%
    \markdownLaTeXCitationsCounter=1%
    \def\markdownLaTeXCitationsTotal{#1}%
    \@ifundefined{autocites}{%
      \@ifundefined{citep}{%
        \expandafter\expandafter\expandafter
        \markdownLaTeXBasicTextCitations
        \expandafter\expandafter\expandafter{%
        \expandafter\expandafter\expandafter}%
        \expandafter\expandafter\expandafter{%
        \expandafter\expandafter\expandafter}%
      }{%
        \expandafter\expandafter\expandafter
        \markdownLaTeXNatbibTextCitations
        \expandafter\expandafter\expandafter{%
        \expandafter\expandafter\expandafter}%
      }%
    }{%
      \expandafter\expandafter\expandafter
      \markdownLaTeXBibLaTeXTextCitations
      \expandafter{\expandafter}%
    }}}}
```

3.3.5.8 Links

Here is an implementation for hypertext links and relative references.

```
\RequirePackage{url}
\RequirePackage{expl3}
\ExplSyntaxOn
\cs_gset_protected:Npn
  \markdownRendererLinkPrototype
  #1#2#3#4
  {
    \tl_set:Nn \l_tmpa_tl { #1 }
    \tl_set:Nn \l_tmpb_tl { #2 }
    \bool_set:Nn
      \l_tmpa_bool
      {
        \tl_if_eq_p:NN
          \l_tmpa_tl
          \l_tmpb_tl
      }
    \tl_set:Nn \l_tmpa_tl { #4 }
    \bool_set:Nn
      \l_tmpb_bool
      {
        \tl_if_empty_p:N
          \l_tmpa_tl
      }
```

If the label and the fully-escaped URI are equivalent and the title is empty, assume that the link is an autolink. Otherwise, assume that the link is either direct or indirect.

```
    \bool_if:nTF
      {
        \l_tmpa_bool && \l_tmpb_bool
      }
      {
        \markdownLaTeXRendererAutolink { #2 } { #3 }
      }
      {
        \markdownLaTeXRendererDirectOrIndirectLink
          { #1 } { #2 } { #3 } { #4 }
      }
  }
\cs_new_protected:Npn
  \markdownLaTeXRendererAutolink #1#2
  {
```

If the URL begins with a hash sign, then we assume that it is a relative reference. Otherwise, we assume that it is an absolute URL.

```
    \tl_set:Nn
      \l_tmpa_tl
      { #2 }
    \tl_trim_spaces:N
      \l_tmpa_tl
```

```
    \tl_set:Nx
      \l_tmpb_tl
      {
        \tl_range:Nnn
          \l_tmpa_tl
          { 1 }
          { 1 }
      }
    \str_if_eq:NNTF
      \l_tmpb_tl
      \c_hash_str
      {
        \tl_set:Nx
          \l_tmpb_tl
          {
            \tl_range:Nnn
              \l_tmpa_tl
              { 2 }
              { -1 }
          }
        \exp_args:NV
          \ref
          \l_tmpb_tl
      }
      {
        \url { #2 }
      }
  }
\ExplSyntaxOff
\def\markdownLaTeXRendererDirectOrIndirectLink#1#2#3#4{%
  #1\footnote{\ifx\empty#4\empty\else#4: \fi\url{#3}}}
```

3.3.5.9 Tables

Here is a basic implementation of tables. If the booktabs package is loaded, then it is used to produce horizontal lines.

```
\newcount\markdownLaTeXRowCounter
\newcount\markdownLaTeXRowTotal
\newcount\markdownLaTeXColumnCounter
\newcount\markdownLaTeXColumnTotal
\newtoks\markdownLaTeXTable
\newtoks\markdownLaTeXTableAlignment
\newtoks\markdownLaTeXTableEnd
\AtBeginDocument{%
  \@ifpackageloaded{booktabs}{%
    \def\markdownLaTeXTopRule{\toprule}%
    \def\markdownLaTeXMidRule{\midrule}%
    \def\markdownLaTeXBottomRule{\bottomrule}%
  }{%
```

```
    \def\markdownLaTeXTopRule{\hline}%
    \def\markdownLaTeXMidRule{\hline}%
    \def\markdownLaTeXBottomRule{\hline}%
  }%
}
\markdownSetup{rendererPrototypes={
  table = {%
    \markdownLaTeXTable={}%
    \markdownLaTeXTableAlignment={}%
    \markdownLaTeXTableEnd={%
      \markdownLaTeXBottomRule
      \end{tabular}}%
    \ifx\empty#1\empty\else
      \addto@hook\markdownLaTeXTable{%
        \begin{table}
        \centering}%
      \addto@hook\markdownLaTeXTableEnd{%
        \caption{#1}}%
    \fi
  }
}}
```

If the `tableAttributes` option is enabled, we will register any identifiers, so that they can be used as LaTeX labels for referencing tables.

```
\ExplSyntaxOn
\seq_new:N
  \l_@@_table_identifiers_seq
\markdownSetup {
  rendererPrototypes = {
    table += {
      \seq_map_inline:Nn
        \l_@@_table_identifiers_seq
        {
          \addto@hook
            \markdownLaTeXTableEnd
            { \label { ##1 } }
        }
    },
  }
}
\markdownSetup {
  rendererPrototypes = {
    tableAttributeContextBegin = {
      \group_begin:
      \markdownSetup {
        rendererPrototypes = {
          attributeIdentifier = {
            \seq_put_right:Nn
              \l_@@_table_identifiers_seq
              { ##1 }
```

```
          },
        },
      }
    },
    tableAttributeContextEnd = {
      \group_end:
    },
  },
}
\ExplSyntaxOff
\markdownSetup{rendererPrototypes={
  table += {%
    \ifx\empty#1\empty\else
      \addto@hook\markdownLaTeXTableEnd{%
        \end{table}}%
    \fi
    \addto@hook\markdownLaTeXTable{\begin{tabular}}%
    \markdownLaTeXRowCounter=0%
    \markdownLaTeXRowTotal=#2%
    \markdownLaTeXColumnTotal=#3%
    \markdownLaTeXRenderTableRow
  }
}}
\def\markdownLaTeXRenderTableRow#1{%
  \markdownLaTeXColumnCounter=0%
  \ifnum\markdownLaTeXRowCounter=0\relax
    \markdownLaTeXReadAlignments#1%
    \markdownLaTeXTable=\expandafter\expandafter\expandafter{%
      \expandafter\the\expandafter\markdownLaTeXTable\expandafter{%
        \the\markdownLaTeXTableAlignment}}%
    \addto@hook\markdownLaTeXTable{\markdownLaTeXTopRule}%
  \else
    \markdownLaTeXRenderTableCell#1%
  \fi
  \ifnum\markdownLaTeXRowCounter=1\relax
    \addto@hook\markdownLaTeXTable\markdownLaTeXMidRule
  \fi
  \advance\markdownLaTeXRowCounter by 1\relax
  \ifnum\markdownLaTeXRowCounter>\markdownLaTeXRowTotal\relax
    \the\markdownLaTeXTable
    \the\markdownLaTeXTableEnd
    \expandafter\@gobble
  \fi\markdownLaTeXRenderTableRow}
\def\markdownLaTeXReadAlignments#1{%
  \advance\markdownLaTeXColumnCounter by 1\relax
  \if#1d%
    \addto@hook\markdownLaTeXTableAlignment{l}%
  \else
    \addto@hook\markdownLaTeXTableAlignment{#1}%
```

```
  \fi
  \ifnum\markdownLaTeXColumnCounter<\markdownLaTeXColumnTotal\relax\else
    \expandafter\@gobble
  \fi\markdownLaTeXReadAlignments}
\def\markdownLaTeXRenderTableCell#1{%
  \advance\markdownLaTeXColumnCounter by 1\relax
  \ifnum\markdownLaTeXColumnCounter<\markdownLaTeXColumnTotal\relax
    \addto@hook\markdownLaTeXTable{#1&}%
  \else
    \addto@hook\markdownLaTeXTable{#1\\}%
    \expandafter\@gobble
  \fi\markdownLaTeXRenderTableCell}
```

3.3.5.10 Line Blocks

Here is a basic implementation of line blocks. If the verse package is loaded, then it is used to produce the verses.

```

\markdownIfOption{lineBlocks}{%
  \RequirePackage{verse}
  \markdownSetup{rendererPrototypes={
    lineBlockBegin = {%
      \begingroup
        \def\markdownRendererHardLineBreak{\\}%
        \begin{verse}%
    },
    lineBlockEnd = {%
        \end{verse}%
      \endgroup
    },
  }}
}{}

```

3.3.5.11 yaml Metadata

The default setup of YAML metadata will invoke the `\title`, `\author`, and `\date` macros when scalar values for keys that correspond to the `title`, `author`, and `date` relative wildcards are encountered, respectively.

```
\ExplSyntaxOn
\keys_define:nn
  { markdown / jekyllData }
  {
    author .value_required:n = { true },
    author .code:n = {
      \author
        { #1 }
    },
    date .value_required:n = { true },
```

```
    date .code:n = {
      \date
        { #1 }
    },
    title .value_required:n = { true },
    title .code:n = {
      \title
        { #1 }
```

To complement the default setup of our key–values, we will use the `\maketitle` macro to typeset the title page of a document at the end of YAML metadata. If we are in the preamble, we will wait macro until after the beginning of the document. Otherwise, we will use the `\maketitle` macro straight away, temporarily resetting the category codes of the percent sign and the hash sign back to comment and parameter, respectively.

```
      \char_set_catcode_comment:N \%
      \char_set_catcode_parameter:N \#
      \AddToHook
        { begindocument / end }
        { \maketitle }
      \char_set_catcode_other:N \%
      \char_set_catcode_other:N \#
    },
  }
```

3.3.5.12 Marked Text

If the `mark` option is enabled, we will load either the soul package or the lua-ul package and use it to implement marked text.

```
\@@_if_option:nT
  { mark }
  {
    \sys_if_engine_luatex:TF
      {
        \RequirePackage
          { luacolor }
        \RequirePackage
          { lua-ul }
        \markdownSetup
          {
            rendererPrototypes = {
              mark = {
                \highLight
                  { #1 }
              },
            }
          }
      }
      {
        \RequirePackage
```

```
        { xcolor }
      \RequirePackage
        { soul }
      \markdownSetup
        {
          rendererPrototypes = {
            mark = {
              \hl
                { #1 }
            },
          }
        }
    }
}
```

3.3.5.13 Strike-Through

If the `strikeThrough` option is enabled, we will load either the soul package or the lua-ul package and use it to implement strike-throughs.

```
\@@_if_option:nT
  { strikeThrough }
  {
    \sys_if_engine_luatex:TF
      {
        \RequirePackage
          { lua-ul }
        \markdownSetup
          {
            rendererPrototypes = {
              strikeThrough = {
                \strikeThrough
                  { #1 }
              },
            }
          }
      }
      {
        \RequirePackage
          { soul }
        \markdownSetup
          {
            rendererPrototypes = {
              strikeThrough = {
                \st
                  { #1 }
              },
            }
          }
      }
```

```
}
```

3.3.5.14 Images and their attributes

We define images to be rendered as floating figures using the command `\includegraphics`, where the image label is the alt text and the image title is the caption of the figure.

If the `linkAttributes` option is enabled, we will make attributes in the form ⟨*key*⟩=⟨*value*⟩ set the corresponding keys of the graphicx package to the corresponding values and we will register any identifiers, so that they can be used as LaTeX labels for referencing figures.

```
\seq_new:N
  \l_@@_image_identifiers_seq
\markdownSetup {
  rendererPrototypes = {
    image = {
      \tl_if_empty:nTF
        { #4 }
        {
          \begin { center }
            \includegraphics
              [ alt = { #1 } ]
              { #3 }
          \end { center }
        }
        {
          \begin { figure }
            \begin { center }
              \includegraphics
                [ alt = { #1 } ]
                { #3 }
              \caption { #4 }
              \seq_map_inline:Nn
                \l_@@_image_identifiers_seq
                { \label { ##1 } }
            \end { center }
          \end { figure }
        }
    },
  }
}
\@@_if_option:nT
  { linkAttributes }
  {
    \RequirePackage { graphicx }
  }
\markdownSetup {
  rendererPrototypes = {
    imageAttributeContextBegin = {
```

```
      \group_begin:
      \markdownSetup {
        rendererPrototypes = {
          attributeIdentifier = {
            \seq_put_right:Nn
              \l_@@_image_identifiers_seq
              { ##1 }
          },
          attributeKeyValue = {
            \setkeys
              { Gin }
              { { ##1 } = { ##2 } }
          },
        },
      }
    },
    imageAttributeContextEnd = {
      \group_end:
    },
  },
}
\ExplSyntaxOff
```

3.3.5.15 Raw Attributes

In the raw block and inline raw span renderer prototypes, display the content using the default templates of the package luaxml when the raw attribute is `html` and default to the plain TeX renderer prototypes otherwise, translating raw attribute `latex` to `tex`.

```
\ExplSyntaxOn
\cs_new:Nn
  \@@_luaxml_print_html:n
  {
    \luabridge_now:n
      {
        local~input_file = assert(io.open(" #1 ", "r"))
        local~input = assert(input_file:read("*a"))
        assert(input_file:close())
        input = "<body>" .. input .. "</body>"
        local~dom = require("luaxml-domobject").html_parse(input)
        local~output = require("luaxml-htmltemplates"):process_dom(dom)
        print(output)
      }
  }
\cs_gset_protected:Npn
  \markdownRendererInputRawInlinePrototype#1#2
  {
    \str_case:nnF
      { #2 }
      {
```

```
        { latex }
          {
            \@@_plain_tex_default_input_raw_inline:nn
              { #1 }
              { tex }
          }
        { html }
          {
```

If we are using TEX4ht[44], we will pass HTML elements to the output HTML document unchanged.

```
            \cs_if_exist:NTF
              \HCode
              {
                \if_mode_vertical:
                  \IgnorePar
                  \EndP
                \fi:
                \special
                  { t4ht* < #1 }
              }
              {
                \@@_luaxml_print_html:n
                  { #1 }
              }
          }
      }
      {
        \@@_plain_tex_default_input_raw_inline:nn
          { #1 }
          { #2 }
      }
  }
\cs_gset_protected:Npn
  \markdownRendererInputRawBlockPrototype#1#2
  {
    \str_case:nnF
      { #2 }
      {
        { latex }
          {
            \@@_plain_tex_default_input_raw_block:nn
              { #1 }
              { tex }
          }
        { html }
          {
```

[44]See https://tug.org/tex4ht/.

If we are using TEX4ht[45], we will pass HTML elements to the output HTML document unchanged.

```
            \cs_if_exist:NTF
              \HCode
              {
                \if_mode_vertical:
                  \IgnorePar
                \fi:
                \EndP
                \special
                  { t4ht* < #1 }
                \par
                \ShowPar
              }
              {
                \@@_luaxml_print_html:n
                  { #1 }
              }
          }
        }
        {
          \@@_plain_tex_default_input_raw_block:nn
            { #1 }
            { #2 }
        }
    }
```

3.3.5.16 Bracketed spans

If the `bracketedSpans` option is enabled, we will register any identifiers, so that they can be used as LATEX labels for referencing the last LATEX counter that has been incremented in e.g. ordered lists.

```
\seq_new:N
  \l_@@_bracketed_span_identifiers_seq
\markdownSetup {
  rendererPrototypes = {
    bracketedSpanAttributeContextBegin $= {
      \markdownSetup {
        rendererPrototypes = {
          attributeIdentifier = {
            \seq_put_right:Nn
              \l_@@_bracketed_span_identifiers_seq
              { ##1 }
          },
        },
      }
    },
```

[45] See https://tug.org/tex4ht/.

```
    bracketedSpanAttributeContextEnd ^= {
      \seq_map_inline:Nn
        \l_@@_bracketed_span_identifiers_seq
        { \label { ##1 } }
    },
  },
}
```

We will also allow acronyms to be manually marked up using the HTML class `acronym`.

```
\markdownSetup {
  rendererPrototypes = {
    bracketedSpanAttributeContextBegin += {
      \markdownSetup {
        rendererPrototypes = {
          attributeClassName = {
            \str_if_eq:nnT
              { ##1 }
              { acronym }
              {
                \markdownSetup {
                  rendererPrototypes = {
                    bracketedSpan = {
                      \bool_set_true:N
                        \g__markdown_record_acronyms_bool
                      \markdownRendererAcronym
                        { ####1 }
                    }
                  }
                }
              }
          },
        },
      }
    },
  },
}
\ExplSyntaxOff
\fi % Closes `\markdownIfOption{plain}{\iffalse}{\iftrue}`
```

3.3.6 Miscellanea

When buffering user input, we should disable the bytes with the high bit set, since these are made active by the inputenc package. We will do this by redefining the `\markdownMakeOther` macro accordingly. The code is courtesy of Scott Pakin, the creator of the filecontents package.

```
\newcommand\markdownMakeOther{%
  \count0=128\relax
  \loop
    \catcode\count0=11\relax
```

```
    \advance\count0 by 1\relax
  \ifnum\count0<256\repeat}%
```

3.4 ConTEXt Implementation

The ConTEXt implementation makes use of the fact that, apart from some subtle differences, the Mark II and Mark IV ConTEXt formats *seem* to implement (the documentation is scarce) the majority of the plain TEX format required by the plain TEX implementation. As a consequence, we can directly reuse the existing plain TEX implementation after supplying the missing plain TEX macros.

When buffering user input, we should disable the bytes with the high bit set, since these are made active by the `\enableregime` macro. We will do this by redefining the `\markdownMakeOther` macro accordingly. The code is courtesy of Scott Pakin, the creator of the filecontents LATEX package.

```
\def\markdownMakeOther{%
  \count0=128\relax
  \loop
    \catcode\count0=11\relax
    \advance\count0 by 1\relax
  \ifnum\count0<256\repeat
```

On top of that, make the pipe character (`|`) inactive during the scanning. This is necessary, since the character is active in ConTEXt.

```
  \catcode`|=12}%
```

3.4.1 Typesetting Markdown

The `\inputmarkdown` and `\inputyaml` macros are defined to accept an optional argument with options recognized by the ConTEXt interface (see Section 2.4.2).

```
\long\def\inputmarkdown{%
  \dosingleempty
  \doinputmarkdown}%
\long\def\doinputmarkdown[#1]#2{%
  \begingroup
    \iffirstargument
      \setupmarkdown[#1]%
    \fi
    \markdownInput{#2}%
  \endgroup}%
\long\def\inputyaml{%
  \dosingleempty
  \doinputyaml}%
\long\def\doinputyaml[#1]#2{%
  \doinputmarkdown
    [jekyllData, expectJekyllData, ensureJekyllData, #1]{#2}}%
```

The `\startmarkdown`, `\stopmarkdown`, `\startyaml`, and `\stopyaml` macros are implemented using the `\markdownReadAndConvert` macro.

In Knuth's TEX, trailing spaces are removed very early on when a line is being put to the input buffer. [21, sec. 31]. According to Eijkhout [22, sec. 2.2], this is because "these spaces are hard to see in an editor". At the moment, there is no option to suppress this behavior in (Lua)TEX, but ConTEXt MkIV funnels all input through its own input handler. This makes it possible to suppress the removal of trailing spaces in ConTEXt MkIV and therefore to insert hard line breaks into markdown text.

```
\startluacode
  document.markdown_buffering = false
  local function preserve_trailing_spaces(line)
    if document.markdown_buffering then
      line = line:gsub("[ \t][ \t]$", "\t\t")
    end
    return line
  end
  resolvers.installinputlinehandler(preserve_trailing_spaces)
\stopluacode
\begingroup
  \catcode`\|=0%
  \catcode`\\=12%
  |gdef|startmarkdown{%
    |ctxlua{document.markdown_buffering = true}%
    |markdownReadAndConvert{\stopmarkdown}%
                           {|stopmarkdown}}%
  |gdef|stopmarkdown{%
    |ctxlua{document.markdown_buffering = false}%
    |markdownEnd}%
  |gdef|startyaml{%
    |begingroup
    |ctxlua{document.markdown_buffering = true}%
    |setupyaml[jekyllData, expectJekyllData, ensureJekyllData]%
    |markdownReadAndConvert{\stopyaml}%
                           {|stopyaml}}%
  |gdef|stopyaml{%
    |ctxlua{document.markdown_buffering = false}%
    |yamlEnd}%
|endgroup
```

3.4.2 Themes

This section overrides the plain TEX implementation of the theme-loading mechanism from Section 3.2.2. Furthermore, this section also implements the built-in ConTEXt themes provided with the Markdown package.

```
\ExplSyntaxOn
\prop_new:N \g_@@_context_loaded_themes_linenos_prop
\prop_new:N \g_@@_context_loaded_themes_versions_prop
\cs_gset_protected:Nn
  \@@_load_theme:nnn
  {
```

Determine whether either this is a built-in theme according to the prop `\g_@@_context_built_in_them`
or a file named `t-markdowntheme`⟨*munged theme name*⟩`.tex` exists. If it does, load it.
Otherwise, try loading a plain TEX theme instead.

```
\bool_if:nTF
  {
    \bool_lazy_or_p:nn
      {
        \prop_if_in_p:Nn
          \g_@@_context_built_in_themes_prop
          { #1 }
      }
      {
        \file_if_exist_p:n
          { t - markdown theme #3.tex }
      }
  }
  {
    \prop_get:NnNTF
      \g_@@_context_loaded_themes_linenos_prop
      { #1 }
      \l_tmpa_tl
      {
        \prop_get:NnN
          \g_@@_context_loaded_themes_versions_prop
          { #1 }
          \l_tmpb_tl
        \str_if_eq:nVTF
          { #2 }
          \l_tmpb_tl
          {
            \msg_warning:nnnVn
              { markdown }
              { repeatedly-loaded-context-theme }
              { #1 }
              \l_tmpa_tl
              { #2 }
          }
          {
            \msg_error:nnnnVV
              { markdown }
              { different-versions-of-context-theme }
              { #1 }
              { #2 }
              \l_tmpb_tl
              \l_tmpa_tl
          }
      }
      {
        \prop_gput:Nnx
```

```
      \g_@@_context_loaded_themes_linenos_prop
      { #1 }
      { \tex_the:D \tex_inputlineno:D }  % noqa: W200
    \prop_gput:Nnn
      \g_@@_context_loaded_themes_versions_prop
      { #1 }
      { #2 }
```

Load built-in plain TEX themes from the prop \g_@@_context_built_in_themes_prop and from the filesystem otherwise.

```
    \prop_if_in:NnTF
      \g_@@_context_built_in_themes_prop
      { #1 }
      {
        \msg_info:nnnn
          { markdown }
          { loading-built-in-context-theme }
          { #1 }
          { #2 }
        \prop_item:Nn
          \g_@@_context_built_in_themes_prop
          { #1 }
      }
      {
        \msg_info:nnnn
          { markdown }
          { loading-context-theme }
          { #1 }
          { #2 }
        \usemodule
          [ t ]
          [ markdown theme #3 ]
      }
  }
  {
    \@@_plain_tex_load_theme:nnn
      { #1 }
      { #2 }
      { #3 }
  }
}
\msg_new:nnn
  { markdown }
  { loading-built-in-context-theme }
  { Loading~version~#2~of~built-in~ConTeXt~Markdown~theme~#1 }
\msg_new:nnn
  { markdown }
  { loading-context-theme }
  { Loading~version~#2~of~ConTeXt~Markdown~theme~#1 }
```

```
\msg_new:nnn
  { markdown }
  { repeatedly-loaded-context-theme }
  {
    Version~#3~of~ConTeXt~Markdown~theme~#1~was~previously~
    loaded~on~line~#2,~not~loading~it~again
  }
\msg_new:nnn
  { markdown }
  { different-versions-of-context-theme }
  {
    Tried~to~load~version~#2~of~ConTeXt~Markdown~theme~#1~
    but~version~#3~has~already~been~loaded~on~line~#4
  }
\ExplSyntaxOff
```

The `witiko/markdown/defaults` ConTEXt theme provides default definitions for token renderer prototypes. First, the ConTEXt theme loads the plain TEX theme with the default definitions for plain TEX:

```
\markdownLoadPlainTeXTheme
```

Next, the ConTEXt theme overrides some of the plain TEX definitions. See Section 3.4.3 for the actual definitions.

3.4.3 Token Renderer Prototypes

The following configuration should be considered placeholder. If the option `plain` has been enabled (see Section 2.2.2.3), none of the definitions will take effect.

```
\markdownIfOption{plain}{\iffalse}{\iftrue}
\def\markdownRendererHardLineBreakPrototype{\blank}%
\def\markdownRendererLeftBracePrototype{\textbraceleft}%
\def\markdownRendererRightBracePrototype{\textbraceright}%
\def\markdownRendererDollarSignPrototype{\textdollar}%
\def\markdownRendererPercentSignPrototype{\percent}%
\def\markdownRendererUnderscorePrototype{\textunderscore}%
\def\markdownRendererCircumflexPrototype{\textcircumflex}%
\def\markdownRendererBackslashPrototype{\textbackslash}%
\def\markdownRendererTildePrototype{\textasciitilde}%
\def\markdownRendererPipePrototype{\char`|}%
\def\markdownRendererLinkPrototype#1#2#3#4{%
  \useURL[#1][#3][][#4]#1\footnote[#1]{\ifx\empty#4\empty\else#4:
  \fi\tt<\hyphenatedurl{#3}>}}%
\usemodule[database]
\defineseparatedlist
  [MarkdownConTeXtCSV]
  [separator={,},
   before=\bTABLE,after=\eTABLE,
   first=\bTR,last=\eTR,
   left=\bTD,right=\eTD]
\def\markdownConTeXtCSV{csv}
```

```
\def\markdownRendererContentBlockPrototype#1#2#3#4{%
  \def\markdownConTeXtCSV@arg{#1}%
  \ifx\markdownConTeXtCSV@arg\markdownConTeXtCSV
    \placetable[][tab:#1]{#4}{%
      \processseparatedfile[MarkdownConTeXtCSV][#3]}%
  \else
    \markdownInput{#3}%
  \fi}%
\def\markdownRendererImagePrototype#1#2#3#4{%
  \placefigure[][]{#4}{\externalfigure[#3]}}%
\def\markdownRendererUlBeginPrototype{\startitemize}%
\def\markdownRendererUlBeginTightPrototype{\startitemize[packed]}%
\def\markdownRendererUlItemPrototype{\item}%
\def\markdownRendererUlEndPrototype{\stopitemize}%
\def\markdownRendererUlEndTightPrototype{\stopitemize}%
\def\markdownRendererOlBeginPrototype{\startitemize[n]}%
\def\markdownRendererOlBeginTightPrototype{\startitemize[packed,n]}%
\def\markdownRendererOlItemPrototype{\item}%
\def\markdownRendererOlItemWithNumberPrototype#1{\sym{#1.}}%
\def\markdownRendererOlEndPrototype{\stopitemize}%
\def\markdownRendererOlEndTightPrototype{\stopitemize}%
\definedescription
  [MarkdownConTeXtDlItemPrototype]
  [location=hanging,
   margin=standard,
   headstyle=bold]%
\definestartstop
  [MarkdownConTeXtDlPrototype]
  [before=\blank,
   after=\blank]%
\definestartstop
  [MarkdownConTeXtDlTightPrototype]
  [before=\blank\startpacked,
   after=\stoppacked\blank]%
\def\markdownRendererDlBeginPrototype{%
  \startMarkdownConTeXtDlPrototype}%
\def\markdownRendererDlBeginTightPrototype{%
  \startMarkdownConTeXtDlTightPrototype}%
\def\markdownRendererDlItemPrototype#1{%
  \startMarkdownConTeXtDlItemPrototype{#1}}%
\def\markdownRendererDlItemEndPrototype{%
  \stopMarkdownConTeXtDlItemPrototype}%
\def\markdownRendererDlEndPrototype{%
  \stopMarkdownConTeXtDlPrototype}%
\def\markdownRendererDlEndTightPrototype{%
  \stopMarkdownConTeXtDlTightPrototype}%
\def\markdownRendererEmphasisPrototype#1{{\em#1}}%
\def\markdownRendererStrongEmphasisPrototype#1{{\bf#1}}%
\def\markdownRendererBlockQuoteBeginPrototype{\startquotation}%
```

```
\def\markdownRendererBlockQuoteEndPrototype{\stopquotation}%
\def\markdownRendererLineBlockBeginPrototype{%
  \begingroup
    \def\markdownRendererHardLineBreak{
    }%
    \startlines
}%
\def\markdownRendererLineBlockEndPrototype{%
    \stoplines
  \endgroup
}%
\def\markdownRendererInputVerbatimPrototype#1{\typefile{#1}}%
```

3.4.3.1 Fenced Code

When no infostring has been specified, default to the indented code block renderer.

```
\ExplSyntaxOn
\cs_gset:Npn
  \markdownRendererInputFencedCodePrototype#1#2#3
  {
    \tl_if_empty:nTF
      { #2 }
      { \markdownRendererInputVerbatim{#1} }
```

Otherwise, extract the first word of the infostring and treat it as the name of the programming language in which the code block is written. This name is then used in the ConTEXt `\definetyping` macro, which allows the user to set up code highlighting mapping as follows:

```
\definetyping [latex]
\setuptyping  [latex] [option=TEX]

\starttext
  \startmarkdown
~~~ latex
\documentclass{article}
\begin{document}
  Hello world!
\end{document}
~~~
  \stopmarkdown
\stoptext
```

```
      {
        \regex_extract_once:nnN
          { \w* }
          { #2 }
          \l_tmpa_seq
```

```
        \seq_pop_left:NN
          \l_tmpa_seq
          \l_tmpa_tl
        \typefile[ \l_tmpa_tl ][] {#1}
      }
  }
\ExplSyntaxOff
\def\markdownRendererHeadingOnePrototype#1{\chapter{#1}}%
\def\markdownRendererHeadingTwoPrototype#1{\section{#1}}%
\def\markdownRendererHeadingThreePrototype#1{\subsection{#1}}%
\def\markdownRendererHeadingFourPrototype#1{\subsubsection{#1}}%
\def\markdownRendererHeadingFivePrototype#1{\subsubsubsection{#1}}%
\def\markdownRendererHeadingSixPrototype#1{\subsubsubsubsection{#1}}%
\def\markdownRendererThematicBreakPrototype{%
  \blackrule[height=1pt, width=\hsize]}%
\def\markdownRendererNotePrototype#1{\footnote{#1}}%
\def\markdownRendererTickedBoxPrototype{$\boxtimes$}
\def\markdownRendererHalfTickedBoxPrototype{$\boxdot$}
\def\markdownRendererUntickedBoxPrototype{$\square$}
\def\markdownRendererStrikeThroughPrototype#1{\overstrikes{#1}}
\def\markdownRendererSuperscriptPrototype#1{\high{#1}}
\def\markdownRendererSubscriptPrototype#1{\low{#1}}
\def\markdownRendererDisplayMathPrototype#1{%
  \startformula#1\stopformula}%
```

3.4.3.2 Tables

There is a basic implementation of tables.

```
\newcount\markdownConTeXtRowCounter
\newcount\markdownConTeXtRowTotal
\newcount\markdownConTeXtColumnCounter
\newcount\markdownConTeXtColumnTotal
\newtoks\markdownConTeXtTable
\newtoks\markdownConTeXtTableFloat
\def\markdownRendererTablePrototype#1#2#3{%
  \markdownConTeXtTable={}%
  \ifx\empty#1\empty
    \markdownConTeXtTableFloat={%
      \the\markdownConTeXtTable}%
  \else
    \markdownConTeXtTableFloat={%
      \placetable{#1}{\the\markdownConTeXtTable}}%
  \fi
  \begingroup
  \setupTABLE[r][each][topframe=off, bottomframe=off,
                       leftframe=off, rightframe=off]
  \setupTABLE[c][each][topframe=off, bottomframe=off,
                       leftframe=off, rightframe=off]
  \setupTABLE[r][1][topframe=on, bottomframe=on]
  \setupTABLE[r][#1][bottomframe=on]
```

```
  \markdownConTeXtRowCounter=0%
  \markdownConTeXtRowTotal=#2%
  \markdownConTeXtColumnTotal=#3%
  \markdownConTeXtRenderTableRow}
\def\markdownConTeXtRenderTableRow#1{%
  \markdownConTeXtColumnCounter=0%
  \ifnum\markdownConTeXtRowCounter=0\relax
    \markdownConTeXtReadAlignments#1%
    \markdownConTeXtTable={\bTABLE}%
  \else
    \markdownConTeXtTable=\expandafter{%
      \the\markdownConTeXtTable\bTR}%
    \markdownConTeXtRenderTableCell#1%
    \markdownConTeXtTable=\expandafter{%
      \the\markdownConTeXtTable\eTR}%
  \fi
  \advance\markdownConTeXtRowCounter by 1\relax
  \ifnum\markdownConTeXtRowCounter>\markdownConTeXtRowTotal\relax
    \markdownConTeXtTable=\expandafter{%
      \the\markdownConTeXtTable\eTABLE}%
    \the\markdownConTeXtTableFloat
    \endgroup
    \expandafter\gobbleoneargument
  \fi\markdownConTeXtRenderTableRow}
\def\markdownConTeXtReadAlignments#1{%
  \advance\markdownConTeXtColumnCounter by 1\relax
  \if#1d%
    \setupTABLE[c][\the\markdownConTeXtColumnCounter][align=right]
  \fi\if#1l%
    \setupTABLE[c][\the\markdownConTeXtColumnCounter][align=right]
  \fi\if#1c%
    \setupTABLE[c][\the\markdownConTeXtColumnCounter][align=middle]
  \fi\if#1r%
    \setupTABLE[c][\the\markdownConTeXtColumnCounter][align=left]
  \fi
  \ifnum\markdownConTeXtColumnCounter<\markdownConTeXtColumnTotal\relax
  \else
    \expandafter\gobbleoneargument
  \fi\markdownConTeXtReadAlignments}
\def\markdownConTeXtRenderTableCell#1{%
  \advance\markdownConTeXtColumnCounter by 1\relax
  \markdownConTeXtTable=\expandafter{%
    \the\markdownConTeXtTable\bTD#1\eTD}%
  \ifnum\markdownConTeXtColumnCounter<\markdownConTeXtColumnTotal\relax
  \else
    \expandafter\gobbleoneargument
  \fi\markdownConTeXtRenderTableCell}
```

3.4.3.3 Raw Attributes

In the raw block and inline raw span renderer prototypes, default to the plain TeX renderer prototypes, translating raw attribute `context` to `tex`.

```
\ExplSyntaxOn
\cs_gset:Npn
  \markdownRendererInputRawInlinePrototype#1#2
  {
    \str_case:nnF
      { #2 }
      {
        { latex }
          {
            \@@_plain_tex_default_input_raw_inline:nn
              { #1 }
              { context }
          }
      }
      {
        \@@_plain_tex_default_input_raw_inline:nn
          { #1 }
          { #2 }
      }
  }
\cs_gset:Npn
  \markdownRendererInputRawBlockPrototype#1#2
  {
    \str_case:nnF
      { #2 }
      {
        { context }
          {
            \@@_plain_tex_default_input_raw_block:nn
              { #1 }
              { tex }
          }
      }
      {
        \@@_plain_tex_default_input_raw_block:nn
          { #1 }
          { #2 }
      }
  }
\cs_gset_eq:NN
  \markdownRendererInputRawBlockPrototype
  \markdownRendererInputRawInlinePrototype
\fi % Closes `\markdownIfOption{plain}{\iffalse}{\iftrue}`
\ExplSyntaxOff
\stopmodule
\protect
```

At the end of the ConTEXt module, we load the `witiko/markdown/defaults` ConTEXt

theme with the default definitions for token renderer prototypes unless the option `noDefaults` has been enabled (see Section 2.2.2.3).

```
\ExplSyntaxOn
\str_if_eq:VVT
  \c_@@_top_layer_tl
  \c_@@_option_layer_context_tl
  {
    \use:c
      { ExplSyntaxOff }
    \@@_if_option:nF
      { noDefaults }
      {
        \@@_if_option:nTF
          { experimental }
          {
            \@@_setup:n
              { theme = witiko/markdown/defaults@experimental }
          }
          {
            \@@_setup:n
              { theme = witiko/markdown/defaults }
          }
      }
    \use:c
      { ExplSyntaxOn }
  }
\ExplSyntaxOff
\stopmodule
\protect
```

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Index

`acronyms` 22, 89, 168, 463, 465, 466
`autoIdentifiers` *22*, 34, 89, 110

`blankBeforeBlockquote` *23*
`blankBeforeCodeFence` *23*
`blankBeforeDivFence` *24*
`blankBeforeHeading` *24*
`blankBeforeHtmlBlock` *24*
`blankBeforeList` *24*
`bracketedSpans` *25*, 93, 498
`breakableBlockquotes` *25*

`cacheDir` 4, 17, 20, 60, 166, 195, 401, 425, 445
`citationNbsps` *25*
`citations` *26*, 96
`codeSpans` *26*
`contentBlocks` 21, *27*, 37
`contentBlocksLanguageMap` 21
`contentLevel` *27*

`debugExtensions` 9, 21, *27*, 345
`debugExtensionsFileName` 21, 27
`defaultOptions` *9*, 53, 399, 401
`definitionLists` *28*, 104
`depth_first_search` *174*

`eagerCache` *17*, 399
`ensureJekyllData` *28*, 29, 30, 39
`entities.char_entity` *248*
`entities.dec_entity` *247*
`entities.hex_entity` *247*
`entities.hex_entity_with_x_char` *247*
`escape_minimal` *251*
`escape_programmatic_text` *251*
`escape_typographic_text` *251*
`expandtabs` *307*
`expectJekyllData` 28, 29, *29*, 30, 39

experimental 4, *18*, 36, 469
experimentalOptions *9*, 399, 401
extensions 30, *173*, 350
extensions.acronyms 174, *350*
extensions.citations *353*
extensions.content_blocks *357*
extensions.definition_lists *360*
extensions.fancy_lists *362*
extensions.fenced_code *368*
extensions.fenced_divs *373*
extensions.header_attributes *377*
extensions.inline_code_attributes *379*
extensions.jekyll_data *395*
extensions.line_blocks *379*
extensions.link_attributes *381*
extensions.mark *380*
extensions.notes *382*
extensions.pipe_table *385*
extensions.raw_inline *389*
extensions.strike_through *389*
extensions.subscripts *390*
extensions.superscripts *391*
extensions.tex_math *391*

fancyLists *31*, 119–124, 469
fencedCode *32*, 42, 97, 109, 125, 413, 415
fencedCodeAttributes *32*, 90, 109, 415
fencedDivs *33*, 43, 109
finalizeCache 18, 22, *33*, 34, 60, 165, 399, 400
frozenCache 22, 33, 60, 78, 79, 165, 413, 424
frozenCacheCounter 34, 400, 453
frozenCacheFileName 22, 33, 60, 400

\g_markdown_diagrams_infostrings_prop *418*
gfmAutoIdentifiers 23, *34*, 90, 110

hashEnumerators *34*
headerAttributes *35*, 43, 90, 110
html 35, *35*, 36, 91, 99, 101, 482
htmlOutput *35*, 91, 99, 101
htmlOverLinks 18, *36*
hybrid 36, *36*, 42, 47, 49, 63, 79, 126, 166, 252, 308, 453

inlineCodeAttributes *38*, 90, 98
inlineNotes *38*

\inputmarkdown *168*, 170, 171, 500
inputTempFileName 61, 63, 446, 447, 449, 450
\inputyaml 29, 30, 39, *168*, 170, 500
iterlines *307*

jekyllData 3, 28–30, *38*, 39, 135–138, 140

\l_markdown_diagrams_command_version_tl 417, *418*
languages_json 357, *357*
lineBlocks *39*, 115
linkAttributes *39*, 90, 113, 116, 326, 495

mark *40*, 117, 493
\markdown 161, *161*, 162, 456
markdown 160, *160*, 161, 455
markdown* 160, *160*, 165, 455
\markdownBegin *54*, 55–57, 158–161, 169
\markdownCleanup *445*
\markdownConvert *445*
\markdownEnd *54*, 55–57, 159–162, 169
\markdownError 158, *158*
\markdownEscape *54*, 58, 453
\markdownIfOption *59*
\markdownIfSnippetExists *83*
\markdownInfo 158, *158*
\markdownInput *54*, 57, 160, 162, 165, 170, 451, 454
\markdownInputFilename *444*
\markdownInputFileStream *445*
\markdownInputPlainTeX *454*
\markdownLoadPlainTeXTheme *166*, 172, 411
\markdownLuaExecute *448*, 451
\markdownLuaOptions *441*, 445
\markdownMakeOther *158*, 499, 500
\markdownOptionExperimental *64*
\markdownOptionFinalizeCache *60*
\markdownOptionFrozenCache *60*
\markdownOptionInputTempFileName *60*
\markdownOptionNoDefaults *62*
\markdownOptionOutputDir 61, *61*, 64, 65
\markdownOptionPlain *62*
\markdownOptionStripPercentSigns *63*
\markdownOutputFileStream *445*
\markdownPrepare *444*
\markdownPrepareInputFilename *444*
\markdownPrepareLuaOptions *441*

\markdownReadAndConvert *158*, 446, 455, 456, 500
\markdownReadAndConvertProcessLine *447*, 448
\markdownReadAndConvertStripPercentSigns *446*
\markdownReadAndConvertTab *445*
\markdownRendererAcronym *89*
\markdownRendererAttributeClassName *90*
\markdownRendererAttributeIdentifier *90*
\markdownRendererAttributeKeyValue *90*
\markdownRendererBlockHtmlComment *99*
\markdownRendererBlockHtmlStandaloneTag *99*
\markdownRendererBlockQuoteBegin *92*
\markdownRendererBlockQuoteEnd *92*
\markdownRendererBracketedSpan *93*
\markdownRendererBracketedSpanAttributeContextBegin *93*
\markdownRendererBracketedSpanAttributeContextEnd *93*
\markdownRendererCite 96, *96*
\markdownRendererCodeSpan *98*
\markdownRendererCodeSpanAttributeContextBegin *98*
\markdownRendererCodeSpanAttributeContextEnd *98*
\markdownRendererContentBlock 103, *103*
\markdownRendererContentBlockCode *104*
\markdownRendererContentBlockOnlineImage *103*
\markdownRendererDisplayMath *132*
\markdownRendererDlBegin *104*
\markdownRendererDlBeginTight *105*
\markdownRendererDlDefinitionBegin *106*
\markdownRendererDlDefinitionEnd *106*
\markdownRendererDlEnd *107*
\markdownRendererDlEndTight *107*
\markdownRendererDlItem *105*
\markdownRendererDlItemEnd *106*
\markdownRendererDocumentBegin *118*
\markdownRendererDocumentEnd *118*
\markdownRendererEllipsis 44, *107*
\markdownRendererEmphasis *108*, 144
\markdownRendererError *134*
\markdownRendererFancyOlBegin 120, *120*
\markdownRendererFancyOlBeginTight *120*
\markdownRendererFancyOlEnd *124*
\markdownRendererFancyOlEndTight *124*
\markdownRendererFancyOlItem *122*
\markdownRendererFancyOlItemEnd *122*
\markdownRendererFancyOlItemWithNumber *123*
\markdownRendererFencedCodeAttributeContextBegin *109*

\markdownRendererFencedCodeAttributeContextEnd *109*
\markdownRendererFencedDivAttributeContextBegin *109*
\markdownRendererFencedDivAttributeContextEnd *109*
\markdownRendererHalfTickedBox *133*
\markdownRendererHardLineBreak *116*
\markdownRendererHeaderAttributeContextBegin *110*
\markdownRendererHeaderAttributeContextEnd *110*
\markdownRendererHeadingFive *112*
\markdownRendererHeadingFour *112*
\markdownRendererHeadingOne *111*
\markdownRendererHeadingSix *112*
\markdownRendererHeadingThree *111*
\markdownRendererHeadingTwo *111*
\markdownRendererImage *113*
\markdownRendererImageAttributeContextBegin *113*
\markdownRendererImageAttributeContextEnd *113*
\markdownRendererInlineHtmlCdataSection *101*
\markdownRendererInlineHtmlCloseTag *101*
\markdownRendererInlineHtmlComment *91*
\markdownRendererInlineHtmlDeclaration *101*
\markdownRendererInlineHtmlEmptyTag *101*
\markdownRendererInlineHtmlOpenTag *101*
\markdownRendererInlineHtmlProcessingInstruction *101*
\markdownRendererInlineHtmlTag *91*, 101
\markdownRendererInlineMath *132*
\markdownRendererInputBlockHtmlCdataElement *99*
\markdownRendererInputBlockHtmlCdataSection *99*
\markdownRendererInputBlockHtmlDeclaration *99*
\markdownRendererInputBlockHtmlElement *91*, 99
\markdownRendererInputBlockHtmlPcdataElement *99*
\markdownRendererInputBlockHtmlProcessingInstruction *99*
\markdownRendererInputFencedCode *97*
\markdownRendererInputRawBlock *125*
\markdownRendererInputRawInline *125*
\markdownRendererInputVerbatim *97*
\markdownRendererInterblockSeparator *114*
\markdownRendererJekyllDataBegin *135*
\markdownRendererJekyllDataBoolean *137*
\markdownRendererJekyllDataEmpty *140*
\markdownRendererJekyllDataEnd *135*
\markdownRendererJekyllDataMappingBegin *135*
\markdownRendererJekyllDataMappingEnd *136*
\markdownRendererJekyllDataNumber *137*
\markdownRendererJekyllDataProgrammaticString 138, *138*, 139

\markdownRendererJekyllDataSequenceBegin *136*
\markdownRendererJekyllDataSequenceEnd *137*
\markdownRendererJekyllDataString 139, *139*, 143
\markdownRendererJekyllDataStringPrototype *153*
\markdownRendererJekyllDataTypographicString 138, *138*, 139, 396
\markdownRendererLineBlockBegin *115*
\markdownRendererLineBlockEnd *115*
\markdownRendererLink *116*, 144
\markdownRendererLinkAttributeContextBegin *116*
\markdownRendererLinkAttributeContextEnd *116*
\markdownRendererMark *117*
\markdownRendererNbsp *118*
\markdownRendererNote *119*
\markdownRendererOlBegin *119*
\markdownRendererOlBeginTight *119*
\markdownRendererOlEnd *123*
\markdownRendererOlEndTight *123*
\markdownRendererOlItem 44, *121*
\markdownRendererOlItemEnd *121*
\markdownRendererOlItemWithNumber 44, *121*
\markdownRendererParagraphSeparator *114*
\markdownRendererReplacementCharacter *126*
\markdownRendererSectionBegin *125*
\markdownRendererSectionEnd *125*
\markdownRendererSoftLineBreak *115*
\markdownRendererStrikeThrough *129*
\markdownRendererStrongEmphasis *108*
\markdownRendererSubscript *130*
\markdownRendererSuperscript *130*
\markdownRendererTable *131*
\markdownRendererTableAttributeContextBegin *130*
\markdownRendererTableAttributeContextEnd *130*
\markdownRendererTextCite *96*
\markdownRendererThematicBreak *132*
\markdownRendererTickedBox *133*
\markdownRendererUlBegin *94*
\markdownRendererUlBeginTight *94*
\markdownRendererUlEnd *95*
\markdownRendererUlEndTight *95*
\markdownRendererUlItem *94*
\markdownRendererUlItemEnd *95*
\markdownRendererUntickedBox *133*
\markdownRendererWarning *134*
\markdownSetup 59, *59*, 63, 164, 165, 171, 456, 466

\markdownSetupSnippet 82, *82*
\markdownThemeVersion 72, *72*, 73
\markdownWarning 158, *158*
\markinline *54*, 56, 160, 162, 449, 454
\markinlinePlainTeX *454*
\mmdcCommand *420*

new *8*, 19, 399, 401
notes *40*, 119

parsers *270*, 306
parsers.commented_line *287*
parsers.unicode *272*
pipeTables 6, *41*, 46, 131
preserveTabs *41*, 45, 307

rawAttribute 37, 42, *42*, 125
read_decompositions *175*
reader *8*, 31, 173, 270, 306, 350
reader->add_special_character *8*, 9, 31, 345
reader->auto_link_email *334*
reader->auto_link_url *334*
reader->create_parser *307*
reader->finalize_grammar *341*, 406
reader->initialize_named_group *345*
reader->insert_pattern *8*, 9, 31, 341, 347
reader->lookup_note_reference *319*
reader->lookup_reference *319*
reader->normalize_tag *307*
reader->options *306*
reader->parser_functions *307*
reader->parser_functions.name *307*
reader->parsers 306, *306*
reader->register_link *319*
reader->update_rule 341, *344*, 347
reader->writer *306*
reader.new 306, *306*, 406
relativeReferences 36, *42*

serialize_byte_parser *174*
serialize_byte_range_parser *175*
serialize_replacement *175*
\setupmarkdown 171, *171*
\setupyaml *171*
shiftHeadings 6, 43

singletonCache *19*
slice 6, 43, 249, 263, 264
smartEllipses *44*, 107, 166
\startmarkdown *168*, 169, 500
startNumber *44*, 121–123
\startyaml 28, 30, 39, *168*, 169, 500
\stopmarkdown *168*, 169, 500
\stopyaml 29, 30, 39, *168*, 169, 500
strikeThrough *44*, 129, 494
stripIndent *45*, 307
stripPercentSigns 446
subscripts *45*, 130
superscripts *45*, 130
syntax *342*, 346

tableAttributes *46*, 130, 490
tableCaptions 6, 46, *46*, 130
taskLists *47*, 133, 481
texComments *47*, 308
texMathDollars 37, *48*, 132
texMathDoubleBackslash 37, *48*, 132
texMathSingleBackslash 37, *48*, 132
tightLists *49*, 94, 95, 105, 107, 119, 120, 123, 124, 469

underscores *49*
unicode_data.casefold_mapping *186*, 196
unicode_data.categories *187*, 272
unicode_data.ccc *189*, 197
unicode_data.composition_mapping *182*, 200
unicode_data.decomposition_mapping *176*, 178, 199
unicodeNormalization *19*, 20
unicodeNormalizationForm 19, *20*
util.cache *191*, 192
util.cache_verbatim *192*
util.canonically_order *197*
util.casefold *196*
util.compose *200*
util.decompose *199*
util.encode_json_string *192*
util.err *191*
util.escaper *194*
util.expand_tabs_in_line *192*
util.find_file *203*
util.find_files *203*

util.flatten *193*
util.intersperse *194*
util.map *194*
util.normalize *203*
util.pathname *195*
util.rope_last *193*
util.rope_to_string *193*
util.salt *195*
util.table_copy *192*
util.walk *192*, 193
util.warning *196*

walkable_syntax *8*, 21, 27, 341, 344–346
writer 173, *173*, 248, 350
writer->acronym *351*
writer->active_attributes 262, *262*, 263, 264
writer->attribute_type_levels *262*
writer->attributes *260*
writer->block_html_cdata_element *256*
writer->block_html_cdata_section *257*
writer->block_html_comment *256*
writer->block_html_declaration *256*
writer->block_html_element *256*
writer->block_html_pcdata_element *257*
writer->block_html_processing_instruction *256*
writer->block_html_standalone_tag *257*
writer->blockquote *259*
writer->bulletitem *254*
writer->bulletlist *254*
writer->citations *353*
writer->code *253*
writer->contentblock *358*
writer->defer_call 270, *270*
writer->definitionlist *360*
writer->display_math *392*
writer->div_begin *373*
writer->div_end *373*
writer->document *259*
writer->ellipsis *250*
writer->emphasis *258*
writer->error *252*
writer->escape *252*
writer->escaped_chars 251, *251*
writer->escaped_minimal_strings 251, *251*

writer->escaped_strings *251*
writer->escaped_uri_chars 251, *251*
writer->fancyitem *364*
writer->fancylist *363*
writer->fencedCode *369*
writer->flatten_inlines 248, *248*
writer->get_state *269*
writer->hard_line_break *250*
writer->heading *268*
writer->identifier *252*
writer->image *254*
writer->infostring *252*
writer->inline_html_cdata_section *258*
writer->inline_html_close_tag *258*
writer->inline_html_comment *255*
writer->inline_html_declaration *257*
writer->inline_html_empty_tag *258*
writer->inline_html_open_tag *258*
writer->inline_html_processing_instruction *257*
writer->inline_html_tag *256*
writer->inline_math *392*
writer->interblocksep *250*
writer->is_writing 249, *249*
writer->jekyllData *396*
writer->lineblock *379*
writer->link *253*
writer->mark *380*
writer->math *252*
writer->nbsp *249*
writer->note *382*
writer->options *248*
writer->ordereditem *255*
writer->orderedlist *255*
writer->paragraph *249*
writer->paragraphsep *250*
writer->plain *249*
writer->pop_attributes *262*, 263, 264
writer->push_attributes *262*, 263, 264
writer->rawBlock *369*
writer->rawInline *389*
writer->set_state *270*
writer->slice_begin *249*
writer->slice_end *249*
writer->soft_line_break *250*

writer->space *249*
writer->span *352*
writer->strike_through *390*
writer->string *252*
writer->strong *258*
writer->subscript *390*
writer->superscript *391*
writer->table *386*
writer->thematic_break *250*
writer->tickbox *259*
writer->undosep *250*, 349
writer->uri *252*
writer->verbatim *259*
writer->warning 196, *252*
writer.new 248, *248*, 406

\yaml *162*
yaml 28, 30, 39, *160*, 161, 162, 455
\yamlBegin 28, 30, 39, *54*, 55, 56, 158, 159, 161, 169
\yamlEnd 28, 30, 39, *54*, 55, 56, 159, 161, 162, 169
\yamlInput 28, 30, 39, *54*, 57, 160, 163, 170, 454
\yamlSetup *59*