A Markdown Interpreter for TEX

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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.

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

Section 2 describes the interfaces exposed by the package. Section 3 describes the implementation 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]

```lua
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",
                 "2016-2024 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).

```lua
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).

```lua
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.

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

```
;(function()  -- luacheck: ignore
```

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)()
```

All the abovelisted modules are statically linked into the current version of the LuaTEX engine [1, 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 [2] from the LATEX3 kernel in TEX Live $\leqslant$ 2019. 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
```

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.

```
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 [1, Section 4.2.4].

The Lua File System module is statically linked into the LuaTeX engine [1, 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_ε format is loaded, a TeX engine that extends ε-TeX, and all the plain TeX prerequisites (see Section 1.1.2).

```
\NeedsTeXFormat{LaTeX2e}
\RequirePackage{expl3}
```

The following packages are soft prerequisites. They are only used to provide default token renderer prototypes (see sections 2.2.6 and 3.3.4) 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.

```
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.

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

```
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 any test phase [3] will also cause enumitem to be used. In a future major version, enumitem will replace paralist altogether.

```
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 strike-throughs 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.

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

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 [4] 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.

The TEX implementation of the package draws inspiration from several sources including the source code of LATEX 2$_\varepsilon$, 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.

2.1 Lua Interface

The Lua interface provides the conversion from UTF-8 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`

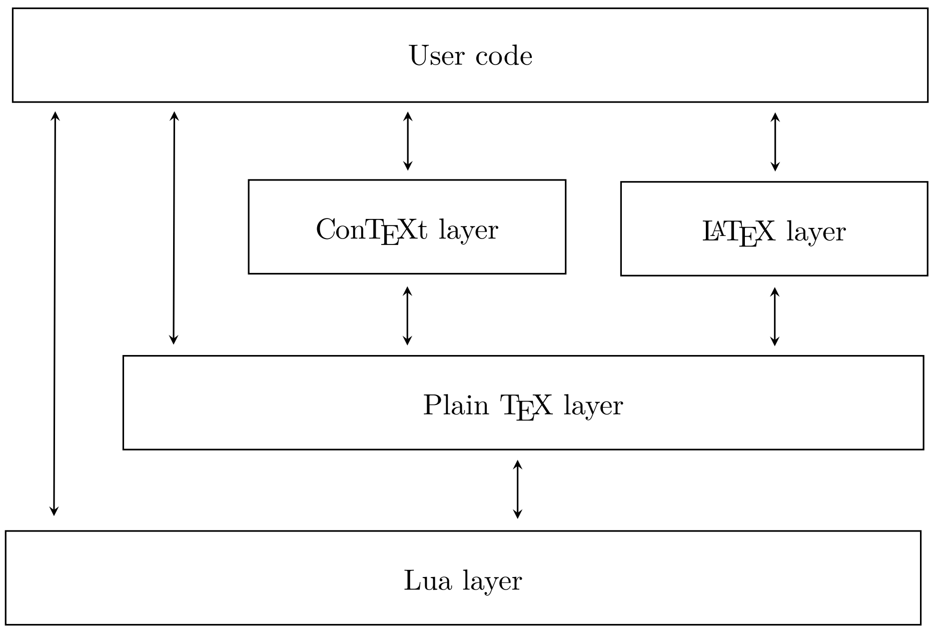


Figure 1: A block diagram of the Markdown package

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` table.

```
local defaultOptions = {}
```

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 Lua options and their types, we will maintain the `\g_@@_default_lua_options_prop` and `\g_@@_lua_option_types_prop` property lists, respectively.

```
\prop_new:N \g_@@_lua_option_types_prop
\prop_new:N \g_@@_default_lua_options_prop
\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:Nn
  \@@_add_lua_option:nnn
  {
    \@@_add_option:Vnnn
      \c_@@_option_layer_lua_tl
      { #1 }
      { #2 }
      { #3 }
  }
\cs_new: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 }
\tl_const:Nn \c_@@_option_value_true_tl  { true  }
\tl_const:Nn \c_@@_option_value_false_tl { false }
\cs_new: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:VV
                  \l_tmpa_tl
                  \c_@@_option_value_true_tl ||
                \str_if_eq_p:VV
                  \l_tmpa_tl
                  \c_@@_option_value_false_tl
              }
              {
                \msg_error:nnnV
                  { 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
  { nnnV }
\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: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_new:Nn
  \@@_get_default_option_value:nN
  {
    \bool_set_false:N
      \l_tmpa_bool
    \seq_map_inline:Nn
      \g_@@_option_layers_seq
      {
        \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: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: }  % noqa: W200
          }
          {
            \@@_option_tl_to_csname:nN
              { #1 }
              \l_tmpa_tl
            \tl_set:Nv
              #2
              { \l_tmpa_tl }
          }
      }
  }
\cs_new: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 }
      }
  }
```

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: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:Nn \@@_camel_case:N  % noqa: w401
  {
    \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:Nn \@@_snake_case:N  % noqa: w401
  {
    \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 and obscures the output of the Lua command-line interface when it is used for plumbing.

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 just means that the version `experimental` of the theme `witiko/markdown/defaults` will be loaded and warnings for hard-deprecated features will become errors. However, the effects may extend to other areas in the future 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 2.2.5.9 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

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

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

```
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
```

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

```
  { 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
```

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
```

bracketedSpans=true, false default: false

true Enable the Pandoc bracketed span syntax extension[10]:

```
[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
```

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

`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
```

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

`true` Enable the Pandoc citation syntax extension[11]:

```
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,
```

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

```
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
```

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

true

: Enable the iA Writer content blocks syntax extension [5]:

~~~
``` md
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`

`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.

`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.

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

```
defaultOptions.ensureJekyllData = false
```

expectJekyllData=true, false default: false

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}
```

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}
```

```
\@@_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.

```
\cs_generate_variant:Nn
  \@@_add_lua_option:nnn
  { nnV }
\@@_add_lua_option:nnV
  { extensions }
  { clist }
  \c_empty_clist
```

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

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

`true` Enable the Pandoc fancy list syntax extension[12]:

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

`false` Disable the Pandoc fancy list syntax extension.

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

```
defaultOptions.fancyLists = false
```

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

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[13]:

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

false Disable the Pandoc fenced code attribute syntax extension.

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

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

```
defaultOptions.fencedCodeAttributes = false
```

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

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

```
::::: {#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
```

[14]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[15]:

```
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.

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

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

```
defaultOptions.hashEnumerators = false
```

`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 inline HTML tags, block HTML elements, HTML comments, HTML instructions, and entities in the input. Inline HTML tags, block HTML elements and HTML comments will be rendered, HTML instructions will be ignored, and HTML entities will be replaced with the corresponding Unicode codepoints.

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

```
\@@_add_lua_option:nnn
  { html }
  { boolean }
  { true }
```

```
defaultOptions.html = 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[16]:

```
`<$>`{.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[17]:

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

[16]See https://pandoc.org/MANUAL.html#extension-inline_code_attributes.
[17]See https://pandoc.org/MANUAL.html#extension-inline_notes.

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[18] 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.

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

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

```
\@@_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[19]:

```
An inline ![image](foo.jpg){#id .class width=30 height=20px}
and a reference ![image][ref] with attributes.

[ref]: foo.jpg "optional title" {#id .class key=val key2=val2}
```

[18]See https://pandoc.org/MANUAL.html#extension-yaml_metadata_block.
[19]See https://pandoc.org/MANUAL.html#extension-link_attributes.

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[20]:

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

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[21]:

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

false Disable the Pandoc mark syntax extension.

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

```
defaultOptions.mark = false
```

[20]See https://pandoc.org/MANUAL.html#extension-line_blocks.
[21]See https://pandoc.org/MANUAL.html#extension-mark.

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

`true` Enable the Pandoc note syntax extension[22]:

```
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.
```

`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.

[22]See https://pandoc.org/MANUAL.html#extension-footnotes.

```
\@@_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[23]:

```
`$H_2 O$`{=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.

[23]See `https://pandoc.org/MANUAL.html#extension-raw_attribute`.

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

```
defaultOptions.rawAttribute = false
```

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

`true` Enable relative references[24] 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.

```
\@@_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. Instead, those headings will be shifted to level 6, when ⟨*shift amount*⟩ is positive, and to level 1, when ⟨*shift amount*⟩ is negative.

```
\@@_add_lua_option:nnn
  { shiftHeadings }
  { number }
  { 0 }
```

```
defaultOptions.shiftHeadings = 0
```

[24]See https://datatracker.ietf.org/doc/html/rfc3986#section-4.2.

`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[25]:

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

false   Disable the Pandoc strike-through syntax extension.

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

```
defaultOptions.strikeThrough = false
```

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
```

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

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

`true` Enable the Pandoc subscript syntax extension[26]:

```
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[27]:

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

`false` Disable the Pandoc superscript syntax extension.

```
\@@_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).

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

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

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

`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[28] for pipe tables (see the `pipeTables` option).

~~~
``` md
| 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 }
```

```
defaultOptions.tableCaptions = false
```

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

`true` Enable the Pandoc task list syntax extension[29]:

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

`false` Disable the Pandoc task list syntax extension.

[28]See https://pandoc.org/MANUAL.html#extension-table_captions.
[29]See https://pandoc.org/MANUAL.html#extension-task_lists.
```

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

```
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.

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

```
defaultOptions.texComments = false
```

`texMathDollars`=`true`, `false` default: `false`

`true`	Enable the Pandoc dollar math syntax extension[30]:

```
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
```

[30]See https://pandoc.org/MANUAL.html#extension-tex_math_dollars.

texMathDoubleBackslash=true, false default: false

true Enable the Pandoc double backslash math syntax extension[31]:

```
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[32]:

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

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

false Disable the Pandoc single backslash math syntax extension.

```
\@@_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:

[31]See https://pandoc.org/MANUAL.html#extension-tex_math_double_backslash.
[32]See https://pandoc.org/MANUAL.html#extension-tex_math_single_backslash.

```
- 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.

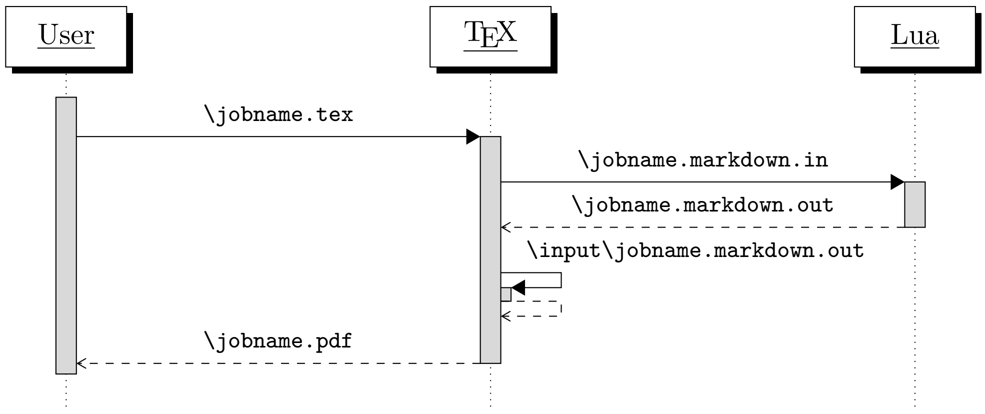


Figure 2: A sequence diagram of the Markdown package typesetting a markdown document using the TeX interface

```
.TH MARKDOWN2TEX 1 "(((LASTMODIFIED)))"
.SH NAME
markdown2tex \- convert .md files to .tex
.SH SYNOPSIS
```

</lua-cli-manpage> <*lua-cli>

```
local HELP_STRING = "Usage: " .. [[
```

</lua-cli> <*lua-cli,lua-cli-manpage>

```
markdown2tex [OPTIONS] -- [INPUT_FILE] [OUTPUT_FILE]

```

</lua-cli,lua-cli-manpage> <*lua-cli-manpage>

```
.SH DESCRIPTION
```

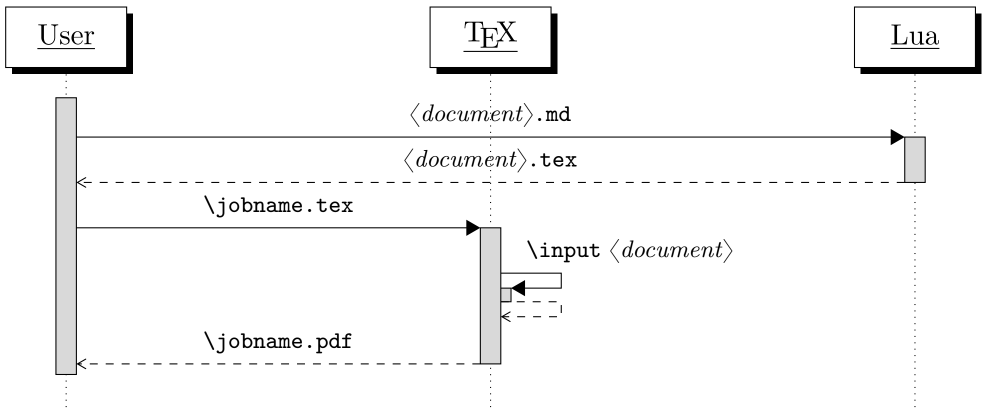


Figure 3: A sequence diagram of the Markdown package typesetting a markdown document using the Lua command-line interface

```
%  \end{macrocode}
⟨/lua-cli-manpage⟩
⟨*lua-cli, lua-cli-manpage⟩
%  \begin{macrocode}
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.
%  \end{macrocode}
⟨/lua-cli, lua-cli-manpage⟩
⟨*lua-cli⟩
%  \begin{macrocode}

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 [6] such as `fancy_lists`, `header_attributes`, and `pipe_tables`, we accept snake_case in addition to camelCase variants of options. As a bonus, studies [7] 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.

```
  elseif output_filename == nil then
    output_filename = arg[i]
  else
    error('Unexpected argument: "' .. arg[i] .. '".')
  end
  ::continue::
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.

```
\def\markdownLastModified{(((LASTMODIFIED)))}%
\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 \inputting 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 [8, 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
```

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 plain TEX options and their types, we will maintain the `\g_@@_default_plain_tex_options_prop` and `\g_@@_plain_tex_option_types_prop` property lists, respectively.

```
\prop_new:N \g_@@_plain_tex_option_types_prop
\prop_new:N \g_@@_default_plain_tex_options_prop
\seq_gput_right:NV
  \g_@@_option_layers_seq
  \c_@@_option_layer_plain_tex_tl
\cs_new: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: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_conditional:Nnn  % noqa: w401
  \@@_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[33]. 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.

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
```

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

```
  { 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 [9] 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: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 [6] such as `fancy_lists`, `header_attributes`, and `pipe_tables`, we accept snake_case in addition to camelCase variants of options. As a bonus, studies [7] 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:Nn
  \@@_define_option_command:n
  {
```

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 [1, 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: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_generate_variant:Nn
  \@@_set_option_value:nn
  { nV }
\cs_new: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: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 .default:n = { true },
          }
      }
      {
        \keys_define:nn
          { markdown/options }
          {
            #3 .code:n = {
              \@@_set_option_value:nn
                { #2 }
                { ##1 }
            },
          }
      }
```

For options of type `clist`, 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_put_right:Nn
          \l_tmpa_tl
          {
            .code:n = {
              \@@_get_option_value:nN
                { #2 }
                \l_tmpa_tl
              \clist_set:NV
                \l_tmpa_clist
                { \l_tmpa_tl , { ##1 } }
              \@@_set_option_value:nV
                { #2 }
                \l_tmpa_clist
            }
          }
        \keys_define:nV
```

```
          { markdown/options }
          \l_tmpa_tl
      }
  }
\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 [10, 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` [11].

```
\ExplSyntaxOn
\keys_define:nn
  { markdown/options }
  {
    theme .code:n = {
      \@@_set_theme:n
        { #1 }
    },
    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: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 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 }
```

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. The remaining attributes are treated as image attributes.

~~~
\documentclass{article}
\usepackage[import=witiko/diagrams@v2, relativeReferences]{markdown}
\begin{document}
\begin{markdown}
``` dot {caption="An example directed graph" 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.

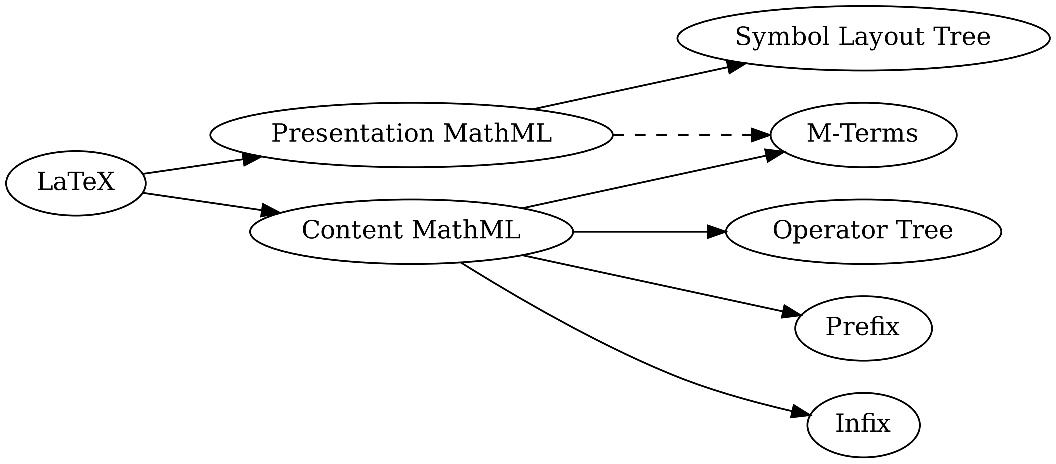


Figure 4: An example directed graph

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/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

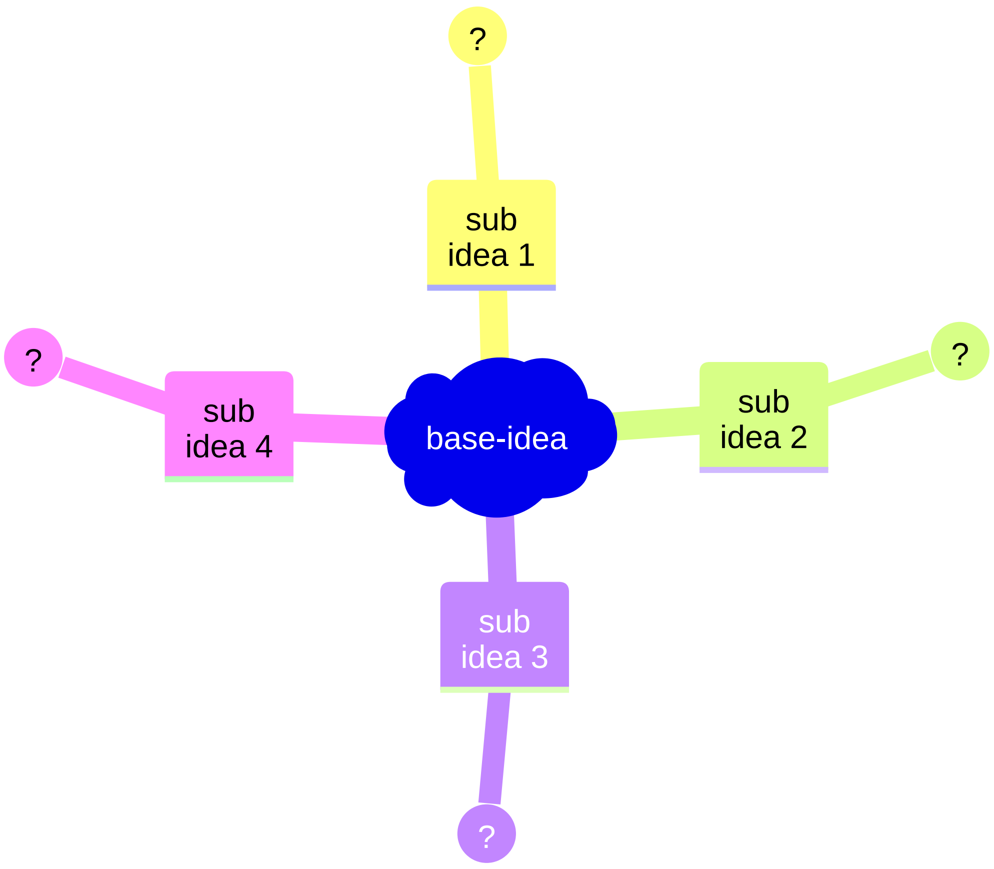


Figure 5: An example mindmap

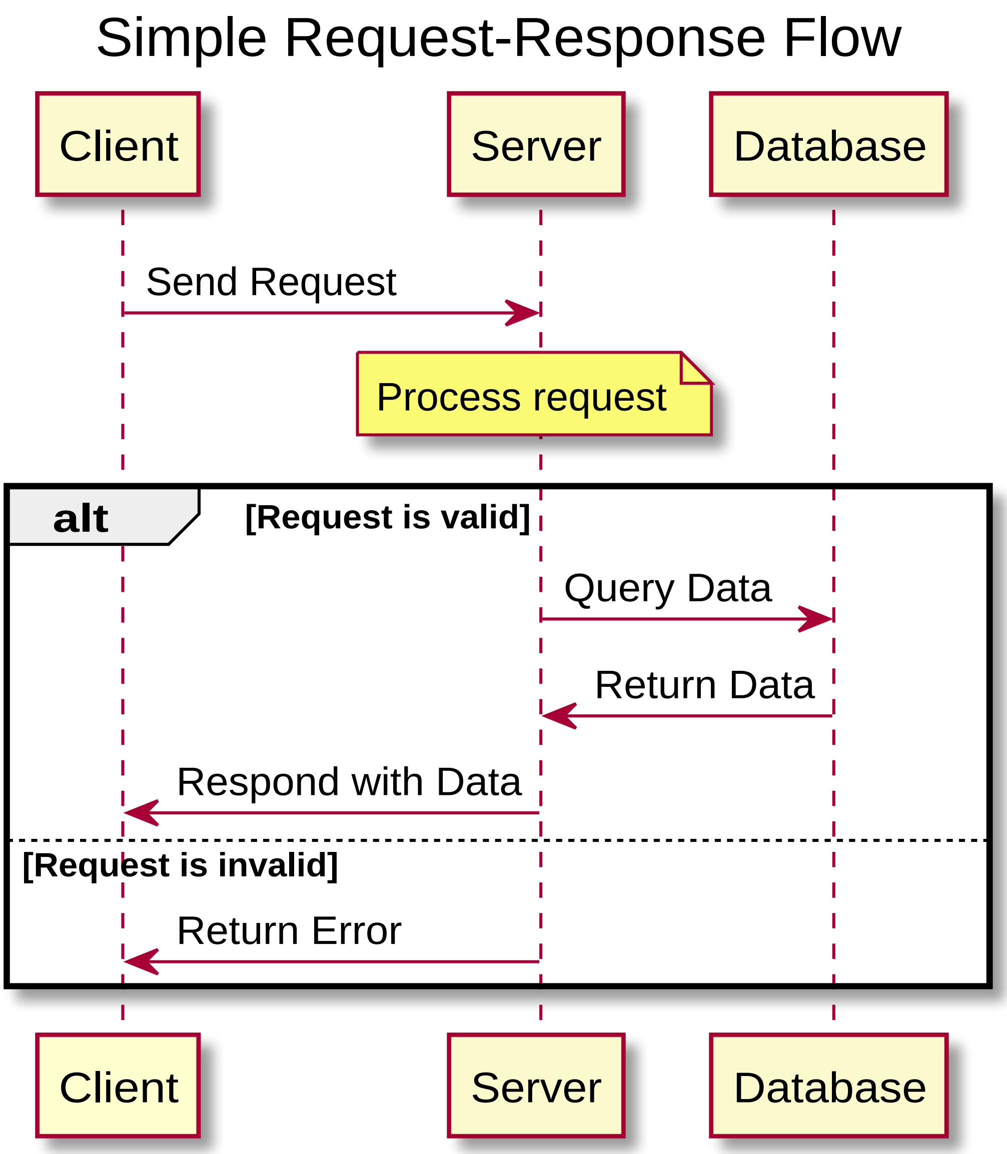
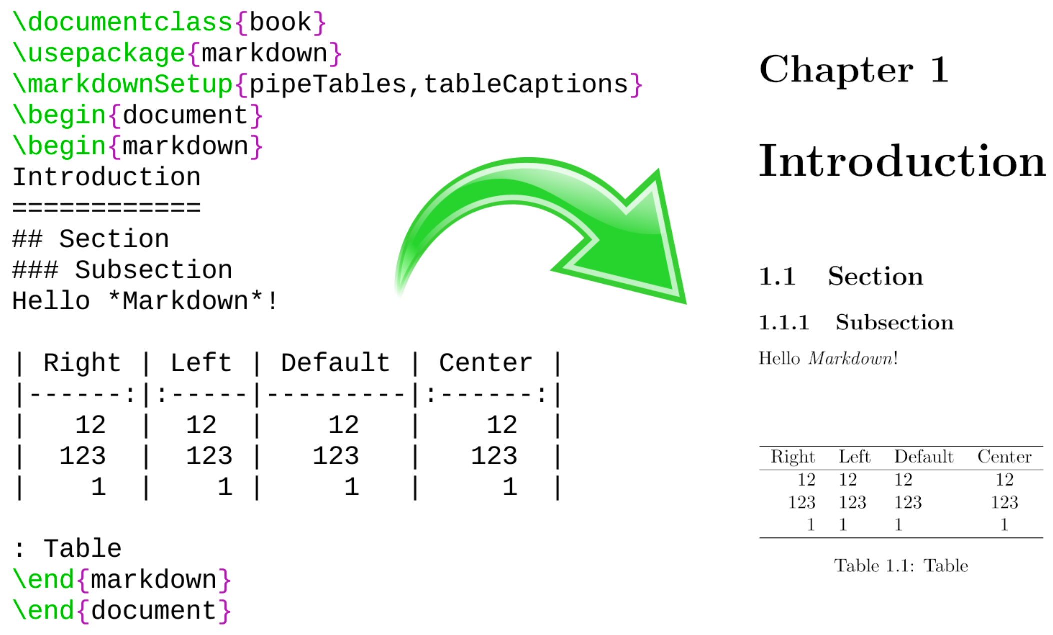


Figure 6: An example UML sequence diagram



```
\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

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
```

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.

Please, 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:Nn
  \@@_setup_snippet:nn
  {
    \tl_if_empty:nT
      { #1 }
      {
        \msg_error:nnn
          { markdown }
          { empty-snippet-name }
          { #1 }
      }
    \tl_set:NV
      \l_tmpa_tl
      \g_@@_current_theme_tl
    \tl_put_right:Nn
      \l_tmpa_tl
      { #1 }
    \@@_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_conditional:Nnn
  \@@_if_snippet_exists:n
  { TF, T }
  {
    \tl_set:NV
      \l_@@_current_snippet_tl
      \g_@@_current_theme_tl
    \tl_put_right:Nn
      \l_@@_current_snippet_tl
      { #1 }
    \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
```

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

```
\keys_define:nn
  { markdown/options }
  {
    snippet .code:n = {
      \tl_set:NV
        \l_tmpa_tl
        \g_@@_current_theme_tl
      \tl_put_right:Nn
        \l_tmpa_tl
        { #1 }
      \@@_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 .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 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 a 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
```

2.2.5.2 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
```

2.2.5.3 Bracketed Spans Attribute Context Renderers

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

The `\markdownRendererBracketedSpanAttributeContextBegin` and `\markdownRendererBrac`
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
```

2.2.5.4 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
```

2.2.5.5 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
```

2.2.5.6 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
```

2.2.5.7 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
```

2.2.5.8 Code Span Attribute Context Renderers

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

The \markdownRendererCodeSpanAttributeContextBegin and \markdownRendererCodeSpanA 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
```

2.2.5.9 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[34] 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 [5] is a good starting point.

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

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

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

2.2.5.10 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
  {
    \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
```

2.2.5.11 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
```

2.2.5.12 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
```

2.2.5.13 Fenced Code Attribute Context Renderers

The following macros are only produced, when the fencedCode and fencedCodeAttributes options are enabled.

The \markdownRendererFencedCodeAttributeContextBegin and \markdownRendererFencedC 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
```

2.2.5.14 Fenced Div Attribute Context Renderers

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

The `\markdownRendererFencedDivAttributeContextBegin` and `\markdownRendererFencedDi`
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
```

2.2.5.15 Header Attribute Context Renderers

The following macros are only produced, when the autoIdentifiers, gfmAutoIdentifiers, or headerAttributes options are enabled.

The \markdownRendererHeaderAttributeContextBegin and \markdownRendererHeaderAttri 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
```

2.2.5.16 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
```

2.2.5.17 Inline HTML Comment Renderer

The \markdownRendererInlineHtmlComment macro represents the contents of an inline HTML comment. This macro will only be produced, when the html option is enabled. The macro receives a single argument that corresponds to the contents of the HTML comment.

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

2.2.5.18 HTML Tag and Element Renderers

The \markdownRendererInlineHtmlTag macro represents an opening, closing, or empty inline HTML tag. This macro will only be produced, when the html option is enabled. 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.

```
\ExplSyntaxOn
\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
```

2.2.5.19 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
```

2.2.5.20 Image Attribute Context Renderers

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

The `\markdownRendererImageAttributeContextBegin` and `\markdownRendererImageAttribu` 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
```

2.2.5.21 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
```

2.2.5.22 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
```

2.2.5.23 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
```

2.2.5.24 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
```

2.2.5.25 Link Attribute Context Renderers

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

The `\markdownRendererLinkAttributeContextBegin` and `\markdownRendererLinkAttribute`
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
```

2.2.5.26 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
```

2.2.5.27 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
```

2.2.5.28 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
```

2.2.5.29 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
```

2.2.5.30 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
```

2.2.5.31 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
```

2.2.5.32 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
```

2.2.5.33 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
```

2.2.5.34 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
```

2.2.5.35 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
```

2.2.5.36 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 }
```

2.2.5.37 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
```

2.2.5.38 Table Attribute Context Renderers

The following macros are only produced, when the `tableCaptions` and `tableAttributes` options are enabled.

The `\markdownRendererTableAttributeContextBegin` and `\markdownRendererTableAttribu`
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
```

2.2.5.39 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
```

2.2.5.40 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
```

2.2.5.41 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
```

2.2.5.42 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
```

2.2.5.43 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
```

2.2.5.44 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 `\markdownRendererJekyllDataP` 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 `\markdownRendererJekyllDataT` 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 `\markdownRendererJekyllDataTypographicSt` macro is more appropriate for texts that are supposed to be typeset with TEX, such as document titles, author names, or exam questions, the

\markdownRendererJekyllDataProgrammaticString 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 \markdownRendererJekyllData macro was not produced. The \markdownRendererJekyllDataString 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
```

2.2.5.45 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:Nn \@@_define_renderers:
  {
    \seq_map_inline:Nn
      \g_@@_renderers_seq
      {
        \@@_define_renderer:n
          { ##1 }
      }
  }
\cs_new: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: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_@@_appending_renderer_bool
\bool_new:N
  \g_@@_unprotected_renderer_bool
\cs_new:Nn \@@_define_renderer:nNn
  {
    \keys_define:nn
      { markdown/options/renderers }
      {
        #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_@@_appending_renderer_bool
            {
              \@@_tl_set_from_cs:NNn
                \l_tmpa_tl
                #2
                { #3 }
              \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 [12]. 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 .code:n = {
      \bool_gset_false:N
        \g_@@_unprotected_renderer_bool
      \keys_set:nn
        { markdown/options/renderers }
        { #1 }
    },
    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_@@_appending_key_regex
  { \s*+$ }
\keys_define:nn
  { markdown/options/renderers }
  {
    unknown .code:n = {
```

Besides defining renderers at once, we can also define them incrementally using the appending operator (`+=`). This can be especially useful in defining rules for processing different HTML class names and identifiers:

```
\markdownSetup{
  renderers = {
    % Start with empty renderers.
    headerAttributeContextBegin = {},
    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:NVTF  % noqa: w202
        \c_@@_appending_key_regex
        \l_keys_key_str
        {
          \bool_gset_true:N
            \g_@@_appending_renderer_bool
          \tl_set:NV
            \l_tmpa_tl
            \l_keys_key_str
          \regex_replace_once:NnN
            \c_@@_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_@@_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.
}
```

```
        {
          \@@_glob_seq:VnN
            \l_keys_key_str
            { g_@@_renderers_seq }
            \l_@@_renderer_glob_results_seq
          \seq_if_empty:NTF
            \l_@@_renderer_glob_results_seq
            {
              \msg_error:nnV
                { markdown }
                { undefined-renderer }
                \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/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 }
  { TF }
\prop_new:N
  \g_@@_glob_cache_prop
\tl_new:N
  \l_@@_current_glob_tl
\cs_new: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 [2] 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 .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 .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*⟩ [13] 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:Nn \@@_define_renderer_prototypes:
  {
    \seq_map_inline:Nn
      \g_@@_renderers_seq
      {
        \@@_define_renderer_prototype:n
          { ##1 }
      }
  }
\cs_new: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: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_@@_appending_renderer_prototype_bool
\bool_new:N
  \g_@@_unprotected_renderer_prototype_bool
\cs_new:Nn \@@_define_renderer_prototype:nNn
```

```
{
  \keys_define:nn
    { markdown/options/renderer-prototypes }
    {
      #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_@@_appending_renderer_prototype_bool
          {
            \@@_tl_set_from_cs:NNn
              \l_tmpa_tl
              #2
              { #3 }
            \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 \markdownRendererImageProto
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 .code:n = {
```

Besides defining renderer prototypes at once, we can also define them incrementally using the appending operator (+=). This can be especially useful in defining rules for processing different HTML class names and identifiers:

```
\markdownSetup{
  rendererPrototypes = {
    % Start with empty renderer prototypes.
    headerAttributeContextBegin = {},
    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 += {...},
        },
      }
    },
  },
}
```

```
      % TODO: Use `\regex_if_match` in TeX Live 2025.
      \regex_match:NVTF  % noqa: w202
        \c_@@_appending_key_regex
        \l_keys_key_str
        {
          \bool_gset_true:N
            \g_@@_appending_renderer_prototype_bool
          \tl_set:NV
            \l_tmpa_tl
            \l_keys_key_str
          \regex_replace_once:NnN
            \c_@@_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/renderer-prototypes }
            \l_tmpb_tl
          \bool_gset_false:N
            \g_@@_appending_renderer_prototype_bool
            }
```

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.
}
```

```
            {
              \@@_glob_seq:VnN
                \l_keys_key_str
                { g_@@_renderers_seq }
                \l_@@_renderer_glob_results_seq
              \seq_if_empty:NTF
                \l_@@_renderer_glob_results_seq
                {
                  \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 .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 .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 .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 2.2.5.45) 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

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}                 \documentclass{article}
\usepackage{markdown}                   \usepackage{markdown}
\begin{document}                        \begin{document}
\begin{markdown}[smartEllipses]         \begin{markdown*}{smartEllipses}
_Hello_ **world** ...                   _Hello_ **world** ...
\end{markdown}                          \end{markdown*}
\end{document}                          \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.

```
\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. [14, 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 "`markdown`foo emphasis: _bar_ baz!`/markdown`", 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 "markdownfoo emphasis_bar_/emphasis baz!/markdown", 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 2.2.5.12. 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 2.2.5.39.

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 [15, 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
```

Please, see Section 3.3.2 for implementation details of the built-in LaTeX themes.

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.

```
3982 \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.

```
\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: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:Nn \@@_caseless:N  % noqa: w401
  {
    \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
```

Please, 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-generat`
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).

```
local function depth_first_search(node, path, visit, leave)
  assert(node._type == "intermediate")
  visit(node, path)
  for label, child in pairs(node) do
```

```
    if label == "_type" then
      goto continue
    end
    if child._type == "intermediate" then
      depth_first_search(child, path .. label, visit, leave)
    else
      assert(child._type == "leaf")
      visit(child, path)
    end
    ::continue::
  end
  leave(node, path)
end
```

The function `serialize_byte_parser` produces the Lua code for a PEG parser that matches a single byte.

```
local function serialize_byte_parser(byte)
  if byte == '"' then
    return "P('" .. byte .. "')"
  elseif byte == "\\" then
    return 'P("\\\\")'
  else
    return 'P("' .. byte .. '")'
  end
end
```

The function `serialize_byte_range_parser` produces the Lua code for a PEG parser that matches a contiguous range of bytes.

```
local function serialize_byte_range_parser(start_byte, end_byte)
  assert(start_byte <= end_byte)
  if start_byte == "\\" then
    start_byte = "\\\\"
  end
  if end_byte == "\\" then
    end_byte = "\\\\"
  end
  if start_byte == '"' or end_byte == '"' then
    return "R('" .. start_byte .. end_byte .. "')"
  else
    return 'R("' .. start_byte .. end_byte .. '")'
  end
end
```

The function `serialize_replacement` produces the Lua code for a string literal with one or more UTF-8-encoded Unicode characters.

```
local function serialize_replacement(codepoints)
  assert(#codepoints > 0)
  local buffer = {'"'}
  for _, codepoint in ipairs(codepoints) do
    local code = utf8.char(codepoint)
    for i = 1, #code do
      local byte = code:sub(i, i)
      if byte == '"' then
        table.insert(buffer, '\\\"')
      elseif byte == "\\" then
        table.insert(buffer, "\\\\")
      else
        table.insert(buffer, byte)
      end
    end
  end
  table.insert(buffer, '"')
  return table.concat(buffer)
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.

```
local function read_decompositions(file)
  return function()
    local from_codepoint, mapping
    for line in file:lines() do
      from_codepoint, mapping
        = 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 [16, 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 pathname = assert(kpse.find_file("UnicodeData.txt"),
    [[Could not locate file "UnicodeData.txt"]])
  local file = assert(io.open(pathname, "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
  end
  for decomposition_type, from_codepoint, to_codepoints
      in read_decompositions(file) do
    local from_code = utf8.char(from_codepoint)
    local node = prefix_trees[decomposition_type][#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
  end
  assert(file:close())
```

Next, we will construct parsers out of the prefix trees.

```
  print("M.decomposition_mapping = {}")
  for _, decomposition_type in ipairs(decomposition_types) do
    print("M.decomposition_mapping." .. decomposition_type .. " = {}")
    for length, prefix_tree in pairs(prefix_trees[decomposition_type])
    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.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 [16, 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 pathname = assert(kpse.find_file("HangulSyllableType.txt"),
    [[Could not locate file "HangulSyllableType.txt"]])
  local file = assert(io.open(pathname, "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
    local subparsers = {}
    depth_first_search(prefix_tree, "", function(node, path)
      if node._type == "leaf" then
        local start_byte, end_byte = table.unpack(node)
        local suffix
        if start_byte == end_byte then
          suffix = serialize_byte_parser(start_byte)
        else
          assert(start_byte < end_byte)
          suffix = serialize_byte_range_parser(start_byte, end_byte)
        end
        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
        if subparsers[path] then
          print(
            "M.decomposition_mapping.hangul." .. syllable_type
            .. "[" .. length .. "] = C(" .. subparsers[path] .. ")"
            .. " / hangul_decompose_" .. syllable_type
          )
        else
          print(
            "M.decomposition_mapping.hangul." .. syllable_type
            .. "[" .. length .. "] = fail"
          )
        end
      end
    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 [16, 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 pathname
    = assert(kpse.find_file("DerivedNormalizationProps.txt"),
    [[Could not locate file "DerivedNormalizationProps.txt"]])
  local file = assert(io.open(pathname, "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`.

```
  pathname = assert(kpse.find_file("UnicodeData.txt"),
    [[Could not locate file "UnicodeData.txt"]])
  file = assert(io.open(pathname, "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 mapping (C and F) [16, 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 pathname = assert(kpse.find_file("CaseFolding.txt"),
    [[Could not locate file "CaseFolding.txt"]])
  local file = assert(io.open(pathname, "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 [16, 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 pathname = assert(kpse.find_file("UnicodeData.txt"),
    [[Could not locate file "UnicodeData.txt"]])
  local file = assert(io.open(pathname, "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 [16, 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 pathname = assert(kpse.find_file("UnicodeData.txt"),
    [[Could not locate file "UnicodeData.txt"]])
  local file = assert(io.open(pathname, "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 [17, 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

$$\sum_{(\texttt{k},\texttt{v})\in\texttt{string\_escapes}} \texttt{P(k) / v} + \texttt{escapable}$$

capture that replaces any occurrence of the string `k` with the string `v` for each $(\texttt{k},\texttt{v}) \in$ `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.

```
  if string_escapes then
    for k,v in pairs(string_escapes) do
      escapable = P(k) / v + escapable
    end
  end
```

Create an LPeg capture `escape_string` that captures anything `escapable` does and matches any other unmatched characters.

```
  local escape_string = Cs((escapable + any)^0)
```

Return a function that matches the input string `s` against the `escape_string` capture.

```
  return function(s)
    return lpeg.match(escape_string, s)
  end
end
```

The `util.pathname` method produces a pathname out of a directory name `dir` and a filename `file` and returns it.

```
function util.pathname(dir, file)
  if #dir == 0 then
    return file
  else
    return dir .. "/" .. file
  end
end
```

The `util.salt` method produces cryptographic salt out of a table of options `options`.

```
function util.salt(options)
  local opt_string = {}
  for k, _ in pairs(defaultOptions) do
    local v = options[k]
    if type(v) == "table" then
      for _, i in ipairs(v) do
        opt_string[#opt_string+1] = k .. "=" .. tostring(i)
      end
```

The `cacheDir` option is disregarded.

```
    elseif k ~= "cacheDir" then
      opt_string[#opt_string+1] = k .. "=" .. tostring(v)
    end
  end
  table.sort(opt_string)
  local salt = table.concat(opt_string, ",")
               .. "," .. metadata.version
  return salt
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.

```
util.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
end)()
```

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
```

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 = {
```

```
["Tab"] = 9,
["NewLine"] = 10,
["excl"] = 33,
["QUOT"] = 34,
["quot"] = 34,
["num"] = 35,
["dollar"] = 36,
["percnt"] = 37,
["AMP"] = 38,
["amp"] = 38,
["apos"] = 39,
["lpar"] = 40,
["rpar"] = 41,
["ast"] = 42,
["midast"] = 42,
["plus"] = 43,
["comma"] = 44,
["period"] = 46,
["sol"] = 47,
["colon"] = 58,
["semi"] = 59,
["LT"] = 60,
["lt"] = 60,
["nvlt"] = {60, 8402},
["bne"] = {61, 8421},
["equals"] = 61,
["GT"] = 62,
["gt"] = 62,
["nvgt"] = {62, 8402},
["quest"] = 63,
["commat"] = 64,
["lbrack"] = 91,
["lsqb"] = 91,
["bsol"] = 92,
["rbrack"] = 93,
["rsqb"] = 93,
["Hat"] = 94,
["UnderBar"] = 95,
["lowbar"] = 95,
["DiacriticalGrave"] = 96,
["grave"] = 96,
["fjlig"] = {102, 106},
["lbrace"] = 123,
["lcub"] = 123,
["VerticalLine"] = 124,
["verbar"] = 124,
["vert"] = 124,
["rbrace"] = 125,
["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,
["Acirc"] = 194,
["Atilde"] = 195,
["Auml"] = 196,
["Aring"] = 197,
["angst"] = 197,
["AElig"] = 198,
["Ccedil"] = 199,
["Egrave"] = 200,
["Eacute"] = 201,
["Ecirc"] = 202,
["Euml"] = 203,
["Igrave"] = 204,
["Iacute"] = 205,
["Icirc"] = 206,
["Iuml"] = 207,
["ETH"] = 208,
["Ntilde"] = 209,
["Ograve"] = 210,
["Oacute"] = 211,
["Ocirc"] = 212,
["Otilde"] = 213,
["Ouml"] = 214,
["times"] = 215,
["Oslash"] = 216,
["Ugrave"] = 217,
["Uacute"] = 218,
["Ucirc"] = 219,
["Uuml"] = 220,
["Yacute"] = 221,
["THORN"] = 222,
["szlig"] = 223,
["agrave"] = 224,
["aacute"] = 225,
["acirc"] = 226,
["atilde"] = 227,
["auml"] = 228,
["aring"] = 229,
["aelig"] = 230,
["ccedil"] = 231,
["egrave"] = 232,
["eacute"] = 233,
["ecirc"] = 234,
["euml"] = 235,
["igrave"] = 236,
["iacute"] = 237,
["icirc"] = 238,
["iuml"] = 239,
["eth"] = 240,
["ntilde"] = 241,
["ograve"] = 242,
["oacute"] = 243,
["ocirc"] = 244,
["otilde"] = 245,
["ouml"] = 246,
["div"] = 247,
["divide"] = 247,
["oslash"] = 248,
["ugrave"] = 249,
["uacute"] = 250,
["ucirc"] = 251,
["uuml"] = 252,
["yacute"] = 253,
["thorn"] = 254,
["yuml"] = 255,
["Amacr"] = 256,
["amacr"] = 257,
["Abreve"] = 258,
["abreve"] = 259,
["Aogon"] = 260,
["aogon"] = 261,
["Cacute"] = 262,
["cacute"] = 263,
["Ccirc"] = 264,
["ccirc"] = 265,
["Cdot"] = 266,
["cdot"] = 267,
["Ccaron"] = 268,
["ccaron"] = 269,
["Dcaron"] = 270,
["dcaron"] = 271,
["Dstrok"] = 272,
["dstrok"] = 273,
["Emacr"] = 274,
["emacr"] = 275,
["Edot"] = 278,
["edot"] = 279,
["Eogon"] = 280,
["eogon"] = 281,
["Ecaron"] = 282,
["ecaron"] = 283,
["Gcirc"] = 284,
["gcirc"] = 285,
["Gbreve"] = 286,
["gbreve"] = 287,
["Gdot"] = 288,
["gdot"] = 289,
["Gcedil"] = 290,
["Hcirc"] = 292,
["hcirc"] = 293,
["Hstrok"] = 294,
["hstrok"] = 295,
["Itilde"] = 296,
["itilde"] = 297,
["Imacr"] = 298,
["imacr"] = 299,
["Iogon"] = 302,
["iogon"] = 303,
["Idot"] = 304,
["imath"] = 305,
["inodot"] = 305,
["IJlig"] = 306,
["ijlig"] = 307,
["Jcirc"] = 308,
["jcirc"] = 309,
["Kcedil"] = 310,
["kcedil"] = 311,
["kgreen"] = 312,
["Lacute"] = 313,
["lacute"] = 314,
["Lcedil"] = 315,
["lcedil"] = 316,
["Lcaron"] = 317,
["lcaron"] = 318,
["Lmidot"] = 319,
["lmidot"] = 320,
["Lstrok"] = 321,
["lstrok"] = 322,
["Nacute"] = 323,
["nacute"] = 324,
["Ncedil"] = 325,
["ncedil"] = 326,
["Ncaron"] = 327,
["ncaron"] = 328,
["napos"] = 329,
["ENG"] = 330,
["eng"] = 331,
["Omacr"] = 332,
["omacr"] = 333,
["Odblac"] = 336,
["odblac"] = 337,
["OElig"] = 338,
["oelig"] = 339,
["Racute"] = 340,
["racute"] = 341,
["Rcedil"] = 342,
["rcedil"] = 343,
["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,
["ring"] = 730,
["ogon"] = 731,
["DiacriticalTilde"] = 732,
["tilde"] = 732,
["DiacriticalDoubleAcute"] = 733,
["dblac"] = 733,
["DownBreve"] = 785,
["Alpha"] = 913,
["Beta"] = 914,
["Gamma"] = 915,
["Delta"] = 916,
["Epsilon"] = 917,
["Zeta"] = 918,
["Eta"] = 919,
["Theta"] = 920,
["Iota"] = 921,
["Kappa"] = 922,
["Lambda"] = 923,
["Mu"] = 924,
["Nu"] = 925,
["Xi"] = 926,
["Omicron"] = 927,
["Pi"] = 928,
["Rho"] = 929,
["Sigma"] = 931,
["Tau"] = 932,
["Upsilon"] = 933,
["Phi"] = 934,
["Chi"] = 935,
["Psi"] = 936,
["Omega"] = 937,
["ohm"] = 937,
["alpha"] = 945,
["beta"] = 946,
["gamma"] = 947,
["delta"] = 948,
["epsi"] = 949,
["epsilon"] = 949,
["zeta"] = 950,
["eta"] = 951,
["theta"] = 952,
["iota"] = 953,
["kappa"] = 954,
["lambda"] = 955,
["mu"] = 956,
["nu"] = 957,
["xi"] = 958,
["omicron"] = 959,
["pi"] = 960,
["rho"] = 961,
["sigmaf"] = 962,
["sigmav"] = 962,
["varsigma"] = 962,
["sigma"] = 963,
["tau"] = 964,
["upsi"] = 965,
["upsilon"] = 965,
["phi"] = 966,
["chi"] = 967,
["psi"] = 968,
["omega"] = 969,
["thetasym"] = 977,
["thetav"] = 977,
["vartheta"] = 977,
["Upsi"] = 978,
["upsih"] = 978,
["phiv"] = 981,
["straightphi"] = 981,
["varphi"] = 981,
["piv"] = 982,
["varpi"] = 982,
["Gammad"] = 988,
["digamma"] = 989,
["gammad"] = 989,
["kappav"] = 1008,
["varkappa"] = 1008,
["rhov"] = 1009,
["varrho"] = 1009,
["epsiv"] = 1013,
["straightepsilon"] = 1013,
["varepsilon"] = 1013,
["backepsilon"] = 1014,
["bepsi"] = 1014,
["IOcy"] = 1025,
["DJcy"] = 1026,
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["Ofr"] = 120082,
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["nfr"] = 120107,
["ofr"] = 120108,
["pfr"] = 120109,
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["Topf"] = 120139,
["Uopf"] = 120140,
["Vopf"] = 120141,
["Wopf"] = 120142,
["Xopf"] = 120143,
["Yopf"] = 120144,
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["bopf"] = 120147,
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["dopf"] = 120149,
["eopf"] = 120150,
["fopf"] = 120151,
["gopf"] = 120152,
["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_char` 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.

```
function self.paragraph(s)
  if not self.is_writing then return "" end
  return s
end
```

Define writer->interblocksep as the output format of a block element separator.

```
self.interblocksep_text = "\\markdownRendererInterblockSeparator\n{}"
function self.interblocksep()
  if not self.is_writing then return "" end
  return self.interblocksep_text
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.

```
self.paragraphsep_text = "\\markdownRendererParagraphSeparator\n{}"
function self.paragraphsep()
  if not self.is_writing then return "" end
  return self.paragraphsep_text
end
```

Define writer->undosep as a function that will remove the output produced by an immediately preceding block element / paragraph separator.

```
self.undosep_text = "\\markdownRendererUndoSeparator\n{}"
function self.undosep()
  if not self.is_writing then return "" end
  return self.undosep_text
end
```

Define writer->soft_line_break as the output format of a soft line break.

```
self.soft_line_break = function()
  if self.flatten_inlines then return "\n" end
  return "\\markdownRendererSoftLineBreak\n{}"
end
```

Define writer->hard_line_break as the output format of a hard line break.

```
self.hard_line_break = function()
  if self.flatten_inlines then return "\n" end
  return "\\markdownRendererHardLineBreak\n{}"
end
```

Define writer->ellipsis as the output format of an ellipsis.

```
self.ellipsis = "\\markdownRendererEllipsis{}"
```

Define writer->thematic_break as the output format of a thematic break.

```
function self.thematic_break()
```

```
    if not self.is_writing then return "" end
    return "\\markdownRendererThematicBreak{}"
  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_
tables to create the escape_typographic_text, escape_programmatic_text, and escape_minimal local escaper functions.

```
local function create_escaper(char_escapes, string_escapes)
  local escape = util.escaper(char_escapes, string_escapes)
  return function(s)
    if self.flatten_inlines then return s end
    return escape(s)
  end
end
local escape_typographic_text = create_escaper(
  self.escaped_chars, self.escaped_strings)
local escape_programmatic_text = create_escaper(
  self.escaped_uri_chars, self.escaped_minimal_strings)
local escape_minimal = create_escaper(
  {}, 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.

```
self.escape = escape_typographic_text
self.math = escape_minimal
if options.hybrid then
  self.identifier = escape_minimal
  self.string = escape_minimal
  self.uri = escape_minimal
  self.infostring = escape_minimal
else
  self.identifier = escape_programmatic_text
  self.string = escape_typographic_text
  self.uri = escape_programmatic_text
  self.infostring = escape_programmatic_text
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.

```
function self.warning(t, m)
  return {"\\markdownRendererWarning{", self.escape(t), "}{",
          escape_minimal(t), "}{", self.escape(m or ""), "}{",
          escape_minimal(m or ""), "}"}
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.

```
  function self.image(lab, src, tit, attributes)
    if self.flatten_inlines then return lab end
    local buf = {}
    if attributes ~= nil then
      table.insert(buf,
                     "\\markdownRendererImageAttributeContextBegin\n")
      table.insert(buf, self.attributes(attributes))
    end
    table.insert(buf, {"\\markdownRendererImage{",lab,"}",
                         "{",self.string(src),"}",
                         "{",self.uri(src),"}",
                         "{",self.string(tit or ""),"}"})
    if attributes ~= nil then
      table.insert(buf,
                     "\\markdownRendererImageAttributeContextEnd{}")
    end
    return buf
  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.

```
  function self.bulletlist(items,tight)
    if not self.is_writing then return "" end
    local buffer = {}
    for _,item in ipairs(items) do
```

```
      if item ~= "" then
        buffer[#buffer + 1] = self.bulletitem(item)
      end
    end
    local contents = util.intersperse(buffer,"\n")
    if tight and options.tightLists then
      return {"\\markdownRendererUlBeginTight\n",contents,
        "\n\\markdownRendererUlEndTight "}
    else
      return {"\\markdownRendererUlBegin\n",contents,
        "\n\\markdownRendererUlEnd "}
    end
  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.

```
  function self.bulletitem(s)
    return {"\\markdownRendererUlItem ",s,
            "\\markdownRendererUlItemEnd "}
  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.

```
  function self.orderedlist(items,tight,startnum)
    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.ordereditem(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 {"\\markdownRendererOlBeginTight\n",contents,
              "\n\\markdownRendererOlEndTight "}
    else
      return {"\\markdownRendererOlBegin\n",contents,
              "\n\\markdownRendererOlEnd "}
    end
  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.

```
function self.ordereditem(s,num)
  if num ~= nil then
    return {"\\markdownRendererOlItemWithNumber{",num,"}",s,
            "\\markdownRendererOlItemEnd "}
  else
    return {"\\markdownRendererOlItem ",s,
            "\\markdownRendererOlItemEnd "}
  end
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.

```
function self.inline_html_comment(contents)
  if self.flatten_inlines then return contents end
  return {"\\markdownRendererInlineHtmlComment{",contents,"}"}
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.

```
function self.inline_html_tag(contents)
  if self.flatten_inlines then return contents end
  return {"\\markdownRendererInlineHtmlTag{",
          self.string(contents),"}"}
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.

```
function self.block_html_element(s)
  if not self.is_writing then return "" end
  local name = util.cache(options.cacheDir, s, nil, nil, ".verbatim")
  return {"\\markdownRendererInputBlockHtmlElement{",name,"}"}
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

local function tear_down_attributes()
  local buf = {}
  for i = #self.active_attributes, 1, -1 do
    local end_output = self.active_attributes[i][4]
    if end_output ~= nil then
      table.insert(buf, end_output)
    end
  end
  return buf
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.

```
function self.push_attributes(attribute_type, attributes,
                              start_output, end_output)
  local attribute_type_level
    = self.attribute_type_levels[attribute_type]
  self.attribute_type_levels[attribute_type]
    = attribute_type_level + 1

  -- index attributes in a hash table for easy lookup
  attributes = attributes or {}
  for i = 1, #attributes do
    attributes[attributes[i]] = true
  end

  local buf = {}
  -- 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
    table.insert(buf, apply_attributes())
    self.is_writing = true
  end
  if self.is_writing and start_output ~= nil then
    table.insert(buf, start_output)
  end
  table.insert(self.active_attributes,
               {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.following_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.following_word
        + parsers.unicode.following_whitespace ),
        char
      ) then
        goto continue
      end

      -- Replace all spaces and newlines with hyphens.
      if lpeg.match(
        ( parsers.newline
        + parsers.unicode.following_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.following_whitespace,
        char
      )
      if is_letter then
        letter_found = true
      else
        goto continue
      end
    end

    -- Remove all non-alphanumeric characters, except underscores
    -- and hyphens.
    if not lpeg.match(
      ( parsers.underscore
      + parsers.dash
      + parsers.unicode.following_word
      + parsers.unicode.following_whitespace ),
      char
    ) then
      prev_space = false
      goto continue
    end
```

```

      -- Replace all spaces and newlines with hyphens.
      if lpeg.match(
        ( parsers.newline
        + parsers.unicode.following_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
```

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.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.eof                    = -parsers.any
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.following_punctuation = parsers.fail
parsers.unicode.following_alpha = parsers.fail
parsers.unicode.following_word = parsers.fail
parsers.unicode.preceding_whitespace = parsers.fail
parsers.unicode.following_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[35].

```
  local punctuation_of_length_n
    = unicode_data.categories.P[n]
    + unicode_data.categories.S[n]
  parsers.unicode.preceding_punctuation
    = parsers.unicode.preceding_punctuation
    + B(punctuation_of_length_n)
  parsers.unicode.following_punctuation
```

[35]See `https://spec.commonmark.org/0.31.2/#unicode-punctuation-character`.

```
    = parsers.unicode.following_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.following_alpha
    = parsers.unicode.following_alpha
    + alpha_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
    = unicode_data.categories.L[n]
    + unicode_data.categories.N[n]
    + unicode_data.categories.Pc[n]
  parsers.unicode.following_word
    = parsers.unicode.following_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.following_whitespace
    = parsers.unicode.following_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

    local passes, new_index, current_trail = traverse_indent(s, i,
      indent_table, is_optional, is_blank)

    if passes then
      local spacing
      if current_trail == nil then
        local newer_spacing, newer_index = lpeg.match(
          C(parsers.spacechar^0) * Cp(), s, i)
        current_trail = process_starter_spacing(0, newer_spacing, 0, 0)
        new_index = newer_index
        spacing = newer_spacing
      else
        spacing = current_trail.remainder
      end
      local result, remainder = check_trail_type(s, new_index,
        current_trail, spacing, trail_type)
      if remainder == nil or omit_remainder then
        if result then
          return new_index
        end
        return false
      end

      if is_blank and reset_rem then
        remainder = remove_remainder_if_blank(indent_table, remainder)
      end
      if result then
        return new_index, remainder
      end
      return false
    end
    return false
  end

```

The following patterns check whitespace indentation at the start of a block.

```
parsers.check_trail = Cmt( Cb("indent_info") * C(parsers.spacechar^0)
                         * Cc(false), check_trail_joined)

parsers.check_trail_no_rem = Cmt( Cb("indent_info")
                                * C(parsers.spacechar^0) * Cc(false)
                                * Cc(true), check_trail_joined)

parsers.check_code_trail  = Cmt( Cb("indent_info")
                               * C(parsers.spacechar^0)
                               * Cc(true), check_trail_joined)

parsers.check_trail_length_range  = function(min, max)
  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")
                       * ((#(parsers.commented_line_letter
                            - parsers.newline)
                          * Cb("backslashes")
                          * Cs(parsers.commented_line_letter
                            - parsers.newline)^1  -- initial
                          * Cg(Cc(""), "backslashes"))
                         + #( parsers.backslash
                            * (parsers.backslash + parsers.newline))
                         * Cg((parsers.backslash  -- even backslash
                              * ( parsers.backslash
                                + #parsers.newline))^1, "backslashes")
                         + (parsers.backslash
                           * (#parsers.percent
                             * Cb("backslashes")
                             / function(backslashes)
                               return string.rep("\\", #backslashes / 2)
                             end
                             * C(parsers.percent)
                             + #parsers.commented_line_letter
                             * Cb("backslashes")
                             * Cc("\\")
```

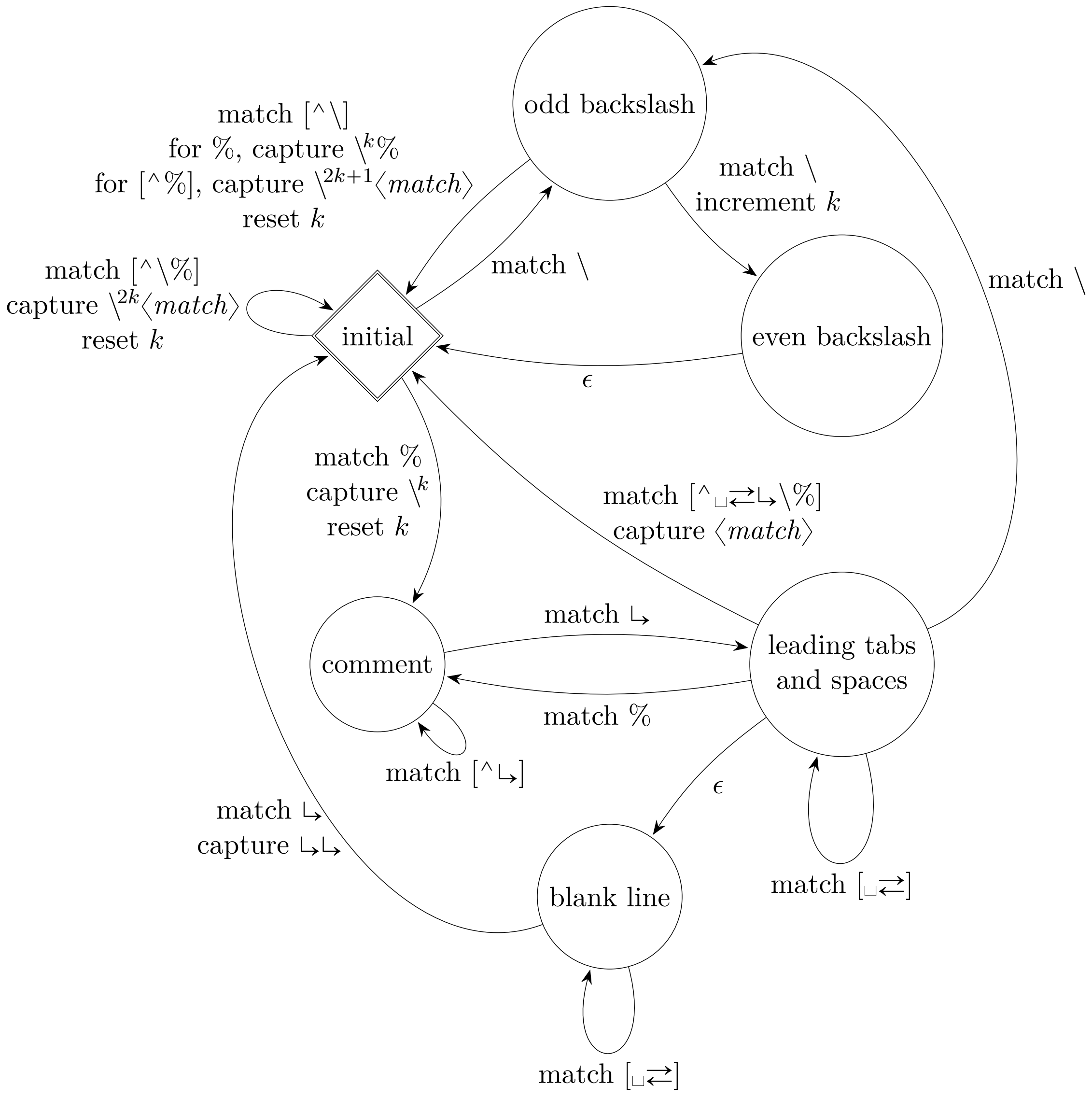

Figure 8: A pushdown automaton that recognizes TEX comments

```
                             * C(parsers.commented_line_letter))
                           * Cg(Cc(""), "backslashes")))^0
                       * (#parsers.percent
                         * Cb("backslashes")
                         / function(backslashes)
                           return string.rep("\\", #backslashes / 2)
                         end
                         * ((parsers.percent  -- comment
                            * parsers.line
                            * #parsers.blankline) -- blank line
                           / "\n"
                           + 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.alphanumeric + S("-_:.")
parsers.attribute_raw_char = parsers.alphanumeric + 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.letter
                            * 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
```

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
       * interior * parsers.rbracket * parsers.spacechar^1
end

parsers.ticked_box = tickbox(S("xX")) * Cc(1.0)
parsers.halfticked_box = tickbox(S("./")) * Cc(0.5)
parsers.unticked_box = tickbox(parsers.spacechar^1) * Cc(0.0)

```

3.1.5.6 Parsers Used for Markdown Code Spans

```
parsers.openticks   = Cg(parsers.backtick^1, "ticks")

local function captures_equal_length(_,i,a,b)
  return #a == #b and i
end

parsers.closeticks  = Cmt(C(parsers.backtick^1)
                          * Cb("ticks"), captures_equal_length)

parsers.intickschar = (parsers.any - S("\n\r`"))
                    + V("NoSoftLineBreakEndline")
                    + (parsers.backtick^1 - parsers.closeticks)

local function process_inticks(s)
  s = s:gsub("\n", " ")
  s = s:gsub("^ (.*) $", "%1")
  return s
end
```

```

parsers.inticks = parsers.openticks
                * C(parsers.space^0)
                * parsers.closeticks
                + parsers.openticks
                * Cs(Cs(parsers.intickschar^0) / process_inticks)
                * parsers.closeticks

```

3.1.5.7 Parsers Used for HTML

```
-- case-insensitive match (we assume s is lowercase)
-- must be single byte encoding
parsers.keyword_exact = function(s)
  local parser = P(0)
  for i=1,#s do
    local c = s:sub(i,i)
    local m = c .. upper(c)
    parser = parser * S(m)
  end
  return parser
end

parsers.special_block_keyword =
    parsers.keyword_exact("pre") +
    parsers.keyword_exact("script") +
    parsers.keyword_exact("style") +
    parsers.keyword_exact("textarea")

parsers.block_keyword =
    parsers.keyword_exact("address") +
    parsers.keyword_exact("article") +
    parsers.keyword_exact("aside") +
    parsers.keyword_exact("base") +
    parsers.keyword_exact("basefont") +
    parsers.keyword_exact("blockquote") +
    parsers.keyword_exact("body") +
    parsers.keyword_exact("caption") +
    parsers.keyword_exact("center") +
    parsers.keyword_exact("col") +
    parsers.keyword_exact("colgroup") +
    parsers.keyword_exact("dd") +
    parsers.keyword_exact("details") +
    parsers.keyword_exact("dialog") +
    parsers.keyword_exact("dir") +
    parsers.keyword_exact("div") +
    parsers.keyword_exact("dl") +
    parsers.keyword_exact("dt") +
    parsers.keyword_exact("fieldset") +
    parsers.keyword_exact("figcaption") +
    parsers.keyword_exact("figure") +
    parsers.keyword_exact("footer") +
    parsers.keyword_exact("form") +
    parsers.keyword_exact("frame") +
    parsers.keyword_exact("frameset") +
    parsers.keyword_exact("h1") +
    parsers.keyword_exact("h2") +
    parsers.keyword_exact("h3") +
    parsers.keyword_exact("h4") +
    parsers.keyword_exact("h5") +
    parsers.keyword_exact("h6") +
    parsers.keyword_exact("head") +
    parsers.keyword_exact("header") +
    parsers.keyword_exact("hr") +
    parsers.keyword_exact("html") +
    parsers.keyword_exact("iframe") +
    parsers.keyword_exact("legend") +
    parsers.keyword_exact("li") +
    parsers.keyword_exact("link") +
    parsers.keyword_exact("main") +
    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(Cs((parsers.newline
          * (parsers.check_minimal_blank_indent_and_any_trail
            * #parsers.blankline
            + parsers.check_minimal_indent_and_any_trail)
          + parsers.linechar - end_marker)^0
          * 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.html_comment_end = P("-->")

parsers.html_comment
  = Cs( parsers.html_comment_start
      * parsers.html_until_end(parsers.html_comment_end))

parsers.html_inline_comment = (parsers.html_comment_start / "")
                            * -P(">") * -P("->")
                            * Cs(( V("NoSoftLineBreakEndline")
                                 + parsers.any
                                 - parsers.nested_breaking_blank
                                 - parsers.html_comment_end)^0)
                            * (parsers.html_comment_end / "")

parsers.html_cdatasection_start = P("<![CDATA[")

parsers.html_cdatasection_end = P("]]>")

parsers.html_cdatasection
  = Cs( parsers.html_cdatasection_start
      * parsers.html_until_end(parsers.html_cdatasection_end))

parsers.html_inline_cdatasection
  = parsers.html_cdatasection_start
  * Cs(V("NoSoftLineBreakEndline") + parsers.any
      - parsers.nested_breaking_blank - parsers.html_cdatasection_end)^0
  * parsers.html_cdatasection_end

parsers.html_declaration_start = P("<!") * parsers.letter

parsers.html_declaration_end = P(">")

parsers.html_declaration
```

```
  = Cs( parsers.html_declaration_start
      * parsers.html_until_end(parsers.html_declaration_end))

parsers.html_inline_declaration
  = parsers.html_declaration_start
  * Cs(V("NoSoftLineBreakEndline") + parsers.any
      - parsers.nested_breaking_blank - parsers.html_declaration_end)^0
  * parsers.html_declaration_end

parsers.html_instruction_start = P("<?")

parsers.html_instruction_end = P("?>")

parsers.html_instruction
  = Cs( parsers.html_instruction_start
      * parsers.html_until_end(parsers.html_instruction_end))

parsers.html_inline_instruction = parsers.html_instruction_start
                                * Cs( V("NoSoftLineBreakEndline")
                                    + parsers.any
                                    - parsers.nested_breaking_blank
                                    - parsers.html_instruction_end)^0
                                * parsers.html_instruction_end

parsers.html_blankline  = parsers.newline
                        * 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

parsers.html_incomplete_open_special_tag
  = parsers.html_tag_start
  * parsers.special_block_keyword
  * parsers.incomplete_special_tag_following

parsers.html_incomplete_close_tag = parsers.html_tag_closing_start
                                  * parsers.block_keyword
                                  * parsers.incomplete_tag_following

parsers.html_incomplete_close_special_tag
  = parsers.html_tag_closing_start
  * parsers.special_block_keyword
  * parsers.incomplete_tag_following

-- closing tags
parsers.html_close_tag  = parsers.html_tag_closing_start
                        * parsers.block_keyword
                        * parsers.html_tag_end
```

```

parsers.html_any_close_tag  = parsers.html_tag_closing_start
                            * parsers.keyword
                            * parsers.html_tag_end

parsers.html_close_special_tag = parsers.html_tag_closing_start
                               * parsers.special_block_keyword
                               * parsers.html_tag_end

-- empty tags
parsers.html_any_empty_inline_tag = parsers.html_tag_start
                                  * parsers.keyword
                                  * parsers.html_attribute^0
                                  * parsers.html_empty_tag_end

parsers.html_any_empty_tag  = parsers.html_tag_start
                            * parsers.keyword
                            * parsers.html_non_newline_attribute^0
                            * parsers.optionalspace
                            * parsers.slash
                            * parsers.more

parsers.html_empty_tag  = parsers.html_tag_start
                        * parsers.block_keyword
                        * parsers.html_attribute^0
                        * parsers.html_empty_tag_end

parsers.html_empty_special_tag  = parsers.html_tag_start
                                * parsers.special_block_keyword
                                * 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
  = parsers.html_special_block_opening
  * parsers.html_until_end(parsers.html_close_special_tag)

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(( V("NoSoftLineBreakEndline")
                                       + 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

```lua
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

parsers.email_address = parsers.email_address_local_part
                      * parsers.at
                      * parsers.email_address_domain

parsers.auto_link_url = parsers.less
                      * C(parsers.absolute_uri)
                      * parsers.more

parsers.auto_link_email = parsers.less
                        * C(parsers.email_address)
                        * parsers.more

```

```
parsers.auto_link_relative_reference = parsers.less
                                     * C(parsers.urlchar^1)
                                     * parsers.more

parsers.autolink  = parsers.auto_link_url
                  + parsers.auto_link_email

-- content in balanced brackets, parentheses, or quotes:
parsers.bracketed   = P{ parsers.lbracket
                       * (( parsers.backslash / "" * parsers.rbracket
                          + parsers.any - (parsers.lbracket
                                          + parsers.rbracket
                                          + parsers.blankline^2)
                          ) + V(1))^0
                       * parsers.rbracket }

parsers.inparens    = P{ parsers.lparent
                       * ((parsers.anyescaped - (parsers.lparent
                                                + parsers.rparent
                                                + parsers.blankline^2)
                          ) + V(1))^0
                       * parsers.rparent }

parsers.squoted     = P{ parsers.squote * parsers.alphanumeric
                       * ((parsers.anyescaped - (parsers.squote
                                                + parsers.blankline^2)
                          ) + V(1))^0
                       * parsers.squote }

parsers.dquoted     = P{ parsers.dquote * parsers.alphanumeric
                       * ((parsers.anyescaped - (parsers.dquote
                                                + parsers.blankline^2)
                          ) + V(1))^0
                       * parsers.dquote }

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("NoSoftLineBreakSpace")
                           + 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("NoSoftLineBreakSpace")
                               + 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("NoSoftLineBreakSpace")
                         + V("NoSoftLineBreakEndline")
                         + ( parsers.anyescaped
                           - parsers.newline
                           - parsers.squote
                           - parsers.blankline^2))^0)
                    * parsers.squote

parsers.title_d     = parsers.dquote
                    * Cs((parsers.html_entities
                         + V("NoSoftLineBreakSpace")
                         + V("NoSoftLineBreakEndline")
                         + ( parsers.anyescaped
                           - parsers.newline
                           - parsers.dquote
                           - parsers.blankline^2))^0)
                    * parsers.dquote

parsers.title_p     = parsers.lparent
                    * Cs((parsers.html_entities
                         + V("NoSoftLineBreakSpace")
                         + 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.

```
function self.normalize_tag(tag)
  tag = util.rope_to_string(tag)
  tag = tag:gsub("[ \n\r\t]+", " ")
  tag = tag:gsub("^ ", ""):gsub(" $", "")
  local form = nil
  if options.unicodeNormalization then
    form = options.unicodeNormalizationForm
  end
  tag = util.casefold(tag, form)
  return tag
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.

```
local function iterlines(s, f)
  local rope = lpeg.match(Ct((parsers.line / f)^1), s)
  return util.rope_to_string(rope)
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.

```
if options.preserveTabs then
  self.expandtabs = function(s) return s end
else
  self.expandtabs = function(s)
                      if s:find("\t") then
                        return iterlines(s, util.expand_tabs_in_line)
                      else
                        return s
                      end
                    end
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.

```
self.parser_functions = {}
self.create_parser = function(name, grammar, toplevel)
  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.

```
      if toplevel and options.stripIndent then
          local min_prefix_length, min_prefix = nil, ''
          str = iterlines(str, function(line)
              if lpeg.match(parsers.nonemptyline, line) == nil then
                  return line
              end
              line = util.expand_tabs_in_line(line)
              local prefix = lpeg.match(C(parsers.optionalspace), line)
              local prefix_length = #prefix
              local is_shorter = min_prefix_length == nil
              if not is_shorter then
                is_shorter = prefix_length < min_prefix_length
              end
              if is_shorter then
                min_prefix_length, min_prefix = prefix_length, prefix
              end
              return line
          end)
          str = str:gsub('^' .. min_prefix, '')
      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.

```
      if toplevel and (options.texComments or options.hybrid) then
        str = lpeg.match(Ct(parsers.commented_line^1), str)
        str = util.rope_to_string(str)
      end
      local res = lpeg.match(grammar(), str)
      if res == nil then
        return writer.error(
          format("Parser `%s` failed to process the input text.", name),
          format("Here are the first 20 characters of the remaining "
              .. "unprocessed text: `%s`.", str:sub(1,20))
        )
      else
        return res
      end
    end
  end

  self.create_parser("parse_blocks",
                     function()
```

```
                          return parsers.blocks
                        end, true)

  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)
```

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
        * paragraph
end

function parsers.create_loop_body_pair(separated_block, paragraph,
                                       block_separator,
                                       paragraph_separator)
  return {
    block = parsers.separator_loop(separated_block, paragraph,
                                 block_separator, block_separator),
    par = parsers.separator_loop(separated_block, paragraph,
                               block_separator, paragraph_separator)
  }
end

parsers.block_sep_group = function(blank)
  return  blank^0 * parsers.eof
        + ( blank^2 / writer.paragraphsep
          + blank^0 / writer.interblocksep
          )
end

parsers.par_sep_group = function(blank)
  return  blank^0 * parsers.eof
        + blank^0 / writer.paragraphsep
end

parsers.sep_group_no_output = function(blank)
  return  blank^0 * parsers.eof
        + blank^0
end

parsers.content_blank = parsers.minimally_indented_blankline

parsers.ref_or_block_separated
  = parsers.sep_group_no_output(parsers.content_blank)
  * ( parsers.minimally_indented_ref
    - parsers.content_blank)
  + parsers.block_sep_group(parsers.content_blank)
  * ( parsers.minimally_indented_block
    - parsers.content_blank)

parsers.loop_body_pair  =
  parsers.create_loop_body_pair(
    parsers.ref_or_block_separated,
    parsers.minimally_indented_par_or_plain_no_blank,
    parsers.block_sep_group(parsers.content_blank),
    parsers.par_sep_group(parsers.content_blank))

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
        local value = t[i]

        if value.rendered ~= nil then
          content[#content + 1] = parse_content_part(content_part)
          content_part = {}
          content[#content + 1] = value.rendered
          value.rendered = nil
        else
          if value.type == "delimiter"
              and value.element == "emphasis" then
            if value.is_active then
              content_part[#content_part + 1]
                = string.rep(value.character, value.current_count)
            end
          else
            content_part[#content_part + 1] = value.content
          end
          value.content = ''
          value.is_active = false
        end
      end

      if next(content_part) ~= nil then
        content[#content + 1] = parse_content_part(content_part)
      end

      return content
    end

```

Render content between the `opening_index` and `closing_index` in the delimiter table `t` as emphasis.

```
  local function fill_emph(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.emphasis(content)
  end

```

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
        current_position = current_position + 1
        goto continue
      end

      local opening_delimiter = t[opener_position]

      local current_opening_count = opening_delimiter.current_count
      local current_closing_count = t[current_position].current_count

      if (current_opening_count >= 2)
        and (current_closing_count >= 2) then
        opening_delimiter.current_count = current_opening_count - 2
        t[current_position].current_count = current_closing_count - 2
        fill_strong(t, opener_position, current_position)
      else
        opening_delimiter.current_count = current_opening_count - 1
        t[current_position].current_count = current_closing_count - 1
        fill_emph(t, opener_position, current_position)
      end

      ::continue::
    end
  end

  parsers.delimiter_run = function(character)
    return  (B(parsers.backslash * character) + -B(character))
          * character^1
          * -#character
  end

  parsers.left_flanking_delimiter_run = function(character)
    return  (B( parsers.any)
              * ( parsers.unicode.preceding_punctuation
                + parsers.unicode.preceding_whitespace)
             + -B(parsers.any))
            * parsers.delimiter_run(character)
            * parsers.unicode.following_punctuation
            + parsers.delimiter_run(character)
            * -#( parsers.unicode.following_punctuation
                + parsers.unicode.following_whitespace
                + parsers.eof)
  end

  parsers.right_flanking_delimiter_run = function(character)
    return  parsers.unicode.preceding_punctuation
          * parsers.delimiter_run(character)
          * ( parsers.unicode.following_punctuation
            + parsers.unicode.following_whitespace
            + 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.following_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
      }
    end
  return ""
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

  parsers.title_s_direct_ref  = parsers.squote
                              * Cs((parsers.html_entities
                                  + ( parsers.anyescaped
                                    - parsers.squote
                                    - parsers.blankline^2))^0)
                              * parsers.squote

  parsers.title_d_direct_ref  = parsers.dquote
                              * Cs((parsers.html_entities
                                  + ( parsers.anyescaped
                                    - parsers.dquote
                                    - parsers.blankline^2))^0)
                              * parsers.dquote

  parsers.title_p_direct_ref  = parsers.lparent
                              * Cs((parsers.html_entities
                                  + ( parsers.anyescaped
                                    - parsers.lparent
                                    - parsers.rparent
                                    - parsers.blankline^2))^0)
                              * parsers.rparent

  parsers.title_direct_ref  = parsers.title_s_direct_ref
                            + parsers.title_d_direct_ref
                            + parsers.title_p_direct_ref

  parsers.inline_direct_ref_inside  = parsers.lparent * parsers.spnl
                                    * Cg(parsers.url + Cc(""), "url")
                                    * parsers.spnl
                                    * Cg( parsers.title_direct_ref
                                        + Cc(""), "title")
                                    * parsers.spnl * parsers.rparent

  parsers.inline_direct_ref = parsers.lparent * parsers.spnlc
                            * Cg(parsers.url + Cc(""), "url")
                            * parsers.spnlc
                            * Cg(parsers.title + Cc(""), "title")
                            * parsers.spnlc * parsers.rparent

  parsers.empty_link  = parsers.lbracket
                      * parsers.rbracket

  parsers.inline_link = parsers.link_text
                      * parsers.inline_direct_ref
```

```

parsers.full_link = parsers.link_text
                  * parsers.link_label

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")

local note_element  = Cg(Cc("note"), "element")
                    * parsers.raw_note_opening
                    * Cg( parsers.lbracket
                        * parsers.circumflex, "content")

local link_element  = Cg(Cc("link"), "element")
                    * parsers.link_opening
                    * Cg(parsers.lbracket, "content")

local opening_elements = parsers.fail

if options.inlineNotes then
  opening_elements = opening_elements + inline_note_element
end

opening_elements = opening_elements + image_element

if options.notes then
  opening_elements = opening_elements + note_element
end

opening_elements = opening_elements + link_element

parsers.link_image_opening  = Ct( Cg(Cc("delimiter"), "type")
                                * Cg(Cc(true), "is_opening")
                                * Cg(Cc(false), "is_closing")
                                * opening_elements)

parsers.link_image_closing  = Ct( Cg(Cc("delimiter"), "type")
                                * Cg(Cc("link"), "element")
                                * Cg(Cc(false), "is_opening")
                                * Cg(Cc(true), "is_closing")
                                * ( Cg(Cc(true), "is_direct")
                                  * Cg( parsers.rbracket
                                      * #parsers.inline_direct_ref,
                                       "content")
                                  + Cg(Cc(false), "is_direct")
                                  * Cg(parsers.rbracket, "content")))

parsers.link_image_open_or_close  = parsers.link_image_opening
```

```
                                   + parsers.link_image_closing

if options.html then
  parsers.link_emph_precedence  = parsers.inticks
                                + parsers.autolink
                                + parsers.html_inline_tags
else
  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, 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)
  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)
    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

      ::continue::
    end

    t[#t].content = t[#t].content:gsub("%s*$","")

    process_emphasis(t, 1, #t)
    local final_result = collect_emphasis_content(t, 1, #t)
    return final_result
  end

  function self.defer_link_and_emphasis_processing(delimiter_table)
    return writer.defer_call(function()
      return process_links_and_emphasis(delimiter_table)
    end)
  end

```

3.1.6.8 Inline Elements (local)

```
  parsers.Str      = ( parsers.normalchar
                     * (parsers.normalchar + parsers.at)^0)
                   / writer.string

  parsers.Symbol   = (parsers.backtick^1 + V("SpecialChar"))
                   / writer.string

  parsers.Ellipsis = P("...") / writer.ellipsis

  parsers.Smart    = parsers.Ellipsis

  parsers.Code     = parsers.inticks / writer.code
```

```

if options.blankBeforeBlockquote then
  parsers.bqstart = parsers.fail
else
  parsers.bqstart = parsers.blockquote_start
end

if options.blankBeforeHeading then
  parsers.headerstart = parsers.fail
else
  parsers.headerstart = parsers.atx_heading
end

if options.blankBeforeList then
  parsers.interrupting_bullets = parsers.fail
  parsers.interrupting_enumerators = parsers.fail
else
  parsers.interrupting_bullets
    = parsers.bullet(parsers.dash, true)
    + parsers.bullet(parsers.asterisk, true)
    + parsers.bullet(parsers.plus, true)

  parsers.interrupting_enumerators
    = parsers.enumerator(parsers.period, true)
    + parsers.enumerator(parsers.rparent, true)
end

if options.html then
  parsers.html_interrupting
    = parsers.check_trail
    * ( parsers.html_incomplete_open_tag
      + parsers.html_incomplete_close_tag
      + parsers.html_incomplete_open_special_tag
      + parsers.html_comment_start
      + parsers.html_cdatasection_start
      + parsers.html_declaration_start
      + parsers.html_instruction_start
      - parsers.html_close_special_tag
      - parsers.html_empty_special_tag)
else
  parsers.html_interrupting = parsers.fail
end

parsers.ListStarter = parsers.starter

parsers.EndlineExceptions
                   = parsers.blankline -- paragraph break
                   + parsers.eof       -- end of document
                   + parsers.bqstart
                   + parsers.thematic_break_lines
                   + parsers.interrupting_bullets
                   + parsers.interrupting_enumerators
                   + parsers.headerstart
                   + parsers.html_interrupting

parsers.NoSoftLineBreakEndlineExceptions = parsers.EndlineExceptions

parsers.endline = parsers.newline
                * (parsers.check_minimal_indent
                  * -V("EndlineExceptions")
                  + parsers.check_optional_indent
                  * -V("EndlineExceptions")
                  * -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.NoSoftLineBreakSpace
                    = 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.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

parsers.InlineHtml = Cs(parsers.html_inline_comment)
                   / 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

parsers.HtmlEntity = parsers.html_entities / writer.string
```

3.1.6.9 Block Elements (local)

```
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

parsers.indented_non_blank_line = parsers.indentedline
                                - parsers.blankline

parsers.Verbatim
  = Cs( parsers.check_code_trail
      * (parsers.line - parsers.blankline)
      * (( parsers.check_minimal_blank_indent_and_full_code_trail
         * parsers.blankline)^0
        * ( (parsers.check_minimal_indent / "")
          * parsers.check_code_trail
          * (parsers.line - parsers.blankline))^1)^0)
  / self.expandtabs / writer.verbatim

parsers.Blockquote   = parsers.blockquote_body
                     / writer.blockquote

parsers.ThematicBreak = parsers.thematic_break_lines
                      / writer.thematic_break

parsers.Reference    = parsers.define_reference_parser
                     / self.register_link

parsers.Paragraph   = parsers.freeze_trail
                    * (Ct((parsers.Inline)^1)
                    * (parsers.newline + parsers.eof)
                    * parsers.unfreeze_trail
                    / writer.paragraph)

parsers.Plain        = parsers.nonindentspace * Ct(parsers.Inline^1)
                     / writer.plain
```

3.1.6.10 Lists (local)

```

if options.taskLists then
  parsers.tickbox = ( parsers.ticked_box
                    + parsers.halfticked_box
                    + parsers.unticked_box
                    ) / writer.tickbox
else
   parsers.tickbox = parsers.fail
end

parsers.list_blank = parsers.conditionally_indented_blankline

parsers.ref_or_block_list_separated
  = parsers.sep_group_no_output(parsers.list_blank)
  * 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
    = Ct( (parsers.blankline / "")
        * #parsers.list_blank
        * remove_indent("li")
        + ( (V("Reference") + (parsers.blankline / ""))
          * parsers.check_minimal_indent
          * parsers.tight_list_content_loop
          + (V("Reference") + (parsers.blankline / ""))
          + (parsers.tickbox^-1 / writer.escape)
          * parsers.tight_list_content_loop
          )
        * parsers.list_item_tightness_condition)

  parsers.indented_content_loose
    = Ct( (parsers.blankline / "")
        * #parsers.list_blank
        + ( (V("Reference") + (parsers.blankline / ""))
          * parsers.check_minimal_indent
          * parsers.loose_list_content_loop
          + (V("Reference") + (parsers.blankline / ""))
          + (parsers.tickbox^-1 / writer.escape)
          * parsers.loose_list_content_loop))

  parsers.TightListItem = function(starter)
    return  -parsers.ThematicBreak
            * parsers.add_indent(starter, "li")
            * parsers.indented_content_tight
  end

  parsers.LooseListItem = function(starter)
    return  -parsers.ThematicBreak
            * parsers.add_indent(starter, "li")
            * parsers.indented_content_loose
            * remove_indent("li")
  end

  parsers.BulletListOfType = function(bullet_type)
    local bullet = parsers.bullet(bullet_type)
    return  ( Ct( parsers.TightListItem(bullet)
                * ( (parsers.check_minimal_indent / "")
                  * parsers.TightListItem(bullet)
                  )^0
              )
              * Cc(true)
              * -#( (parsers.list_blank^0 / "")
                  * parsers.check_minimal_indent
                  * (bullet - parsers.ThematicBreak)
              )
              + Ct( parsers.LooseListItem(bullet)
                  * ( (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
    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,
      NoSoftLineBreakSpace
                         = parsers.NoSoftLineBreakSpace,
      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,
      Symbol                = parsers.Symbol,
      SpecialChar           = parsers.fail,
      InitializeState       = parsers.succeed,
    }
```

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].

```
  self.update_rule = function(rule_name, get_pattern)
    assert(current_extension_name ~= nil)
    assert(syntax[rule_name] ~= nil,
      [[Rule ]] .. rule_name
      .. [[ -> ... does not exist in markdown grammar]])
    local previous_pattern
    local extension_name
    if walkable_syntax[rule_name] then
      local previous_accountable_pattern
        = walkable_syntax[rule_name][1]
      previous_pattern = previous_accountable_pattern[1]
      extension_name
        = previous_accountable_pattern[2]
        .. ", " .. current_extension_name
    else
      previous_pattern = nil
      extension_name = current_extension_name
    end
    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
```

```
      if type(get_pattern) == "function" then
        pattern = get_pattern(previous_pattern)
      else
        assert(previous_pattern == nil,
               [[Rule ]] .. rule_name ..
               [[ has already been updated by ]] .. extension_name)
        pattern = get_pattern
      end
      local accountable_pattern = { pattern, extension_name, rule_name }
      walkable_syntax[rule_name] = { accountable_pattern }
    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.

```
    local special_characters = {}
    self.add_special_character = function(c)
      table.insert(special_characters, c)
      syntax.SpecialChar = S(table.concat(special_characters, ""))
    end

    self.add_special_character("*")
    self.add_special_character("[")
    self.add_special_character("]")
    self.add_special_character("<")
    self.add_special_character("!")
    self.add_special_character("\\")
```

Add method `reader->initialize_named_group` that defines named groups with a default capture value.

```
    self.initialize_named_group = function(name, value)
      local pattern = Ct("")
      if value ~= nil then
        pattern = pattern / value
      end
      syntax.InitializeState = syntax.InitializeState
                             * Cg(pattern, name)
    end
```

Add a named group for indentation.

```
    self.initialize_named_group("indent_info")
```

Apply syntax extensions.

```
    for _, extension in ipairs(extensions) do
      current_extension_name = extension.name
      extension.extend_writer(writer)
      extension.extend_reader(self)
    end
    current_extension_name = nil
```

If the debugExtensions option is enabled, serialize walkable_syntax to a JSON for debugging purposes.

```
    if options.debugExtensions then
      local sorted_lhs = {}
      for lhs, _ in pairs(walkable_syntax) do
        table.insert(sorted_lhs, lhs)
      end
      table.sort(sorted_lhs)

      local output_lines = {"{"}
      for lhs_index, lhs in ipairs(sorted_lhs) do
        local encoded_lhs = util.encode_json_string(lhs)
        table.insert(output_lines, [[    ]] ..encoded_lhs .. [[: []])
        local rule = walkable_syntax[lhs]
        for rhs_index, rhs in ipairs(rule) do
          local human_readable_rhs
          if type(rhs) == "string" then
            human_readable_rhs = rhs
          else
            local pattern_name
            if rhs[3] then
              pattern_name = rhs[3]
            else
              pattern_name = "Anonymous Pattern"
            end
            local extension_name = rhs[2]
            human_readable_rhs = pattern_name .. [[ (]]
                               .. extension_name .. [[)]]
          end
          local encoded_rhs
            = util.encode_json_string(human_readable_rhs)
          local output_line = [[        ]] .. encoded_rhs
          if rhs_index < #rule then
            output_line = output_line .. ","
          end
          table.insert(output_lines, output_line)
        end
        local output_line = "    ]"
        if lhs_index < #sorted_lhs then
          output_line = output_line .. ","
        end
        table.insert(output_lines, output_line)
      end
      table.insert(output_lines, "}")

      local output = table.concat(output_lines, "\n")
      local output_filename = options.debugExtensionsFileName
      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())
    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`.

```
    for lhs, rule in pairs(walkable_syntax) do
      syntax[lhs] = parsers.fail
      for _, rhs in ipairs(rule) do
        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
    end

    if options.contentLevel == "inline" then
      syntax[1] = "Inlines"
      syntax.Inlines = V("InitializeState")
                     * parsers.Inline^0
                     * ( parsers.spacing^0
                       * parsers.eof / "")
      syntax.Space = parsers.Space + parsers.blankline / writer.space
    end

    local blocks_nested_t = util.table_copy(syntax)
    blocks_nested_t.ExpectedJekyllData = parsers.succeed
    parsers.blocks_nested = Ct(blocks_nested_t)

    parsers.blocks = Ct(syntax)

    local inlines_t = util.table_copy(syntax)
    inlines_t[1] = "Inlines"
    inlines_t.Inlines = V("InitializeState")
                      * parsers.Inline^0
                      * ( parsers.spacing^0
                        * parsers.eof / "")
    parsers.inlines = Ct(inlines_t)

    local inlines_no_inline_note_t = util.table_copy(inlines_t)
    inlines_no_inline_note_t.InlineNote = parsers.fail
    parsers.inlines_no_inline_note = Ct(inlines_no_inline_note_t)

    local inlines_no_html_t = util.table_copy(inlines_t)
    inlines_no_html_t.DisplayHtml = parsers.fail
    inlines_no_html_t.InlineHtml = parsers.fail
    inlines_no_html_t.HtmlEntity = parsers.fail
    parsers.inlines_no_html = Ct(inlines_no_html_t)

    local inlines_nbsp_t = util.table_copy(inlines_t)
    inlines_nbsp_t.Endline = parsers.NonbreakingEndline
    inlines_nbsp_t.Space = parsers.NonbreakingSpace
    parsers.inlines_nbsp = Ct(inlines_nbsp_t)

    local inlines_no_link_or_emphasis_t = util.table_copy(inlines_t)
    inlines_no_link_or_emphasis_t.LinkAndEmph = parsers.fail
    inlines_no_link_or_emphasis_t.EndlineExceptions
      = parsers.EndlineExceptions - parsers.eof
    parsers.inlines_no_link_or_emphasis
      = Ct(inlines_no_link_or_emphasis_t)
```

Return a function that converts markdown string `input` into a plain TEX output and returns it..

```
    return function(input)
```

Unicode-normalize the input.

```
      if options.unicodeNormalization then
        local form = options.unicodeNormalizationForm
        input = util.normalize(input, form)
      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.

```
      input = input:gsub("\r\n?", "\n")
      if input:sub(-1) ~= "\n" then
        input = input .. "\n"
      end
```

Clear the table of references.

```
      references = {}
      local document = self.parser_functions.parse_blocks(input)
      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`.

```
      local undosep_start, undosep_end
      local potential_secend_start, secend_start
      local potential_sep_start, sep_start
      while true do
        -- find a `writer->undosep`
        undosep_start, undosep_end
          = output:find(writer.undosep_text, 1, true)
        if undosep_start == nil then break end
        -- skip any preceding section ends
        secend_start = undosep_start
        while true do
          potential_secend_start = secend_start - #writer.secend_text
          if potential_secend_start < 1
             or output:sub(potential_secend_start,
                           secend_start - 1) ~= writer.secend_text
             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 Bracketed Spans

The extensions.bracketed_spans function implements the Pandoc bracketed span syntax extension.

```
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),
                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.

```
      function self.citations(text_cites, cites)
        local buffer = {}
        if self.flatten_inlines then
          for _,cite in ipairs(cites) do
            if cite.prenote then
              table.insert(buffer, {cite.prenote, " "})
            end
            table.insert(buffer, cite.name)
            if cite.postnote then
              table.insert(buffer, {" ", cite.postnote})
            end
          end
        else
          table.insert(buffer,
                       {"\\markdownRenderer",
                        text_cites and "TextCite" or "Cite",
                        "{", #cites, "}"})
          for _,cite in ipairs(cites) do
            table.insert(buffer,
                         {cite.suppress_author and "-" or "+", "{",
                          cite.prenote or "", "}{",
                          cite.postnote or "", "}{", cite.name, "}"})
          end
        end
        return buffer
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local writer = self.writer

      local citation_chars
                    = parsers.alphanumeric
                    + S("#$%&-+<>~/_")

      local citation_name
                    = Cs(parsers.dash^-1) * parsers.at
                    * Cs(citation_chars
                        * ((( citation_chars
                            + parsers.internal_punctuation
                            - parsers.comma - parsers.semicolon)
                           * -#(( parsers.internal_punctuation
                                - 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.

```
    local languages_json = (function()
      local base, prev, curr
      for _, pathname in ipairs{kpse.lookup(language_map,
                                            {all=true})} do
        local file = io.open(pathname, "r")
        if not file then goto continue end
        local input = assert(file:read("*a"))
        assert(file:close())
        local json = input:gsub('("[^\n]-"):','[%1]=')
        curr = load("_ENV = {}; return "..json)()
        if type(curr) == "table" then
          if base == nil then
            base = curr
          else
            setmetatable(prev, { __index = curr })
          end
          prev = curr
        end
        ::continue::
      end
      return base or {}
    end)()

    return {
      name = "built-in content_blocks syntax extension",
      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.

```
      function self.contentblock(src,suf,type,tit)
        if not self.is_writing then return "" end
        src = src.."."..suf
        suf = suf:lower()
        if type == "onlineimage" then
          return {"\\markdownRendererContentBlockOnlineImage{",suf,"}",
                  "{",self.string(src),"}",
                  "{",self.uri(src),"}",
                  "{",self.string(tit or ""),"}"}
        elseif languages_json[suf] then
          return {"\\markdownRendererContentBlockCode{",suf,"}",
                  "{",self.string(languages_json[suf]),"}",
                  "{",self.string(src),"}",
                  "{",self.uri(src),"}",
                  "{",self.string(tit or ""),"}"}
        else
          return {"\\markdownRendererContentBlock{",suf,"}",
                  "{",self.string(src),"}",
                  "{",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.

```
    local function dlitem(term, defs)
      local retVal = {"\\markdownRendererDlItem{",term,"}"}
      for _, def in ipairs(defs) do
        retVal[#retVal+1]
          = {"\\markdownRendererDlDefinitionBegin ",def,
             "\\markdownRendererDlDefinitionEnd "}
      end
      retVal[#retVal+1] = "\\markdownRendererDlItemEnd "
      return retVal
    end

    function self.definitionlist(items,tight)
      if not self.is_writing then return "" end
      local buffer = {}
      for _,item in ipairs(items) do
        buffer[#buffer + 1] = dlitem(item.term, item.definitions)
      end
      if tight and tight_lists then
        return {"\\markdownRendererDlBeginTight\n", buffer,
          "\n\\markdownRendererDlEndTight"}
      else
        return {"\\markdownRendererDlBegin\n", buffer,
          "\n\\markdownRendererDlEnd"}
      end
    end
  end, extend_reader = function(self)
    local parsers = self.parsers
    local writer = self.writer

    local defstartchar = S("~:")

    local defstart
      = parsers.check_trail_length(0) * defstartchar
      * #parsers.spacing
      * (parsers.tab + parsers.space^-3)
      + parsers.check_trail_length(1)
      * defstartchar * #parsers.spacing
      * (parsers.tab + parsers.space^-2)
      + parsers.check_trail_length(2)
      * defstartchar * #parsers.spacing
      * (parsers.tab + parsers.space^-1)
      + parsers.check_trail_length(3)
      * defstartchar * #parsers.spacing

    local indented_line
```

```
        = (parsers.check_minimal_indent / "")
        * parsers.check_code_trail * parsers.line

      local blank
        = parsers.check_minimal_blank_indent_and_any_trail
        * parsers.optionalspace * parsers.newline

      local dlchunk = Cs(parsers.line * (indented_line - blank)^0)

      local indented_blocks = function(bl)
        return Cs( bl
              * (blank^1 * (parsers.check_minimal_indent / "")
                * parsers.check_code_trail * -parsers.blankline * bl)^0
              * (blank^1 + parsers.eof))
      end

      local function definition_list_item(term, defs, _)
        return { term = self.parser_functions.parse_inlines(term),
                 definitions = defs }
      end

      local DefinitionListItemLoose
        = C(parsers.line) * blank^0
        * Ct((parsers.check_minimal_indent * (defstart
             * indented_blocks(dlchunk)
             / self.parser_functions.parse_blocks_nested))^1)
        * Cc(false) / definition_list_item

      local DefinitionListItemTight
        = C(parsers.line)
        * Ct((parsers.check_minimal_indent * (defstart * dlchunk
             / self.parser_functions.parse_blocks_nested))^1)
        * Cc(true) / definition_list_item

      local DefinitionList
        = ( Ct(DefinitionListItemLoose^1) * Cc(false)
          + Ct(DefinitionListItemTight^1)
          * (blank^0
            * -DefinitionListItemLoose * Cc(true))
          ) / writer.definitionlist

      self.insert_pattern("Block after Heading",
                          DefinitionList, "DefinitionList")
    end
  }
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 "}
        end
      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.

```
      function self.fancyitem(s,num)
        if num ~= nil then
          return {"\\markdownRendererFancyOlItemWithNumber{",num,"}",s,
                  "\\markdownRendererFancyOlItemEnd "}
        else
          return {"\\markdownRendererFancyOlItem ",s,
                  "\\markdownRendererFancyOlItemEnd "}
        end
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local options = self.options
      local writer = self.writer

      local function combine_markers_and_delims(markers, delims)
        local markers_table = {}
        for _,marker in ipairs(markers) do
          local start_marker
          local continuation_marker
          if type(marker) == "table" then
            start_marker = marker[1]
            continuation_marker = marker[2]
          else
            start_marker = marker
            continuation_marker = marker
          end
          for _,delim in ipairs(delims) do
            table.insert(markers_table,
                         {start_marker, continuation_marker, delim})
          end
        end
        return markers_table
      end

      local function join_table_with_func(func, markers_table)
        local pattern = func(table.unpack(markers_table[1]))
        for i = 2, #markers_table do
          pattern = pattern + func(table.unpack(markers_table[i]))
        end
        return pattern
      end

      local lowercase_letter_marker = R("az")
      local uppercase_letter_marker = R("AZ")

      local roman_marker = function(chars)
        local m, d, c = P(chars[1]), P(chars[2]), P(chars[3])
        local l, x, v, i
          = P(chars[4]), P(chars[5]), P(chars[6]), P(chars[7])
        return  m^-3
                * (c*m + c*d + d^-1 * c^-3)
                * (x*c + x*l + l^-1 * x^-3)
                * (i*x + i*v + v^-1 * i^-3)
      end

      local lowercase_roman_marker
        = roman_marker({"m", "d", "c", "l", "x", "v", "i"})
      local uppercase_roman_marker
        = roman_marker({"M", "D", "C", "L", "X", "V", "I"})

      local lowercase_opening_roman_marker  = P("i")
      local uppercase_opening_roman_marker  = P("I")

      local digit_marker = parsers.dig * parsers.dig^-8

      local markers = {
        {lowercase_opening_roman_marker, lowercase_roman_marker},
        {uppercase_opening_roman_marker, uppercase_roman_marker},
        lowercase_letter_marker,
        uppercase_letter_marker,
        lowercase_roman_marker,
        uppercase_roman_marker,
        digit_marker
      }

      local delims = {
        parsers.period,
        parsers.rparent
      }

      local markers_table = combine_markers_and_delims(markers, delims)

      local function enumerator(start_marker, _,
                                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 = start_marker
          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"
        elseif delimend == "." then
          numdelim = "Period"
        else
          numdelim = "Default"
        end

        local num
        num = numstr:match("^([I])$")
        if num then
          return roman2number(num), "UpperRoman", numdelim
        end
        num = numstr:match("^([i])$")
        if num then
          return roman2number(string.upper(num)), "LowerRoman", numdelim
        end
        num = numstr:match("^([A-Z])$")
        if num then
          return string.byte(num) - string.byte("A") + 1,
                 "UpperAlpha", numdelim
        end
        num = numstr:match("^([a-z])$")
        if num then
          return string.byte(num) - string.byte("a") + 1,
                 "LowerAlpha", numdelim
        end
        num = numstr:match("^([IVXLCDM]+)")
        if num then
          return roman2number(num), "UpperRoman", numdelim
        end
        num = numstr:match("^([ivxlcdm]+)")
        if num then
          return roman2number(string.upper(num)), "LowerRoman", numdelim
        end
        return math.floor(tonumber(numstr) or 1), "Decimal", numdelim
      end

```

```
      local function fancylist(items,tight,start)
        local startnum, numstyle, numdelim
          = sniffstyle(start[2][1], start[2][2])
        return writer.fancylist(items,tight,
                                options.startNumber and startnum or 1,
                                numstyle or "Decimal",
                                numdelim or "Default")
      end

      local FancyListOfType
        = function(start_marker, continuation_marker, delimiter_type)
          local enumerator_start
            = 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.

```
      function self.fencedCode(s, i, attr)
        if not self.is_writing then return "" end
        s = s:gsub("\n$", "")
        local buf = {}
        if attr ~= nil then
          table.insert(buf,
            {"\\markdownRendererFencedCodeAttributeContextBegin",
             self.attributes(attr)})
        end
        local name = util.cache_verbatim(options.cacheDir, s)
        table.insert(buf,
          {"\\markdownRendererInputFencedCode{",
           name,"}{",self.string(i),"}{",self.infostring(i),"}"})
        if attr ~= nil then
          table.insert(buf,
            "\\markdownRendererFencedCodeAttributeContextEnd{}")
        end
        return buf
      end

```

Define writer->rawBlock as a function that will transform an input raw block s with the raw attribute attr to the output format.

```
      if allow_raw_blocks then
        function self.rawBlock(s, attr)
          if not self.is_writing then return "" end
          s = s:gsub("\n$", "")
          local name = util.cache_verbatim(options.cacheDir, s)
          return {"\\markdownRendererInputRawBlock{",
                  name,"}{", self.string(attr),"}"}
        end
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local writer = self.writer

      local function captures_geq_length(_,i,a,b)
        return #a >= #b and i
      end

      local function strip_enclosing_whitespaces(str)
        return str:gsub("^%s*(.-)%s*$", "%1")
      end

      local tilde_infostring = Cs(Cs((V("HtmlEntity")
                                     + parsers.anyescaped
                                     - 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

      local fencetail = function(char)
        return parsers.check_trail_no_rem
             * Cmt(C(char^3) * Cb("fencelength"), captures_geq_length)
             * parsers.optionalspace * (parsers.newline + parsers.eof)
             + parsers.eof
      end

      local process_fenced_line =
        function(s, i, -- luacheck: ignore s i
                 indent_table, line_content, is_blank)
          local remainder = ""
          if has_trail(indent_table) then
            remainder = indent_table.trail.internal_remainder
          end

          if is_blank
             and get_last_indent_name(indent_table) == "li" then
            remainder = ""
          end

          local str = remainder .. line_content
          local index = 1
          local remaining = fenceindent

          while true do
            local c = str:sub(index, index)
            if c == " " and remaining > 0 then
              remaining = remaining - 1
              index = index + 1
            elseif c == "\t" and remaining > 3 then
              remaining = remaining - 4
              index = index + 1
            else
              break
            end
          end

          return true, str:sub(index)
        end

      local fencedline = function(char)
        return Cmt( Cb("indent_info")
                  * C(parsers.line - fencetail(char))
                  * Cc(false), process_fenced_line)
      end

      local blankfencedline
        = Cmt( Cb("indent_info")
             * C(parsers.blankline)
             * Cc(true), process_fenced_line)

      local TildeFencedCode
        = fencehead(parsers.tilde, tilde_infostring)
        * Cs(( (parsers.check_minimal_blank_indent / "")
             * blankfencedline
             + ( parsers.check_minimal_indent / "")
               * fencedline(parsers.tilde))^0)
        * ( (parsers.check_minimal_indent / "")
          * fencetail(parsers.tilde) + parsers.succeed)

      local BacktickFencedCode
             = fencehead(parsers.backtick, backtick_infostring)
             * Cs(( (parsers.check_minimal_blank_indent / "")
                  * blankfencedline
                  + (parsers.check_minimal_indent / "")
                  * fencedline(parsers.backtick))^0)
             * ( (parsers.check_minimal_indent / "")
               * fencetail(parsers.backtick) + parsers.succeed)

      local infostring_with_attributes
                        = Ct(C((parsers.linechar
                              - ( parsers.optionalspace
                                * parsers.attributes))^0)
                            * parsers.optionalspace
                            * Ct(parsers.attributes))

      local FencedCode
        = ((TildeFencedCode + BacktickFencedCode)
        / function(infostring, code)
          local expanded_code = self.expandtabs(code)

          if allow_raw_blocks then
            local raw_attr = lpeg.match(parsers.raw_attribute,
                                        infostring)
            if raw_attr then
              return writer.rawBlock(expanded_code, raw_attr)
            end
          end

          local attr = nil
          if allow_attributes then
            local match = lpeg.match(infostring_with_attributes,
                                     infostring)
            if match then
              infostring, attr = table.unpack(match)
            end
          end
          return writer.fencedCode(expanded_code, infostring, attr)
        end)

      self.insert_pattern("Block after Verbatim",
                          FencedCode, "FencedCode")

      local fencestart
      if blank_before_code_fence then
        fencestart = parsers.fail
      else
        fencestart = fencehead(parsers.backtick, backtick_infostring)
                   + fencehead(parsers.tilde, tilde_infostring)
      end

      self.update_rule("EndlineExceptions", function(previous_pattern)
        if previous_pattern == nil then
          previous_pattern = parsers.EndlineExceptions
        end
        return previous_pattern + fencestart
      end)

      self.add_special_character("`")
      self.add_special_character("~")
    end
  }
```

```
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.

```
M.extensions.fenced_divs = function(blank_before_div_fence)
  return {
    name = "built-in fenced_divs syntax extension",
    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.

```
      function self.div_begin(attributes)
        local start_output
          = {"\\markdownRendererFencedDivAttributeContextBegin\n",
             self.attributes(attributes)}
        local end_output
          = {"\\markdownRendererFencedDivAttributeContextEnd{}"}
        return self.push_attributes(
          "div", attributes, start_output, end_output)
      end
```

Define `writer->div_end` as a function that will produce the end of a fenced div in the output format.

```
      function self.div_end()
        return self.pop_attributes("div")
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local writer = self.writer
```

Define basic patterns for matching the opening and the closing tag of a div.

```
      local fenced_div_infostring
                              = C((parsers.linechar
                                 - ( parsers.spacechar^1
                                   * parsers.colon^1))^1)

      local fenced_div_begin = parsers.nonindentspace
                              * parsers.colon^3
                              * parsers.optionalspace
                              * fenced_div_infostring
                              * ( parsers.spacechar^1
                                * parsers.colon^1)^0
                              * parsers.optionalspace
                              * (parsers.newline + parsers.eof)

       local fenced_div_end = parsers.nonindentspace
                            * parsers.colon^3
                            * parsers.optionalspace
                            * (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.

```
      self.initialize_named_group("fenced_div_level", "0")
      self.initialize_named_group("fenced_div_num_opening_indents")

      local function increment_div_level()
        local push_indent_table =
          function(s, i, indent_table, -- luacheck: ignore s i
                   fenced_div_num_opening_indents, fenced_div_level)
            fenced_div_level = tonumber(fenced_div_level) + 1
            local num_opening_indents = 0
            if indent_table.indents ~= nil then
              num_opening_indents = #indent_table.indents
            end
            fenced_div_num_opening_indents[fenced_div_level]
              = num_opening_indents
            return true, fenced_div_num_opening_indents
          end

        local increment_level =
          function(s, i, fenced_div_level) -- luacheck: ignore s i
            fenced_div_level = tonumber(fenced_div_level) + 1
            return true, tostring(fenced_div_level)
          end

        return Cg( Cmt( Cb("indent_info")
                      * Cb("fenced_div_num_opening_indents")
                      * Cb("fenced_div_level"), push_indent_table)
                 , "fenced_div_num_opening_indents")
             * Cg( Cmt( Cb("fenced_div_level"), increment_level)
                 , "fenced_div_level")
      end

      local function decrement_div_level()
        local pop_indent_table =
          function(s, i, -- luacheck: ignore s i
                   fenced_div_indent_table, fenced_div_level)
            fenced_div_level = tonumber(fenced_div_level)
            fenced_div_indent_table[fenced_div_level] = nil
            return true, tostring(fenced_div_level - 1)
          end

        return Cg( Cmt( Cb("fenced_div_num_opening_indents")
                      * Cb("fenced_div_level"), pop_indent_table)
                 , "fenced_div_level")
      end


      local non_fenced_div_block
        = parsers.check_minimal_indent * V("Block")
        - parsers.check_minimal_indent_and_trail * fenced_div_end

      local non_fenced_div_paragraph
        = parsers.check_minimal_indent * V("Paragraph")
        - parsers.check_minimal_indent_and_trail * fenced_div_end

      local blank = parsers.minimally_indented_blank

      local block_separated = parsers.block_sep_group(blank)
                            * non_fenced_div_block

      local loop_body_pair
        = 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
                      / function (infostring)
                          local attr
                            = lpeg.match(Ct(parsers.attributes),
                                         infostring)
                          if attr == nil then
                            attr = {"." .. infostring}
                          end
```

```
                                return attr
                              end
                            / 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
      self.update_rule("Heading", Heading)
    end
  }
end
```

3.1.7.9 Inline Code Attributes

The `extensions.inline_code_attributes` function implements the Pandoc inline code attribute syntax extension.

```
M.extensions.inline_code_attributes = function()
  return {
    name = "built-in inline_code_attributes syntax extension",
    extend_writer = function()
    end, extend_reader = function(self)
      local writer = self.writer

      local CodeWithAttributes = parsers.inticks
                               * Ct(parsers.attributes)
                               / writer.code

      self.insert_pattern("Inline before Code",
                          CodeWithAttributes,
                          "CodeWithAttributes")
    end
  }
end
```

3.1.7.10 Line Blocks

The `extensions.line_blocks` function implements the Pandoc line block syntax extension.

```
M.extensions.line_blocks = function()
  return {
    name = "built-in line_blocks syntax extension",
    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.

```
      function self.lineblock(lines)
        if not self.is_writing then return "" end
        local buffer = {}
        for i = 1, #lines - 1 do
          buffer[#buffer + 1] = { lines[i], self.hard_line_break }
        end
        buffer[#buffer + 1] = lines[#lines]

        return {"\\markdownRendererLineBlockBegin\n"
                ,buffer,
                "\n\\markdownRendererLineBlockEnd "}
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local writer = self.writer

      local LineBlock
        = Ct((Cs(( (parsers.pipe * parsers.space) / ""
                 * ((parsers.space)/entities.char_entity("nbsp"))^0
                 * parsers.linechar^0 * (parsers.newline/""))
                 * (-parsers.pipe
                   * (parsers.space^1/" ")
                   * parsers.linechar^1
                   * (parsers.newline/"")
                   )^0
                 * (parsers.blankline/"")^0)
             / self.parser_functions.parse_inlines)^1)
        / writer.lineblock

      self.insert_pattern("Block after Blockquote",
                          LineBlock, "LineBlock")
    end
  }
end
```

3.1.7.11 Marked text

The `extensions.mark` function implements the Pandoc mark syntax extension.

```
M.extensions.mark = function()
  return {
    name = "built-in mark syntax extension",
    extend_writer = function(self)
```

Define `writer->mark` as a function that will transform an input marked text `s` to the output format.

```
      function self.mark(s)
        if self.flatten_inlines then return s end
        return {"\\markdownRendererMark{", s, "}"}
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local writer = self.writer

      local doubleequals = P("==")

      local Mark
        = parsers.between(V("Inline"), doubleequals, doubleequals)
        / function (inlines) return writer.mark(inlines) end

      self.add_special_character("=")
      self.insert_pattern("Inline before LinkAndEmph",
                          Mark, "Mark")
    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

      self.insert_pattern("Inline before AutoLinkUrl",
                          AutoLinkUrlWithAttributes,
                          "AutoLinkUrlWithAttributes")

      local AutoLinkEmailWithAttributes
                        = parsers.auto_link_email
                        * Ct(parsers.attributes)
                        / self.auto_link_email

      self.insert_pattern("Inline before AutoLinkEmail",
                          AutoLinkEmailWithAttributes,
                          "AutoLinkEmailWithAttributes")

      if options.relativeReferences then

        local AutoLinkRelativeReferenceWithAttributes
                          = parsers.auto_link_relative_reference
                          * Ct(parsers.attributes)
                          / self.auto_link_url

        self.insert_pattern(
          "Inline before AutoLinkRelativeReference",
          AutoLinkRelativeReferenceWithAttributes,
          "AutoLinkRelativeReferenceWithAttributes")

      end

    end
  }
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.

```
M.extensions.notes = function(notes, inline_notes)
  assert(notes or inline_notes)
  return {
    name = "built-in notes syntax extension",
    extend_writer = function(self)
```

Define `writer->note` as a function that will transform an input note `s` to the output format.

```
      function self.note(s)
        if self.flatten_inlines then return "" end
        return {"\\markdownRendererNote{",s,"}"}
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local writer = self.writer

      local rawnotes = parsers.rawnotes

      if inline_notes then
        local InlineNote
          = parsers.circumflex
          * ( parsers.link_label
            / self.parser_functions.parse_inlines_no_inline_note)
          / writer.note

        self.insert_pattern("Inline after LinkAndEmph",
                            InlineNote, "InlineNote")
      end
      if notes then
        local function strip_first_char(s)
          return s:sub(2)
        end

        local RawNoteRef
                      = #(parsers.lbracket * parsers.circumflex)
                      * parsers.link_label / strip_first_char

        -- like indirect_link
        local function lookup_note(ref)
          return writer.defer_call(function()
            local found = rawnotes[self.normalize_tag(ref)]
            if found then
              return writer.note(
                self.parser_functions.parse_blocks_nested(found))
            else
              return {"[",
                self.parser_functions.parse_inlines("^" .. ref), "]"}
            end
          end)
        end

        local function register_note(ref,rawnote)
          local normalized_tag = self.normalize_tag(ref)
          if rawnotes[normalized_tag] == nil then
            rawnotes[normalized_tag] = rawnote
          end
          return ""
        end

        local NoteRef = RawNoteRef / lookup_note

        local optionally_indented_line
          = parsers.check_optional_indent_and_any_trail * parsers.line

        local blank
          = parsers.check_optional_blank_indent_and_any_trail
          * parsers.optionalspace * parsers.newline

        local chunk
          = Cs(parsers.line
          * (optionally_indented_line - blank)^0)

        local indented_blocks = function(bl)
          return Cs( bl
                * ( blank^1 * (parsers.check_optional_indent / "")
                  * parsers.check_code_trail
                  * -parsers.blankline * bl)^0)
        end

        local NoteBlock
                    = parsers.check_trail_no_rem
                    * RawNoteRef * parsers.colon
                    * parsers.spnlc * indented_blocks(chunk)
                    / register_note

        self.update_rule("Reference", function(previous_pattern)
          if previous_pattern == nil then
            previous_pattern = parsers.Reference
          end
          return NoteBlock + previous_pattern
        end)

        self.insert_pattern("Inline before LinkAndEmph",
                            NoteRef, "NoteRef")
      end

      self.add_special_character("^")
    end
  }
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.

```
M.extensions.pipe_tables = function(table_captions, table_attributes)

  local function make_pipe_table_rectangular(rows)
    local num_columns = #rows[2]
    local rectangular_rows = {}
    for i = 1, #rows do
      local row = rows[i]
      local rectangular_row = {}
      for j = 1, num_columns do
        rectangular_row[j] = row[j] or ""
      end
      table.insert(rectangular_rows, rectangular_row)
    end
    return rectangular_rows
  end

  local function pipe_table_row(allow_empty_first_column
                               , nonempty_column
                               , column_separator
                               , column)
    local row_beginning
    if allow_empty_first_column then
      row_beginning = -- empty first column
                      #(parsers.spacechar^4
                       * column_separator)
                    * parsers.optionalspace
                    * column
                    * parsers.optionalspace
                    -- non-empty first column
                    + parsers.nonindentspace
                    * nonempty_column^-1
                    * parsers.optionalspace
    else
      row_beginning = parsers.nonindentspace
                    * nonempty_column^-1
                    * parsers.optionalspace
    end

    return Ct(row_beginning
             * (-- 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
        table.insert(buffer,
                     "\\markdownRendererTableAttributeContextEnd{}")
      end
      return buffer
    end
  end, extend_reader = function(self)
    local parsers = self.parsers
    local writer = self.writer

    local table_hline_separator = parsers.pipe + parsers.plus

    local table_hline_column = (parsers.dash
                               - #(parsers.dash
                                  * (parsers.spacechar
                                    + table_hline_separator
                                    + parsers.newline)))^1
                             * (parsers.colon * Cc("r")
                               + parsers.dash * Cc("d"))
                             + parsers.colon
                             * (parsers.dash
                               - #(parsers.dash
                                  * (parsers.spacechar
                                    + table_hline_separator
                                    + parsers.newline)))^1
                             * (parsers.colon * Cc("c")
                               + parsers.dash * Cc("l"))

    local table_hline = pipe_table_row(false
                                      , table_hline_column
                                      , table_hline_separator
                                      , table_hline_column)

    local table_caption_beginning
      = ( parsers.check_minimal_blank_indent_and_any_trail_no_rem
        * parsers.optionalspace * parsers.newline)^0
      * parsers.check_minimal_indent_and_trail
      * (P("Table")^-1 * parsers.colon)
      * parsers.optionalspace

    local function strip_trailing_spaces(s)
      return s:gsub("%s*$","")
    end

    local table_row
      = pipe_table_row(true
                      , (C((parsers.linechar - parsers.pipe)^1)
                        / strip_trailing_spaces
                        / self.parser_functions.parse_inlines)
                      , 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)
                             / 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 {
    name = "built-in strike_through syntax extension",
    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.

```
      function self.strike_through(s)
        if self.flatten_inlines then return s end
        return {"\\markdownRendererStrikeThrough{",s,"}"}
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local writer = self.writer

      local StrikeThrough = (
        parsers.between(parsers.Inline, parsers.doubletildes,
                        parsers.doubletildes)
      ) / writer.strike_through

      self.insert_pattern("Inline after LinkAndEmph",
                          StrikeThrough, "StrikeThrough")

      self.add_special_character("~")
    end
  }
end
```

3.1.7.17 Subscripts

The `extensions.subscripts` function implements the Pandoc subscript syntax extension.

```
M.extensions.subscripts = function()
  return {
    name = "built-in subscripts syntax extension",
    extend_writer = function(self)
```

Define `writer->subscript` as a function that will transform a subscript span `s` of input text to the output format.

```
      function self.subscript(s)
        if self.flatten_inlines then return s end
        return {"\\markdownRendererSubscript{",s,"}"}
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local writer = self.writer

      local Subscript = (
        parsers.between(parsers.Str, parsers.tilde, parsers.tilde)
      ) / writer.subscript

      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)
      if self.flatten_inlines then return s end
      return {"\\markdownRendererSuperscript{",s,"}"}
    end
  end, extend_reader = function(self)
    local parsers = self.parsers
    local writer = self.writer

    local Superscript = (
      parsers.between(parsers.Str, parsers.circumflex,
                      parsers.circumflex)
    ) / writer.superscript

    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)
        if self.flatten_inlines then return s end
        return {"\\markdownRendererDisplayMath{",self.math(s),"}"}
      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)
        if self.flatten_inlines then return s end
        return {"\\markdownRendererInlineMath{",self.math(s),"}"}
      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 / writer.display_math
                    + inline_math / writer.inline_math

      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.

```
      function self.jekyllData(d, t, p)
        if not self.is_writing then return "" end

        local buf = {}

        local keys = {}
        for k, _ in pairs(d) do
          table.insert(keys, k)
        end
```

For reproducibility, sort the keys. For mixed string-and-numeric keys, sort numeric keys before string keys.

```
        table.sort(keys, function(first, second)
          if type(first) ~= type(second) then
            return type(first) < type(second)
          else
            return first < second
          end
        end)

        if not p then
          table.insert(buf, "\\markdownRendererJekyllDataBegin")
        end

        local is_sequence = false
        if #d > 0 and #d == #keys then
          for i=1, #d do
            if d[i] == nil then
              goto not_a_sequence
            end
          end
          is_sequence = true
        end
```

```
      ::not_a_sequence::

      if is_sequence then
        table.insert(buf,
          "\\markdownRendererJekyllDataSequenceBegin{")
        table.insert(buf, self.identifier(p or "null"))
        table.insert(buf, "}{")
        table.insert(buf, #keys)
        table.insert(buf, "}")
      else
        table.insert(buf, "\\markdownRendererJekyllDataMappingBegin{")
        table.insert(buf, self.identifier(p or "null"))
        table.insert(buf, "}{")
        table.insert(buf, #keys)
        table.insert(buf, "}")
      end

      for _, k in ipairs(keys) do
        local v = d[k]
        local typ = type(v)
        k = tostring(k or "null")
        if typ == "table" and next(v) ~= nil then
          table.insert(
            buf,
            self.jekyllData(v, t, k)
          )
        else
          k = self.identifier(k)
          v = tostring(v)
          if typ == "boolean" then
            table.insert(buf, "\\markdownRendererJekyllDataBoolean{")
            table.insert(buf, k)
            table.insert(buf, "}{")
            table.insert(buf, v)
            table.insert(buf, "}")
          elseif typ == "number" then
            table.insert(buf, "\\markdownRendererJekyllDataNumber{")
            table.insert(buf, k)
            table.insert(buf, "}{")
            table.insert(buf, v)
            table.insert(buf, "}")
          elseif typ == "string" then
            table.insert(buf,
              "\\markdownRendererJekyllDataProgrammaticString{")
            table.insert(buf, k)
            table.insert(buf, "}{")
            table.insert(buf, self.identifier(v))
            table.insert(buf, "}")
            table.insert(buf,
              "\\markdownRendererJekyllDataTypographicString{")
            table.insert(buf, k)
            table.insert(buf, "}{")
            table.insert(buf, t(v))
            table.insert(buf, "}")
          elseif typ == "table" then
            table.insert(buf, "\\markdownRendererJekyllDataEmpty{")
            table.insert(buf, k)
            table.insert(buf, "}")
          else
            local error = self.error(format(
              "Unexpected type %s for value of "
              .. "YAML key %s.", typ, k))
            table.insert(buf, error)
          end
        end
      end

      if is_sequence then
        table.insert(buf, "\\markdownRendererJekyllDataSequenceEnd")
      else
        table.insert(buf, "\\markdownRendererJekyllDataMappingEnd")
      end

      if not p then
        table.insert(buf, "\\markdownRendererJekyllDataEnd")
      end

      return buf
    end
  end, extend_reader = function(self)
    local parsers = self.parsers
    local writer = self.writer

    local JekyllData
      = Cmt( C((parsers.line - P("---") - P("..."))^0)
           , function(s, i, text) -- luacheck: ignore s i
               local data
               local ran_ok, _ = pcall(function()
                 local tinyyaml = require("tinyyaml")
                 data = tinyyaml.parse(text, {timestamps=false})
               end)
               if ran_ok and data ~= nil then
                 return true, writer.jekyllData(data, function(s)
                   return self.parser_functions.parse_blocks_nested(s)
```

```
                  end, nil)
                else
                  return false
                end
              end
            )

      local UnexpectedJekyllData
        = P("---")
        * parsers.blankline / 0
        -- if followed by blank, it's thematic break
        * #(-parsers.blankline)
        * JekyllData
        * (P("---") + P("..."))

      local ExpectedJekyllData
        = ( P("---")
          * parsers.blankline / 0
          -- if followed by blank, it's thematic break
          * #(-parsers.blankline)
          )^-1
        * JekyllData
        * (P("---") + P("..."))^-1

      if ensure_jekyll_data then
        ExpectedJekyllData = ExpectedJekyllData
                           * parsers.eof
      else
        ExpectedJekyllData = ( ExpectedJekyllData
                             * (V("Blank")^0 / writer.interblocksep)
                             )^-1
      end

      self.insert_pattern("Block before Blockquote",
                          UnexpectedJekyllData, "UnexpectedJekyllData")
      if expect_jekyll_data then
        self.update_rule("ExpectedJekyllData", ExpectedJekyllData)
      end
    end
  }
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.

```
function M.new(options)
```

Make the options table inherit from the defaultOptions table.

```
  options = options or {}
  setmetatable(options, { __index = function (_, key)
    return defaultOptions[key] 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 table.

```
    options = options or {}
```

```
  setmetatable(options, { __index = function (_, key)
    return defaultOptions[key] 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.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()
    table.insert(extensions, header_attributes_extension)
  end

  if options.inlineCodeAttributes then
    local inline_code_attributes_extension =
      M.extensions.inline_code_attributes()
    table.insert(extensions, inline_code_attributes_extension)
  end

  if options.jekyllData then
    local jekyll_data_extension = M.extensions.jekyll_data(
      options.expectJekyllData, options.ensureJekyllData)
    table.insert(extensions, jekyll_data_extension)
  end

  if options.linkAttributes then
    local link_attributes_extension =
      M.extensions.link_attributes()
    table.insert(extensions, link_attributes_extension)
  end

  if options.lineBlocks then
    local line_block_extension = M.extensions.line_blocks()
    table.insert(extensions, line_block_extension)
  end

  if options.mark then
    local mark_extension = M.extensions.mark()
    table.insert(extensions, mark_extension)
  end

  if options.pipeTables then
    local pipe_tables_extension = M.extensions.pipe_tables(
      options.tableCaptions, options.tableAttributes)
    table.insert(extensions, pipe_tables_extension)
  end
```

```

if options.rawAttribute then
  local raw_inline_extension = M.extensions.raw_inline()
  table.insert(extensions, raw_inline_extension)
end

if options.strikeThrough then
  local strike_through_extension = M.extensions.strike_through()
  table.insert(extensions, strike_through_extension)
end

if options.subscripts then
  local subscript_extension = M.extensions.subscripts()
  table.insert(extensions, subscript_extension)
end

if options.superscripts then
  local superscript_extension = M.extensions.superscripts()
  table.insert(extensions, superscript_extension)
end

if options.texMathDollars or
   options.texMathSingleBackslash or
   options.texMathDoubleBackslash then
  local tex_math_extension = M.extensions.tex_math(
    options.texMathDollars,
    options.texMathSingleBackslash,
    options.texMathDoubleBackslash)
  table.insert(extensions, tex_math_extension)
end

if options.notes or options.inlineNotes then
  local notes_extension = M.extensions.notes(
    options.notes, options.inlineNotes)
  table.insert(extensions, notes_extension)
end

if options.citations then
  local citations_extension
    = M.extensions.citations(options.citationNbsps)
  table.insert(extensions, citations_extension)
end

if options.fancyLists then
  local fancy_lists_extension = M.extensions.fancy_lists()
  table.insert(extensions, fancy_lists_extension)
end
```

Apply user-defined syntax extensions based on `options.extensions`.

```
  for _, user_extension_filename in ipairs(options.extensions) do
    local user_extension = (function(filename)
```

First, load and compile the contents of the user-defined syntax extension.

```
      local pathname = assert(kpse.find_file(filename),
        [[Could not locate user-defined syntax extension "]]
        .. filename)
      local input_file = assert(io.open(pathname, "r"),
        [[Could not open user-defined syntax extension "]]
        .. pathname .. [[" for reading]])
      local input = assert(input_file:read("*a"))
      assert(input_file:close())
      local user_extension, err = load([[
        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:Npn
      \markdownInfo #1
      {
        \msg_info:nne
          { markdown }
          { generic-message }
          { #1 }
      }
  }
\cs_if_free:NT
  \markdownWarning
  {
    \cs_new:Npn
      \markdownWarning #1
      {
        \msg_warning:nne
          { markdown }
          { generic-message }
          { #1 }
      }
  }
\cs_if_free:NT
  \markdownError
  {
    \cs_new: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: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: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 }
          {
            \markdownWarning
              {
                Write~"witiko/diagrams@v2"~to~pin~version~"v2"~of~the~
                theme~"witiko/diagrams".~This~will~keep~your~documents~
                from~suddenly~breaking~when~we~have~released~future~
                versions~of~the~theme~with~backwards-incompatible~
                syntax~and~behavior.
              }
            \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 }
            }
        }
\cs_generate_variant:Nn
  \msg_error:nnnnn
  { nnnen }
\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 and the desired format of the diagram.

```
    \tl_new:N
      \l_@@_diagrams_caption_tl
    \tl_new:N
      \l_@@_diagrams_format_tl
    \tl_set:Nn
      \l_@@_diagrams_format_tl
      { pdf }
    \@@_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 }
                          }
                      }
                      {
                        \@@_diagrams_previous_key_value:nn
                          { ##1 }
                          { ##2 }
                      }
                  },
                },
              }
          },
          fencedCodeAttributeContextEnd = {
            \markdownRendererImageAttributeContextEnd
            \group_end:
          },
        },
      }
    \cs_new:Nn
      \@@_diagrams_render_diagram:nnnn
      {
        \@@_if_option:nF
          { frozenCache }
          {
            \sys_shell_now:n
              {
                if~!~test~-e~#2.source~
                ||~!~diff~#1~#2.source;
                then~
                  (#3);
                  cp~#1~#2.source;
                fi
              }
            \exp_args:NNnV
              \exp_last_unbraced:No
              \markdownRendererImage
                {
                  { #4 }
                  { #2 }
                  { #2 }
                }
                \l_@@_diagrams_caption_tl
          }
      }
```

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.

```
  \prop_new:N
    \g_markdown_diagrams_infostrings_prop
```

If we know a processing function for a given infostring, use it.

```
  \@@_setup:n
    {
      rendererPrototypes = {
        inputFencedCode = {
          \prop_get:NnNTF
            \g_markdown_diagrams_infostrings_prop
            { #2 }
            \l_tmpa_tl
            {
              \cs_set:NV
                \@@_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
            {
              \@@_diagrams_render_diagram:nnnn
                { #1 }
                { #1.pdf }
                { dot~-Tpdf~-o~#1.pdf~#1 }
                { Graphviz~image }
            }
          \@@_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`.

```
          \cs_set:Nn
            \@@_diagrams_infostrings_current:n
            {
              \@@_diagrams_render_diagram:nnnn
                { #1 }
                { #1.pdf }
                { mmdc~--pdfFit~-i~#1~-o~#1.pdf }
                { Mermaid~image }
            }
          \@@_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:nVVn
            { #1 }
            \l_tmpa_tl
            \l_tmpb_tl
            { PlantUML~image }
        }
      \cs_generate_variant:Nn
        \@@_diagrams_render_diagram:nnnn
        { nVVn }
      \cs_generate_variant:Nn
        \regex_replace_once:NnN
        { NxN }
      \@@_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:Npn
  \markdownRendererHeaderAttributeContextBeginPrototype
  {
    \group_begin:
    \color_group_begin:
  }
\cs_gset: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: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}}%
```

3.2.3.1 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
```

3.2.3.2 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: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: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: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: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: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: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.

```
\def\markdownRendererJekyllDataSequenceBeginPrototype#1#2{
  \@@_jekyll_data_push:nN
    { #1 }
    \c_@@_jekyll_data_sequence_tl
}
\def\markdownRendererJekyllDataMappingBeginPrototype#1#2{
  \@@_jekyll_data_push:nN
    { #1 }
    \c_@@_jekyll_data_mapping_tl
}
\def\markdownRendererJekyllDataSequenceEndPrototype{
  \@@_jekyll_data_pop:
}
\def\markdownRendererJekyllDataMappingEndPrototype{
  \@@_jekyll_data_pop:
}
\def\markdownRendererJekyllDataBooleanPrototype#1#2{
  \@@_jekyll_data_set_keyvals_known:nn
    { #1 }
    { #2 }
}
\def\markdownRendererJekyllDataEmptyPrototype#1{}
\def\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{}
\def\markdownRendererJekyllDataTypographicStringPrototype#1#2{
  \@@_jekyll_data_set_keyvals_known:nn
    { #1 }
    { #2 }
}
\ExplSyntaxOff
```

3.2.3.3 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 .default:n = { },
      }
  }
\seq_new:N
  \l_@@_jekyll_data_current_position_seq
\tl_new:N
  \l_@@_jekyll_data_current_position_tl
\cs_new: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
            },
```

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`.

```
            jekyllDataBoolean = {
              \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 / boolean }
                {
                  \@@_keys_set:xn
                    {
                      \tl_use:N
                        \l_@@_jekyll_data_current_position_tl
                      / ##1 / boolean
                    }
                    { ##2 }
                }
                {
                  \@@_keys_set:xn
                    {
                      \tl_use:N
                        \l_@@_jekyll_data_current_position_tl
                      / ##1
                    }
                    { ##2 }
                }
            },
            jekyllDataNumber = {
              \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 / number }
                {
                  \@@_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, respectively. 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.

```
        jekyllDataTypographicString = {
          \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 / typographicString }
            {
              \@@_keys_set:xn
                {
                  \tl_use:N
```

```
                      \l_@@_jekyll_data_current_position_tl
                    / ##1 / typographicString
                  }
                  { ##2 }
              }
              {
                \keys_if_exist:VnTF
                  \l_@@_jekyll_data_current_position_tl
                  { ##1 / programmaticString }
                  {
                    \@@_keys_set_known:xn
                      {
                        \tl_use:N
                          \l_@@_jekyll_data_current_position_tl
                        / ##1
                      }
                      { ##2 }
                  }
                  {
                    \@@_keys_set:xn
                      {
                        \tl_use:N
                          \l_@@_jekyll_data_current_position_tl
                        / ##1
                      }
                      { ##2 }
                  }
              }
          },
          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:Nn
  \@@_keys_set:nn
  {
    \keys_set:nn
      { }
      { { #1 } = { #2 } }
  }
\cs_new: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: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: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:Nn
      \@@_lua_escape:nN
      {
        \tl_set:Nx
          #2
          {
            \lua_escape:n
              { #1 }
          }
      }
  }
  {
    \regex_const:Nn
      \c_@@_lua_escape_regex
      { [\\"'] }
    \cs_new: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: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_ε \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@
            |expandafter|expandafter|expandafter##1@
        |fi@
      }{@
```

```
        |expandafter@
          |markdownReadAndConvertProcessLine@
          |expandafter##1@
      }@
    }@
```

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.

```
    |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.

```
      |ifx|relax##3|relax@
        |markdownIfOption{frozenCache}{}{@
          |immediate|write|markdownOutputFileStream{##1}@
        }@
      |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.

```
        |def^^M{@
          |markdownInfo{The ending token sequence was found}@
          |markdownIfOption{frozenCache}{}{@
            |immediate|closeout|markdownOutputFileStream@
          }@
          |endgroup@
          |markdownInput{@
            |markdownOptionOutputDir@
            /|markdownOptionInputTempFileName@
          }@
          #2}@
      |fi@
```

Repeat with the next line.

```
      ^^M}@
```

Make the tab character active at expansion time and make it expand to a literal tab character.

```
    |catcode`|^^I=13@
    |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: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: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_regex_replace_once:nnF
      { { (.*?) } }
      {
```

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: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.

```
    |begingroup
    |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.

```
    |catcode`|#=12
```

If we are reading from the frozen cache, input it, expand the corresponding \markdownFrozenCache⟨*number*⟩ macro, and increment frozenCacheCounter.

```
    |markdownIfOption{frozenCache}{%
      |ifnum|markdownOptionFrozenCacheCounter=0|relax
        |markdownInfo{Reading frozen cache from
          "|markdownOptionFrozenCacheFileName"}%
        |input|markdownOptionFrozenCacheFileName|relax
      |fi
      |markdownInfo{Including markdown document number
        "|the|markdownOptionFrozenCacheCounter" from frozen cache}%
      |csname markdownFrozenCache%
        |the|markdownOptionFrozenCacheCounter|endcsname
      |global|advance|markdownOptionFrozenCacheCounter by 1|relax
    }{%
      |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.

```
      |openin|markdownInputFileStream{&1}%
      |closein|markdownInputFileStream
      |markdownPrepareLuaOptions
      |markdownPrepareInputFilename{&1}%
      |markdownLuaExecute{%
        |markdownPrepare
        |markdownConvert
        |markdownCleanup}%
```

If we are finalizing the frozen cache, increment `frozenCacheCounter`.

```
      |markdownIfOption{finalizeCache}{%
        |global|advance|markdownOptionFrozenCacheCounter by 1|relax}{}%
    }%
    |endgroup
  }%
|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.

```
\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 [18, 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: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]     \begin{markdown}
% This is an optional argument ^       [smartEllipses]
% ...                                % ^ This is link
\end{markdown}                       \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 12 (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:nnn
            { markdown }
            { latex-markdown-star-deprecated }
            { #1 }
        }
        {
          \msg_warning:nnn
            { markdown }
            { latex-markdown-star-deprecated }
            { #1 }
        }
      \@@_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: e405, 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:Nn  % noqa: w401
  \@@_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:nnn
              { markdown }
              { latex-theme-after-preamble }
              { #1 }
          }
```

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
\ExplSyntaxOff
```

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 3.3.4 for the actual definitions.

3.3.3 Options

The supplied package options are processed using the \markdownSetup macro.

```
\DeclareOption*{%
  \expandafter\markdownSetup\expandafter{\CurrentOption}}%
\ProcessOptions\relax
```

3.3.4 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}
```

3.3.4.1 Lists

If either the tightLists or the fancyLists Lua 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.

```
\ExplSyntaxOn
\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
        }
      }
  }
\prg_generate_conditional_variant:Nnn
  \str_if_eq:nn
  { en }
  { TF }
\bool_if:nT
  {
    \g_@@_tight_or_fancy_lists_bool &&
    ! \g_@@_beamer_paralist_or_enumitem_bool
  }
  {
    \str_if_eq:enTF
      { \markdownThemeVersion }
      { experimental }
      {
        \RequirePackage
          { enumitem }
      }
      {
        \IfDocumentMetadataTF
          {
            \RequirePackage
              { enumitem }
          }
          {
            \RequirePackage
              { paralist }
          }
      }
  }
\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
\@ifpackageloaded { enumitem } {
  \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.

```
}
{ \@ifpackageloaded { paralist } {
  \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,[36] we can reliably detect math mode inside the renderer.

[36]This property may actually be undecidable. Suppose a span of text is a part of a macro definition.

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
  }}}
```

3.3.4.2 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 }
        {
          { csv }
            {
              \begin { table }
                \begin { center }
                  \csvautotabular { #3 }
                \end{ center }
                \tl_if_empty:nF
                  { #4 }
                  { \caption { #4 } }
              \end { table }
            }
          { html }
            {
```

If we are using TEX4ht[37], we will pass HTML elements to the output HTML document unchanged.

```
            \cs_if_exist:NTF
              \HCode
              {
```

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.

[37]See `https://tug.org/tex4ht/`.

```
                  \if_mode_vertical:
                    \IgnorePar
                  \fi:
                  \EndP
                  \special
                    { t4ht* < #3 }
                  \par
                  \ShowPar
                }
                {
                  \@@_luaxml_print_html:n
                    { #3 }
                }
              }
            { tex }
              {
                \markdownEscape
                  { #3 }
              }
        }
        {
          \markdownInput
            { #3 }
        }
    },
  },
}
\ExplSyntaxOff
\markdownSetup{rendererPrototypes={
  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 = 0
                    \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}}}}
```

3.3.4.3 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
\def\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}}}}
}%
```

3.3.4.4 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
}
```

3.3.4.5 HTML elements

If the `html` option is enabled and we are using TEX4ht[38], 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
      },
    },
  }
}
```

3.3.4.6 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
```

[38]See https://tug.org/tex4ht/.

```
      \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}%
    }}}}
```

3.3.4.7 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 }
      }
  }
\def\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}}}
```

3.3.4.8 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}
```

3.3.4.9 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
    },
  }}
}{}

```

3.3.4.10 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 .code:n = {
      \author
        { #1 }
    },
    date .code:n = {
      \date
        { #1 }
    },
    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.

```
      \AddToHook
        { begindocument / end }
        { \maketitle }
    },
  }
```

3.3.4.11 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 }
                },
              }
            }
        }
    }
```

3.3.4.12 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 }
              },
            }
          }
      }
  }
```

3.3.4.13 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
```

3.3.4.14 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[39], 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 }
```

[39]See https://tug.org/tex4ht/.

```
            }
          { html }
            {
```

If we are using TeX4ht[40], 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 }
        }
    }
```

3.3.4.15 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 = {
      \group_begin:
      \markdownSetup {
        rendererPrototypes = {
          attributeIdentifier = {
            \seq_put_right:Nn
```

[40]See https://tug.org/tex4ht/.

```
              \l_@@_bracketed_span_identifiers_seq
              { ##1 }
          },
        },
      }
    },
    bracketedSpanAttributeContextEnd = {
      \seq_map_inline:Nn
        \l_@@_bracketed_span_identifiers_seq
        { \label { ##1 } }
      \group_end:
    },
  },
}
\ExplSyntaxOff
\fi % Closes `\markdownIfOption{plain}{\iffalse}{\iftrue}`
```

3.3.5 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. [19, sec. 31]. According to Eijkhout [20, 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:Nn  % noqa: w401
  \@@_load_theme:nnn
  {
```

Determine whether either this is a built-in theme according to the prop `\g_@@_context_built_in_themes_prop` 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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