A Markdown Interpreter for TeX

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1 Introduction

The Markdown package[1] converts markdown[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 convertors, the Markdown package does not require any external programs, and makes it easy to redefine how each and every markdown element is rendered. Creative abuse of the markdown syntax is encouraged. 😉

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

[1] See `https://ctan.org/pkg/markdown`.
[2] See `https://daringfireball.net/projects/markdown/basics`.

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]

```
local metadata = {
    version   = "(((VERSION)))",
    comment   = "A module for the conversion from markdown to plain TeX",
    author    = "John MacFarlane, Hans Hagen, Vít Novotný",
    copyright = {"2009-2016 John MacFarlane, Hans Hagen",
                 "2016-2022 Vít Novotný"},
    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:

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 (TEXLive $\geqslant$ 2013).

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

Selene Unicode A library that provides support for the processing of wide strings. It is used by the Lunamark library to cast image, link, and note tags to the lower case. Selene Unicode is included in all releases of LuaTEX (TEXLive $\geqslant$ 2008).

```
local unicode
(function()
  local ran_ok
  ran_ok, unicode = pcall(require, "unicode")
```

If the Selene Unicode library is unavailable and we are using Lua $\geqslant$ 5.3, we will use the built-in support for Unicode.

```
  if not ran_ok then
```

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

```
    unicode = {["utf8"]={char=utf8.char}}
  end
end)()
```

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 (TEXLive $\geqslant$ 2008).

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

All the abovelisted modules are statically linked into the current version of the LuaTEX engine [1, Section 4.3]. Beside these, we also carry 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.

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 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.

```
⟨@@=markdown⟩
\ifx\ExplSyntaxOn\undefined
  \input expl3-generic\relax
\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.

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 2.1.6), 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) or if you enforce the use of shell using the `\markdownMode` macro, 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,

```
\NeedsTeXFormat{LaTeX2e}%
```

a TeX engine that extends ε-TeX, and all the plain TeX prerequisites (see Section 1.1.2):

The following packages are soft prerequisites. They are only used to provide default token renderer prototypes (see sections 2.2.4 and 3.3.4) or LaTeX themes (see Section 2.3.2.2) and will not be loaded if the `plain` package option has been enabled (see Section 2.3.2.1):

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

graphicx A package that provides the `\includegraphics` macro for the typesetting of images.

paralist A package that provides the `compactitem`, `compactenum`, and `compactdesc` macros for the typesetting of tight bulleted lists, ordered lists, and definition lists.

ifthen A package that provides a concise syntax for the inspection of macro values. It is used in the `witiko/dot` LaTeX theme (see Section 2.3.2.2).

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

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

gobble A package that provides the `\@gobblethree` TeX command that is used in the default renderer prototype for citations. The package is included in TeXLive $\geqslant$ 2016.

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

catchfile A package that catches the contents of a file and puts it in a macro. It is used in the `witiko/graphicx/http` LaTeX theme, see Section 2.3.2.2.

grffile A package that extends the name processing of package graphics to support a larger range of file names in $2006 \leqslant$ TeX Live $\leqslant 2019$. Since TeX Live $\geqslant 2020$, the functionality of the package has been integrated in the LaTeX 2$_\varepsilon$ kernel. It is used in the `witiko/dot` and `witiko/graphicx/http` LaTeX themes, see Section 2.3.2.2.

etoolbox A package that is used to polyfill the general hook management system in the default renderer prototypes for YAML metadata, see Section 3.3.4.6, and also in the default renderer prototype for attribute identifiers.

soulutf8 A package that is used in the default renderer prototype for strike-throughs.

```
\RequirePackage{expl3}
```

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 2.2.4).

1.2 Feedback

Please use the Markdown project page on GitHub[4] 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.[5] community question answering web site under the `markdown` tag.

1.3 Acknowledgements

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

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

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

Funding by the the Faculty of Informatics at the Masaryk University in Brno [2] 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_ε, 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` 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.

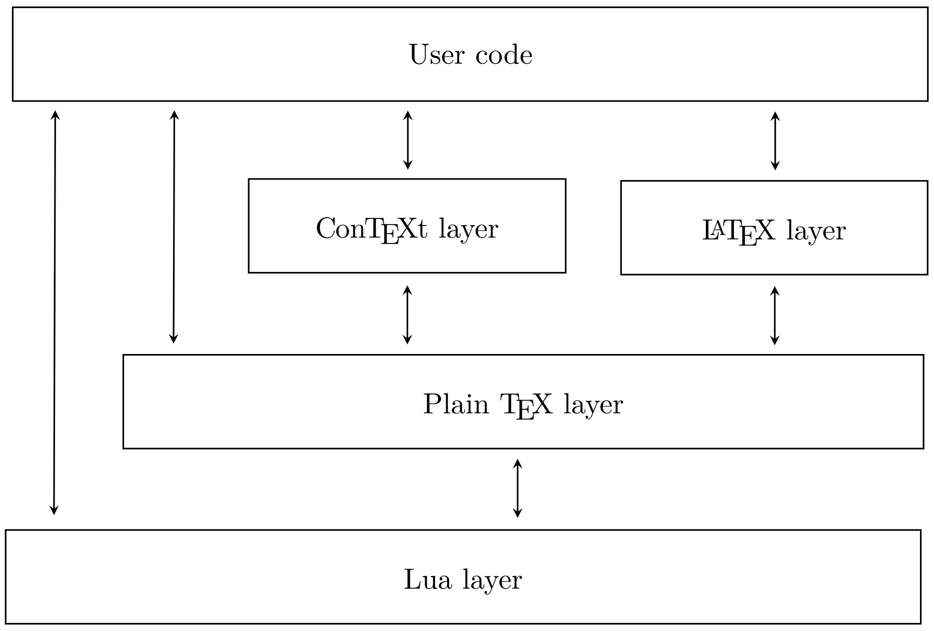


Figure 1: A block diagram of the Markdown package

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",
    "Heading",
    "DisplayHtml",
    "Paragraph",
    "Plain",
  },
  Inline = {
    "Str",
    "Space",
    "Endline",
    "UlOrStarLine",
    "Strong",
    "Emph",
    "Link",
    "Image",
    "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 -> Emph` and `Inline -> Link` rules, we would call `reader->insert_pattern` with `"Inline after Emph"` (or `"Inline before Link"`) 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
                  { @@ }
                  { failed-typecheck-for-boolean-option }
                  { #1 }
                  \l_tmpa_tl
              }
          }
      }
  }
\msg_new:nnn
  { @@ }
  { 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
          { @@ }
          { undefined-option }
          { #1 }
      }
    \seq_if_in:NVF
      \g_@@_option_types_seq
      \l_tmpa_tl
      {
        \msg_error:nnnV
          { @@ }
          { unknown-option-type }
          { #1 }
          \l_tmpa_tl
      }
    \tl_set_eq:NN
      #2
      \l_tmpa_tl
  }
\msg_new:nnn
  { @@ }
  { unknown-option-type }
  {
    Option~#1~has~unknown~type~#2.
  }
\msg_new:nnn
  { @@ }
  { 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
          { @@ }
          { 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: }
          }
          {
            \@@_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 }
      }
  }
\seq_new:N \g_@@_cases_seq
\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 }
  }
\cs_new:Nn \@@_camel_case:N
  {
    \regex_replace_all:nnN
      { _ ([a-z]) }
      { \c { str_uppercase:n } \cB\{ \1 \cE\} }
      #1
    \tl_set:Nx
      #1
      { #1 }
  }
\seq_gput_right:Nn \g_@@_cases_seq { @@_camel_case:N }
\cs_new:Nn \@@_snake_case:N
  {
    \regex_replace_all:nnN
      { ([a-z])([A-Z]) }
      { \1 _ \c { str_lowercase:n } \cB\{ \2 \cE\} }
      #1
    \tl_set:Nx
      #1
      { #1 }
  }
```

```
\seq_gput_right:Nn \g_@@_cases_seq { @@_snake_case:N }
```

2.1.4 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.

```
\@@_add_lua_option:nnn
  { cacheDir }
  { path }
  { \markdownOptionOutputDir / _markdown_\jobname }
```

```
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 2.2.3.7 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 3.1.6) and user-defined syntax extensions (see Section 2.1.2) have been applied.

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

2.1.5 Parser Options

`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
```

bracketedSpans=true, false default: false

true	Enable the Pandoc bracketed spans extension:
false	Disable the Pandoc bracketed spans extension:

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

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

```
defaultOptions.bracketedSpans = false
```

breakableBlockquotes=true, false default: false

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 }
  { false }
```

```
defaultOptions.breakableBlockquotes = false
```

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:

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

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

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

`false` Disable the Pandoc citation syntax extension.

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

```
defaultOptions.citations = false
```

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

`true` Enable the code span syntax:

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

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

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

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

```
defaultOptions.codeSpans = true
```

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

`true` Enable the iA,Writer content blocks syntax extension [3]:

```
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
```

`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 3.1.6) 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
```

`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. 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.

This behavior will only be used when the `finalizeCache` option is disabled. Recursive nesting of markdown document fragments is undefined behavior when `eagerCache` is disabled.

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

```
defaultOptions.eagerCache = true
```

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 = 2,
  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 Emph", 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 = 2
```

```
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 \luamref{reader} object, such as
the \luamref{reader->insert_pattern} and
\luamref{reader->add_special_character} methods,
see Section <#luauserextensions>.
```

```
\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 extension:

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

false Disable the Pandoc fancy list extension.

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

```
defaultOptions.fancyLists = false
```

fencedCode=true, false default: false

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 }
  { false }
```

```
defaultOptions.fencedCode = false
```

fencedDivs=true, false default: false

true Enable the Pandoc fenced divs extension:

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

And another.
:::::
```

false Disable the Pandoc fenced divs 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
```

`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
```

`hardLineBreaks`=`true`, `false` default: `false`

`true`	Interpret all newlines within a paragraph as hard line breaks instead of spaces.
`false`	Interpret all newlines within a paragraph as spaces.

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

```
defaultOptions.hardLineBreaks = false
```

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

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

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

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

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

```
defaultOptions.hashEnumerators = false
```

`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: `false`

`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 }
  { false }
```

```
defaultOptions.html = false
```

`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 interpretted by TEX. This is encouraged when typesetting automatically generated content or markdown documents that were not prepared with this package in mind.

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

```
defaultOptions.hybrid = false
```

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

`true` Enable the Pandoc inline note syntax extension:

```
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.]
```

`false`	Disable the Pandoc inline note syntax extension.

The inlineFootnotes option has been deprecated and will be removed in Markdown 3.0.0.

```
\@@_add_lua_option:nnn
  { inlineFootnotes }
  { boolean }
  { false }
\@@_add_lua_option:nnn
  { inlineNotes }
  { boolean }
  { false }
```

```
defaultOptions.inlineFootnotes = false
defaultOptions.inlineNotes = false
```

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

`true` Enable the Pandoc `yaml_metadata_block` syntax extension 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
```

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

`true` Enable the Pandoc note syntax extension:

```
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.

The footnotes option has been deprecated and will be removed in Markdown 3.0.0.

```
\@@_add_lua_option:nnn
  { footnotes }
  { boolean }
  { false }
\@@_add_lua_option:nnn
  { notes }
  { boolean }
  { false }
```

```
defaultOptions.footnotes = false
defaultOptions.notes = false
```

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

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

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

false Disable the PHP Markdown pipe table syntax extension.

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

preserveTabs=true, false default: false

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 }
  { false }
defaultOptions.preserveTabs = false
```

rawAttribute=true, false default: false

true Enable the Pandoc raw attribute syntax extension:

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

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

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

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

`false`	Disable the Pandoc raw attribute syntax extension.

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

```
defaultOptions.rawAttribute = true
```

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

`true` Enable relative references[6] 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
```

[6]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 (`$`) selects the end of a document.
- `^`⟨*identifier*⟩ selects the beginning of a section with the HTML attribute `#`⟨*identifier*⟩ (see the `headerAttributes` option).
- `$`⟨*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:

```
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
```

subscripts=true, false default: false

true Enable the Pandoc subscript syntax extension:

```
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:

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

false Disable the Pandoc superscript syntax extension.

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

```
defaultOptions.superscripts = false
```

tableCaptions=true, false default: false

true Enable the Pandoc table_captions syntax extension for pipe tables (see the pipeTables option).

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

  : Demonstration of pipe table syntax.
```

false Disable the Pandoc table_captions syntax extension.

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

```
defaultOptions.tableCaptions = false
```

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

`true` Enable the Pandoc `task_lists` syntax extension.

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

`false` Disable the Pandoc `task_lists` syntax extension.

```
\@@_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
```

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

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

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

- This is

  not a tight

- unordered list.
```

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

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

```
defaultOptions.tightLists = true
```

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

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

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

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

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

```
defaultOptions.underscores = true
```

2.1.6 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.

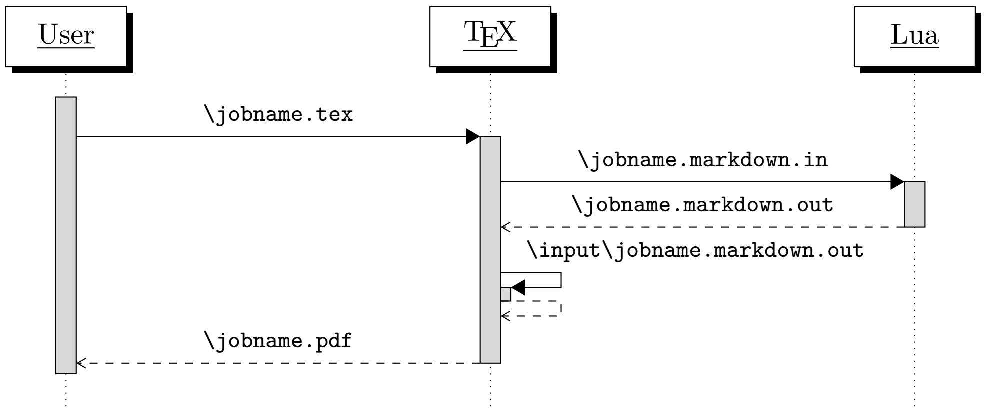


Figure 2: A sequence diagram of the Markdown package typesetting a markdown document using the TeX interface

```

local HELP_STRING = [[
Usage: texlua ]] .. arg[0] .. [[ [OPTIONS] -- [INPUT_FILE] [OUTPUT_FILE]
where OPTIONS are documented in the Lua interface section of the
technical Markdown package documentation.

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

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

```

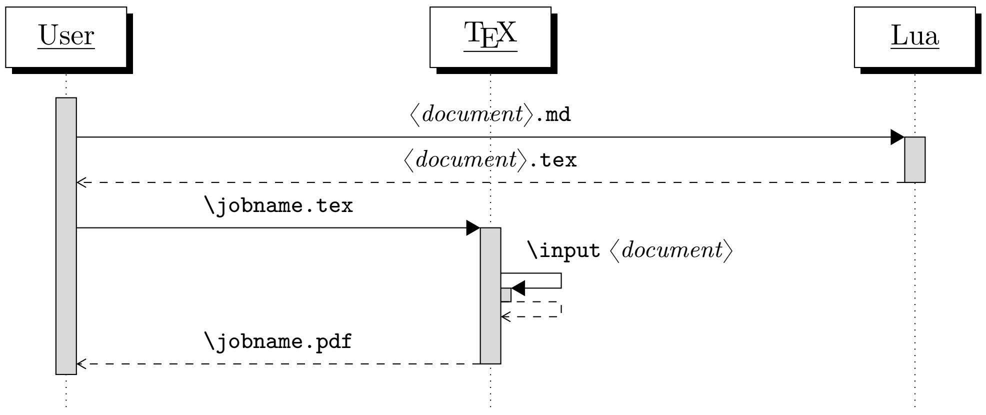


Figure 3: A sequence diagram of the Markdown package typesetting a markdown document using the Lua command-line interface

```
local VERSION_STRING = [[
markdown-cli.lua (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 [4] such as `fancy_lists`, `header_attributes`, and `pipe_tables`, we accept snake_case in addition to camelCase variants of options. As a bonus, studies [5] 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 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 patters 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 patters 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 `markdown-cli.lua` file that can be invoked from the command line as follows:

```
texlua /path/to/markdown-cli.lua 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 `\input`ting the file.

2.2.1 Typesetting Markdown

The interface exposes the `\markdownBegin`, `\markdownEnd`, `\markdownInput`, and `\markdownEscape` macros.

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 [6, 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 `\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
```

This macro is not subject to the abovelisted 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
```

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

```
\ExplSyntaxOn
\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
\tl_const:Nn \c_@@_option_layer_plain_tex_tl { plain_tex }
\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 }
  }
```

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 `\markdownOptionHelperScriptFileName` macro sets the filename of the helper Lua script file that is created during the conversion from markdown to plain TEX in TEX engines without the `\directlua` primitive. It defaults to `\jobname.markdown.lua`, where `\jobname` is the base name of the document being typeset.

The expansion of this macro must not contain quotation marks (`"`) or backslash symbols (`\`). Mind that TEX engines tend to put quotation marks around `\jobname`, when it contains spaces.

```
\@@_add_plain_tex_option:nnn
  { helperScriptFileName }
  { path }
  { \jobname.markdown.lua }
```

The `helperScriptFileName` macro has been deprecated and will be removed in Markdown 3.0.0. To control the filename of the helper Lua script file, use the `\g_luabridge_helper_script_filename_str` macro from the lt3luabridge package.

```
\str_new:N
  \g_luabridge_helper_script_filename_str
\tl_gset:Nn
  \g_luabridge_helper_script_filename_str
  { \markdownOptionHelperScriptFileName }
```

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 same limitations as in the case of the `helperScriptFileName` macro apply here.

```
\@@_add_plain_tex_option:nnn
  { inputTempFileName }
  { path }
  { \jobname.markdown.in }
```

The `\markdownOptionOutputTempFileName` macro sets the filename of the temporary output file that is created during the conversion from markdown to plain TEX in `\markdownMode` other than `2` It defaults to `\jobname.markdown.out`. The same limitations apply here as in the case of the `helperScriptFileName` macro.

```
\@@_add_plain_tex_option:nnn
  { outputTempFileName }
  { path }
  { \jobname.markdown.out }
```

The `outputTempFileName` macro has been deprecated and will be removed in Markdown 3.0.0.

```
\str_new:N
  \g_luabridge_standard_output_filename_str
\tl_gset:Nn
  \g_luabridge_standard_output_filename_str
  { \markdownOptionOutputTempFileName }
```

The `\markdownOptionErrorTempFileName` macro sets the filename of the temporary output file that is created when a Lua error is encountered during the conversion from markdown to plain TEX in `\markdownMode` other than 2. It defaults to `\jobname.markdown.err`. The same limitations apply here as in the case of the `helperScriptFileName` macro.

```
\@@_add_plain_tex_option:nnn
  { errorTempFileName }
  { path }
  { \jobname.markdown.err }
```

The `errorTempFileName` macro has been deprecated and will be removed in Markdown 3.0.0. To control the filename of the temporary file for Lua errors, use the `\g_luabridge_error_output_filename_str` macro from the lt3luabridge package.

```
\str_new:N
  \g_luabridge_error_output_filename_str
\tl_gset:Nn
  \g_luabridge_error_output_filename_str
  { \markdownOptionErrorTempFileName }
```

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 `.`.

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 `helperScriptFileName` macro.

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

Here, we automatically define plain TEX macros for the above plain TEX options.

Furthemore, we also define macros 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.

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 `helperScriptFileName` macro.

```
\cs_new:Nn \@@_plain_tex_define_option_commands:
  {
    \seq_map_inline:Nn
      \g_@@_option_layers_seq
      {
        \seq_map_inline:cn
          { g_@@_ ##1 _options_seq }
          {
            \@@_plain_tex_define_option_command:n
              { ####1 }
          }
      }
  }
\cs_new:Nn \@@_plain_tex_define_option_command:n
  {
    \@@_get_default_option_value:nN
      { #1 }
      \l_tmpa_tl
    \@@_set_option_value:nV
      { #1 }
      \l_tmpa_tl
  }
\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 }
          }
      }
  }
\@@_plain_tex_define_option_commands:
```

2.2.2.3 Miscellaneous Options

The `\markdownOptionStripPercentSigns` macro controls whether a percent sign (`%`) at the beginning of a line will be discarded when buffering Markdown input (see Section 3.2.4) or not. Notably, this enables the use of markdown when writing TeX package documentation using the Doc LaTeX package [7] 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 }
\ExplSyntaxOff
```

2.2.3 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 2.2.4).

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

```
\ExplSyntaxOn
\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
```

2.2.3.1 Attribute Renderers The following macros are only produced, when the `headerAttributes` option is enabled.

`\markdownRendererAttributeIdentifier` represents the ⟨*identifier*⟩ of a markdown element (`id="`⟨*identifier*⟩`"` in HTML and `#`⟨*identifier*⟩ in Markdown's `headerAttributes` syntax extension). 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's `headerAttributes` syntax extension). 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.

```
\def\markdownRendererAttributeIdentifier{%
  \markdownRendererAttributeIdentifierPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { attributeIdentifier }
\prop_gput:Nnn
```

```
  \g_@@_renderer_arities_prop
  { attributeIdentifier }
  { 1 }
\ExplSyntaxOff
\def\markdownRendererAttributeClassName{%
  \markdownRendererAttributeClassNamePrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { attributeClassName }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { attributeClassName }
  { 1 }
\ExplSyntaxOff
\def\markdownRendererAttributeKeyValue{%
  \markdownRendererAttributeKeyValuePrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { attributeKeyValue }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { attributeKeyValue }
  { 2 }
\ExplSyntaxOff
```

2.2.3.2 Block Quote Renderers

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

```
\def\markdownRendererBlockQuoteBegin{%
  \markdownRendererBlockQuoteBeginPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererBlockQuoteEnd{%
  \markdownRendererBlockQuoteEndPrototype}%
\ExplSyntaxOn
```

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

2.2.3.3 Bracketed Spans 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 an inline bracketed span in which the attributes of the span apply. The macros receive no arguments.

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

2.2.3.4 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.

```
\def\markdownRendererUlBegin{%
  \markdownRendererUlBeginPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererUlBeginTight{%
  \markdownRendererUlBeginTightPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererUlItem{%
  \markdownRendererUlItemPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererUlItemEnd{%
  \markdownRendererUlItemEndPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererUlEnd{%
  \markdownRendererUlEndPrototype}%
\ExplSyntaxOn
\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.

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

2.2.3.5 Code Block Renderers

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

```
\def\markdownRendererInputVerbatim{%
  \markdownRendererInputVerbatimPrototype}%
\ExplSyntaxOn
\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 two arguments that correspond to the filename of a file contaning the code block contents and to the code fence infostring.

```
\def\markdownRendererInputFencedCode{%
  \markdownRendererInputFencedCodePrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inputFencedCode }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inputFencedCode }
  { 2 }
\ExplSyntaxOff
```

2.2.3.6 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.

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

2.2.3.7 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.

```
\def\markdownRendererContentBlock{%
  \markdownRendererContentBlockPrototype}%
```

```
\ExplSyntaxOn
\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`.

```
\def\markdownRendererContentBlockOnlineImage{%
  \markdownRendererContentBlockOnlineImagePrototype}%
\ExplSyntaxOn
\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[7] 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 [3] is a good starting point.

```
\def\markdownRendererContentBlockCode{%
  \markdownRendererContentBlockCodePrototype}%
\ExplSyntaxOn
```

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

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

2.2.3.8 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.

```
\def\markdownRendererDlBegin{%
  \markdownRendererDlBeginPrototype}%
\ExplSyntaxOn
\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 an item with several paragraphs of text (the list is not tight). This macro will only be produced, when the `tightLists` option is disabled. The macro receives no arguments.

```
\def\markdownRendererDlBeginTight{%
  \markdownRendererDlBeginTightPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererDlItem{%
```

```
  \markdownRendererDlItemPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererDlItemEnd{%
  \markdownRendererDlItemEndPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererDlDefinitionBegin{%
  \markdownRendererDlDefinitionBeginPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererDlDefinitionEnd{%
  \markdownRendererDlDefinitionEndPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererDlEnd{%
  \markdownRendererDlEndPrototype}%
\ExplSyntaxOn
\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.

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

2.2.3.9 Ellipsis Renderer

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

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

2.2.3.10 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.

```
\def\markdownRendererEmphasis{%
  \markdownRendererEmphasisPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererStrongEmphasis{%
  \markdownRendererStrongEmphasisPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { strongEmphasis }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { strongEmphasis }
  { 1 }
\ExplSyntaxOff
```

2.2.3.11 Fenced Div 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 div in which the attributes of the div apply. The macros receive no arguments.

```
\def\markdownRendererFencedDivAttributeContextBegin{%
  \markdownRendererFencedDivAttributeContextBeginPrototype}%
```

```
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { fencedDivAttributeContextBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { fencedDivAttributeContextBegin }
  { 0 }
\ExplSyntaxOff
\def\markdownRendererFencedDivAttributeContextEnd{%
  \markdownRendererFencedDivAttributeContextEndPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { fencedDivAttributeContextEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { fencedDivAttributeContextEnd }
  { 0 }
\ExplSyntaxOff
```

2.2.3.12 Header Attribute Context Renderers

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

The `\markdownRendererHeaderAttributeContextBegin` and `\markdownRendererHeaderAttri`
macros represent the beginning and the end of a section in which the attributes of a heading apply. The macros receive no arguments.

```
\def\markdownRendererHeaderAttributeContextBegin{%
  \markdownRendererHeaderAttributeContextBeginPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { headerAttributeContextBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { headerAttributeContextBegin }
  { 0 }
\ExplSyntaxOff
\def\markdownRendererHeaderAttributeContextEnd{%
  \markdownRendererHeaderAttributeContextEndPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { headerAttributeContextEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { headerAttributeContextEnd }
  { 0 }
\ExplSyntaxOff
```

2.2.3.13 Heading Renderers

The \markdownRendererHeadingOne macro represents a first level heading. The macro receives a single argument that corresponds to the heading text.

```
\def\markdownRendererHeadingOne{%
  \markdownRendererHeadingOnePrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererHeadingTwo{%
  \markdownRendererHeadingTwoPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererHeadingThree{%
  \markdownRendererHeadingThreePrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererHeadingFour{%
  \markdownRendererHeadingFourPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererHeadingFive{%
  \markdownRendererHeadingFivePrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererHeadingSix{%
  \markdownRendererHeadingSixPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { headingSix }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { headingSix }
  { 1 }
\ExplSyntaxOff
```

2.2.3.14 HTML Comment Renderers

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.

The \markdownRendererBlockHtmlCommentBegin and \markdownRendererBlockHtmlCommentEn
macros represent the beginning and the end of a block HTML comment. The macros receive no arguments.

```
\def\markdownRendererInlineHtmlComment{%
  \markdownRendererInlineHtmlCommentPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inlineHtmlComment }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inlineHtmlComment }
  { 1 }
\ExplSyntaxOff
\def\markdownRendererBlockHtmlCommentBegin{%
  \markdownRendererBlockHtmlCommentBeginPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { blockHtmlCommentBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { blockHtmlCommentBegin }
  { 0 }
\ExplSyntaxOff
\def\markdownRendererBlockHtmlCommentEnd{%
  \markdownRendererBlockHtmlCommentEndPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { blockHtmlCommentEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { blockHtmlCommentEnd }
  { 0 }
\ExplSyntaxOff
```

2.2.3.15 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.

```
\def\markdownRendererInlineHtmlTag{%
  \markdownRendererInlineHtmlTagPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inlineHtmlTag }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inlineHtmlTag }
  { 1 }
\ExplSyntaxOff
\def\markdownRendererInputBlockHtmlElement{%
  \markdownRendererInputBlockHtmlElementPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inputBlockHtmlElement }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inputBlockHtmlElement }
  { 1 }
\ExplSyntaxOff
```

2.2.3.16 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.

```
\def\markdownRendererImage{%
  \markdownRendererImagePrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { image }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { image }
  { 4 }
\ExplSyntaxOff
```

2.2.3.17 Interblock Separator Renderer

The `\markdownRendererInterblockSeparator` macro represents a separator between two markdown block elements. The macro receives no arguments.

```
\def\markdownRendererInterblockSeparator{%
  \markdownRendererInterblockSeparatorPrototype}%
\ExplSyntaxOn
```

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

2.2.3.18 Line Break Renderer

The \markdownRendererLineBreak macro represents a forced line break. The macro receives no arguments.

```
\def\markdownRendererLineBreak{%
  \markdownRendererLineBreakPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { lineBreak }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { lineBreak }
  { 0 }
\ExplSyntaxOff
```

2.2.3.19 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.

```
\def\markdownRendererLink{%
  \markdownRendererLinkPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { link }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { link }
  { 4 }
\ExplSyntaxOff
```

2.2.3.20 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.

```
\def\markdownRendererDocumentBegin{%
  \markdownRendererDocumentBeginPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { documentBegin }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { documentBegin }
  { 0 }
\ExplSyntaxOff
\def\markdownRendererDocumentEnd{%
  \markdownRendererDocumentEndPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { documentEnd }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { documentEnd }
  { 0 }
\ExplSyntaxOff
```

2.2.3.21 Non-Breaking Space Renderer

The `\markdownRendererNbsp` macro represents a non-breaking space.

```
\def\markdownRendererNbsp{%
  \markdownRendererNbspPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { nbsp }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { nbsp }
  { 0 }
\ExplSyntaxOff
```

2.2.3.22 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.

The `\markdownRendererFootnote` and `\markdownRendererFootnotePrototype` macros have been deprecated and will be removed in Markdown 3.0.0.

```
\ExplSyntaxOn
\cs_new:Npn
  \markdownRendererNote
  {
    \cs_if_exist:NTF
      \markdownRendererFootnote
      {
        \markdownWarning
          {
            Footnote~renderer~has~been~deprecated,~
            to~be~removed~in~Markdown~3.0.0
          }
        \markdownRendererFootnote
      }
      {
        \cs_if_exist:NTF
          \markdownRendererFootnotePrototype
          {
            \markdownWarning
              {
                Footnote~renderer~prototype~has~been~deprecated,~
                to~be~removed~in~Markdown~3.0.0
              }
            \markdownRendererFootnotePrototype
          }
          {
            \markdownRendererNotePrototype
          }
      }
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { footnote }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { footnote }
  { 1 }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { note }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { note }
  { 1 }
\ExplSyntaxOff
```

2.2.3.23 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.

```
\def\markdownRendererOlBegin{%
  \markdownRendererOlBeginPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererOlBeginTight{%
  \markdownRendererOlBeginTightPrototype}%
\ExplSyntaxOn
\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).

```
\def\markdownRendererFancyOlBegin{%
  \markdownRendererFancyOlBeginPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererFancyOlBeginTight{%
  \markdownRendererFancyOlBeginTightPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererOlItem{%
  \markdownRendererOlItemPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererOlItemEnd{%
  \markdownRendererOlItemEndPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererOlItemWithNumber{%
  \markdownRendererOlItemWithNumberPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererFancyOlItem{%
  \markdownRendererFancyOlItemPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererFancyOlItemEnd{%
  \markdownRendererFancyOlItemEndPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererFancyOlItemWithNumber{%
  \markdownRendererFancyOlItemWithNumberPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererOlEnd{%
  \markdownRendererOlEndPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererOlEndTight{%
  \markdownRendererOlEndTightPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererFancyOlEnd{%
  \markdownRendererFancyOlEndPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererFancyOlEndTight{%
  \markdownRendererFancyOlEndTightPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { fancyOlEndTight }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { fancyOlEndTight }
  { 0 }
\ExplSyntaxOff
```

2.2.3.24 Parenthesized Citations Renderer 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.

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

2.2.3.25 Raw Content Renderers

The `\markdownRendererInputRawInline` macro represents an inline raw span. The macro receives two arguments: the filename of a file contaning 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.

```
\def\markdownRendererInputRawInline{%
  \markdownRendererInputRawInlinePrototype}%
\ExplSyntaxOn
\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 contaning 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.

```
\def\markdownRendererInputRawBlock{%
  \markdownRendererInputRawBlockPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { inputRawBlock }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { inputRawBlock }
  { 2 }
```

```
\ExplSyntaxOff
```

2.2.3.26 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`.

```
\def\markdownRendererLeftBrace{%
  \markdownRendererLeftBracePrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { leftBrace }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { leftBrace }
  { 0 }
\ExplSyntaxOff
\def\markdownRendererRightBrace{%
  \markdownRendererRightBracePrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { rightBrace }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { rightBrace }
  { 0 }
\ExplSyntaxOff
\def\markdownRendererDollarSign{%
  \markdownRendererDollarSignPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { dollarSign }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { dollarSign }
  { 0 }
\ExplSyntaxOff
\def\markdownRendererPercentSign{%
  \markdownRendererPercentSignPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { percentSign }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { percentSign }
  { 0 }
\ExplSyntaxOff
\def\markdownRendererAmpersand{%
  \markdownRendererAmpersandPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { ampersand }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { ampersand }
  { 0 }
\ExplSyntaxOff
\def\markdownRendererUnderscore{%
  \markdownRendererUnderscorePrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { underscore }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { underscore }
  { 0 }
\ExplSyntaxOff
\def\markdownRendererHash{%
  \markdownRendererHashPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { hash }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { hash }
  { 0 }
\ExplSyntaxOff
\def\markdownRendererCircumflex{%
  \markdownRendererCircumflexPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { circumflex }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { circumflex }
  { 0 }
\ExplSyntaxOff
```

```
\def\markdownRendererBackslash{%
  \markdownRendererBackslashPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { backslash }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { backslash }
  { 0 }
\ExplSyntaxOff
\def\markdownRendererTilde{%
  \markdownRendererTildePrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { tilde }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { tilde }
  { 0 }
\ExplSyntaxOff
\def\markdownRendererPipe{%
  \markdownRendererPipePrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { pipe }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { pipe }
  { 0 }
\ExplSyntaxOff
```

2.2.3.27 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.

```
\def\markdownRendererStrikeThrough{%
  \markdownRendererStrikeThroughPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { strikeThrough }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { strikeThrough }
  { 1 }
\ExplSyntaxOff
```

2.2.3.28 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.

```
\def\markdownRendererSubscript{%
  \markdownRendererSubscriptPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { subscript }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { subscript }
  { 1 }
```

2.2.3.29 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.

```
\def\markdownRendererSuperscript{%
  \markdownRendererSuperscriptPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { superscript }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { superscript }
  { 1 }
\ExplSyntaxOff
```

2.2.3.30 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.

```
\def\markdownRendererTable{%
  \markdownRendererTablePrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { table }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { table }
  { 3 }
\ExplSyntaxOff
```

2.2.3.31 Text Citations Renderer

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.

```
\def\markdownRendererTextCite{%
  \markdownRendererTextCitePrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { textCite }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { textCite }
  { 1 }
\ExplSyntaxOff
```

2.2.3.32 Thematic Break Renderer

The `\markdownRendererThematicBreak` macro represents a thematic break. The macro receives no arguments.

The `\markdownRendererHorizontalRule` and `\markdownRendererHorizontalRulePrototype` macros have been deprecated and will be removed in Markdown 3.0.0.

```
\ExplSyntaxOn
\cs_new:Npn
  \markdownRendererThematicBreak
  {
    \cs_if_exist:NTF
      \markdownRendererHorizontalRule
      {
        \markdownWarning
          {
            Horizontal~rule~renderer~has~been~deprecated,~
            to~be~removed~in~Markdown~3.0.0
          }
        \markdownRendererHorizontalRule
      }
      {
        \cs_if_exist:NTF
          \markdownRendererHorizontalRulePrototype
          {
            \markdownWarning
              {
                Horizontal~rule~renderer~prototype~has~been~deprecated,~
                to~be~removed~in~Markdown~3.0.0
              }
            \markdownRendererHorizontalRulePrototype
          }
          {
            \markdownRendererThematicBreakPrototype
          }
      }
  }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { horizontalRule }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { horizontalRule }
  { 0 }
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { thematicBreak }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { thematicBreak }
  { 0 }
\ExplSyntaxOff
```

2.2.3.33 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.

```
\def\markdownRendererTickedBox{%
  \markdownRendererTickedBoxPrototype}%
\ExplSyntaxOn
```

```
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { tickedBox }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { tickedBox }
  { 0 }
\ExplSyntaxOff
\def\markdownRendererHalfTickedBox{%
  \markdownRendererHalfTickedBoxPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { halfTickedBox }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { halfTickedBox }
  { 0 }
\ExplSyntaxOff
\def\markdownRendererUntickedBox{%
  \markdownRendererUntickedBoxPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { untickedBox }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { untickedBox }
  { 0 }
\ExplSyntaxOff
```

2.2.3.34 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.

```
\def\markdownRendererJekyllDataBegin{%
  \markdownRendererJekyllDataBeginPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererJekyllDataEnd{%
  \markdownRendererJekyllDataEndPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererJekyllDataMappingBegin{%
  \markdownRendererJekyllDataMappingBeginPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererJekyllDataMappingEnd{%
  \markdownRendererJekyllDataMappingEndPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererJekyllDataSequenceBegin{%
  \markdownRendererJekyllDataSequenceBeginPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererJekyllDataSequenceEnd{%
  \markdownRendererJekyllDataSequenceEndPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererJekyllDataBoolean{%
  \markdownRendererJekyllDataBooleanPrototype}%
\ExplSyntaxOn
\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.

```
\def\markdownRendererJekyllDataNumber{%
  \markdownRendererJekyllDataNumberPrototype}%
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { jekyllDataNumber }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { jekyllDataNumber }
  { 2 }
\ExplSyntaxOff
```

The \markdownRendererJekyllDataString macro represents a string 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, cast to a string following YAML serialization rules, and the scalar value.

```
\def\markdownRendererJekyllDataString{%
  \markdownRendererJekyllDataStringPrototype}%
\ExplSyntaxOn
\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 2.2.4.1 for the description of the high-level expl3 interface that you can also use to react to YAML metadata.

```
\def\markdownRendererJekyllDataEmpty{%
  \markdownRendererJekyllDataEmptyPrototype}%
```

```
\ExplSyntaxOn
\seq_gput_right:Nn
  \g_@@_renderers_seq
  { jekyllDataEmpty }
\prop_gput:Nnn
  \g_@@_renderer_arities_prop
  { jekyllDataEmpty }
  { 1 }
\ExplSyntaxOff
```

2.2.4 Token Renderer Prototypes

2.2.4.1 YAML Metadata Renderer Prototypes

By default, the renderer prototypes for YAML metadata provide a high-level interface that can be programmed using the `markdown/jekyllData` key–values from the l3keys module of the LaTeX3 kernel.

```
\ExplSyntaxOn
\keys_define:nn
  { markdown/jekyllData }
  { }
\ExplSyntaxOff
```

The following TeX macros provide definitions for the token renderers (see Section 2.2.3) that have not been redefined by the user. These macros are intended to be redefined by macro package authors who wish to provide sensible default token renderers. They are also redefined by the LaTeX and ConTeXt implementations (see sections 3.3 and 3.4).

```
\ExplSyntaxOn
\cs_new:Nn \@@_plaintex_define_renderer_prototypes:
  {
    \seq_map_function:NN
      \g_@@_renderers_seq
      \@@_plaintex_define_renderer_prototype:n
    \let\markdownRendererBlockHtmlCommentBeginPrototype=\iffalse
    \let\markdownRendererBlockHtmlCommentBegin=\iffalse
    \let\markdownRendererBlockHtmlCommentEndPrototype=\fi
    \let\markdownRendererBlockHtmlCommentEnd=\fi
```

The `\markdownRendererFootnote` and `\markdownRendererFootnotePrototype` macros have been deprecated and will be removed in Markdown 3.0.0.

```
    \cs_undefine:N \markdownRendererFootnote
    \cs_undefine:N \markdownRendererFootnotePrototype
```

The `\markdownRendererHorizontalRule` and `\markdownRendererHorizontalRulePrototype` macros have been deprecated and will be removed in Markdown 3.0.0.

```
    \cs_undefine:N \markdownRendererHorizontalRule
    \cs_undefine:N \markdownRendererHorizontalRulePrototype
  }
```

```
\cs_new:Nn \@@_plaintex_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
    \@@_plaintex_define_renderer_prototype:cV
      { \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
      }
  }
\cs_new:Nn \@@_plaintex_define_renderer_prototype:Nn
  {
    \cs_generate_from_arg_count:NNnn
      #1
      \cs_set:Npn
      { #2 }
      { }
  }
\cs_generate_variant:Nn
  \@@_plaintex_define_renderer_prototype:Nn
  { cV }
\@@_plaintex_define_renderer_prototypes:
\ExplSyntaxOff
```

2.2.5 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.

2.2.6 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` macro. The first argument specifies the token sequence that will terminate the markdown input (`\markdownEnd` in the instance of the `\markdownBegin` macro) when the plain TEX special characters have had their category changed to *other*. 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}}%
|endgroup
```

The macro is exposed in the interface, so that the user can create their own markdown environments. Due to the way the arguments are passed to Lua (see Section 3.2.6), the first argument may not contain the string `]]` (regardless of the category code of the bracket symbol (`]`)).

The `\markdownMode` macro specifies how the plain TEX implementation interfaces with the Lua interface. The valid values and their meaning are as follows:

- `0` – Shell escape via the 18 output file stream
- `1` – Shell escape via the Lua `os.execute` method
- `2` – Direct Lua access
- `3` – The lt3luabridge Lua package

By defining the macro, the user can coerce the package to use a specific mode. If the user does not define the macro prior to loading the plain TEX implementation, the correct value will be automatically detected. The outcome of changing the value of `\markdownMode` after the implementation has been loaded is undefined.

The \markdownMode macro has been deprecated and will be removed in Markdown 3.0.0. The code that corresponds to \markdownMode value of 3 will be the only implementation.

```
\ExplSyntaxOn
\cs_if_exist:NF
  \markdownMode
  {
    \file_if_exist:nTF
      { lt3luabridge.tex }
      {
        \cs_new:Npn
          \markdownMode
          { 3 }
      }
      {
        \cs_if_exist:NTF
          \directlua
          {
            \cs_new:Npn
              \markdownMode
              { 2 }
          }
          {
            \cs_new:Npn
              \markdownMode
              { 0 }
          }
      }
  }
\ExplSyntaxOff
```

The \markdownLuaRegisterIBCallback and \markdownLuaUnregisterIBCallback macros have been deprecated and will be removed in Markdown 3.0.0:

```
\def\markdownLuaRegisterIBCallback#1{\relax}%
\def\markdownLuaUnregisterIBCallback#1{\relax}%
```

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).

The LaTeX implementation redefines the plain TeX logging macros (see Section 3.2.1) to use the LaTeX \PackageInfo, \PackageWarning, and \PackageError macros.

```
\newcommand\markdownInfo[1]{\PackageInfo{markdown}{#1}}%
\newcommand\markdownWarning[1]{\PackageWarning{markdown}{#1}}%
\newcommand\markdownError[2]{\PackageError{markdown}{#1}{#2.}}%
\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 2.3.2). Note that ⟨*options*⟩ inside the `\usepackage` macro may not set the `markdownRenderers` (see Section 2.3.2.5) and `markdownRendererPrototypes` (see Section 2.3.2.6) keys. This limitation is due to the way LaTeX 2_ε parses package options.

2.3.1 Typesetting Markdown

The interface exposes the `markdown` and `markdown*` LaTeX environments, and redefines the `\markdownInput` command.

The `markdown` and `markdown*` LaTeX environments are used to typeset markdown document fragments. The starred version of the `markdown` environment accepts LaTeX interface options (see Section 2.3.2) as its only argument. These options will only influence this markdown document fragment.

```
\newenvironment{markdown}\relax\relax
\newenvironment{markdown*}[1]\relax\relax
```

You may prepend your own code to the `\markdown` macro and append your own code to the `\endmarkdown` macro to produce special effects before and after the `markdown` LaTeX environment (and likewise for the starred version).

Note that the `markdown` and `markdown*` LaTeX environments are subject to the same limitations as the `\markdownBegin` and `\markdownEnd` macros exposed by the plain TeX interface.

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}                   \begin{markdown*}{smartEllipses}
_Hello_ **world** ...              _Hello_ **world** ...
\end{markdown}                     \end{markdown*}
% ...                              % ...
\end{document}                     \end{document}
```

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 2.3.2) as its optional argument. These options will only influnce 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}
```

2.3.2 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.

Except for the plain option described in Section 2.3.2.1, and the LaTeX themes described in Section 2.3.2.2, and the LaTeX setup snippets described in Section 2.3.2.3, 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 2.2.3 and 2.2.4).

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. The \markdownSetup macro receives the options to set up as its only argument:

```
\ExplSyntaxOn
\cs_new:Nn
  \@@_setup:n
  {
    \keys_set:nn
      { markdown/latex-options }
      { #1 }
  }
\let\markdownSetup=\@@_setup:n
\ExplSyntaxOff
```

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

```
\newcommand\markdownSetupSnippet[2]{%
  \markdownIfSnippetExists{#1}%
    {%
      \markdownWarning
        {Redefined setup snippet \markdownLaTeXThemeName#1}%
      \csname markdownLaTeXSetupSnippet%
        \markdownLaTeXThemeName#1\endcsname={#2}%
    }{%
      \newtoks\next
        \next={#2}%
      \expandafter\let\csname markdownLaTeXSetupSnippet%
        \markdownLaTeXThemeName#1\endcsname=\next
    }}%
```

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

```
\newcommand\markdownIfSnippetExists[3]{%
  \@ifundefined
    {markdownLaTeXSetupSnippet\markdownLaTeXThemeName#1}%
    {#3}{#2}}%
```

See Section 2.3.2.2 for information on interactions between setup snippets and LaTeX themes. See Section 2.3.2.3 for information about invoking the stored setup snippets.

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

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

To enable the reflection of default LaTeX options and their types, we will maintain the `\g_@@_default_latex_options_prop` and `\g_@@_latex_option_types_prop` property lists, respectively.

```
\prop_new:N \g_@@_latex_option_types_prop
\prop_new:N \g_@@_default_latex_options_prop
\tl_const:Nn \c_@@_option_layer_latex_tl { latex }
\seq_gput_right:NV \g_@@_option_layers_seq \c_@@_option_layer_latex_tl
\cs_new:Nn
  \@@_add_latex_option:nnn
  {
    \@@_add_option:Vnnn
      \c_@@_option_layer_latex_tl
      { #1 }
      { #2 }
      { #3 }
  }
```

2.3.2.1 No default token renderer prototypes

Default token renderer prototypes require LaTeX packages that may clash with other packages used in a document.

Additionally, if we redefine token renderers and renderer prototypes ourselves, the default definitions will bring no benefit to us. Using the `plain` package option, we can keep the default definitions from the plain TeX implementation (see Section 3.2.2) and prevent the soft LaTeX prerequisites in Section 1.1.3 from being loaded: The plain option must be set before or when loading the package. Setting the option after loading the package will have no effect.

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

```
\@@_add_latex_option:nnn
  { plain }
  { boolean }
  { false }
\ExplSyntaxOff
```

2.3.2.2 LaTeX themes

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

The LaTeX option `theme`=⟨*theme name*⟩ loads a LaTeX package (further referred to as *a theme*) named `markdowntheme`⟨*munged theme name*⟩`.sty`, where the *munged theme name* is the *theme name* after the substitution of all forward slashes (`/`) for an underscore (`_`), the theme *name* is *qualified* and contains no underscores, and a value is qualified if and only if it contains at least one forward slash. Themes are inspired by the Beamer LaTeX package, which provides similar functionality with its `\usetheme` macro [8, Section 15.1].

Theme names must be qualified to minimize naming conflicts between different themes intended for a single LaTeX document class or for a single LaTeX package. The preferred format of a theme name is ⟨*theme author*⟩`/`⟨*target LaTeX document class or package*⟩`/`⟨*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, because LaTeX packages are identified only by their filenames, not by their pathnames. [9] Therefore, we can't store the qualified theme names directly using directories, but we must encode the individual segments of the qualified theme in the filename. For example, loading a theme named `witiko/beamer/MU` would load a LaTeX package named `markdownthemewitiko_beamer_MU.sty`.

If the LaTeX option with key `theme` 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, there is a theme named `witiko/dot`, which typesets fenced code blocks with the `dot` infostring as images of directed graphs rendered by the Graphviz tools. The following code would first load the Markdown package, then the `markdownthemewitiko_beamer_MU.sty` LaTeX package, and finally the `markdownthemewitiko_dot.sty` LaTeX package:

```
\usepackage[
  theme = witiko/beamer/MU,
  theme = witiko/dot,
]{markdown}
```

```
\newif\ifmarkdownLaTeXLoaded
  \markdownLaTeXLoadedfalse
\AtEndOfPackage{\markdownLaTeXLoadedtrue}
\ExplSyntaxOn
\tl_new:N \markdownLaTeXThemePackageName
\cs_new:Nn
  \@@_set_latex_theme:n
  {
    \str_if_in:nnF
      { #1 }
      { / }
      {
        \markdownError
        { Won't~load~theme~with~unqualified~name~#1 }
        { Theme~names~must~contain~at~least~one~forward~slash }
      }
    \str_if_in:nnT
      { #1 }
      { _ }
      {
        \markdownError
        { Won't~load~theme~with~an~underscore~in~its~name~#1 }
        { Theme~names~must~not~contain~underscores~in~their~names }
      }
    \tl_set:Nn \markdownLaTeXThemePackageName { #1 }
    \str_replace_all:Nnn
      \markdownLaTeXThemePackageName
      { / }
      { _ }
    \edef\markdownLaTeXThemePackageName{
      markdowntheme\markdownLaTeXThemePackageName}
    \expandafter\markdownLaTeXThemeLoad\expandafter{
      \markdownLaTeXThemePackageName}{#1/}
  }
\keys_define:nn
  { markdown/latex-options }
  {
    theme .code:n = { \@@_set_latex_theme:n { #1 } },
  }
\ExplSyntaxOff
```

The LaTeX themes have a useful synergy with the setup snippets (see Section 2.3.2): To make it less likely that different themes will define setup snippets with the same name, we will prepend ⟨*theme name*⟩/ before the snippet name and use the result as the snippet name. For example, if the `witiko/dot` theme defines the `product` setup snippet, the setup snippet will be available under the name `witiko/dot/product`.Due to limitations of LaTeX, themes may not be loaded after the beginning of a LaTeX document.

```
\ExplSyntaxOn
\@onlypreamble
  \@@_set_latex_theme:n
\ExplSyntaxOff
```

Example themes provided with the Markdown package include:

witiko/dot A theme that typesets fenced code blocks with the `dot …` infostring as images of directed graphs rendered by the Graphviz tools. The right tail of the infostring is used as the image title.

~~~
\documentclass{article}
\usepackage[theme=witiko/dot]{markdown}
\setkeys{Gin}{
  width = \columnwidth,
  height = 0.65\paperheight,
  keepaspectratio}
\begin{document}
\begin{markdown}
``` dot Various formats of mathematical formulae
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"];
}
```
\end{markdown}
\end{document}
```

Typesetting the above document produces the output shown in Figure 4.

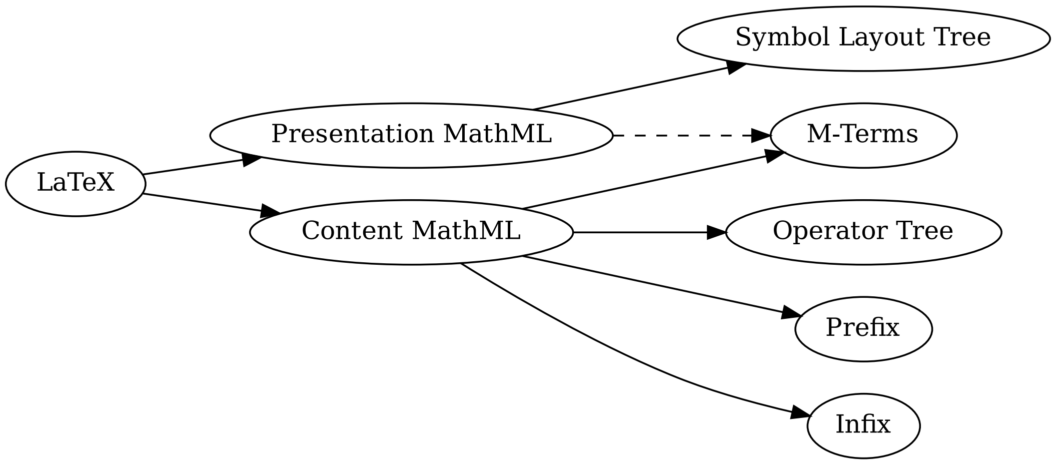

LaTeX
Presentation MathML
Content MathML
Symbol Layout Tree
M-Terms
Operator Tree
Prefix
Infix

Figure 4: Various formats of mathemathical formulae

The theme requires a Unix-like operating system with GNU Diffutils and Graphviz installed. The theme also requires shell access unless the `frozenCache` plain TEX option is enabled.

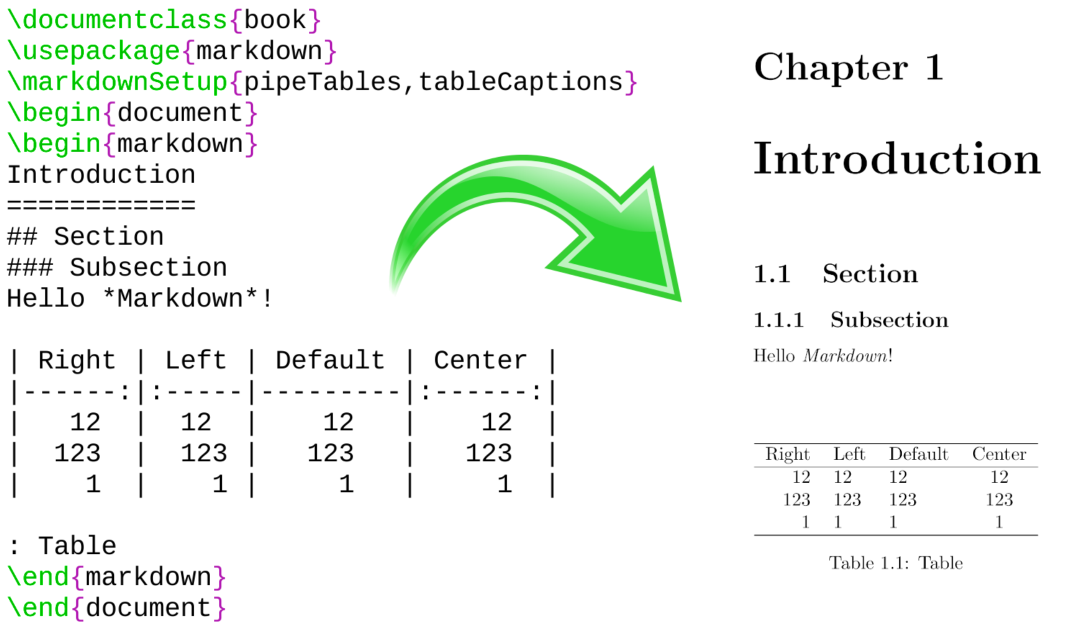
```
2214 \ProvidesPackage{markdownthemewitiko_dot}[2021/03/09]%
```

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

```
\documentclass{article}
\usepackage[theme=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 5. The



```
\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 5: 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.

```
\ProvidesPackage{markdownthemewitiko_graphicx_http}[2021/03/22]%
```

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

```
\documentclass{article}
\usepackage[theme=witiko/tilde]{markdown}
\begin{document}
```

```
\begin{markdown}
Bartel~Leendert van~der~Waerden
\end{markdown}
\end{document}
```

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

```
\ProvidesPackage{markdownthemewitiko_tilde}[2021/03/22]%
```

Please, see Section 3.3.2.1 for implementation details of the example themes.

2.3.2.3 LaTeX setup snippets

The LaTeX option with key snippet invokes a snippet named ⟨*value*⟩:

```
\ExplSyntaxOn
\keys_define:nn
  { markdown/latex-options }
  {
    snippet .code:n = {
      \markdownIfSnippetExists{#1}
        {
          \expandafter\markdownSetup\expandafter{
            \the\csname markdownLaTeXSetupSnippet
            \markdownLaTeXThemeName#1\endcsname}
        }{
          \markdownError
            {Can't~invoke~setup~snippet~#1}
            {The~setup~snippet~is~undefined}
        }
    }
  }
\ExplSyntaxOff
```

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

```
\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*}
```

2.3.2.4 Plain TEX Interface Options

Here, we automatically define plain TEX macros and the ⟨*key*⟩=⟨*value*⟩ interface for the above LATEX options.

```
\ExplSyntaxOn
\cs_new:Nn \@@_latex_define_option_commands_and_keyvals:
  {
    \seq_map_inline:Nn
      \g_@@_latex_options_seq
      {
        \@@_plain_tex_define_option_command:n
          { ##1 }
      }
```

Furthermore, we also define the ⟨*key*⟩=⟨*value*⟩ interface for all option macros recognized by the Lua and plain TEX interfaces.

```
    \seq_map_inline:Nn
      \g_@@_option_layers_seq
      {
        \seq_map_inline:cn
          { g_@@_ ##1 _options_seq }
          {
```

To make it easier to copy-and-paste options from Pandoc [4] such as `fancy_lists`, `header_attributes`, and `pipe_tables`, we accept snake_case in addition to camelCase variants of options. As a bonus, studies [5] also show that snake_case is faster to read than camelCase.

```
            \@@_with_various_cases:nn
              { ####1 }
              {
                \@@_latex_define_option_keyval:nnn
                  { ##1 }
                  { ####1 }
                  { ########1 }
              }
```

```
          }
      }
  }
\cs_new:Nn \@@_latex_define_option_keyval:nnn
  {
    \prop_get:cnN
      { g_@@_ #1 _option_types_prop }
      { #2 }
      \l_tmpa_tl
    \keys_define:nn
      { markdown/latex-options }
      {
        #3 .code:n = {
          \@@_set_option_value:nn
            { #2 }
            { ##1 }
        },
      }
    \str_if_eq:VVT
      \l_tmpa_tl
      \c_@@_option_type_boolean_tl
      {
        \keys_define:nn
          { markdown/latex-options }
          {
            #3 .default:n = { true },
          }
      }
```

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
                { @@ }
                { 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/latex-options }
          \l_tmpa_tl
      }
  }
\cs_generate_variant:Nn
  \clist_set:Nn
  { NV }
\cs_generate_variant:Nn
  \keys_define:nn
  { nV }
\cs_generate_variant:Nn
  \@@_set_option_value:nn
  { nV }
\prg_generate_conditional_variant:Nnn
  \str_if_eq:nn
  { en }
  { F }
\msg_new:nnn
  { @@ }
  { malformed-name-for-clist-option }
  {
    Clist~option~name~#1~does~not~end~with~-s.
  }
\@@_latex_define_option_commands_and_keyvals:
\ExplSyntaxOff
```

The finalizeCache and frozenCache plain TEX options are exposed through LATEX options with keys finalizeCache and frozenCache.

To ensure compatibility with the minted package [10, Section 5.1], which supports the finalizecache and frozencache package options with similar semantics, the Markdown package also recognizes these as aliases and recognizes 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}}
```

The following example LATEX code showcases a possible configuration of plain TEX interface options hybrid, smartEllipses, and cacheDir.

```
\markdownSetup{
  hybrid,
  smartEllipses,
  cacheDir = /tmp,
}
```

2.3.2.5 Plain TEX Markdown Token Renderers

The LATEX interface recognizes an option with the renderers key, whose value must be a list of options that map directly to the markdown token renderer macros exposed by the plain TEX interface (see Section 2.2.3).

```
\ExplSyntaxOn
\cs_new:Nn \@@_latex_define_renderers:
  {
    \seq_map_function:NN
      \g_@@_renderers_seq
      \@@_latex_define_renderer:n
  }
\cs_new:Nn \@@_latex_define_renderer:n
  {
    \@@_renderer_tl_to_csname:nN
      { #1 }
      \l_tmpa_tl
    \prop_get:NnN
      \g_@@_renderer_arities_prop
      { #1 }
      \l_tmpb_tl
    \@@_latex_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 }
      }
  }
\cs_new:Nn \@@_latex_define_renderer:nNn
  {
    \@@_with_various_cases:nn
      { #1 }
      {
        \keys_define:nn
          { markdown/latex-options/renderers }
          {
            ##1 .code:n = {
              \cs_generate_from_arg_count:NNnn
                #2
                \cs_set:Npn
                { #3 }
                { ####1 }
              },
            }
        }
    }
\cs_generate_variant:Nn
  \@@_latex_define_renderer:nNn
  { ncV }
\ExplSyntaxOff
```

The following example LaTeX code showcases a possible configuration of the `\markdownRendererLink` and `\markdownRendererEmphasis` markdown token renderers.

```
\markdownSetup{
  renderers = {
    link = {#4},                   % Render links as the link title.
    emphasis = {\emph{#1}},    % Render emphasized text via `\emph`.
  }
}
```

2.3.2.6 Plain TEX Markdown Token Renderer Prototypes

The LaTeX interface recognizes an option with the `rendererPrototypes` key, whose value must be a list of options that map directly to the markdown token renderer prototype macros exposed by the plain TEX interface (see Section 2.2.4).

```
\ExplSyntaxOn
\cs_new:Nn \@@_latex_define_renderer_prototypes:
  {
    \seq_map_function:NN
      \g_@@_renderers_seq
      \@@_latex_define_renderer_prototype:n
  }
\cs_new:Nn \@@_latex_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
    \@@_latex_define_renderer_prototype:ncV
      { #1 }
      { \l_tmpa_tl }
      \l_tmpb_tl
  }
\cs_new:Nn \@@_latex_define_renderer_prototype:nNn
  {
    \@@_with_various_cases:nn
      { #1 }
      {
        \keys_define:nn
          { markdown/latex-options/renderer-prototypes }
          {
            ##1 .code:n = {
              \cs_generate_from_arg_count:NNnn
                #2
                \cs_set:Npn
                { #3 }
                { ####1 }
            },
          }
      }
  }
\cs_generate_variant:Nn
  \@@_latex_define_renderer_prototype:nNn
  { ncV }
\ExplSyntaxOff
```

The following example LaTeX code showcases a possible configuration of the \markdownRendererImagePrototype and \markdownRendererCodeSpanPrototype markdown token renderer prototypes.

```
\markdownSetup{
  rendererPrototypes = {
    image = {\includegraphics{#2}},
    codeSpan = {\texttt{#1}},     % Render inline code via `\texttt`.
  }
}
```

2.4 ConTEXt Interface

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]
\unprotect
```

The ConTEXt implementation redefines the plain TEX logging macros (see Section 3.2.1) to use the ConTEXt `\writestatus` macro.

```
\def\markdownInfo#1{\writestatus{markdown}{#1.}}%
\def\markdownWarning#1{\writestatus{markdown\space warn}{#1.}}%
\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

The interface exposes the `\startmarkdown` and `\stopmarkdown` macro pair for the typesetting of a markdown document fragment, and defines the `\inputmarkdown` command.

```
\let\startmarkdown\relax
\let\stopmarkdown\relax
\let\inputmarkdown\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.

Note that the `\startmarkdown` and `\stopmarkdown` macros are subject to the same limitations as the `\markdownBegin` and `\markdownEnd` macros exposed by the plain TEX interface.

The following example ConTEXt code showcases the usage of the `\startmarkdown` and `\stopmarkdown` macros:

```
\usemodule[t][markdown]
\starttext
\startmarkdown
_Hello_ **world** ...
\stopmarkdown
\stoptext
```

The `\inputmarkdown` 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 ConTeXt interface options (see Section 2.4.2) as its optional argument. These options will only influnce this markdown document.

The following example LaTeX code showcases the usage of the `\markdownInput` macro:

```
\usemodule[t][markdown]
\starttext
\inputmarkdown[smartEllipses]{hello.md}
\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), or via the `\setupmarkdown` macro. The `\setupmarkdown` macro receives the options to set up as its only argument:

```
\ExplSyntaxOn
\cs_new:Nn
  \@@_setup:n
  {
    \keys_set:nn
      { markdown/context-options }
      { #1 }
  }
\long\def\setupmarkdown[#1]
  {
    \@@_setup:n
      { #1 }
  }
\ExplSyntaxOff
```

2.4.2.1 ConTeXt Interface Options

We define the ⟨*key*⟩`=`⟨*value*⟩ interface for all option macros recognized by the Lua and plain TeX interfaces.

```
\ExplSyntaxOn
\cs_new:Nn \@@_context_define_option_commands_and_keyvals:
  {
    \seq_map_inline:Nn
      \g_@@_option_layers_seq
      {
        \seq_map_inline:cn
          { g_@@_ ##1 _options_seq }
          {
```

To make it easier to copy-and-paste options from Pandoc [4] such as `fancy_lists`, `header_attributes`, and `pipe_tables`, we accept snake_case in addition to camel-Case variants of options. As a bonus, studies [5] also show that snake_case is faster to read than camelCase.

```
              \@@_with_various_cases:nn
                { ####1 }
                {
                  \@@_context_define_option_keyval:nnn
                    { ##1 }
                    { ####1 }
                    { ########1 }
                }
          }
      }
  }
```

Furthermore, we also accept caseless variants of options in line with the style of ConTEXt.

```
\cs_new:Nn \@@_caseless:N
  {
    \regex_replace_all:nnN
      { ([a-z])([A-Z]) }
      { \1 \c { str_lowercase:n } \cB\{ \2 \cE\} }
      #1
    \tl_set:Nx
      #1
      { #1 }
  }
\seq_gput_right:Nn \g_@@_cases_seq { @@_caseless:N }
\cs_new:Nn \@@_context_define_option_keyval:nnn
  {
    \prop_get:cnN
      { g_@@_ #1 _option_types_prop }
      { #2 }
      \l_tmpa_tl
    \keys_define:nn
      { markdown/context-options }
      {
        #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
        },
      }
    \str_if_eq:VVT
      \l_tmpa_tl
      \c_@@_option_type_boolean_tl
      {
        \keys_define:nn
          { markdown/context-options }
          {
            #3 .default:n = { true },
          }
      }
  }
\cs_generate_variant:Nn
  \@@_set_option_value:nn
  { nV }
\@@_context_define_option_commands_and_keyvals:
\ExplSyntaxOff
```

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).

```
local upper, gsub, format, length =
  string.upper, string.gsub, string.format, string.len
local P, R, S, V, C, Cg, Cb, Cmt, Cc, Ct, B, Cs, 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.P(1)
```

3.1.1 Utility Functions

This section documents the utility functions 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 computes the digest of `string` and `salt`, adds the `suffix` and looks into the directory `dir`, whether a file with such a name exists. If it does not, it gets created with `transform(string)` as its content. The filename is then returned.

```
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")
  if file == nil then -- If no cache entry exists, then create a new one.
    file = assert(io.open(name, "w"),
      [[Could not open file "]] .. name .. [[" for writing]])
    local result = string
    if transform ~= nil then
      result = transform(result)
    end
    assert(file:write(result))
    assert(file:close())
  end
  return name
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)
  string = string:gsub('[\r\n%s]*$', '')
  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.lookup_files method looks up files with filename f and returns its path. If the kpathsea library is available, it will search for files not only in the current working directory but also in the TeX directory structure. Further options for kpathsea can be specified in table options. [1, Section 10.7.4]

```
util.lookup_files = (function()
  local ran_ok, kpse = pcall(require, "kpse")
  if ran_ok then
    kpse.set_program_name("luatex")
  else
    kpse = { lookup = function(f, _) return f end }
  end

  local function lookup_files(f, options)
    return kpse.lookup(f, options)
  end

  return lookup_files
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 [11, 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 occurances 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 occurance 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
```

3.1.2 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,
  ["equals"] = 61,
  ["gt"] = 62,
  ["GT"] = 62,
  ["quest"] = 63,
  ["commat"] = 64,
  ["lsqb"] = 91,
  ["lbrack"] = 91,
  ["bsol"] = 92,
  ["rsqb"] = 93,
  ["rbrack"] = 93,
  ["Hat"] = 94,
  ["lowbar"] = 95,
  ["grave"] = 96,
  ["DiacriticalGrave"] = 96,
  ["lcub"] = 123,
  ["lbrace"] = 123,
  ["verbar"] = 124,
  ["vert"] = 124,
  ["VerticalLine"] = 124,
  ["rcub"] = 125,
  ["rbrace"] = 125,
  ["nbsp"] = 160,
  ["NonBreakingSpace"] = 160,
  ["iexcl"] = 161,
  ["cent"] = 162,
  ["pound"] = 163,
  ["curren"] = 164,
  ["yen"] = 165,
  ["brvbar"] = 166,
  ["sect"] = 167,
  ["Dot"] = 168,
  ["die"] = 168,
  ["DoubleDot"] = 168,
  ["uml"] = 168,
  ["copy"] = 169,
  ["COPY"] = 169,
  ["ordf"] = 170,
  ["laquo"] = 171,
  ["not"] = 172,
  ["shy"] = 173,
  ["reg"] = 174,
  ["circledR"] = 174,
  ["REG"] = 174,
  ["macr"] = 175,
  ["OverBar"] = 175,
  ["strns"] = 175,
  ["deg"] = 176,
  ["plusmn"] = 177,
  ["pm"] = 177,
  ["PlusMinus"] = 177,
  ["sup2"] = 178,
  ["sup3"] = 179,
  ["acute"] = 180,
  ["DiacriticalAcute"] = 180,
  ["micro"] = 181,
  ["para"] = 182,
  ["middot"] = 183,
  ["centerdot"] = 183,
  ["CenterDot"] = 183,
  ["cedil"] = 184,
  ["Cedilla"] = 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,
  ["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,
  ["divide"] = 247,
  ["div"] = 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,
  ["caron"] = 711,
  ["Hacek"] = 711,
  ["breve"] = 728,
  ["Breve"] = 728,
  ["dot"] = 729,
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  ["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)
  return unicode.utf8.char(tonumber(s))
end
```

Given a string `s` of hexadecimal digits, the `entities.hex_entity` returns the corresponding UTF8-encoded Unicode codepoint.

```
function entities.hex_entity(s)
  return unicode.utf8.char(tonumber("0x"..s))
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 n = character_entities[s]
  if n == nil then
```

```
    return "&" .. s .. ";"
  end
  return unicode.utf8.char(n)
end
```

3.1.3 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.

```
function M.writer.new(options)
  local self = {}
```

Make options available as writer->options, so that it is accessible from extensions.

```
  self.options = options
```

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

  if self.slice_begin == "^" and self.slice_end ~= "^" then
    self.is_writing = true
  else
    self.is_writing = false
  end
```

Define `writer->suffix` as the suffix of the produced cache files.

```
  self.suffix = ".tex"
```

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->pack` as a function that will take the filename `name` of the output file prepared by the reader and transform it to the output format.

```
  function self.pack(name)
    return [[\input ]] .. name .. [[\relax]]
  end
```

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

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

Define `writer->linebreak` as the output format of a forced line break.

```
  self.linebreak = "\\markdownRendererLineBreak\n{}"
```

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
```

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{}",
 }
 self.escaped_minimal_strings = {
   ["^^"] = "\\markdownRendererCircumflex\\markdownRendererCircumflex ",
   ["☒"] = "\\markdownRendererTickedBox{}",
   ["⊡"] = "\\markdownRendererHalfTickedBox{}",
   ["☐"] = "\\markdownRendererUntickedBox{}",
 }
```

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 for typeset content.

```
self.escaped_chars = {
   ["{"] = "\\markdownRendererLeftBrace{}",
   ["}"] = "\\markdownRendererRightBrace{}",
   ["%"] = "\\markdownRendererPercentSign{}",
   ["\\"] = "\\markdownRendererBackslash{}",
   ["#"] = "\\markdownRendererHash{}",
   ["$"] = "\\markdownRendererDollarSign{}",
   ["&"] = "\\markdownRendererAmpersand{}",
   ["_"] = "\\markdownRendererUnderscore{}",
   ["^"] = "\\markdownRendererCircumflex{}",
   ["~"] = "\\markdownRendererTilde{}",
   ["|"] = "\\markdownRendererPipe{}",
 }
```

Use the `writer->escaped_chars`, `writer->escaped_uri_chars`, and `writer->escaped_minima` tables to create the `writer->escape`, `writer->escape_uri`, and `writer->escape_minimal` escaper functions.

```
self.escape = util.escaper(self.escaped_chars, self.escaped_minimal_strings)
self.escape_uri = util.escaper(self.escaped_uri_chars, self.escaped_minimal_strings
self.escape_minimal = util.escaper({}, self.escaped_minimal_strings)
```

Define writer->string as a function that will transform an input plain text span s to the output format and writer->uri as a function that will transform an input URI u to the output format. If the hybrid option is enabled, use the writer->escape_minimal. Otherwise, use the writer->escape, and writer->escape_uri functions.

```
if options.hybrid then
  self.string = self.escape_minimal
  self.uri = self.escape_minimal
else
  self.string = self.escape
  self.uri = self.escape_uri
end
```

Define writer->code as a function that will transform an input inline code span s to the output format.

```
function self.code(s)
  return {"\\markdownRendererCodeSpan{",self.escape(s),"}"}
end
```

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, and tit to the title of the link.

```
function self.link(lab,src,tit)
  return {"\\markdownRendererLink{",lab,"}",
                      "{",self.escape(src),"}",
                      "{",self.uri(src),"}",
                      "{",self.string(tit or ""),"}"}
end
```

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, and tit to the title of the image.

```
function self.image(lab,src,tit)
  return {"\\markdownRendererImage{",lab,"}",
                       "{",self.string(src),"}",
                       "{",self.uri(src),"}",
                       "{",self.string(tit or ""),"}"}
end
```

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
    buffer[#buffer + 1] = self.bulletitem(item)
  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
      buffer[#buffer + 1] = self.ordereditem(item,num)
      if num ~= nil 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
```

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)
    return {"\\markdownRendererInlineHtmlComment{",contents,"}"}
  end
```

Define writer->block_html_comment as a function that will transform the contents of a block HTML comment, to the output format, where contents are the contents of the HTML comment.

```
  function self.block_html_comment(contents)
    if not self.is_writing then return "" end
    return {"\\markdownRendererBlockHtmlCommentBegin\n",contents,
            "\n\\markdownRendererBlockHtmlCommentEnd "}
  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)
    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
```

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

```
  function self.emphasis(s)
    return {"\\markdownRendererEmphasis{",s,"}"}
  end
```

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
```

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)
  return {"\\markdownRendererStrongEmphasis{",s,"}"}
end
```

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

```
function self.blockquote(s)
  if #util.rope_to_string(s) == 0 then return "" end
  return {"\\markdownRendererBlockQuoteBegin\n",s,
    "\n\\markdownRendererBlockQuoteEnd "}
end
```

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
  local name = util.cache_verbatim(options.cacheDir, s)
  return {"\\markdownRendererInputVerbatim{",name,"}"}
end
```

Define `writer->document` as a function that will transform a document `d` to the output format.

```
function self.document(d)
  local active_attributes = self.active_attributes
  local buf = {"\\markdownRendererDocumentBegin\n", d}

  -- pop attributes for sections that have ended
  if options.headerAttributes and self.is_writing then
    while #active_attributes > 0 do
      local attributes = active_attributes[#active_attributes]
      if #attributes > 0 then
        table.insert(buf, "\\markdownRendererHeaderAttributeContextEnd")
      end
      table.remove(active_attributes, #active_attributes)
    end
  end

```

```
    table.insert(buf, "\\markdownRendererDocumentEnd")

    return buf
  end
```

Define `writer->attributes` as a function that will transform input attributes `attr` to the output format.

```
  function self.attributes(attr)
    local buf = {}

    table.sort(attr)
    local key, value
    for i = 1, #attr do
      if attr[i]:sub(1, 1) == "#" then
        table.insert(buf, {"\\markdownRendererAttributeIdentifier{",
                           attr[i]:sub(2), "}"})
      elseif attr[i]:sub(1, 1) == "." then
        table.insert(buf, {"\\markdownRendererAttributeClassName{",
                           attr[i]:sub(2), "}"})
      else
        key, value = attr[i]:match("([^= ]+)%s*=%s*(.*)")
        table.insert(buf, {"\\markdownRendererAttributeKeyValue{",
                           key, "}{", value, "}"})
      end
    end

    return buf
  end
```

Define `writer->active_attributes` as a stack of attributes of the headings that are currently active. The `writer->active_headings` member variable is mutable.

```
  self.active_attributes = {}
```

Define `writer->heading` as a function that will transform an input heading `s` at level `level` with attributes `attributes` to the output format.

```
  function self.heading(s, level, attributes)
    attributes = attributes or {}
    for i = 1, #attributes do
      attributes[attributes[i]] = true
    end

    local active_attributes = self.active_attributes
    local slice_begin_type = self.slice_begin:sub(1, 1)
    local slice_begin_identifier = self.slice_begin:sub(2) or ""
    local slice_end_type = self.slice_end:sub(1, 1)
    local slice_end_identifier = self.slice_end:sub(2) or ""

    local buf = {}

    -- push empty attributes for implied sections
    while #active_attributes < level-1 do
      table.insert(active_attributes, {})
    end

    -- pop attributes for sections that have ended
    while #active_attributes >= level do
      local active_identifiers = active_attributes[#active_attributes]
      -- tear down all active attributes at slice end
      if active_identifiers["#" .. slice_end_identifier] ~= nil
          and slice_end_type == "$" then
        for header_level = #active_attributes, 1, -1 do
          if options.headerAttributes and #active_attributes[header_level] > 0 then
            table.insert(buf, "\\markdownRendererHeaderAttributeContextEnd")
          end
        end
        self.is_writing = false
      end
      table.remove(active_attributes, #active_attributes)
      if self.is_writing and options.headerAttributes and #active_identifiers > 0 ther
        table.insert(buf, "\\markdownRendererHeaderAttributeContextEnd")
      end
      -- apply all active attributes at slice beginning
      if active_identifiers["#" .. slice_begin_identifier] ~= nil
          and slice_begin_type == "$" then
        for header_level = 1, #active_attributes do
          if options.headerAttributes and #active_attributes[header_level] > 0 then
            table.insert(buf, "\\markdownRendererHeaderAttributeContextBegin")
          end
        end
        self.is_writing = true
      end
    end

    -- tear down all active attributes at slice end
    if attributes["#" .. slice_end_identifier] ~= nil
        and slice_end_type == "^" then
      for header_level = #active_attributes, 1, -1 do
        if options.headerAttributes and #active_attributes[header_level] > 0 then
          table.insert(buf, "\\markdownRendererHeaderAttributeContextEnd")
        end
      end
      self.is_writing = false
    end

    -- push attributes for the new section
    table.insert(active_attributes, attributes)
    if self.is_writing and options.headerAttributes and #attributes > 0 then
      table.insert(buf, "\\markdownRendererHeaderAttributeContextBegin")
    end

    -- apply all active attributes at slice beginning
    if attributes["#" .. slice_begin_identifier] ~= nil
        and slice_begin_type == "^" then
      for header_level = 1, #active_attributes do
        if options.headerAttributes and #active_attributes[header_level] > 0 then
          table.insert(buf, "\\markdownRendererHeaderAttributeContextBegin")
        end
      end
      self.is_writing = true
    end

    if self.is_writing then
      table.insert(buf, self.attributes(attributes))
    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, "{", s, "}"})
    end

    return buf
  end
```

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,
      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
```

3.1.4 Parsers

The parsers hash table stores PEG patterns that are static and can be reused between different reader objects.

```
local parsers                  = {}
```

3.1.4.1 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.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.tightblocksep        = P("\001")

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^0
parsers.internal_punctuation = S(":;,.?")

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.escapable            = S("!\"#$%&'()*+,-./:;<=>?@[\\]^_`{|}~")
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.tightblocksep)
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
```

The `parsers.commented_line^1` parser recognizes the regular language of TEX comments, see an equivalent finite automaton in Figure 6.

```
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)
```

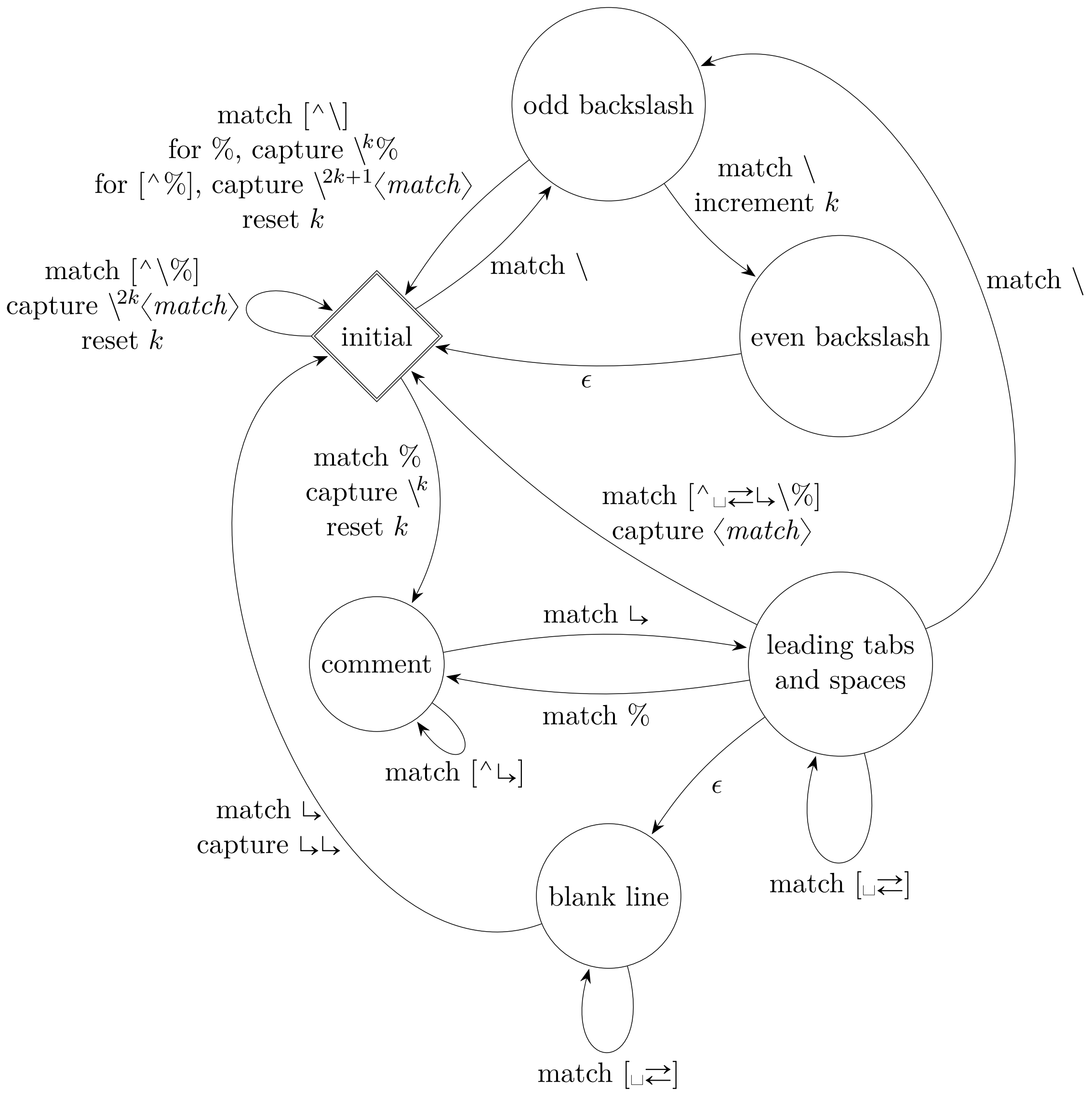

Figure 6: A pushdown automaton that recognizes TEX comments

```
                                * Cg((parsers.backslash  -- even backslash
                                     * parsers.backslash)^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("\\")
                                    * 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 tabs and space
                                + #(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_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.anyescaped - parsers.dquote - parsers.rbrac
                                - parsers.space)^0

parsers.attribute = (parsers.dash * Cc(".unnumbered"))
                  + C((parsers.hash + parsers.period)
                     * parsers.attribute_key)
                  + 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

-- 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
```

3.1.4.2 Parsers Used for Markdown Lists

```
parsers.bulletchar = C(parsers.plus + parsers.asterisk + parsers.dash)

parsers.bullet = ( parsers.bulletchar * #parsers.spacing
                                      * (parsers.tab + parsers.space^-
3)
                 + parsers.space * parsers.bulletchar * #parsers.spacing
                                 * (parsers.tab + parsers.space^-2)
                 + parsers.space * parsers.space * parsers.bulletchar
                                 * #parsers.spacing
                                 * (parsers.tab + parsers.space^-1)
                 + parsers.space * parsers.space * parsers.space
                                 * parsers.bulletchar * #parsers.spacing
                 )

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)

```

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

parsers.intickschar = (parsers.any - S(" \n\r`"))
                    + (parsers.newline * -parsers.blankline)
                    + (parsers.space - parsers.closeticks)
                    + (parsers.backtick^1 - parsers.closeticks)

parsers.inticks     = parsers.openticks * parsers.space^-1
                    * C(parsers.intickschar^0) * parsers.closeticks
```

3.1.4.4 Parsers Used for Fenced Code Blocks

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

parsers.tilde_infostring
                     = C((parsers.linechar
                        - (parsers.spacechar^1 * parsers.newline))^0)
                     * parsers.optionalspace
                     * (parsers.newline + parsers.eof)

parsers.backtick_infostring
                     = C((parsers.linechar
                        - (parsers.backtick
                          + parsers.spacechar^1 * parsers.newline))^0)
                     * parsers.optionalspace
                     * (parsers.newline + parsers.eof)

local fenceindent
parsers.fencehead    = function(char, infostring)
  return               C(parsers.nonindentspace) / function(s) fenceindent = #s end
                     * Cg(char^3, "fencelength")
                     * parsers.optionalspace * infostring
end

parsers.fencehead_with_attributes
                     = function(char)
  return               C(parsers.nonindentspace) / function(s) fenceindent = #s end
                     * Cg(char^3, "fencelength")
                     * parsers.optionalspace * Ct(parsers.attributes)
                     * parsers.optionalspace * (parsers.newline + parsers.eof)
end

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

parsers.fencedline   = function(char)
  return               C(parsers.line - parsers.fencetail(char))
                     / function(s)
                         local i = 1
                         local remaining = fenceindent
                         while true do
                           local c = s:sub(i, i)
                           if c == " " and remaining > 0 then
                             remaining = remaining - 1
                             i = i + 1
                           elseif c == "\t" and remaining > 3 then
                             remaining = remaining - 4
                             i = i + 1
                           else
                             break
                           end
                         end
                         return s:sub(i)
                       end
end
```

3.1.4.5 Parsers Used for Markdown Tags and Links

```
parsers.leader      = parsers.space^-3

-- 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 }

-- bracketed tag for markdown links, allowing nested brackets:
parsers.tag         = parsers.lbracket
                    * Cs((parsers.alphanumeric^1
                         + parsers.bracketed
                         + parsers.inticks
                         + ( parsers.backslash / "" * parsers.rbracket
                           + parsers.any
                           - (parsers.rbracket + parsers.blankline^2)))^0)
                    * parsers.rbracket

-- url for markdown links, allowing nested brackets:
parsers.url         = parsers.less * Cs((parsers.anyescaped
                                        - parsers.more)^0)
                                   * parsers.more
                    + Cs((parsers.inparens + (parsers.anyescaped
                                             - parsers.spacing
                                             - parsers.rparent))^1)

-- quoted text, possibly with nested quotes:
parsers.title_s     = parsers.squote * Cs(((parsers.anyescaped-parsers.squote)
                                          + parsers.squoted)^0)
                                     * parsers.squote

parsers.title_d     = parsers.dquote * Cs(((parsers.anyescaped-parsers.dquote)
                                          + parsers.dquoted)^0)
                                     * parsers.dquote

parsers.title_p     = parsers.lparent
                    * Cs((parsers.inparens + (parsers.anyescaped-parsers.rparent))^0)
                    * parsers.rparent

```

```
parsers.title       = parsers.title_d + parsers.title_s + parsers.title_p

parsers.optionaltitle
                    = parsers.spnl * parsers.title * parsers.spacechar^0
                    + Cc("")
```

3.1.4.6 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.block_keyword =
    parsers.keyword_exact("address") + parsers.keyword_exact("blockquote") +
    parsers.keyword_exact("center") + parsers.keyword_exact("del") +
    parsers.keyword_exact("dir") + parsers.keyword_exact("div") +
    parsers.keyword_exact("p") + parsers.keyword_exact("pre") +
    parsers.keyword_exact("li") + parsers.keyword_exact("ol") +
    parsers.keyword_exact("ul") + parsers.keyword_exact("dl") +
    parsers.keyword_exact("dd") + parsers.keyword_exact("form") +
    parsers.keyword_exact("fieldset") + parsers.keyword_exact("isindex") +
    parsers.keyword_exact("ins") + parsers.keyword_exact("menu") +
    parsers.keyword_exact("noframes") + 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("hr") + parsers.keyword_exact("script") +
    parsers.keyword_exact("noscript") + parsers.keyword_exact("table") +
    parsers.keyword_exact("tbody") + parsers.keyword_exact("tfoot") +
    parsers.keyword_exact("thead") + parsers.keyword_exact("th") +
    parsers.keyword_exact("td") + parsers.keyword_exact("tr")

-- There is no reason to support bad html, so we expect quoted attributes
parsers.htmlattributevalue
                          = parsers.squote * (parsers.any - (parsers.blankline
                                                           + parsers.squote))^0
                                           * parsers.squote
                          + parsers.dquote * (parsers.any - (parsers.blankline
                                                           + parsers.dquote))^0
                                           * parsers.dquote
```

```

parsers.htmlattribute     = parsers.spacing^1
                          * (parsers.alphanumeric + S("_-"))^1
                          * parsers.sp * parsers.equal * parsers.sp
                          * parsers.htmlattributevalue

parsers.htmlcomment       = P("<!--")
                          * parsers.optionalspace
                          * Cs((parsers.any - parsers.optionalspace * P("-->"))^0)
                          * parsers.optionalspace
                          * P("-->")

parsers.htmlinstruction   = P("<?") * (parsers.any - P("?>"))^0 * P("?>")

parsers.openelt_any = parsers.less * parsers.keyword * parsers.htmlattribute^0
                    * parsers.sp * parsers.more

parsers.openelt_exact = function(s)
  return parsers.less * parsers.sp * parsers.keyword_exact(s)
       * parsers.htmlattribute^0 * parsers.sp * parsers.more
end

parsers.openelt_block = parsers.sp * parsers.block_keyword
                      * parsers.htmlattribute^0 * parsers.sp * parsers.more

parsers.closeelt_any = parsers.less * parsers.sp * parsers.slash
                     * parsers.keyword * parsers.sp * parsers.more

parsers.closeelt_exact = function(s)
  return parsers.less * parsers.sp * parsers.slash * parsers.keyword_exact(s)
       * parsers.sp * parsers.more
end

parsers.emptyelt_any = parsers.less * parsers.sp * parsers.keyword
                     * parsers.htmlattribute^0 * parsers.sp * parsers.slash
                     * parsers.more

parsers.emptyelt_block = parsers.less * parsers.sp * parsers.block_keyword
                       * parsers.htmlattribute^0 * parsers.sp * parsers.slash
                       * parsers.more

parsers.displaytext = (parsers.any - parsers.less)^1

-- return content between two matched HTML tags
parsers.in_matched = function(s)
  return { parsers.openelt_exact(s)
         * (V(1) + parsers.displaytext
          + (parsers.less - parsers.closeelt_exact(s)))^0
        * parsers.closeelt_exact(s) }
end

local function parse_matched_tags(s,pos)
  local t = string.lower(lpeg.match(C(parsers.keyword),s,pos))
  return lpeg.match(parsers.in_matched(t),s,pos-1)
end

parsers.in_matched_block_tags = parsers.less
                              * Cmt(#parsers.openelt_block, parse_matched_tags)

```

3.1.4.7 Parsers Used for HTML Entities

```
parsers.hexentity = parsers.ampersand * parsers.hash * S("Xx")
                  * C(parsers.hexdigit^1) * parsers.semicolon
parsers.decentity = parsers.ampersand * parsers.hash
                  * C(parsers.digit^1) * parsers.semicolon
parsers.tagentity = parsers.ampersand * C(parsers.alphanumeric^1)
                  * parsers.semicolon
```

3.1.4.8 Helpers for References

```
-- parse a reference definition:  [foo]: /bar "title"
parsers.define_reference_parser = parsers.leader * parsers.tag * parsers.colon
                                * parsers.spacechar^0 * parsers.url
                                * parsers.optionaltitle * parsers.blankline^1
```

3.1.4.9 Inline Elements

```
parsers.Inline         = V("Inline")
parsers.IndentedInline = V("IndentedInline")

-- 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

parsers.urlchar      = parsers.anyescaped - parsers.newline - parsers.more
```

3.1.4.10 Block Elements

```
parsers.TildeFencedCode
       = parsers.fencehead(parsers.tilde,
                           parsers.tilde_infostring)
       * Cs(parsers.fencedline(parsers.tilde)^0)
       * parsers.fencetail(parsers.tilde)
```

```

parsers.BacktickFencedCode
       = parsers.fencehead(parsers.backtick,
                           parsers.backtick_infostring)
       * Cs(parsers.fencedline(parsers.backtick)^0)
       * parsers.fencetail(parsers.backtick)

parsers.lineof = function(c)
    return (parsers.leader * (P(c) * parsers.optionalspace)^3
           * (parsers.newline * parsers.blankline^1
             + parsers.newline^-1 * parsers.eof))
end
```

3.1.4.11 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.equal^1 * Cc(1) + parsers.dash^1 * Cc(2)

local function strip_atx_end(s)
  return s:gsub("[#%s]*\n$","")
end
```

3.1.5 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
```

3.1.5.1 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)
  return string.lower(
    gsub(util.rope_to_string(tag), "[ \n\r\t]+", " "))
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
```

3.1.5.2 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
            is_shorter = is_shorter or prefix_length < min_prefix_length
            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
      error(format("%s failed on:\n%s", name, 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_link",
                   function()
                     return parsers.inlines_no_link
                   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)
```

3.1.5.3 Parsers Used for Markdown Lists (local)

```
if options.hashEnumerators then
  parsers.dig = parsers.digit + parsers.hash
else
  parsers.dig = parsers.digit
end

parsers.enumerator = C(parsers.dig^3 * parsers.period) * #parsers.spacing
```

```
                      + C(parsers.dig^2 * parsers.period) * #parsers.spacing
                                        * (parsers.tab + parsers.space^1)
                      + C(parsers.dig * parsers.period) * #parsers.spacing
                                      * (parsers.tab + parsers.space^-2)
                      + parsers.space * C(parsers.dig^2 * parsers.period)
                                      * #parsers.spacing
                      + parsers.space * C(parsers.dig * parsers.period)
                                      * #parsers.spacing
                                      * (parsers.tab + parsers.space^-1)
                      + parsers.space * parsers.space * C(parsers.dig^1
                                      * parsers.period) * #parsers.spacing
```

3.1.5.4 Parsers Used for Blockquotes (local)

```
-- strip off leading > and indents, and run through blocks
parsers.blockquote_body = ((parsers.leader * parsers.more * parsers.space^-
1)/""
                             * parsers.linechar^0 * parsers.newline)^1
                            * (-(parsers.leader * parsers.more
                                + parsers.blankline) * parsers.linechar^1
                              * parsers.newline)^0

if not options.breakableBlockquotes then
  parsers.blockquote_body = parsers.blockquote_body
                            * (parsers.blankline^0 / "")
end
```

3.1.5.5 Helpers for Links and References (local)

```
-- List of references defined in the document
local references

-- add a reference to the list
local function register_link(tag,url,title)
    references[self.normalize_tag(tag)] = { url = url, title = title }
    return ""
end

-- lookup link reference and return either
-- the link or nil and fallback text.
local function lookup_reference(label,sps,tag)
    local tagpart
    if not tag then
        tag = label
        tagpart = ""
    elseif tag == "" then
        tag = label
        tagpart = "[]"
    else
        tagpart = {"[",
          self.parser_functions.parse_inlines(tag),
          "]"}
    end
    if sps then
      tagpart = {sps, tagpart}
    end
    local r = references[self.normalize_tag(tag)]
    if r then
      return r
    else
      return nil, {"[",
        self.parser_functions.parse_inlines(label),
        "]", tagpart}
    end
end

-- lookup link reference and return a link, if the reference is found,
-- or a bracketed label otherwise.
local function indirect_link(label,sps,tag)
  return writer.defer_call(function()
    local r,fallback = lookup_reference(label,sps,tag)
    if r then
      return writer.link(
        self.parser_functions.parse_inlines_no_link(label),
        r.url, r.title)
    else
      return fallback
    end
  end)
end

-- lookup image reference and return an image, if the reference is found,
-- or a bracketed label otherwise.
local function indirect_image(label,sps,tag)
  return writer.defer_call(function()
    local r,fallback = lookup_reference(label,sps,tag)
    if r then
      return writer.image(writer.string(label), r.url, r.title)
    else
      return {"!", fallback}
    end
  end)
end
```

3.1.5.6 Inline Elements (local)

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

parsers.Symbol   = (V("SpecialChar") - parsers.tightblocksep)
                 / 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.more
end

if options.blankBeforeHeading then
  parsers.headerstart = parsers.fail
else
  parsers.headerstart = parsers.hash
                      + (parsers.line * (parsers.equal^1 + parsers.dash^1)
                      * parsers.optionalspace * parsers.newline)
end

parsers.EndlineExceptions
                   = parsers.blankline -- paragraph break
                   + parsers.tightblocksep  -- nested list
                   + parsers.eof       -- end of document
                   + parsers.bqstart
                   + parsers.headerstart

parsers.Endline   = parsers.newline
                  * -V("EndlineExceptions")
                  * parsers.spacechar^0
                  / (options.hardLineBreaks and writer.linebreak
                                            or writer.space)

parsers.OptionalIndent
                   = parsers.spacechar^1 / writer.space

parsers.Space      = parsers.spacechar^2 * parsers.Endline / writer.linebreak
                   + parsers.spacechar^1 * parsers.Endline^-1 * parsers.eof / ""
                   + parsers.spacechar^1 * parsers.Endline
                                         * parsers.optionalspace
```

```
                                          / (options.hardLineBreaks
                                             and writer.linebreak
                                              or writer.space)
                   + parsers.spacechar^1 * parsers.optionalspace
                                          / writer.space

parsers.NonbreakingEndline
                  = parsers.newline
                  * -V("EndlineExceptions")
                  * parsers.spacechar^0
                  / (options.hardLineBreaks and writer.linebreak
                                              or writer.nbsp)

parsers.NonbreakingSpace
                = parsers.spacechar^2 * parsers.Endline / writer.linebreak
                + parsers.spacechar^1 * parsers.Endline^-1 * parsers.eof / ""
                + parsers.spacechar^1 * parsers.Endline
                                      * parsers.optionalspace
                                      / (options.hardLineBreaks
                                         and writer.linebreak
                                          or writer.nbsp)
                + parsers.spacechar^1 * parsers.optionalspace
                                      / writer.nbsp

if options.underscores then
  parsers.Strong = ( parsers.between(parsers.Inline, parsers.doubleasterisks,
                                     parsers.doubleasterisks)
                   + parsers.between(parsers.Inline, parsers.doubleunderscores,
                                     parsers.doubleunderscores)
                   ) / writer.strong

  parsers.Emph   = ( parsers.between(parsers.Inline, parsers.asterisk,
                                     parsers.asterisk)
                   + parsers.between(parsers.Inline, parsers.underscore,
                                     parsers.underscore)
                   ) / writer.emphasis
else
  parsers.Strong = ( parsers.between(parsers.Inline, parsers.doubleasterisks,
                                     parsers.doubleasterisks)
                   ) / writer.strong

  parsers.Emph   = ( parsers.between(parsers.Inline, parsers.asterisk,
                                     parsers.asterisk)
                   ) / writer.emphasis
end

parsers.AutoLinkUrl    = parsers.less
```

```
                       * C(parsers.alphanumeric^1 * P("://") * parsers.urlchar^1)
                       * parsers.more
                       / function(url)
                           return writer.link(writer.escape(url), url)
                         end

parsers.AutoLinkEmail = parsers.less
                      * C((parsers.alphanumeric + S("-._+"))^1
                      * P("@") * parsers.urlchar^1)
                      * parsers.more
                      / function(email)
                          return writer.link(writer.escape(email),
                                             "mailto:"..email)
                        end

parsers.AutoLinkRelativeReference
                       = parsers.less
                       * C(parsers.urlchar^1)
                       * parsers.more
                       / function(url)
                           return writer.link(writer.escape(url), url)
                         end

parsers.DirectLink    = (parsers.tag / self.parser_functions.parse_inlines_no_link)
                      * parsers.spnl
                      * parsers.lparent
                      * (parsers.url + Cc(""))  -- link can be empty [foo]()
                      * parsers.optionaltitle
                      * parsers.rparent
                      / writer.link

parsers.IndirectLink  = parsers.tag * (C(parsers.spnl) * parsers.tag)^-
1
                      / indirect_link

-- parse a link or image (direct or indirect)
parsers.Link          = parsers.DirectLink + parsers.IndirectLink

parsers.DirectImage   = parsers.exclamation
                      * (parsers.tag / self.parser_functions.parse_inlines)
                      * parsers.spnl
                      * parsers.lparent
                      * (parsers.url + Cc(""))  -- link can be empty [foo]()
                      * parsers.optionaltitle
                      * parsers.rparent
                      / writer.image
```

```
parsers.IndirectImage = parsers.exclamation * parsers.tag
                      * (C(parsers.spnl) * parsers.tag)^-1 / indirect_image

parsers.Image         = parsers.DirectImage + parsers.IndirectImage

-- avoid parsing long strings of * or _ as emph/strong
parsers.UlOrStarLine  = parsers.asterisk^4 + parsers.underscore^4
                      / writer.string

parsers.EscapedChar   = parsers.backslash * C(parsers.escapable) / writer.string

parsers.InlineHtml    = parsers.emptyelt_any / writer.inline_html_tag
                      + (parsers.htmlcomment / self.parser_functions.parse_inlines_n
                      / writer.inline_html_comment
                      + parsers.htmlinstruction
                      + parsers.openelt_any / writer.inline_html_tag
                      + parsers.closeelt_any / writer.inline_html_tag

parsers.HtmlEntity    = parsers.hexentity / entities.hex_entity  / writer.string
                      + parsers.decentity / entities.dec_entity  / writer.string
                      + parsers.tagentity / entities.char_entity / writer.string
```

3.1.5.7 Block Elements (local)

```
parsers.DisplayHtml  = (parsers.htmlcomment / self.parser_functions.parse_blocks_nes
                     / writer.block_html_comment
                     + parsers.emptyelt_block / writer.block_html_element
                     + parsers.openelt_exact("hr") / writer.block_html_element
                     + parsers.in_matched_block_tags / writer.block_html_element
                     + parsers.htmlinstruction

parsers.Verbatim     = Cs( (parsers.blanklines
                         * ((parsers.indentedline - parsers.blankline))^1)^1
                         ) / self.expandtabs / writer.verbatim

parsers.Blockquote   = Cs(parsers.blockquote_body^1)
                     / self.parser_functions.parse_blocks_nested
                     / writer.blockquote

parsers.ThematicBreak = ( parsers.lineof(parsers.asterisk)
                        + parsers.lineof(parsers.dash)
                        + parsers.lineof(parsers.underscore)
                        ) / writer.thematic_break

parsers.Reference    = parsers.define_reference_parser / register_link

parsers.Paragraph    = parsers.nonindentspace * Ct(parsers.Inline^1)
```

```
                     * ( parsers.newline
                     * ( parsers.blankline^1
                       + #parsers.hash
                       + #(parsers.leader * parsers.more * parsers.space^-1)
                       + parsers.eof
                       )
                     + parsers.eof )
                     / writer.paragraph

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

3.1.5.8 Lists (local)

```
parsers.starter = parsers.bullet + parsers.enumerator

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

-- we use \001 as a separator between a tight list item and a
-- nested list under it.
parsers.NestedList            = Cs((parsers.optionallyindentedline
                                   - parsers.starter)^1)
                              / function(a) return "\001"..a end

parsers.ListBlockLine         = parsers.optionallyindentedline
                              - parsers.blankline - (parsers.indent^-1
                                                     * parsers.starter)

parsers.ListBlock             = parsers.line * parsers.ListBlockLine^0

parsers.ListContinuationBlock = parsers.blanklines * (parsers.indent / "")
                              * parsers.ListBlock

parsers.TightListItem = function(starter)
    return -parsers.ThematicBreak
           * (Cs(starter / "" * parsers.tickbox^-1 * parsers.ListBlock * parsers.Nes
1)
             / self.parser_functions.parse_blocks_nested)
           * -(parsers.blanklines * parsers.indent)
end

parsers.LooseListItem = function(starter)
    return -parsers.ThematicBreak
           * Cs( starter / "" * parsers.tickbox^-1 * parsers.ListBlock * Cc("\n")
             * (parsers.NestedList + parsers.ListContinuationBlock^0)
             * (parsers.blanklines / "\n\n")
             ) / self.parser_functions.parse_blocks_nested
end

parsers.BulletList = ( Ct(parsers.TightListItem(parsers.bullet)^1) * Cc(true)
                     * parsers.skipblanklines * -parsers.bullet
                     + Ct(parsers.LooseListItem(parsers.bullet)^1) * Cc(false)
                     * parsers.skipblanklines )
                   / writer.bulletlist

local function ordered_list(items,tight,startnum)
  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.OrderedList = Cg(parsers.enumerator, "listtype") *
                    ( Ct(parsers.TightListItem(Cb("listtype"))
                        * parsers.TightListItem(parsers.enumerator)^0)
                    * Cc(true) * parsers.skipblanklines * -parsers.enumerator
                    + Ct(parsers.LooseListItem(Cb("listtype"))
                        * parsers.LooseListItem(parsers.enumerator)^0)
                    * Cc(false) * parsers.skipblanklines
                    ) * Cb("listtype") / ordered_list
```

3.1.5.9 Blank (local)

```
parsers.Blank        = parsers.blankline / ""
                     + parsers.Reference
                     + (parsers.tightblocksep / "\n")
```

3.1.5.10 Headings (local)

```
-- parse atx header
parsers.AtxHeading = Cg(parsers.heading_start, "level")
```

```
                   * parsers.optionalspace
                   * (C(parsers.line)
                     / strip_atx_end
                     / self.parser_functions.parse_inlines)
                   * Cb("level")
                   / writer.heading

parsers.SetextHeading = #(parsers.line * S("=-"))
                      * Ct(parsers.linechar^1
                          / self.parser_functions.parse_inlines)
                      * parsers.newline
                      * parsers.heading_level
                      * parsers.optionalspace
                      * parsers.newline
                      / writer.heading

parsers.Heading = parsers.AtxHeading + parsers.SetextHeading
```

3.1.5.11 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 / writer.interblocksep))^-
  1
                              * V("Blank")^0
                              * V("Block")^-1
                              * ( V("Blank")^0 / writer.interblocksep
                                * V("Block"))^0
                              * V("Blank")^0 * parsers.eof,

        ExpectedJekyllData      = parsers.fail,

        Blank                   = parsers.Blank,

        Blockquote              = parsers.Blockquote,
        Verbatim                = parsers.Verbatim,
        ThematicBreak           = parsers.ThematicBreak,
        BulletList              = parsers.BulletList,
        OrderedList             = parsers.OrderedList,
        Heading                 = parsers.Heading,
        DisplayHtml             = parsers.DisplayHtml,
        Paragraph               = parsers.Paragraph,
        Plain                   = parsers.Plain,
        EndlineExceptions       = parsers.EndlineExceptions,

        Str                     = parsers.Str,
        Space                   = parsers.Space,
        OptionalIndent          = parsers.OptionalIndent,
        Endline                 = parsers.Endline,
        UlOrStarLine            = parsers.UlOrStarLine,
        Strong                  = parsers.Strong,
        Emph                    = parsers.Emph,
        Link                    = parsers.Link,
        Image                   = parsers.Image,
        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_
      else
        previous_pattern = nil
        extension_name = current_extension_name
      end
      local pattern = get_pattern(previous_pattern)
      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("!")
    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)
      syntax.InitializeState = syntax.InitializeState
                             * Cg(Ct("") / value, name)
    end
```

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
```

Duplicate the `Inline` rule as `IndentedInline` with the right-hand-side terminal symbol `Space` replaced with `OptionalIndent`.

```
    walkable_syntax["IndentedInline"] = util.table_copy(
      walkable_syntax["Inline"])
    self.insert_pattern(
      "IndentedInline instead of Space",
      "OptionalIndent")
```

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 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
    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

    local blocks_nested_t = util.table_copy(syntax)
    blocks_nested_t.ExpectedJekyllData = parsers.fail
    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_link_t = util.table_copy(inlines_t)
    inlines_no_link_t.Link = parsers.fail
    parsers.inlines_no_link = Ct(inlines_no_link_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)
```

Return a function that converts markdown string `input` into a plain TEX output and returns it. Note that the converter assumes that the input has UNIX line endings.

```
    return function(input)
      references = {}
```

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). The `cacheDir` option is disregarded.

```
      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
        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
      local output
```

If we cache markdown documents, produce the cache file and transform its filename to plain TEX output via the `writer->pack` method.

```
      local function convert(input)
        local document = self.parser_functions.parse_blocks(input)
        return util.rope_to_string(writer.document(document))
      end
      if options.eagerCache or options.finalizeCache then
        local name = util.cache(options.cacheDir, input, salt, convert,
                                ".md" .. writer.suffix)
        output = writer.pack(name)
```

Otherwise, return the result of the conversion directly.

```
      else
        output = convert(input)
      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{]] .. output .. [[}]] .. "\n"))
        assert(file:close())
      end
      return output
    end
  end
  return self
end
```

3.1.6 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 = {}
```

3.1.6.1 Bracketed Spans

The extensions.bracketed_spans function implements the Pandoc bracketed spans 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)
        return {"\\markdownRendererBracketedSpanAttributeContextBegin",
                self.attributes(attr),
                s,
                "\\markdownRendererBracketedSpanAttributeContextEnd{}"}
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local writer = self.writer

      local Span = parsers.between(parsers.Inline,
                                   parsers.lbracket,
                                   parsers.rbracket)
                 * Ct(parsers.attributes)
                 / writer.span

      self.insert_pattern("Inline after Emph",
                          Span, "Span")
    end
  }
end
```

3.1.6.2 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)
```

Define table `escaped_citation_chars` containing the characters to escape in citations.

```
  local escaped_citation_chars = {
    ["{"] = "\\markdownRendererLeftBrace{}",
    ["}"] = "\\markdownRendererRightBrace{}",
    ["%"] = "\\markdownRendererPercentSign{}",
    ["\\"] = "\\markdownRendererBackslash{}",
    ["#"] = "\\markdownRendererHash{}",
  }
  return {
    name = "built-in citations syntax extension",
    extend_writer = function(self)
      local options = self.options

```

Use the `escaped_citation_chars` to create the `escape_citation` escaper functions.

```
      local escape_citation = util.escaper(
        escaped_citation_chars,
        self.escaped_minimal_strings)
```

Define writer->citation as a function that will transform an input citation name c to the output format. If option hybrid is enabled, use the writer->escape_minimal function. Otherwise, use the escape_citation function.

```
      if options.hybrid then
        self.citation = self.escape_minimal
      else
        self.citation = escape_citation
      end
```

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 = {"\\markdownRenderer", text_cites and "TextCite" or "Cite",
          "{", #cites, "}"}
        for _,cite in ipairs(cites) do
          buffer[#buffer+1] = {cite.suppress_author and "-" or "+", "{",
            cite.prenote or "", "}{", cite.postnote or "", "}{", cite.name, "}"}
        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.anyescaped
                           - (parsers.rbracket + parsers.blankline^2))
                         - (parsers.spnl * parsers.dash^-1 * parsers.at))^0)

      local citation_body_postnote
                    = Cs((parsers.alphanumeric^1
                         + parsers.bracketed
                         + parsers.inticks
                         + (parsers.anyescaped
                           - (parsers.rbracket + parsers.semicolon
                             + parsers.blankline^2))
                         - (parsers.spnl * parsers.rbracket))^0)

      local citation_body_chunk
                    = citation_body_prenote
                    * parsers.spnl * citation_name
                    * (parsers.internal_punctuation - parsers.semicolon)^-
1
                    * parsers.spnl * citation_body_postnote

      local citation_body
                    = citation_body_chunk
                    * (parsers.semicolon * parsers.spnl
                      * citation_body_chunk)^0

      local citation_headless_body_postnote
                    = Cs((parsers.alphanumeric^1
                         + parsers.bracketed
                         + parsers.inticks
                         + (parsers.anyescaped
                           - (parsers.rbracket + parsers.at
                             + parsers.semicolon + parsers.blankline^2))
                         - (parsers.spnl * parsers.rbracket))^0)

      local citation_headless_body
                    = citation_headless_body_postnote
                    * (parsers.sp * parsers.semicolon * parsers.spnl
                      * 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.citation(raw_cites[i+2]),
                  postnote = normalize(raw_cites[i+3]),
              }
          end
          return writer.citations(text_cites, cites)
      end

      local TextCitations
                    = Ct((parsers.spnl
                    * Cc("")
                    * citation_name
                    * ((parsers.spnl
                        * parsers.lbracket
                        * citation_headless_body
                        * parsers.rbracket) + Cc("")))^1)
                    / function(raw_cites)
                        return citations(true, raw_cites)
                      end

      local ParenthesizedCitations
                    = Ct((parsers.spnl
                    * parsers.lbracket
                    * citation_body
                    * parsers.rbracket)^1)
                    / function(raw_cites)
                        return citations(false, raw_cites)
                      end
```

```

      local Citations = TextCitations + ParenthesizedCitations

      self.insert_pattern("Inline after Emph",
                          Citations, "Citations")

      self.add_special_character("@")
      self.add_special_character("-")
    end
  }
end
```

3.1.6.3 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{util.lookup_files(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.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.leader
                      * (localfilepath + onlineimageurl)
                      * contentblock_tail
                      / writer.contentblock

        self.insert_pattern("Block before Blockquote",
                            ContentBlock, "ContentBlock")
      end
    }
end
```

3.1.6.4 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 = ( defstartchar * #parsers.spacing
                                      * (parsers.tab + parsers.space^-
3)
                       + parsers.space * defstartchar * #parsers.spacing
                                       * (parsers.tab + parsers.space^-
2)
                       + parsers.space * parsers.space * defstartchar
                                       * #parsers.spacing
                                       * (parsers.tab + parsers.space^-
1)
                       + parsers.space * parsers.space * parsers.space
                                       * defstartchar * #parsers.spacing
                       )

      local dlchunk = Cs(parsers.line * (parsers.indentedline - parsers.blankline)^0)

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

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

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

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

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

3.1.6.5 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
          buffer[#buffer + 1] = self.fancyitem(item,num)
          if num ~= nil 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,"\\markdownRendererFancyOlItemEn
        end
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local options = self.options
      local writer = self.writer

      local label = parsers.dig + parsers.letter
      local numdelim = parsers.period + parsers.rparent
      local enumerator = C(label^3 * numdelim) * #parsers.spacing
                       + C(label^2 * numdelim) * #parsers.spacing
                                         * (parsers.tab + parsers.space^1)
                       + C(label * numdelim) * #parsers.spacing
                                       * (parsers.tab + parsers.space^-
2)
                       + parsers.space * C(label^2 * numdelim)
                                       * #parsers.spacing
                       + parsers.space * C(label * numdelim)
                                       * #parsers.spacing
                                       * (parsers.tab + parsers.space^-
1)
                       + parsers.space * parsers.space * C(label^1
                                       * numdelim) * #parsers.spacing
      local starter = parsers.bullet + enumerator

      local NestedList = Cs((parsers.optionallyindentedline
                            - starter)^1)
                       / function(a) return "\001"..a end

      local ListBlockLine  = parsers.optionallyindentedline
                           - parsers.blankline - (parsers.indent^-1
                                                 * starter)

      local ListBlock = parsers.line * ListBlockLine^0

      local ListContinuationBlock = parsers.blanklines * (parsers.indent / "")
                                  * ListBlock

      local TightListItem = function(starter)
          return -parsers.ThematicBreak
                 * (Cs(starter / "" * parsers.tickbox^-1 * ListBlock * NestedList^-
1)
                   / self.parser_functions.parse_blocks_nested)
                 * -(parsers.blanklines * parsers.indent)
      end

      local LooseListItem = function(starter)
          return -parsers.ThematicBreak
                 * Cs( starter / "" * parsers.tickbox^-1 * ListBlock * Cc("\n")
                   * (NestedList + ListContinuationBlock^0)
                   * (parsers.blanklines / "\n\n")
                   ) / self.parser_functions.parse_blocks_nested
      end

      local function roman2number(roman)
        local romans = { ["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,
          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(itemprefix)
        local numstr, delimend = itemprefix:match("^([A-Za-z0-9]*)([.)]*)")
        local numdelim
        if delimend == ")" then
          numdelim = "OneParen"
        elseif delimend == "." then
          numdelim = "Period"
        else
          numdelim = "Default"
        end
        numstr = numstr or itemprefix

        local num
        num = numstr:match("^([IVXL]+)")
        if num then
          return roman2number(num), "UpperRoman", numdelim
        end
        num = numstr:match("^([ivxl]+)")
        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
        return math.floor(tonumber(numstr) or 1), "Decimal", numdelim
      end

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

      local FancyList = Cg(enumerator, "listtype") *
                      ( Ct(TightListItem(Cb("listtype"))
                          * TightListItem(enumerator)^0)
                      * Cc(true) * parsers.skipblanklines * -enumerator
                      + Ct(LooseListItem(Cb("listtype"))
                              * LooseListItem(enumerator)^0)
                          * Cc(false) * parsers.skipblanklines
                          ) * Cb("listtype") / fancylist

      self.update_rule("OrderedList", function() return FancyList end)
    end
  }
end
```

3.1.6.6 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.

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

```

Define `writer->codeFence` as a function that will transform an input fenced code block `s` with the infostring `i` to the output format.

```
      function self.fencedCode(s, i)
        if not self.is_writing then return "" end
        local name = util.cache_verbatim(options.cacheDir, s)
        return {"\\markdownRendererInputFencedCode{",
                name,"}{",self.string(i),"}"}
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local writer = self.writer

      local FencedCode = (parsers.TildeFencedCode
                         + parsers.BacktickFencedCode)
                       / function(infostring, code)
                           local expanded_code = self.expandtabs(code)
                           return writer.fencedCode(expanded_code,
                                                    infostring)
                         end

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

      local fencestart
      if blank_before_code_fence then
        fencestart = parsers.fail
      else
        fencestart = parsers.fencehead(parsers.backtick,
                                       parsers.backtick_infostring)
                   + parsers.fencehead(parsers.tilde,
                                       parsers.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("~")
    end
  }
end
```

3.1.6.7 Fenced Divs

The `extensions.fenced_divs` function implements the Pandoc fenced divs 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` as a function that will transform an input fenced div with content `c` and with attributes `attr` to the output format.

```
      function self.div(c, attr)
        return {"\\markdownRendererFencedDivAttributeContextBegin",
                self.attributes(attr),
                c,
                "\\markdownRendererFencedDivAttributeContextEnd"}
      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 `div_level` for tracking how deep we are nested in divs.

```
self.initialize_named_group("div_level", "0")

local function increment_div_level(increment)
  local function update_div_level(s, i, current_level) -- luacheck: ignore s i
    current_level = tonumber(current_level)
    local next_level = tostring(current_level + increment)
    return true, next_level
  end

  return Cg( Cmt(Cb("div_level"), update_div_level)
           , "div_level")
end

local FencedDiv = fenced_div_begin * increment_div_level(1)
                * parsers.skipblanklines
                * Ct( (V("Block") - fenced_div_end)^-1
                    * ( parsers.blanklines
                      / function()
                          return writer.interblocksep
                        end
                      * (V("Block") - fenced_div_end))^0)
                * parsers.skipblanklines
                * fenced_div_end * increment_div_level(-1)
                / function (infostring, div)
                    local attr = lpeg.match(Ct(parsers.attributes), infostring)
                    if attr == nil then
                      attr = {"." .. infostring}
                    end
                    return div, attr
                  end
                / writer.div

```

```
      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.

```
      if not blank_before_div_fence then
        local function check_div_level(s, i, current_level) -- luacheck: ignore s i
          current_level = tonumber(current_level)
          return current_level > 0
        end

        local is_inside_div = Cmt(Cb("div_level"), check_div_level)
        local fencestart = is_inside_div * fenced_div_end
        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
```

3.1.6.8 Header Attributes

The extensions.header_attributes function implements the Pandoc header attributes 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 AtxHeading = Cg(parsers.heading_start, "level")
                       * parsers.optionalspace
                       * (C(((parsers.linechar
                              - ((parsers.hash^1
                                 * parsers.optionalspace
                                 * parsers.attributes^-1
                                 + parsers.attributes)
                                * parsers.optionalspace
                                * parsers.newline))
                             * (parsers.linechar
                              - parsers.hash
                              - parsers.lbrace)^0)^1)
                           / self.parser_functions.parse_inlines)
                       * Cg(Ct(parsers.newline
                              + (parsers.hash^1
                                * parsers.optionalspace
                                * parsers.attributes^-1
                                + parsers.attributes)
                              * parsers.optionalspace
                              * parsers.newline), "attributes")
                       * Cb("level")
                       * Cb("attributes")
                       / writer.heading

      local SetextHeading = #(parsers.line * S("=-"))
                          * (C(((parsers.linechar
                                - (parsers.attributes
                                  * parsers.optionalspace
                                  * parsers.newline))
                               * (parsers.linechar
                                 - parsers.lbrace)^0)^1)
                              / self.parser_functions.parse_inlines)
                          * Cg(Ct(parsers.newline
                                 + (parsers.attributes
                                   * parsers.optionalspace
                                   * parsers.newline)), "attributes")
                          * parsers.heading_level
                          * Cb("attributes")
                          * parsers.optionalspace
                          * parsers.newline
                          / writer.heading

      local Heading = AtxHeading + SetextHeading
      self.update_rule("Heading", function() return Heading end)
    end
  }
end
```

3.1.6.9 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)
        return {"\\markdownRendererNote{",s,"}"}
      end
    end, extend_reader = function(self)
      local parsers = self.parsers
      local writer = self.writer

      if inline_notes then
        local InlineNote
                    = parsers.circumflex
                    * (parsers.tag / self.parser_functions.parse_inlines_no_inline_not
                    / writer.note

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

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

        local rawnotes = {}

        -- 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)
          rawnotes[self.normalize_tag(ref)] = rawnote
          return ""
        end

        local NoteRef = RawNoteRef / lookup_note

        local NoteBlock
                    = parsers.leader * RawNoteRef * parsers.colon
                    * parsers.spnl * parsers.indented_blocks(parsers.chunk)
                    / register_note

        local Blank = NoteBlock + parsers.Blank
        self.update_rule("Blank", function() return Blank end)

        self.insert_pattern("Inline after Emph",
                            NoteRef, "NoteRef")
      end

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

3.1.6.10 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_captions` syntax extension for table captions.

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

  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)
        if not self.is_writing then return "" end
        local 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
        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.skipblanklines
                                    * parsers.nonindentspace
                                    * (P("Table")^-1 * parsers.colon)
                                    * parsers.optionalspace

      local table_row = pipe_table_row(true
                                      , (C((parsers.linechar - parsers.pipe)^1)
                                        / self.parser_functions.parse_inlines)
                                      , parsers.pipe
                                      , (C((parsers.linechar - parsers.pipe)^0)
                                        / self.parser_functions.parse_inlines))

      local table_caption
      if table_captions then
        table_caption = #table_caption_beginning
                      * table_caption_beginning
                      * Ct(parsers.IndentedInline^1)
                      * parsers.newline
      else
        table_caption = parsers.fail
      end

      local PipeTable = Ct(table_row * parsers.newline
                        * table_hline
                        * (parsers.newline * table_row)^0)
                      / make_pipe_table_rectangular
                      * table_caption^-1
                      / writer.table

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

3.1.6.11 Raw Attributes

The `extensions.raw_attribute` function implements the Pandoc raw attribute syntax extension.

```
M.extensions.raw_attribute = function()
  return {
    name = "built-in raw_attribute 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
        local name = util.cache_verbatim(options.cacheDir, s)
        return {"\\markdownRendererInputRawInline{",
                 name,"}{", self.string(attr),"}"}
      end

      if options.fencedCode then
```

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

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

      local raw_attribute = parsers.lbrace
                          * parsers.optionalspace
                          * parsers.equal
                          * C(parsers.attribute_key)
                          * parsers.optionalspace
                          * parsers.rbrace

      local RawInline = parsers.inticks
                      * raw_attribute
                      / writer.rawInline

      self.insert_pattern("Inline before Code",
                          RawInline, "RawInline")

      if options.fencedCode then
        local RawBlock = (parsers.TildeFencedCode
                       + parsers.BacktickFencedCode)
                     / function(infostring, code)
                         local expanded_code = self.expandtabs(code)
                         local attr = lpeg.match(raw_attribute, infostring)
                         if attr then
                           return writer.rawBlock(expanded_code, attr)
                         else
                           return writer.fencedCode(expanded_code,
                                                    infostring)
                         end
                       end

        self.insert_pattern("Block after Verbatim",
                              RawBlock, "RawBlock")
      end
    end
  }
end
```

3.1.6.12 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)
        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 Emph",
                          StrikeThrough, "StrikeThrough")

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

3.1.6.13 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)
        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 Emph",
                          Subscript, "Subscript")

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

3.1.6.14 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)
        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 Emph",
                          Superscript, "Superscript")

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

3.1.6.15 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.

```
M.extensions.jekyll_data = function(expect_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`.

```
      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
        table.sort(keys)

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

        if #d > 0 then
            table.insert(buf, "\\markdownRendererJekyllDataSequenceBegin{")
            table.insert(buf, self.uri(p or "null"))
            table.insert(buf, "}{")
            table.insert(buf, #keys)
            table.insert(buf, "}")
        else
            table.insert(buf, "\\markdownRendererJekyllDataMappingBegin{")
            table.insert(buf, self.uri(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.uri(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, "\\markdownRendererJekyllDataString{")
              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
              error(format("Unexpected type %s for value of " ..
                           "YAML key %s", typ, k))
            end
          end
        end

        if #d > 0 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("markdown-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
                    * #(-parsers.blankline)  -- if followed by blank, it's thematic br
                    * JekyllData
                    * (P("---") + P("..."))

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

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

```
end
```

3.1.7 Conversion from Markdown to Plain TeX

The `new` function 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 })
```

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

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

  if options.rawAttribute then
    local raw_attribute_extension = M.extensions.raw_attribute()
    table.insert(extensions, raw_attribute_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

```

The footnotes and inlineFootnotes option has been deprecated and will be removed in Markdown 3.0.0.

```
  if options.footnotes or options.inlineFootnotes or
     options.notes or options.inlineNotes then
    local notes_extension = M.extensions.notes(
      options.footnotes or options.notes,
      options.inlineFootnotes or 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 = util.lookup_files(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 3.1.6.)

```
      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 and return 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)

  return convert
end

return M
```

3.1.8 Command-Line Implementation

The command-line implementation provides the actual conversion routine for the command-line interface described in Section 2.1.6.

```

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

local ran_ok, kpse = pcall(require, "kpse")
if ran_ok then kpse.set_program_name("luatex") 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)
```

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.

```
local output = convert(input:gsub("\r\n?", "\n") .. "\n")

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
```

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

```
\ifx\markdownInfo\undefined
  \def\markdownInfo#1{%
    \immediate\write-1{(l.\the\inputlineno) markdown.tex info: #1.}}%
\fi
\ifx\markdownWarning\undefined
  \def\markdownWarning#1{%
    \immediate\write16{(l.\the\inputlineno) markdown.tex warning: #1}}%
\fi
\ifx\markdownError\undefined
  \def\markdownError#1#2{%
    \errhelp{#2.}%
    \errmessage{(l.\the\inputlineno) markdown.tex error: #1}}%
\fi
```

3.2.2 Token Renderer Prototypes

The following definitions should be considered placeholder.

```
\def\markdownRendererInterblockSeparatorPrototype{\par}%
\def\markdownRendererLineBreakPrototype{\hfil\break}%
\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}}%
\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{\par\begingroup\it}%
\def\markdownRendererBlockQuoteEndPrototype{\endgroup\par}%
\def\markdownRendererInputVerbatimPrototype#1{%
  \par{\tt\input#1\relax{}}\par}%
\def\markdownRendererInputFencedCodePrototype#1#2{%
  \markdownRendererInputVerbatimPrototype{#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}%
```

3.2.2.1 Raw Attribute Renderer Prototypes

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_gset:Npn
  \markdownRendererInputRawInlinePrototype#1#2
  {
    \str_case:nn
      { #2 }
      {
        { tex } { \markdownEscape{#1} }
        { md  } { \markdownInput{#1}  }
      }
  }
\cs_gset_eq:NN
  \markdownRendererInputRawBlockPrototype
  \markdownRendererInputRawInlinePrototype
\ExplSyntaxOff
```

3.2.2.2 YAML Metadata Renderer Prototypes

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 `\markdown_jekyll_data_push_address_segment:n` macro.

```
\seq_new:N \g_@@_jekyll_data_wildcard_absolute_address_seq
\cs_new:Nn \markdown_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 `\markdown_jekyll_data_concatenate_address:NN` macro and we will construct both token lists using the `\markdown_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 \markdown_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 \markdown_jekyll_data_update_address_tls:
  {
    \markdown_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 `\markdown_jekyll_data_push:nN` and `\markdown_jekyll_data_pop:` macros.

```
\cs_new:Nn \markdown_jekyll_data_push:nN
  {
    \markdown_jekyll_data_push_address_segment:n
      { #1 }
    \seq_put_right:NV
     \g_@@_jekyll_data_datatypes_seq
     #2
    \markdown_jekyll_data_update_address_tls:
  }
\cs_new:Nn \markdown_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
    \markdown_jekyll_data_update_address_tls:
  }
```

To set a single key–value, we will use the \markdown_jekyll_data_set_keyval:Nn macro, ignoring unknown keys. To set key–values for both absolute and relative wildcards, we will use the \markdown_jekyll_data_set_keyvals:nn macro.

```
\cs_new:Nn \markdown_jekyll_data_set_keyval:nn
  {
    \keys_set_known:nn
      { markdown/jekyllData }
      { { #1 } = { #2 } }
  }
\cs_generate_variant:Nn
  \markdown_jekyll_data_set_keyval:nn
  { Vn }
\cs_new:Nn \markdown_jekyll_data_set_keyvals:nn
  {
    \markdown_jekyll_data_push:nN
      { #1 }
      \c_@@_jekyll_data_scalar_tl
    \markdown_jekyll_data_set_keyval:Vn
      \g_@@_jekyll_data_wildcard_absolute_address_tl
      { #2 }
    \markdown_jekyll_data_set_keyval:Vn
      \g_@@_jekyll_data_wildcard_relative_address_tl
      { #2 }
    \markdown_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{
  \markdown_jekyll_data_push:nN
    { #1 }
    \c_@@_jekyll_data_sequence_tl
}
\def\markdownRendererJekyllDataMappingBeginPrototype#1#2{
  \markdown_jekyll_data_push:nN
    { #1 }
    \c_@@_jekyll_data_mapping_tl
}
```

```
\def\markdownRendererJekyllDataSequenceEndPrototype{
  \markdown_jekyll_data_pop:
}
\def\markdownRendererJekyllDataMappingEndPrototype{
  \markdown_jekyll_data_pop:
}
\def\markdownRendererJekyllDataBooleanPrototype#1#2{
  \markdown_jekyll_data_set_keyvals:nn
    { #1 }
    { #2 }
}
\def\markdownRendererJekyllDataEmptyPrototype#1{}
\def\markdownRendererJekyllDataNumberPrototype#1#2{
  \markdown_jekyll_data_set_keyvals:nn
    { #1 }
    { #2 }
}
\def\markdownRendererJekyllDataStringPrototype#1#2{
  \markdown_jekyll_data_set_keyvals:nn
    { #1 }
    { #2 }
}
\ExplSyntaxOff
```

3.2.3 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
              {
                \tl_gput_right:Nx
                  \g_@@_formatted_lua_options_tl
                  { "##1" ,~ }
              }
            \tl_gput_right:Nx
              \g_@@_formatted_lua_options_tl
              { \c_right_brace_str ,~ }
          }
      }
      {
        \@@_get_option_value:nN
```

```
          { #1 }
          \l_tmpa_tl
        \tl_gput_right:Nx
          \g_@@_formatted_lua_options_tl
          { #1~=~ " \l_tmpa_tl " ,~ }
      }
  }
\cs_generate_variant:Nn
  \clist_map_inline:nn
  { Vn }
\let\markdownPrepareLuaOptions=\@@_format_lua_options:
\def\markdownLuaOptions{{ \g_@@_formatted_lua_options_tl }}
\ExplSyntaxOff
```

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.

```
\def\markdownPrepare{%
```

First, ensure that the `cacheDir` directory exists.

```
  local lfs = require("lfs")
  local cacheDir = "\markdownOptionCacheDir"
  if not lfs.isdir(cacheDir) then
    assert(lfs.mkdir(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(\markdownLuaOptions)
}%
```

3.2.4 Buffering Markdown Input

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.

```
\ExplSyntaxOn
\cs_new:Nn
  \@@_if_option:nTF
  {
    \@@_get_option_type:nN
      { #1 }
      \l_tmpa_tl
    \str_if_eq:NNF
      \l_tmpa_tl
      \c_@@_option_type_boolean_tl
      {
        \msg_error:nnxx
          { @@ }
          { 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
      { #2 }
      { #3 }
  }
\msg_new:nnn
  { @@ }
  { expected-boolean-option }
  {
    Option~#1~has~type~#2,~
    but~a~boolean~was~expected.
  }
\let\markdownIfOption=\@@_if_option:nTF
\ExplSyntaxOff
```

The macros `\markdownInputFileStream` and `\markdownOutputFileStream` contain the number of the input and output file streams that will be used for the IO operations of the package.

```
\csname newread\endcsname\markdownInputFileStream
\csname newwrite\endcsname\markdownOutputFileStream
```

The `\markdownReadAndConvertTab` macro contains the tab character literal.

```
\begingroup
  \catcode`\^^I=12%
  \gdef\markdownReadAndConvertTab{^^I}%
\endgroup
```

The `\markdownReadAndConvert` macro is largely a rewrite of the LaTeX 2$_\varepsilon$ `\filecontents` macro to plain TeX.

```
\begingroup
```

Make the newline and tab characters active and swap the character codes of the backslash symbol (`\`) and the pipe symbol (`|`), so that we can use the backslash as an ordinary character inside the macro definition. Likewise, swap the character codes of the percent sign (`%`) and the ampersand (`@`), so that we can remove percent signs from the beginning of lines when `stripPercentSigns` is enabled.

```
  \catcode`\^^M=13%
```

```
\catcode`\^^I=13%
\catcode`|=0%
\catcode`\\=12%
|catcode`@=14%
|catcode`|%=12@
|gdef|markdownReadAndConvert#1#2{@
  |begingroup@
```

If we are not reading markdown documents from the frozen cache, open the inputTempFileName file for writing.

```
  |markdownIfOption{frozenCache}{}{@
    |immediate|openout|markdownOutputFileStream@
      |markdownOptionInputTempFileName|relax@
    |markdownInfo{Buffering 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
```

The following two sections of the implementation have been deprecated and will be removed in Markdown 3.0.0. The code that corresponds to \markdownMode value of 3 will be the only implementation.

```
\ExplSyntaxOn
\int_compare:nT
  { \markdownMode = 3 }
  {
    \markdownInfo{Using~mode~3:~The~lt3luabridge~package}
    \file_input:n { lt3luabridge.tex }
    \cs_new:Npn
      \markdownLuaExecute
      { \luabridgeExecute }
  }
\ExplSyntaxOff
```

3.2.5 Lua Shell Escape Bridge

The following TEX code is intended for TEX engines that do not provide direct access to Lua, but expose the shell of the operating system. This corresponds to the \markdownMode values of 0 and 1.

The \markdownLuaExecute macro defined here and in Section 3.2.6 are meant to be indistinguishable to the remaining code.

The package assumes that although the user is not using the LuaTEX engine, their TEX distribution contains it, and uses shell access to produce and execute Lua scripts using the TEXLua interpreter [1, Section 4.1.1].

```
\ifnum\markdownMode<2\relax
\ifnum\markdownMode=0\relax
  \markdownWarning{Using mode 0: Shell escape via write18
                   (deprecated, to be removed in Markdown 3.0.0)}%
\else
  \markdownWarning{Using mode 1: Shell escape via os.execute
                   (deprecated, to be removed in Markdown 3.0.0)}%
\fi
```

The \markdownExecuteShellEscape macro contains the numeric value indicating whether the shell access is enabled (1), disabled (0), or restricted (2).

Inherit the value of the the \pdfshellescape (LuaTEX, PdfTEX) or the \shellescape (XƎTEX) commands. If neither of these commands is defined and Lua is available, attempt to access the status.shell_escape configuration item.

If you cannot detect, whether the shell access is enabled, act as if it were.

```
\ifx\pdfshellescape\undefined
  \ifx\shellescape\undefined
    \ifnum\markdownMode=0\relax
      \def\markdownExecuteShellEscape{1}%
    \else
      \def\markdownExecuteShellEscape{%
        \directlua{tex.sprint(status.shell_escape or "1")}}%
    \fi
  \else
    \let\markdownExecuteShellEscape\shellescape
  \fi
\else
  \let\markdownExecuteShellEscape\pdfshellescape
\fi
```

The `\markdownExecuteDirect` macro executes the code it has received as its first argument by writing it to the output file stream 18, if Lua is unavailable, or by using the Lua `os.execute` method otherwise.

```
\ifnum\markdownMode=0\relax
  \def\markdownExecuteDirect#1{\immediate\write18{#1}}%
\else
  \def\markdownExecuteDirect#1{%
    \directlua{os.execute("\luaescapestring{#1}")}}%
\fi
```

The `\markdownExecute` macro is a wrapper on top of `\markdownExecuteDirect` that checks the value of `\markdownExecuteShellEscape` and prints an error message if the shell is inaccessible.

```
\def\markdownExecute#1{%
  \ifnum\markdownExecuteShellEscape=1\relax
    \markdownExecuteDirect{#1}%
  \else
    \markdownError{I can not access the shell}{Either run the TeX
      compiler with the --shell-escape or the --enable-write18 flag,
      or set shell_escape=t in the texmf.cnf file}%
  \fi}%
```

The `\markdownLuaExecute` macro executes the Lua code it has received as its first argument. The Lua code may not directly interact with the TEX engine, but it can use the `print` function in the same manner it would use the `tex.print` method.

```
\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.

```
  \catcode`|=0%
  \catcode`\\=12%
  |gdef|markdownLuaExecute#1{%
```

Create the file helperScriptFileName and fill it with the input Lua code prepended with kpathsea initialization, so that Lua modules from the TEX distribution are available.

```
    |immediate|openout|markdownOutputFileStream=%
      |markdownOptionHelperScriptFileName
    |markdownInfo{Writing a helper Lua script to the file
      "|markdownOptionHelperScriptFileName"}%
    |immediate|write|markdownOutputFileStream{%
      local ran_ok, error = pcall(function()
        local ran_ok, kpse = pcall(require, "kpse")
        if ran_ok then kpse.set_program_name("luatex") end
        #1
      end)
```

If there was an error, use the file errorTempFileName to store the error message.

```
      if not ran_ok then
        local file = io.open("%
          |markdownOptionOutputDir
          /|markdownOptionErrorTempFileName", "w")
        if file then
          file:write(error .. "\n")
          file:close()
        end
        print('\\markdownError{An error was encountered while executing
               Lua code}{For further clues, examine the file
               "|markdownOptionOutputDir
               /|markdownOptionErrorTempFileName"}')
      end}%
    |immediate|closeout|markdownOutputFileStream
```

Execute the generated helperScriptFileName Lua script using the TEXLua binary and store the output in the outputTempFileName file.

```
    |markdownInfo{Executing a helper Lua script from the file
      "|markdownOptionHelperScriptFileName" and storing the result in the
      file "|markdownOptionOutputTempFileName"}%
    |markdownExecute{texlua "|markdownOptionOutputDir
      /|markdownOptionHelperScriptFileName" > %
      "|markdownOptionOutputDir
      /|markdownOptionOutputTempFileName"}%
```

\input the generated outputTempFileName file.

```
    |input|markdownOptionOutputTempFileName|relax}%
|endgroup
```

3.2.6 Direct Lua Access

The following TEX code is intended for TEX engines that provide direct access to Lua (LuaTEX). The macro \markdownLuaExecute defined here and in Section 3.2.5

are meant to be indistinguishable to the remaining code. This corresponds to the `\markdownMode` value of 2.

```
\fi
\ifnum\markdownMode=2\relax
  \markdownWarning{Using mode 2: Direct Lua access
                   (deprecated, to be removed in Markdown 3.0.0)}%
```

The direct Lua access version of the `\markdownLuaExecute` macro is defined in terms of the `\directlua` primitive. The `print` function is set as an alias to the `tex.print` method in order to mimic the behaviour of the `\markdownLuaExecute` definition from Section 3.2.5,

```
\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.

```
  \catcode`|=0%
  \catcode`\\=12%
  |gdef|markdownLuaExecute#1{%
    |directlua{%
      local function print(input)
        local output = {}
        for line in input:gmatch("[^\r\n]+") do
          table.insert(output, line)
        end
        tex.print(output)
      end
      #1
    }%
  }%
|endgroup
\fi
```

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.

```
\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|markdownInput#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
        |markdownLuaExecute{%
          |markdownPrepare
          local file = assert(io.open("&1", "r"),
            [[Could not open file "&1" for reading]])
          local input = assert(file:read("*a"))
          assert(file:close())
```

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.

```
          print(convert(input:gsub("\r\n?", "\n") .. "\n"))}%
```

In case we were finalizing the frozen cache, increment `frozenCacheCounter`.

```
        |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 implemenation makes use of the fact that, apart from some subtle differences, LATEX implements the majority of the plain TEX format [12, 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]%
```

Use reflection to define the renderers and rendererPrototypes keys of \markdownSetup as well as the keys that correspond to Lua options.

```
\ExplSyntaxOn
\@@_latex_define_renderers:
\@@_latex_define_renderer_prototypes:
\ExplSyntaxOff
```

3.3.1 Logging Facilities

The LATEX implementation redefines the plain TEX logging macros (see Section 3.2.1) to use the LATEX \PackageInfo, \PackageWarning, and \PackageError macros.

3.3.2 Typesetting Markdown

The \markdownInputPlainTeX macro is used to store the original plain TEX implementation of the \markdownInput macro. The \markdownInput is then redefined to accept an optional argument with options recognized by the LATEX interface (see Section 2.3.2).

```
\let\markdownInputPlainTeX\markdownInput
\renewcommand\markdownInput[2][]{%
  \begingroup
    \markdownSetup{#1}%
    \markdownInputPlainTeX{#2}%
  \endgroup}%
```

The markdown, and markdown* LaTeX environments are implemented using the \markdownReadAndConvert macro.

```
\renewenvironment{markdown}{%
  \markdownReadAndConvert@markdown{}}{%
  \markdownEnd}%
\renewenvironment{markdown*}[1]{%
  \markdownSetup{#1}%
  \markdownReadAndConvert@markdown*}{%
  \markdownEnd}%
\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@markdown#1<%
    |markdownReadAndConvert<\end{markdown#1}>%
                           <|end<markdown#1>>>%
|endgroup
```

3.3.2.1 LaTeX Themes

This section implements the theme-loading mechanism and the example themes provided with the Markdown package.

```
\ExplSyntaxOn
```

To keep track of our current place when packages themes have been nested, we will maintain the \g_@@_latex_themes_seq stack of theme names.

```
\newcommand\markdownLaTeXThemeName{}
\seq_new:N \g_@@_latex_themes_seq
\seq_gput_right:NV
  \g_@@_latex_themes_seq
  \markdownLaTeXThemeName
\newcommand\markdownLaTeXThemeLoad[2]{
  \def\@tempa{%
    \def\markdownLaTeXThemeName{#2}
    \seq_gput_right:NV
      \g_@@_latex_themes_seq
      \markdownLaTeXThemeName
    \RequirePackage{#1}
    \seq_pop_right:NN
      \g_@@_latex_themes_seq
      \l_tmpa_tl
    \seq_get_right:NN
```

```
      \g_@@_latex_themes_seq
      \l_tmpa_tl
    \exp_args:NNV
      \def
      \markdownLaTeXThemeName
      \l_tmpa_tl}
  \ifmarkdownLaTeXLoaded
    \@tempa
  \else
    \exp_args:No
      \AtEndOfPackage
      { \@tempa }
  \fi}
\ExplSyntaxOff
```

The `witiko/dot` theme enables the `fencedCode` Lua option:

```
\markdownSetup{fencedCode}%
```

We load the ifthen and grffile packages, see also Section 1.1.3:

```
\RequirePackage{ifthen,grffile}
```

We store the previous definition of the fenced code token renderer prototype:

```
\let\markdown@witiko@dot@oldRendererInputFencedCodePrototype
  \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:

```
\renewcommand\markdownRendererInputFencedCode[2]{%
  \def\next##1 ##2\relax{%
    \ifthenelse{\equal{##1}{dot}}{%
      \markdownIfOption{frozenCache}{}{%
        \immediate\write18{%
          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:

```
      \markdownRendererImage{Graphviz image}{#1.pdf}{#1.pdf}{##2}%
```

If the infostring does not start with `dot …`, we use the previous definition of the fenced code token renderer prototype:

```
    }{%
      \markdown@witiko@dot@oldRendererInputFencedCodePrototype{#1}{#2}%
    }%
  }%
  \next#2 \relax}%
```

The witiko/graphicx/http theme stores the previous definition of the image token renderer prototype:

```
\let\markdown@witiko@graphicx@http@oldRendererImagePrototype
  \markdownRendererImagePrototype
```

We load the catchfile and grffile packages, see also Section 1.1.3:

```
\RequirePackage{catchfile,grffile}
```

We define the \markdown@witiko@graphicx@http@counter counter to enumerate the images for caching and the \markdown@witiko@graphicx@http@filename command, which will store the pathname of the file containing the pathname of the downloaded image file.

```
\newcount\markdown@witiko@graphicx@http@counter
\markdown@witiko@graphicx@http@counter=0
\newcommand\markdown@witiko@graphicx@http@filename{%
  \markdownOptionCacheDir/witiko_graphicx_http%
  .\the\markdown@witiko@graphicx@http@counter}%
```

We define the \markdown@witiko@graphicx@http@download command, which 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 command will produce a shell command that tries to downloads the online image to the pathname.

```
\newcommand\markdown@witiko@graphicx@http@download[2]{%
  wget -O #2 #1 || curl --location -o #2 #1 || rm -f #2}
```

We locally swap the category code of the percentage sign with the line feed control character, so that we can use percentage signs in the shell code:

```
\begingroup
\catcode`\%=12
\catcode`\^^A=14
```

We redefine the image token renderer prototype, so that it tries to download an online image.

```
\global\def\markdownRendererImagePrototype#1#2#3#4{^^A
  \begingroup
    \edef\filename{\markdown@witiko@graphicx@http@filename}^^A
```

The image will be downloaded only if the image URL has the http or https protocols and the frozenCache plain TEX option is disabled:

```
    \markdownIfOption{frozenCache}{}{^^A
      \immediate\write18{^^A
        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 "$OUTPUT" ];
            then
              \markdown@witiko@graphicx@http@download{'#3'}{"$OUTPUT"};
              printf '%s' "$OUTPUT" > "\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' > "\filename";
          fi}}^^A
```

We load the pathname of the downloaded image and we typeset the image using the previous definition of the image renderer prototype:

```
      \CatchFileDef{\filename}{\filename}{\endlinechar=-1}^^A
      \markdown@witiko@graphicx@http@oldRendererImagePrototype^^A
        {#1}{#2}{\filename}{#4}^^A
    \endgroup
    \global\advance\markdown@witiko@graphicx@http@counter by 1\relax}^^A
  \endgroup
```

The `witiko/tilde` theme redefines the tilde token renderer prototype, so that it expands to a non-breaking space:

```
\renewcommand\markdownRendererTildePrototype{~}%
```

3.3.3 Options

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

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

After processing the options, activate the `jekyllDataRenderes`, `renderers`, `rendererPrototypes`, and `code` keys.

```
\ExplSyntaxOn
\keys_define:nn
  { markdown/latex-options }
  {
    renderers .code:n = {
      \keys_set:nn
        { markdown/latex-options/renderers }
        { #1 }
    },
  }
\@@_with_various_cases:nn
  { rendererPrototypes }
  {
    \keys_define:nn
      { markdown/latex-options }
      {
        #1 .code:n = {
          \keys_set:nn
            { markdown/latex-options/renderer-prototypes }
            { ##1 }
        },
      }
  }
```

The code key is used to immediately expand and execute code, which can be especially useful in LaTeX setup snippets.

```
\keys_define:nn
  { markdown/latex-options }
  {
    code .code:n = { #1 },
  }
```

The jekyllDataRenderers key can be used as a syntactic sugar for setting the markdown/jekyllData key–values (see Section 2.2.4.1) without using the expl3 language.

```
\@@_with_various_cases:nn
  { jekyllDataRenderers }
  {
    \keys_define:nn
      { markdown/latex-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 nput 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/latex-options/jekyll-data-renderers }
            \l_tmpa_tl
        },
      }
  }
\keys_define:nn
  { markdown/latex-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
    }
  }
\cs_generate_variant:Nn
  \keys_define:nn
  { nV }
\cs_generate_variant:Nn
  \tl_replace_all:Nnn
  { NVn }
\cs_generate_variant:Nn
  \tl_replace_all:Nnn
  { NnV }
\ExplSyntaxOff
```

3.3.4 Token Renderer Prototypes

The following configuration should be considered placeholder. If the `plain` package option has been enabled (see Section 2.3.2.1), none of it will take effect.

```
\markdownIfOption{plain}{\iffalse}{\iftrue}
```

If the `tightLists` Lua option is disabled or the current document class is beamer, do not load the paralist package.

```
\markdownIfOption{tightLists}{
  \@ifclassloaded{beamer}{}{\RequirePackage{paralist}}%
}{}
```

If we loaded the paralist package, define the respective renderer prototypes to make use of the capabilities of the package. Otherwise, define the renderer prototypes to fall back on the corresponding renderers for the non-tight lists.

```
\ExplSyntaxOn
\@ifpackageloaded{paralist}{
  \tl_new:N
    \l_@@_latex_fancy_list_item_label_number_style_tl
  \tl_new:N
    \l_@@_latex_fancy_list_item_label_delimiter_style_tl
  \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_new:Nn
    \@@_latex_paralist_style:nn
    {
      \str_case:nn
        { #1 }
        {
          { Decimal } { 1 }
          { LowerRoman } { i }
          { UpperRoman } { I }
          { LowerAlpha } { a }
          { UpperAlpha } { A }
        }
      \@@_latex_fancy_list_item_label_delimiter:n
        { #2 }
    }
  \markdownSetup{rendererPrototypes={
    ulBeginTight = {\begin{compactitem}},
    ulEndTight = {\end{compactitem}},
    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 }
      \tl_set:Nn
        \l_tmpa_tl
        { \begin{enumerate}[ }
      \tl_put_right:Nx
        \l_tmpa_tl
        { \@@_latex_paralist_style:nn { #1 } { #2 } }
      \tl_put_right:Nn
        \l_tmpa_tl
        { ] }
      \l_tmpa_tl
    },
    fancyOlEnd = {
      \end{enumerate}
      \group_end:
    },
    olBeginTight = {\begin{compactenum}},
    olEndTight = {\end{compactenum}},
    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 }
      \tl_set:Nn
        \l_tmpa_tl
        { \begin{compactenum}[ }
      \tl_put_right:Nx
        \l_tmpa_tl
        { \@@_latex_paralist_style:nn { #1 } { #2 } }
      \tl_put_right:Nn
        \l_tmpa_tl
        { ] }
      \l_tmpa_tl
    },
    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 }
        ]
    },
    dlBeginTight = {\begin{compactdesc}},
    dlEndTight = {\end{compactdesc}}}}
  \cs_generate_variant:Nn
    \@@_latex_fancy_list_item_label:nnn
    { VVn }
}{
  \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={
  lineBreak = {\\},
  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,[8] we can reliably detect math mode inside the renderer.

Here, we will redefine the code span renderer prototype to typeset upright text in math formulae and typewriter text outside math formulae.

```
  codeSpan = {%
    \ifmmode
      \text{#1}%
    \else
      \texttt{#1}%
    \fi
  }}}
\ExplSyntaxOn
\markdownSetup{
  rendererPrototypes = {
    contentBlock = {
```

[8]This property may actually be undecidable. Suppose a span of text is a part of a macro definition. Then, whether the span of text is part of a math formula or not depends on where the macro is later used, which may easily be *both* inside and outside a math formula.

```
      \str_case:nnF
        { #1 }
        {
          { csv }
            {
              \begin{table}
                \begin{center}
                  \csvautotabular{#3}
                \end{center}
                \tl_if_empty:nF
                  { #4 }
                  { \caption{#4} }
              \end{table}
            }
          { tex } { \markdownEscape{#3} }
        }
        { \markdownInput{#3} }
    },
  },
}
\ExplSyntaxOff
\markdownSetup{rendererPrototypes={
  image = {%
    \begin{figure}%
      \begin{center}%
        \includegraphics{#3}%
      \end{center}%
      \ifx\empty#4\empty\else
        \caption{#4}%
      \fi
    \end{figure}},
  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 identifier attributes appear at the beginning of a section, we make the next heading produce the `\label` macro.

```
  headerAttributeContextBegin = {
    \markdownSetup{
      rendererPrototypes = {
        attributeIdentifier = {%
          \begingroup
          \def\next####1{%
            \def####1########1{%
              \endgroup
              ####1{########1}%
              \label{##1}%
            }%
          }%
          \next\markdownRendererHeadingOne
          \next\markdownRendererHeadingTwo
          \next\markdownRendererHeadingThree
          \next\markdownRendererHeadingFour
          \next\markdownRendererHeadingFive
          \next\markdownRendererHeadingSix
        },
      },
    }%
  },
  superscript = {\textsuperscript{#1}},
  subscript = {\textsubscript{#1}},
  blockQuoteBegin = {\begin{quotation}},
  blockQuoteEnd = {\end{quotation}},
  inputVerbatim = {\VerbatimInput{#1}},
  inputFencedCode = {%
    \ifx\relax#2\relax
      \VerbatimInput{#1}%
    \else
      \@ifundefined{minted@code}{%
        \@ifundefined{lst@version}{%
          \markdownRendererInputFencedCode{#1}{}%
```

When the listings package is loaded, use it for syntax highlighting.

```
        }{%
          \lstinputlisting[language=#2]{#1}%
        }%
```

When the minted package is loaded, use it for syntax highlighting. The minted package is preferred over listings.

```
      }{%
        \catcode`\#=6\relax
        \inputminted{#2}{#1}%
        \catcode`\#=12\relax
      }%
    \fi},
  thematicBreak = {\noindent\rule[0.5ex]{\linewidth}{1pt}},
  note = {\footnote{#1}}}}
```

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}\leavevmode},
    headingFive = {\subparagraph{#1}\leavevmode}}}
}{%
  \markdownSetup{rendererPrototypes = {
    headingOne = {\chapter{#1}},
    headingTwo = {\section{#1}},
    headingThree = {\subsection{#1}},
    headingFour = {\subsubsection{#1}},
    headingFive = {\paragraph{#1}\leavevmode},
    headingSix = {\subparagraph{#1}\leavevmode}}}
}%
```

3.3.4.1 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
}
```

3.3.4.2 HTML elements

If the `html` option is enabled and we are using TeX4ht[9], 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
      },
    },
  }
}
```

3.3.4.3 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.

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

```
\newcount\markdownLaTeXCitationsCounter

% Basic implementation
\RequirePackage{gobble}
\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}%  Without prenotes and postnotes, just accumulate cites
        \expandafter\expandafter\expandafter
        \expandafter\expandafter\expandafter\expandafter
        \@gobblethree
      \fi
    \else%  Before a postnote (#5), dump the accumulator
      \ifx\relax#1\relax\else
        \cite{#1}%
      \fi
      \cite[#5]{#6}%
      \ifnum\markdownLaTeXCitationsCounter>\markdownLaTeXCitationsTotal\relax
      \else
        \expandafter\expandafter\expandafter
        \expandafter\expandafter\expandafter\expandafter
        \expandafter\expandafter\expandafter
        \expandafter\expandafter\expandafter\expandafter
        \markdownLaTeXBasicCitations
      \fi
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter{%
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter}%
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter{%
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter}%
      \expandafter\expandafter\expandafter
      \@gobblethree
    \fi
  \else%  Before a prenote (#4), dump the accumulator
    \ifx\relax#1\relax\else
      \cite{#1}%
    \fi
    \ifnum\markdownLaTeXCitationsCounter>1\relax
      \space  % Insert a space before the prenote in later citations
    \fi
    #4~\expandafter\cite\ifx\relax#5\relax{#6}\else[#5]{#6}\fi
    \ifnum\markdownLaTeXCitationsCounter>\markdownLaTeXCitationsTotal\relax
    \else
      \expandafter\expandafter\expandafter
      \expandafter\expandafter\expandafter\expandafter
      \markdownLaTeXBasicCitations
    \fi
    \expandafter\expandafter\expandafter{%
    \expandafter\expandafter\expandafter}%
    \expandafter\expandafter\expandafter{%
    \expandafter\expandafter\expandafter}%
    \expandafter
    \@gobblethree
  \fi\markdownLaTeXBasicCitations{#1#2#6},}
\let\markdownLaTeXBasicTextCitations\markdownLaTeXBasicCitations

% Natbib implementation
\def\markdownLaTeXNatbibCitations#1#2#3#4#5{%
  \advance\markdownLaTeXCitationsCounter by 1\relax
  \ifx\relax#3\relax
    \ifx\relax#4\relax
      \ifnum\markdownLaTeXCitationsCounter>\markdownLaTeXCitationsTotal\relax
        \citep{#1,#5}%  Without prenotes and 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}%  Without prenotes and 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}%
    }}}
```

3.3.4.4 Links

Before consuming the parameters for the hyperlink renderer, we change the category code of the hash sign (#) to other, so that it cannot be mistaken for a parameter character.

```
\RequirePackage{url}
\RequirePackage{expl3}
\ExplSyntaxOn
\def\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}}}
```

3.3.4.5 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}
        \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}
```

3.3.4.6 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.

```
% TODO: Remove the command definition in TeX Live 2021.
\providecommand\IfFormatAtLeastTF{\@ifl@t@r\fmtversion}
\markdownSetup{
  rendererPrototypes = {
    jekyllDataEnd = {
%     TODO: Remove the else branch in TeX Live 2021.
      \IfFormatAtLeastTF
        { 2020-10-01 }
        { \AddToHook{begindocument/end}{\maketitle} }
        {
          \ifx\@onlypreamble\@notprerr
            % We are in the document
            \maketitle
          \else
            % We are in the preamble
            \RequirePackage{etoolbox}
            \AfterEndPreamble{\maketitle}
          \fi
        }
    },
  },
}
\ExplSyntaxOff
```

3.3.4.7 Strike-Through

If the `strikeThrough` option is enabled, we will load the soulutf8 package and use it to implement strike-throughs.

```
\markdownIfOption{strikeThrough}{%
  \RequirePackage{soulutf8}%
  \markdownSetup{
    rendererPrototypes = {
      strikeThrough = {%
        \st{#1}%
      },
    }
  }
}{}
```

3.3.4.8 Raw Attribute Renderer Prototypes

In the raw block and inline raw span renderer prototypes, execute the content with TeX when the raw attribute is `tex` or `latex`, display the content as markdown when the raw attribute is `md`, and ignore the content otherwise.

```
\ExplSyntaxOn
\cs_gset:Npn
  \markdownRendererInputRawInlinePrototype#1#2
  {
    \str_case:nn
      { #2 }
      {
        { tex   } { \markdownEscape{#1} }
        { latex } { \markdownEscape{#1} }
        { md    } { \markdownInput{#1}  }
      }
  }
\cs_gset_eq:NN
  \markdownRendererInputRawBlockPrototype
  \markdownRendererInputRawInlinePrototype
\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` is 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}%
```

The `\startmarkdown` and `\stopmarkdown` 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. [13, sec. 31]. According to Eijkhout [14, 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.

```
\ifx\startluacode\undefined  % MkII
  \begingroup
    \catcode`\|=0%
    \catcode`\\=12%
    |gdef|startmarkdown{%
      |markdownReadAndConvert{\stopmarkdown}%
                             {|stopmarkdown}}%
    |gdef|stopmarkdown{%
      |markdownEnd}%
  |endgroup
\else  % MkIV
  \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}%
  |endgroup
\fi
```

3.4.2 Token Renderer Prototypes

The following configuration should be considered placeholder.

```
\def\markdownRendererLineBreakPrototype{\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\markdownRendererInputVerbatimPrototype#1{\typefile{#1}}%
\def\markdownRendererInputFencedCodePrototype#1#2{%
  \ifx\relax#2\relax
    \typefile{#1}%
  \else
```

The code fence infostring is used as a name from the ConTEXt `\definetyping` macro. This 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
```

```
    \typefile[#2][]{#1}%
  \fi}%
\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}}
```

3.4.2.1 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}
```

3.4.2.2 Raw Attribute Renderer Prototypes

In the raw block and inline raw span renderer prototypes, execute the content with TeX when the raw attribute is `tex` or `context`, display the content as markdown when the raw attribute is `md`, and ignore the content otherwise.

```
\ExplSyntaxOn
\cs_gset:Npn
  \markdownRendererInputRawInlinePrototype#1#2
  {
    \str_case:nn
      { #2 }
      {
        { tex     } { \markdownEscape{#1} }
        { context } { \markdownEscape{#1} }
        { md      } { \markdownInput{#1}  }
      }
  }
```

```
\cs_gset_eq:NN
  \markdownRendererInputRawBlockPrototype
  \markdownRendererInputRawInlinePrototype
\ExplSyntaxOff
\stopmodule\protect
```

References

[1] LuaTEX development team. *LuaTEX reference manual*. Version 1.10 (stable). July 23, 2021. URL: https://www.pragma-ade.com/general/manuals/luatex.pdf (visited on 09/30/2022).

[2] Vít Novotný. *TeXový interpret jazyka Markdown (markdown.sty)*. 2015. URL: https://www.muni.cz/en/research/projects/32984 (visited on 02/19/2018).

[3] Anton Sotkov. *File transclusion syntax for Markdown*. Jan. 19, 2017. URL: https://github.com/iainc/Markdown-Content-Blocks (visited on 01/08/2018).

[4] John MacFarlane. *Pandoc. a universal document converter*. 2022. URL: https://pandoc.org/ (visited on 10/05/2022).

[5] Bonita Sharif and Jonathan I. Maletic. "An Eye Tracking Study on camelCase and under_score Identifier Styles." In: *2010 IEEE 18th International Conference on Program Comprehension*. 2010, pp. 196–205. DOI: 10.1109/ICPC.2010.41.

[6] Donald Ervin Knuth. *The TEXbook*. 3rd ed. Vol. A. Computers & Typesetting. Reading, MA: Addison-Wesley, 1986. ix, 479. ISBN: 0-201-13447-0.

[7] Frank Mittelbach. *The doc and shortvrb Packages*. Apr. 15, 2017. URL: https://mirrors.ctan.org/macros/latex/base/doc.pdf (visited on 02/19/2018).

[8] Till Tantau, Joseph Wright, and Vedran Miletić. *The Beamer class*. Feb. 10, 2021. URL: https://mirrors.ctan.org/macros/latex/contrib/beamer/doc/beameruserguide.pdf (visited on 02/11/2021).

[9] Vít Novotný. *LATEX 2ε no longer keys packages by pathnames*. Feb. 20, 2021. URL: https://github.com/latex3/latex2e/issues/510 (visited on 02/21/2021).

[10] Geoffrey M. Poore. *The minted Package. Highlighted source code in LATEX*. July 19, 2017. URL: https://mirrors.ctan.org/macros/latex/contrib/minted/minted.pdf (visited on 09/01/2020).

[11] Roberto Ierusalimschy. *Programming in Lua*. 3rd ed. Rio de Janeiro: PUC-Rio, 2013. xviii, 347. ISBN: 978-85-903798-5-0.

[12] Johannes Braams et al. *The LATEX 2ε Sources*. Apr. 15, 2017. URL: https://mirrors.ctan.org/macros/latex/base/source2e.pdf (visited on 01/08/2018).

[13] Donald Ervin Knuth. *TEX: The Program*. Vol. B. Computers & Typesetting. Reading, MA: Addison-Wesley, 1986. xvi, 594. ISBN: 0-201-13437-7.

[14] Victor Eijkhout. *TEX by Topic. A TEXnician's Reference*. Wokingham, England: Addison-Wesley, Feb. 1, 1992. 307 pp. ISBN: 0-201-56882-0.

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