

# The documented source of Memoize, Advice and CollArgs

Memoize v1.1.0, Advice v1.1.0, CollArgs v1.1.0  
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This file contains the documented source code of package [Memoize](#) and, somewhat unconventionally, its two independently distributed auxiliary packages [Advice](#) and [CollArgs](#).

The source code of the  $\text{\TeX}$  parts of the package resides in `memoize.edtx`, `advice.edtx` and `collargs.edtx`. These files are written in [EasyDTX](#), a format of my own invention which is almost like the DTX format but eliminates the need for all those pesky `macrocode` environments: Any line introduced by a single comment counts as documentation, and to top it off, documentation lines may be indented. An `.edtx` file is converted to a `.dtx` by a little Perl script called `edtx2dtx`; there is also a rudimentary Emacs mode, implemented in `easydoctex-mode.el`, which takes care of fontification, indentation, and forward and inverse search.

The `.edtx` files contain the code for all three formats supported by the three packages —  $\text{\LaTeX}$  (guard `latex`), plain  $\text{\TeX}$  (guard `plain`) and  $\text{\ConTeXt}$  (guard `context`) — but upon reading the code, it will quickly become clear that Memoize was first developed for  $\text{\LaTeX}$ . In §1, we manually define whatever  $\text{\LaTeX}$  tools are “missing” in plain  $\text{\TeX}$  and  $\text{\ConTeXt}$ . Even worse,  $\text{\ConTeXt}$  code is often just the same as plain  $\text{\TeX}$  code, even in cases where I’m sure  $\text{\ConTeXt}$  offers the relevant tools. This nicely proves that I have no clue about  $\text{\ConTeXt}$ . If you are willing to  $\text{\ConTeXt}$ -ualize my code — please do so, your help is welcome!

The runtimes of Memoize (and also Advice) comprise of more than just the main runtime for each format. Memoize ships with two additional stub packages, `nomemoize` and `memoizable`, and a  $\text{\TeX}$ -based extraction script `memoize-extract-one`; Advice optionally offers a `TikZ` support defined in `advice-tikz.code.tex`. For the relation between guards and runtimes, consult the core of the `.ins` files below.

memoize.ins

```
\generate{%
  \file{memoize.sty}{\from{memoize.dtx}{mmz,latex}}%
  \file{memoize.tex}{\from{memoize.dtx}{mmz,plain}}%
  \file{t-memoize.tex}{\from{memoize.dtx}{mmz,context}}%
  \file{nomemoize.sty}{\from{memoize.dtx}{nommz,latex}}%
  \file{nomemoize.tex}{\from{memoize.dtx}{nommz,plain}}%
  \file{t-nomemoize.tex}{\from{memoize.dtx}{nommz,context}}%
  \file{memoizable.sty}{\from{memoize.dtx}{mmzable,latex}}%
  \file{memoizable.tex}{\from{memoize.dtx}{mmzable,plain}}%
  \file{t-memoizable.tex}{\from{memoize.dtx}{mmzable,context}}%
  \file{memoizable.code.tex}{\from{memoize.dtx}{mmzable,generic}}%
  \file{memoize-extract-one.tex}{\from{memoize.dtx}{extract-one}}%
}
```

advice.ins

```
\file{advice.sty}{\from{advice.dtx}{main,latex}}%
\file{advice.tex}{\from{advice.dtx}{main,plain}}%
\file{t-advice.tex}{\from{advice.dtx}{main,context}}%
\file{advice-tikz.code.tex}{\from{advice.dtx}{tikz}}%
```

collargs.ins

```
\file{collargs.sty}{\from{collargs.dtx}{latex}}%
\file{collargs.tex}{\from{collargs.dtx}{plain}}%
\file{t-collargs.tex}{\from{collargs.dtx}{context}}%
```

Memoize also contains two scripts, `memoize-extract` and `memoize-clean`. Both come in two functionally equivalent implementations: Perl (`.pl`) and a Python (`.py`). Their code is listed in §9.

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# 1 First things first

Identification of memoize, memoizable and nomemoize.

```
1 <*mmz>
2 <latex>\ProvidesPackage{memoize}[2024/1/02 v1.1.0 Fast and flexible externalization]
3 <context>%D \module[
4 <context>%D      file=t-memoize.tex,
5 <context>%D      version=1.1.0,
6 <context>%D      title=Memoize,
7 <context>%D      subtitle=Fast and flexible externalization,
8 <context>%D      author=Saso Zivanovic,
9 <context>%D      date=2024-01-02,
10 <context>%D      copyright=Saso Zivanovic,
11 <context>%D      license=LPPL,
12 <context>%D ]
13 <context>\writestatus{loading}{ConTeXt User Module / memoize}
14 <context>\unprotect
15 <context>\startmodule[memoize]
16 <plain>% Package memoize 2024/01/02 v1.1.0
17 </mmz>
18 <*mmzable>
19 <latex>\ProvidesPackage{memoizable}[2024/1/02 v1.1.0 A programmer's stub for Memoize]
20 <context>%D \module[
21 <context>%D      file=t-memoizable.tex,
22 <context>%D      version=1.1.0,
23 <context>%D      title=Memoizable,
24 <context>%D      subtitle=A programmer's stub for Memoize,
25 <context>%D      author=Saso Zivanovic,
26 <context>%D      date=2024-01-02,
27 <context>%D      copyright=Saso Zivanovic,
28 <context>%D      license=LPPL,
29 <context>%D ]
30 <context>\writestatus{loading}{ConTeXt User Module / memoizable}
31 <context>\unprotect
32 <context>\startmodule[memoizable]
33 <plain>% Package memoizable 2024/01/02 v1.1.0
34 </mmzable>
35 <*nommz>
36 <latex>\ProvidesPackage{nomemoize}[2024/1/02 v1.1.0 A no-op stub for Memoize]
37 <context>%D \module[
38 <context>%D      file=t-nomemoize.tex,
39 <context>%D      version=1.1.0,
40 <context>%D      title=Memoize,
41 <context>%D      subtitle=A no-op stub for Memoize,
42 <context>%D      author=Saso Zivanovic,
43 <context>%D      date=2024-01-02,
44 <context>%D      copyright=Saso Zivanovic,
45 <context>%D      license=LPPL,
46 <context>%D ]
47 <context>\writestatus{loading}{ConTeXt User Module / nomemoize}
48 <context>\unprotect
49 <context>\startmodule[nomemoize]
50 <mmz>% Package nomemoize 2024/01/02 v1.1.0
51 </nommz>
```

Required packages and L<sup>A</sup>T<sub>E</sub>Xization of plain T<sub>E</sub>X and ConT<sub>E</sub>Xt.

```
52 <*(mmz,mmzable,nommz)&(plain,context)>
53 \input miniltx
54 </(mmz,mmzable,nommz)&(plain,context)>
```

Some stuff which is “missing” in miniltx, copied here from latex.ltx.

```

55 <*mmz & (plain, context)>
56 \def\PackageWarning#1#2{%
57     \newlinechar``^^J\def\MessageBreak{^^J\space\space#1: }%
58     \message{#1: #2}}
59 </mmz & (plain, context)>

```

Same as the official definition, but without `\outer`. Needed for record file declarations.

```

60 <*mmz & plain>
61 \def\newtoks{\alloc@5\toks\toksdef\@cclvi}
62 \def\newwrite{\alloc@7\write\chardef\sixt@n}
63 </mmz & plain>

```

I can't really write any code without `etoolbox` ...

```

64 <*mmz>
65 <latex>\RequirePackage{etoolbox}
66 <plain, context>\input etoolbox-generic

```

Setup the `memoize` namespace in `LuaTeX`.

```

67 \ifdefined\luatexversion
68     \directlua{memoize = {}}
69 \fi

```

`pdfdoccmds.sty` eases access to some PDF primitives, but I cannot manage to load it in `ConTeXt`, even if it's supposed to be a generic package. So let's load `pdfdoccmds.lua` and copy-paste what we need from `pdfdoccmds.sty`.

```

70 <latex>\RequirePackage{pdfdoccmds}
71 <plain>\input pdfdoccmds.sty
72 <*context>
73 \directlua{%
74     require("pdfdoccmds")
75     tex.enableprimitives('pdf@', {'draftmode'})
76 }
77 \long\def\pdf@mdfivesum#1{%
78     \directlua{%
79         oberdiek.pdfdoccmds.mdfivesum("\luaescapestring{#1}", "byte")%
80     }%
81 }%
82 \def\pdf@system#1{%
83     \directlua{%
84         oberdiek.pdfdoccmds.system("\luaescapestring{#1}")%
85     }%
86 }
87 \let\pdf@primitive\primitive

```

Lua function `oberdiek.pdfdoccmds.filesize` requires the `kpse` library, which is not loaded in `ConTeXt`, see [github.com/latex3/lua-uni-algos/issues/3](https://github.com/latex3/lua-uni-algos/issues/3), so we define our own `filesize` function.

```

88 \directlua{%
89     function memoize.filesize(filename)
90         local filehandle = io.open(filename, "r")

```

We can't easily use `~=`, as `~` is an active character, so the `else` workaround.

```

91         if filehandle == nil then
92             else
93                 tex.write(filehandle:seek("end"))
94                 io.close(filehandle)
95             end
96         end

```

```

97 }%
98 \def\pdf@filesize#1{%
99   \directlua{memoize.filesize("\luaescapestring{#1}")}%
100 }
101 </context>

```

Take care of some further differences between the engines.

```

102 \ifdef\pdftexversion{%
103 }{%
104   \def\pdfhorigin{1true in}%
105   \def\pdfvorigin{1true in}%
106   \ifdef\XeTeXversion{%
107     \let\quitvmode\leavevmode
108   }{%
109     \ifdef\luatexversion{%
110       \let\pdfpagewidth\pagewidth
111       \let\pdfpageheight\pageheight
112       \def\pdfmajorversion{\pdfvariable majorversion}%
113       \def\pdfminorversion{\pdfvariable minorversion}%
114     }{%
115       \PackageError{memoize}{Support for this TeX engine is not implemented}{}%
116     }%
117   }%
118 }
119 </mmz>

```

In ConT<sub>E</sub>Xt, `\unexpanded` means `\protected`, and the usual `\unexpanded` is available as `\normalunexpanded`. Option one: use dtx guards to produce the correct control sequence. I tried this option. I find it ugly, and I keep forgetting to guard. Option two: `\let` an internal control sequence, like `\mmz@unexpanded`, to the correct thing, and use that all the time. I never tried this, but I find it ugly, too, and I guess I would forget to use the new control sequence, anyway. Option three: use `\unexpanded` in the .dtx, and `sed` through the generated ConT<sub>E</sub>Xt files to replace all its occurrences by `\normalunexpanded`. Oh yeah!

Load `pgfkeys` in `nomemoize` and `memoizable`. Not necessary in `memoize`, as it is already loaded by `CollArgs`.

```

120 <*nommz, mmzable>
121 <latex>\RequirePackage{pgfkeys}
122 <plain>\input pgfkeys
123 <context>\input t-pgfkey
124 </nommz, mmzable>

```

Different formats of `memoizable` merely load `memoizable.code.tex`, which exists so that `memoizable` can be easily loaded by generic code, like a `tikz` library.

```

125 <mmzable&!generic>\input memoizable.code.tex

```

**Shipout** We will next load our own auxiliary package, `CollArgs`, but before we do that, we need to grab `\shipout` in plain T<sub>E</sub>X. The problem is, `Memoize` needs to hack into the `shipout` routine, but it has best chances of working as intended if it redefines the *primitive* `\shipout`. However, `CollArgs` loads `pgfkeys`, which in turn (and perhaps with no for reason) loads `atbegshi`, which redefines `\shipout`. For details, see section 3.6. Below, we first check that the current meaning of `\shipout` is primitive, and then redefine it.

```

126 <*mmz>
127 <*plain>
128 \def\mmz@regular@shipout{%
129   \global\advance\mmzRegularPages1\relax
130   \mmz@primitive@shipout
131 }
132 \edef\mmz@temp{\string\shipout}%

```

```

133 \edef\mmz@tempa{\meaning\shipout}%
134 \ifx\mmz@temp\mmz@tempa
135   \let\mmz@primitive\shipout\shipout
136   \let\shipout\mmz@regular\shipout
137 \else
138   \PackageError{memoize}{Cannot grab \string\shipout, it is already redefined}{}%
139 \fi
140 </plain>

```

Our auxiliary package (<sup>M</sup>§5.6.3, §8.2). We also need it in `nomemoize`, to collect manual environments.

```

141 <latex>\RequirePackage{advice}
142 <plain>\input advice
143 <context>\input t-advice
144 </mmz>

```

**Loading order** `memoize` and `nomemoize` are mutually exclusive, and `memoizable` must be loaded before either of them. `\mmz@loadstatus`: 1 = `memoize`, 2 = `memoizable`, 3 = `nomemoize`.

```

145 <*mmz,nommz>
146 \def\ifmmz@loadstatus#1{%
147   \ifnum#1=0\csname mmz@loadstatus\endcsname\relax
148     \expandafter\@firstoftwo
149   \else
150     \expandafter\@secondoftwo
151   \fi
152 }
153 </mmz,nommz>
154 <*mmz>
155 \ifmmz@loadstatus{3}{%
156   \PackageError{memoize}{Cannot load the package, as "nomemoize" is already
157     loaded. Memoization will NOT be in effect}{Packages "memoize" and
158     "nomemoize" are mutually exclusive, please load either one or the other.}%
159 <latex> \pgfkeys{/memoize/package options/.unknown/.code={}}
160 <latex> \ProcessPgfPackageOptions{/memoize/package options}
161   \endinput
162 }{}%
163 \ifmmz@loadstatus{2}{%
164   \PackageError{memoize}{Cannot load the package, as "memoizable" is already
165     loaded}{Package "memoizable" is loaded by packages which support
166     memoization. Memoize must be loaded before all such packages. The
167     compilation log can help you figure out which package loaded "memoizable";
168     please move
169 <latex>   "\string\usepackage{memoize}"
170 <plain>   "\string\input memoize"
171 <context> "\string\usemodule[memoize]"
172     before the
173 <latex>   "\string\usepackage"
174 <plain>   "\string\input"
175 <context> "\string\usemodule"
176     of that package.}%
177 <latex> \pgfkeys{/memoize/package options/.unknown/.code={}}
178 <latex> \ProcessPgfPackageOptions{/memoize/package options}
179   \endinput
180 }{}%
181 \ifmmz@loadstatus{1}{\endinput}{}%
182 \def\mmz@loadstatus{1}%
183 </mmz>
184 <*mmzable & generic>
185 \ifcsname mmz@loadstatus\endcsname\endinput\fi
186 \def\mmz@loadstatus{2}%
187 </mmzable & generic>

```

```

188 <*/nommz>
189 \ifmmz@loadstatus{1}{%
190   \PackageError{nomemoize}{Cannot load the package, as "memoize" is already
191     loaded; memoization will remain in effect}{Packages "memoize" and
192     "nomemoize" are mutually exclusive, please load either one or the other.}%
193   \endinput }{}%
194 \ifmmz@loadstatus{2}{%
195   \PackageError{nomemoize}{Cannot load the package, as "memoizable" is already
196     loaded}{Package "memoizable" is loaded by packages which support
197     memoization. (No)Memoize must be loaded before all such packages. The
198     compilation log can help you figure out which package loaded
199     "memoizable"; please move
200 <latex>   "\string\usepackage{nomemoize}"
201 <plain>   "\string\input memoize"
202 <context> "\string\usemodule[memoize]"
203   before the
204 <latex>   "\string\usepackage"
205 <plain>   "\string\input"
206 <context> "\string\usemodule"
207   of that package.}%
208   \endinput
209 }{}%
210 \ifmmz@loadstatus{3}{\endinput}{}%
211 \def\mmz@loadstatus{3}%
212 </nommz>

213 <*/mmz>

```

**\filetotoks** Read T<sub>E</sub>X file #2 into token register #1 (under the current category code regime); \toksapp is defined in CollArgs.

```

214 \def\filetotoks#1#2{%
215   \immediate\mmz@openin0{#2}%
216   #1={}%
217   \loop
218   \unless\ifeof0
219     \read0 to \totoks@temp

```

We need the \expandafters for our \toksapp macro.

```

220   \expandafter\toksapp\expandafter#1\expandafter{\totoks@temp}%
221   \repeat
222   \immediate\closein0
223 }

```

**\mmz@openin** A workaround for morewrites.

```

\mmz@openout
224 \let\mmz@openin\openin
225 \let\mmz@openout\openout

```

Other little things.

```

226 \newif\ifmmz@temp
227 \newtoks\mmz@temptoks
228 \newbox\mmz@box
229 \newwrite\mmz@out

```

## 2 The basic configuration

**\mmzset** The user primarily interacts with Memoize through the pgfkeys-based configuration macro \mmzset, which executes keys in path /mmz. In nomemoize and memoizable, it exists as a no-op.

```

230 \def\mmzset#1{\pgfkeys{/mmz}{#1}\ignorespaces}

```

```

231 </mmz>
232 <*nmmz, mmzable & generic>
233 \def\mmzset#1{\ignorespaces}
234 </nmmz, mmzable & generic>

```

**\nmmzkeys** Any /mmz keys used outside of \mmzset must be declared by this macro for **nomemoize** package to work.

```

235 <mmz> \def\nommzkeys#1{}
236 <*nmmz, mmzable & generic>
237 \def\nommzkeys{\pgfqkeys{/mmz}}
238 \pgfqkeys{/mmz}{.unknown/.code={\pgfkeysdef{\pgfkeyscurrentkey}{}}}
239 </nmmz, mmzable & generic>

```

**enable** These keys set  $\text{\TeX}$ -style conditional **\ifmemoize**, used as the central on/off switch for the func-

**disable** tionality of the package — it is inspected in **\Memoize** and by run conditions of automemoization

**\ifmemoize** handlers.

If used in the preamble, the effect of these keys is delayed until the beginning of the document. The delay is implemented through a special style, **begindocument**, which is executed at **begindocument** hook in  $\text{\LaTeX}$ ; in other formats, the user must invoke it manually (<sup>M</sup>§5.1).

**Nomemoize** does not need the keys themselves, but it does need the underlying conditional — which will be always false.

```

240 <*mmz, nmmz, mmzable & generic>
241 \newif\ifmemoize
242 </mmz, nmmz, mmzable & generic>
243 <*mmz>
244 \mmzset{%
245   enable/.style={begindocument/.append code=\memoizetrue},
246   disable/.style={begindocument/.append code=\memoizefalse},
247   begindocument/.append style={
248     enable/.code=\memoizetrue,
249     disable/.code=\memoizefalse,
250   },

```

Memoize is enabled at the beginning of the document, unless explicitly disabled by the user in the preamble.

```

251   enable,

```

**options** Execute the given value as a keylist of Memoize settings.

```

252   options/.style={#1},
253 }

```

**normal** When Memoize is enabled, it can be in one of three modes (<sup>M</sup>§2.4): normal, readonly, and

**readonly** recompile. The numeric constants are defined below. The mode is stored in **\mmz@mode**, and only

**recompile** matters in **\Memoize** (and **\mmz@process@ccmemo**).<sup>1</sup>

```

254 \def\mmz@mode@normal{0}
255 \def\mmz@mode@readonly{1}
256 \def\mmz@mode@recompile{2}
257 \let\mmz@mode\mmz@mode@normal
258 \mmzset{%
259   normal/.code={\let\mmz@mode\mmz@mode@normal},
260   readonly/.code={\let\mmz@mode\mmz@mode@readonly},
261   recompile/.code={\let\mmz@mode\mmz@mode@recompile},
262 }

```

---

<sup>1</sup>In fact, this code treats anything but 1 and 2 as normal.



**prefix** Key **path** executes the given keylist in path `/mmz/path`, to determine the full *path prefix* to memo and extern files (<sup>M</sup>§2.5,4.2): **relative**, true by default, determines whether the location of these files is relative to the current directory; **dir** sets their directory; and **prefix** sets the first, fixed part of their basename; the second part containing the MD5 sum(s) is not under user control, and neither is the suffix. These subkeys will be initialized a bit later, via **no memo dir**.

```
263 \mmzset{%
264   prefix/.code={\mmz@parse@prefix{#1}},
265 }
```

**\mmz@split@prefix** This macro stores the detokenized expansion of **#1** into `\mmz@prefix`, which it then splits into `\mmz@prefix@dir` and `\mmz@prefix@name` at the final `/`. The slash goes into `\mmz@prefix@dir`. If there is no slash, `\mmz@prefix@dir` is empty.

```
266 \beginingroup
267 \catcode`\/=12
268 \gdef\mmz@parse@prefix#1{%
269   \edef\mmz@prefix{\detokenize\expandafter\expanded{#1}}}%
270   \def\mmz@prefix@dir{%
271     \def\mmz@prefix@name{%
272       \expandafter\mmz@parse@prefix@i\mmz@prefix/\mmz@eov
273     }
274     \gdef\mmz@parse@prefix@i#1/#2{%
275       \ifx\mmz@eov#2%
276         \def\mmz@prefix@name{#1}%
277       \else
278         \appto\mmz@prefix@dir{#1/}%
279         \expandafter\mmz@parse@prefix@i\expandafter#2%
280       \fi
281     }
282 \endgroup
```

Key **prefix** concludes by performing two actions: it creates the given directory if **mkdir** is in effect, and notes the new prefix in record files (by eventually executing **record/prefix**, which typically puts a `\mmzPrefix` line in the `.mmz` file). In the preamble, only the final setting of **prefix** matters, so this key is only equipped with the action-triggering code at the beginning of the document.

```
283 \mmzset{%
284   beginindocument/.append style={
285     prefix/.append code=\mmz@maybe@mkmemodir\mmz@record@prefix,
286   },
```

Consequently, the post-prefix-setting actions must be triggered manually at the beginning of the document. Below, we trigger directory creation; **record/prefix** will be called from **record/begin**, which is executed at the beginning of the document, so it shouldn't be mentioned here.

```
287   beginindocument/.append code=\mmz@maybe@mkmemodir,
288 }
```

**mkdir** Should we create the memo/extern directory if it doesn't exist? And which command should we **mkdir command** use to create it? There is no initial value for the latter, because **mkdir** cannot be executed out of the box, but note that **extract=perl** and **extract=python** will set the extraction script with option **--mkdir** as the value of **mkdir command**.

```
289 \mmzset{
290   mkdir/.is if=\mmz@mkdir,
291   mkdir command/.store in=\mmz@mkdir@command,
292   mkdir command={},
293 }
```

The underlying conditional `\ifmmz@mkdir` is only ever used in `\mmz@maybe@mkmemodir` below, which is itself only executed at the end of `prefix` and in `begindocument`.

```
294 \newif\ifmmz@mkdir
295 \mmz@mkdirtrue
```

We only attempt to create the memo directory if `\ifmmz@mkdir` is in effect and if both `\mmz@mkdir@command` and `\mmz@prefix@dir` are specified (i.e. non-empty).

```
296 \def\mmz@maybe@mkmemodir{%
297   \ifmmz@mkdir
298     \ifdefempty\mmz@mkdir@command{}\{%
299       \ifdefempty\mmz@prefix@dir{}\{%
300         \mmz@remove@quotes{\mmz@prefix@dir}\mmz@temp
301         \pdf@system{\mmz@mkdir@command\space"\mmz@temp"}%
302       }%
303     }%
304   \fi
305 }
```

`memo dir` Shortcuts for two common settings of `path` keys. The default `no memo dir` will place the `no memo dir` memos and externs in the current directory, prefixed with `#1.`, where `#1` defaults to (unquoted) `\jobname`. Key `memo dir` places the memos and externs in a dedicated directory, `#1.memo.dir`; the filenames themselves have no prefix. Furthermore, `memo dir` triggers the creation of the directory.

```
306 \mmzset{%
307   memo dir/.style={prefix={#1.memo.dir/}},
308   memo dir/.default=\jobname,
309   no memo dir/.style={prefix={#1.}},
310   no memo dir/.default=\jobname,
311   no memo dir,
312 }
```

`\mmz@remove@quotes` This macro removes fully expands `#1`, detokenizes the expansion and then removes all double quotes the string. The result is stored in the control sequence given in `#2`.

We use this macro when we are passing a filename constructed from `\jobname` to external programs.

```
313 \def\mmz@remove@quotes#1#2{%
314   \def\mmz@remove@quotes@end{\let#2\mmz@temp}%
315   \def\mmz@temp{%
316     \expanded{%
317       \noexpand\mmz@remove@quotes@i
318       \detokenize\expandafter{\expanded{#1}}%
319       "\noexpand\mmz@eov
320     }%
321   }
322 \def\mmz@remove@quotes@i{%
323   \CollectArgumentsRaw
324   {\collargsBraceCollectedfalse
325     \collargsNoDelimiterstrue
326     \collargsAppendPostwrap{##1}}%
327   }%
328   {u"u\mmz@eov}%
329   \mmz@remove@quotes@ii
330 }
331 \def\mmz@remove@quotes@ii#1#2{%
332   \appto\mmz@temp{#1}%
333   \ifx&#2&%
334     \mmz@remove@quotes@end
335     \expandafter\@gobble
```

```

336 \else
337 \expandafter\@firstofone
338 \fi
339 {\mmz@remove@quotes@i#2\mmz@eov}%
340 }

```

**ignore spaces** The underlying conditional will be inspected by automemoization handlers, to maybe put `\ignorespaces` after the invocation of the handler.

```

341 \newif\ifmmz@ignorespaces
342 \mmzset{
343 ignore spaces/.is if=mmz@ignorespaces,
344 }

```

**verbatim** These keys are tricky. For one, there’s **verbatim**, which sets all characters’ category codes to

**verb** other, and there’s **verb**, which leaves braces untouched (well, honestly, it redefines them). But

**no verbatim** Memoize itself doesn’t really care about this detail — it only uses the underlying conditional `\ifmmz@verbatim`. It is `CollArgs` which cares about the difference between the “long” and the “short” verbatim, so we need to tell it about it. That’s why the verbatim options “append themselves” to `\mmzRawCollectorOptions`, which is later passed on to `\CollectArgumentsRaw` as a part of its optional argument.

```

345 \newif\ifmmz@verbatim
346 \def\mmzRawCollectorOptions{}
347 \mmzset{
348 verbatim/.code={%
349 \def\mmzRawCollectorOptions{\collargsVerbatim}%
350 \mmz@verbatimtrue
351 },
352 verb/.code={%
353 \def\mmzRawCollectorOptions{\collargsVerb}%
354 \mmz@verbatimtrue
355 },
356 no verbatim/.code={%
357 \def\mmzRawCollectorOptions{\collargsNoVerbatim}%
358 \mmz@verbatimfalse
359 },
360 }

```

## 3 Memoization

### 3.1 Manual memoization

**\mmz** The core of this macro will be a simple invocation of `\Memoize`, but to get there, we have to collect the optional argument carefully, because we might have to collect the memoized code verbatim.

```

361 \protected\def\mmz{\futurelet\mmz@temp\mmz@i}
362 \def\mmz@i{%

```

Anyone who wants to call `\Memoize` must open a group, because `\Memoize` will close a group.

```

363 \begingroup

```

As the optional argument occurs after a control sequence (`\mmz`), any spaces were consumed and we can immediately test for the opening bracket.

```

364 \ifx\mmz@temp[%
365 \def\mmz@verbatim@fix{}%
366 \expandafter\mmz@ii
367 \else

```

If there was no optional argument, the opening brace (or the unlikely single token) of our mandatory argument is already tokenized. If we are requested to memoize in a verbatim mode, this non-verbatim tokenization was wrong, so we will use option `\collargsFixFromNoVerbatim` to ask CollArgs to fix the situation. (`\mmz@verbatim@fix` will only be used in the verbatim mode.)

```
368 \def\mmz@verbatim@fix{\noexpand\collargsFixFromNoVerbatim}%
```

No optional argument, so we can skip `\mmz@ii`.

```
369 \expandafter\mmz@iii
370 \fi
371 }
372 \def\mmz@ii[#1]{%
```

Apply the options given in the optional argument.

```
373 \mmzset{#1}%
374 \mmz@iii
375 }
376 \def\mmz@iii{%
```

In the non-verbatim mode, we avoid collecting the single mandatory argument using `\CollectArguments`.

```
377 \ifmmz@verbatim
378 \expandafter\mmz@do@verbatim
379 \else
380 \expandafter\mmz@do
381 \fi
382 }
```

This macro grabs the mandatory argument of `\mmz` and calls `\Memoize`.

```
383 \long\def\mmz@do#1{%
384 \Memoize{#1}{#1}%
385 }%
```

The following macro uses `\CollectArgumentsRaw` of package CollArgs (§8.2) to grab the argument verbatim; the appropriate verbatim mode triggering raw option was put in `\mmzRawCollectorOptions` by key `verb(atim)`. The macro also `\mmz@verbatim@fix` contains the potential request for a category code fix (§8.2.6).

```
386 \def\mmz@do@verbatim#1{%
387 \expanded{%
388 \noexpand\CollectArgumentsRaw{%
389 \noexpand\collargsCaller{\noexpand\mmz}%
390 \expandonce\mmzRawCollectorOptions
391 \mmz@verbatim@fix
392 }%
393 }{+m}\mmz@do
394 }
```

**memoize (env.)** The definition of the manual memoization environment proceeds along the same lines as the definition of `\mmz`, except that we also have to implement space-trimming, and that we will collect the environment using `\CollectArguments` in both the verbatim and the non-verbatim and mode.

We define the L<sup>A</sup>T<sub>E</sub>X, plain T<sub>E</sub>X and ConT<sub>E</sub>Xt environments in parallel. The definition of the plain T<sub>E</sub>X and ConT<sub>E</sub>Xt version is complicated by the fact that space-trimming is affected by the presence vs. absence of the optional argument (for purposes of space-trimming, it counts as present even if it is empty).

```
395 <*\latex>
```

We define the L<sup>A</sup>T<sub>E</sub>X environment using `\newenvironment`, which kindly grabs any spaces in front of the optional argument, if it exists — and if doesn’t, we want to trim spaces at the beginning of the environment body anyway.

```
396 \newenvironment{memoize}[1][\mmz@noarg]{%
```

We close the environment right away. We’ll collect the environment body, complete with the end-tag, so we have to reintroduce the end-tag somewhere. Another place would be after the invocation of `\Memoize`, but that would put memoization into a double group and `\mmzAfterMemoization` would not work.

```
397 \end{memoize}%
```

We open the group which will be closed by `\Memoize`.

```
398 \begingroup
```

As with `\mmz` above, if there was no optional argument, we have to ask Collargs for a fix. The difference is that, as we have collected the optional argument via `\newcommand`, we have to test for its presence in a roundabout way.

```
399 \def\mmz@temp{#1}%
400 \ifx\mmz@temp\mmz@noarg
401   \def\mmz@verbatim@fix{\noexpand\collargsFixFromNoVerbatim}%
402 \else
403   \def\mmz@verbatim@fix{}%
404   \mmzset{#1}%
405 \fi
406 \mmz@env@iii
407 }{}
408 \def\mmz@noarg{\mmz@noarg}
409 %
410 (plain) \def\memoize{%
411 (context) \def\startmemoize{%
412   (*plain, context)
413   \begingroup
```

In plain T<sub>E</sub>X and ConT<sub>E</sub>Xt, we don’t have to worry about any spaces in front of the optional argument, as the environments are opened by a control sequence.

```
414 \futurelet\mmz@temp\mmz@env@i
415 }
416 \def\mmz@env@i{%
417   \ifx\mmz@temp[%]
418     \def\mmz@verbatim@fix{}%
419     \expandafter\mmz@env@ii
420   \else
421     \def\mmz@verbatim@fix{\noexpand\collargsFixFromNoVerbatim}%
422     \expandafter\mmz@env@iii
423   \fi
424 }
425 \def\mmz@env@ii[#1]{%
426   \mmzset{#1}%
427   \mmz@env@iii
428 }
429 %
430 \def\mmz@env@iii{%
431   \long\edef\mmz@do##1{%
```

`\unskip` will “trim” spaces at the end of the environment body.

```
432   \noexpand\Memoize{##1}{##1\unskip}%
433 }%
434 \expanded{%
435   \noexpand\CollectArgumentsRaw{%
```

\CollectArgumentsRaw will adapt the caller to the format automatically.

```
436 \noexpand\collargsCaller{memoize}%
```

verb(atim) is in here if it was requested.

```
437 \expandonce\mmzRawCollectorOptions
```

The category code fix, if needed.

```
438 \ifmmz@verbatim\mmz@verbatim@fix\fi
439 }%
```

Spaces at the beginning of the environment body are trimmed by setting the first argument to !t<space> and disappearing it with \collargsAppendPostwrap{}; note that this removes any number of space tokens. \CollectArgumentsRaw automatically adapts the argument type b to the format.

```
440 }{&&{\collargsAppendPostwrap{}}!t{ }+b{memoize}}{\mmz@do}%
441 }%
442 </mmz>
```

**\nommz** We throw away the optional argument if present, and replace the opening brace with begin-group plus \memoizefalse. This way, the “argument” of \nommz will be processed in a group (with Memoize disabled) and even the verbatim code will work because the “argument” will not have been tokenized.

As a user command, \nommz has to make it into package nomemoize as well, and we’ll \let \mmz equal it there; it is not needed in mmzable.

```
443 <*mmz, nommz>
444 \protected\def\nommz#1#{%
445 \afterassignment\nommz@i
446 \let\mmz@temp
447 }
448 \def\nommz@i{%
449 \bgroup
450 \memoizefalse
451 }
452 <nommz>\let\mmz\nommz
```

**nomemoize (env.)** We throw away the optional argument and take care of the spaces at the beginning and at the end of the body.

```
453 <*latex>
454 \newenvironment{nomemoize}[1][]{%
455 \memoizefalse
456 \ignorespaces
457 }{%
458 \unskip
459 }
460 </latex>
461 <*plain, context>
462 <plain>\def\nomemoize{%
463 <context>\def\startnomemoize{%
```

Start a group to delimit \memoizefalse.

```
464 \begingroup
465 \memoizefalse
466 \futurelet\mmz@temp\nommz@env@i
467 }
468 \def\nommz@env@i{%
469 \ifx\mmz@temp[%
470 \expandafter\nommz@env@ii
```

No optional argument, no problems with spaces.

```
471 \fi
472 }
473 \def\nommz@env@ii[#1]{%
474 \ignorespaces
475 }
476 <plain>\def\endmemoize{%
477 <context>\def\stopmemoize{%
478 \endgroup
479 \unskip
480 }
481 </plain,context>
482 <*nommz>
483 <plain,latex>\let\memoize\nomemoize
484 <plain,latex>\let\endmemoize\endnomemoize
485 <context>\let\startmemoize\startnomemoize
486 <context>\let\stopmemoize\stopnomemoize
487 </nommz>
488 </mmz,nommz>
```

### 3.2 The memoization process

**\ifmemoizing** This conditional is set to true when we start memoization (but not when we start regular compilation or utilization); it should never be set anywhere else. It is checked by **\Memoize** to prevent nested memoizations, deployed in advice run conditions set by **run only if memoizing**, etc.

```
489 <*mmz,nommz,mmzable & generic>
490 \newif\ifmemoizing
```

**\ifinmemoize** This conditional is set to true when we start either memoization or regular compilation (but not when we start utilization); it should never be set anywhere else. It is deployed in the default advice run conditions, making sure that automemoized commands are not handled even when we're regularly compiling some code submitted to memoization.

```
491 \newif\ifinmemoize
```

**\mmz@maybe@scantokens** An auxiliary macro which rescans the given code using **\scantokens** if the verbatim mode is active. We also need it in NoMemoize, to properly grab verbatim manually memoized code.

```
492 </mmz,nommz,mmzable & generic>
493 <*mmz>
494 \def\mmz@maybe@scantokens{%
495 \ifmmz@verbatim
496 \expandafter\mmz@scantokens
497 \else
498 \expandafter\@firstofone
499 \fi
500 }
```

Without **\newlinechar=13**, **\scantokens** would see receive the entire argument as one long line — but it would not *see* the entire argument, but only up to the first newline character, effectively losing most of the tokens. (We need to manually save and restore **\newlinechar** because we don't want to execute the memoized code in yet another group.)

```
501 \long\def\mmz@scantokens#1{%
502 \expanded{%
503 \newlinechar=13
504 \unexpanded{\scantokens{#1\endinput}}}%
505 \newlinechar=\the\newlinechar
506 }%
507 }
```

`\Memoize` Memoization is invoked by executing `\Memoize`. This macro is a decision hub. It test for the existence of the memos and externs associated with the memoized code, and takes the appropriate action (memoization: `\mmz@memoize`; regular compilation: `\mmz@compile`, utilization: `\mmz@process@cmemo` plus `\mmz@process@ccmemo` plus further complications) depending on the memoization mode (normal, readonly, recompile). Note that one should open a  $\TeX$  group prior to executing `\Memoize`, because `\Memoize` will close a group (<sup>M</sup>§4.1).

`\Memoize` takes two arguments, which contain two potentially different versions of the code submitted to memoization: `#1` contains the code which  $\langle code MD5 sum \rangle$  is computed off of, while `#2` contains the code which is actually executed during memoization and regular compilation. The arguments will contain the same code in the case of manual memoization, but they will differ in the case of automemoization, where the executable code will typically prefixed by `\AdviceOriginal`. As the two codes will be used not only by `\Memoize` but also by macros called from `\Memoize`, `\Memoize` stores them into dedicated toks registers, declared below.

```
508 \newtoks\mmz@mdfive@source
509 \newtoks\mmz@exec@source
```

Finally, the definition of the macro. In package NoMemoize, we should simply execute the code in the second argument. But in Memoize, we have work to do.

```
510 \let\Memoize\@secondoftwo
511 \long\def\Memoize#1#2{%
```

We store the first argument into token register `\mmz@mdfive@source` because we might have to include it in tracing info (when `trace` is in effect), or paste it into the c-memo (depending on include source in `cmemo`).

```
512 \mmz@mdfive@source{#1}%
```

We store the executable code in `\mmz@exec@source`. In the verbatim mode, the code will have to be rescanned. This is implemented by `\mmz@maybe@scantokens`, and we wrap the code into this macro right away, once and for all. Even more, we pre-expand `\mmz@maybe@scantokens` (three times), effectively applying the current `\ifmmz@verbatim` and eliminating the need to save and restore this conditional in `\mmz@compile`, which (regularly) compiles the code *after* closing the `\Memoize` group — after this pre-expansion, `\mmz@exec@source` will contain either `\mmz@scantokens{...}` or `\@firstofone{...}`.

```
513 \expandafter\expandafter\expandafter\expandafter
514 \expandafter\expandafter\expandafter
515 \mmz@exec@source
516 \expandafter\expandafter\expandafter\expandafter
517 \expandafter\expandafter\expandafter
518 {%
519 \mmz@maybe@scantokens{#2}%
520 }%
521 \mmz@trace@Memoize
```

In most branches below, we end up with regular compilation, so let this be the default action.

```
522 \let\mmz@action\mmz@compile
```

If Memoize is disabled, or if memoization is currently taking place, we will perform a regular compilation.

```
523 \ifmemoizing
524 \else
525 \ifmemoize
```

Compute  $\langle code md5sum \rangle$  off of the first argument, and globally store it into `\mmz@code@mdfivesum` — globally, because we need it in utilization to include externs, but the `\Memoize` group is closed (by `\mmzMemo`) while inputting the cc-memo.

```
526 \xdef\mmz@code@mdfivesum{\pdf@mdfivesum{\the\mmz@mdfive@source}}%
527 \mmz@trace@code@mdfive
```



Recompile mode forces memoization.

```

528      \ifnum\mmz@mode=\mmz@mode@recompile\relax
529      \ifnum\pdf@draftmode=0
530      \let\mmz@action\mmz@memoize
531      \fi
532      \else

```

In the normal and the readonly mode, we try to utilize the memos. The c-memo comes first. If the c-memo does not exist (or if something is wrong with it), `\mmz@process@cmemo` (defined in §3.4) will set `\ifmmz@abort` to true. It might also set `\ifmmzUnmemoizable` which means we should compile normally regardless of the mode.

```

533      \mmz@process@cmemo
534      \ifmmzUnmemoizable
535      \mmz@trace@cmemo@unmemoizable
536      \else
537      \ifmmz@abort

```

If there is no c-memo, or it is invalid, we memoize, unless the read-only mode is in effect.

```

538      \mmz@trace@process@cmemo@fail
539      \ifnum\mmz@mode=\mmz@mode@readonly\relax
540      \else
541      \ifnum\pdf@draftmode=0
542      \let\mmz@action\mmz@memoize
543      \fi
544      \fi
545      \else
546      \mmz@trace@process@cmemo@ok

```

If the c-memo was fine, the formal action decided upon is to try utilizing the cc-memo. If it exists and everything is fine with it, `\mmz@process@ccmemo` (defined in section 3.5) will utilize it, i.e. the core of the cc-memo (the part following `\mmzMemo`) will be executed (typically including the single `\extern`). Otherwise, `\mmz@process@ccmemo` will trigger either memoization (in the normal mode) or regular compilation (in the readonly mode). This final decision is left to `\mmz@process@ccmemo` because if we made it here, the code would get complicated, as the cc-memo must be processed outside the `\Memoize` group and all the conditionals in this macro.

```

547      \let\mmz@action\mmz@process@ccmemo
548      \fi
549      \fi
550      \fi
551      \fi
552      \fi
553      \mmz@action
554 }

```

**`\mmz@compile`** This macro performs regular compilation — this is signalled to the memoized code and the memoization driver by setting `\ifinmemoize` to true for the duration of the compilation; `\ifmemoizing` is not touched. The group opened prior to the invocation of `\Memoize` is closed before executing the code in `\mmz@exec@source`, so that compiling the code has the same local effect as if was not submitted to memoization; it is closing this group early which complicates the restoration of `\ifinmemoize` at the end of compilation. Note that `\mmz@exec@source` is already set to properly deal with the current verbatim mode, so any further inspection of `\ifmmz@verbatim` is unnecessary; the same goes for `\ifmmz@ignorespaces`, which was (or at least should be) taken care of by whoever called `\Memoize`.

```

555 \def\mmz@compile{%
556   \mmz@trace@compile
557   \expanded{%
558     \endgroup

```

```

559 \noexpand\inmemoizetrue
560 \the\mmz@exec@source
561 \ifinmemoize\noexpand\inmemoizetrue\else\noexpand\inmemoizefalse\fi
562 }%
563 }

```

`abortOnError` In Lua<sub>T</sub><sub>E</sub>X, we can whether an error occurred during memoization, and abort if it `\mmz@lua@atbeginmemoization` did. (We're going through `memoize.abort`, because `tex.print` does not seem to `\mmz@lua@atendmemoization` work during error handling.) We omit all this in ConT<sub>E</sub>Xt, as it appears to stop on any error?

```

564 <(!context>
565 \ifdefined\luatexversion
566 \directlua{%
567   luatexbase.add_to_callback(
568     "show_error_message",
569     function()
570       memoize.abort = true
571       texio.write_nl(status.lasterrorstring)
572     end,
573     "Abort memoization on error"
574   )
575 }%
576 \def\mmz@lua@atbeginmemoization{%
577   \directlua{memoize.abort = false}%
578 }%
579 \def\mmz@lua@atendmemoization{%
580   \directlua{%
581     if memoize.abort then
582       tex.print("\noexpand\\mmzAbort")
583     end
584   }%
585 }%
586 \else
587 </(!context>
588 \let\mmz@lua@atbeginmemoization\relax
589 \let\mmz@lua@atendmemoization\relax
590 <(!context>\fi

```

`\mmz@memoize` This macro performs memoization — this is signalled to the memoized code and the memoization driver by setting both `\ifinmemoize` and `\ifinmemoizing` to true.

```

591 \def\mmz@memoize{%
592   \mmz@trace@memoize
593   \memoizingtrue
594   \inmemoizetrue

```

Initialize the various macros and registers used in memoization (to be described below, or later). Note that most of these are global, as they might be adjusted arbitrarily deep within the memoized code.

```

595 \edef\memoizinggrouplevel{\the\currentgrouplevel}%
596 \global\mmz@abortfalse
597 \global\mmzUnmemoizablefalse
598 \global\mmz@seq 0
599 \global\setbox\mmz@tbe@box\vbox{}%
600 \global\mmz@ccmemo@resources{}%
601 \global\mmzCMemo{}%
602 \global\mmzCCMemo{}%
603 \global\mmzContextExtra{}%
604 \gdef\mmzAtEndMemoizationExtra{}%
605 \gdef\mmzAfterMemoizationExtra{}%
606 \mmz@lua@atbeginmemoization

```

Execute the pre-memoization hook, the memoized code (wrapped in the driver), and the post-memoization hook.

```

607 \mmzAtBeginMemoization
608 \mmzDriver{\the\mmz@exec@source}%
609 \mmzAtEndMemoization
610 \mmzAtEndMemoizationExtra
611 \mmz@lua@atendmemoization
612 \ifmmzUnmemoizable

```

To permanently prevent memoization, we have to write down the c-memo (containing `\mmzUnmemoizabletrue`). We don't need the extra context in this case.

```

613 \global\mmzContextExtra{}%
614 \gtoksapp\mmzCMemo{\global\mmzUnmemoizabletrue}%
615 \mmz@write@cmemo
616 \mmz@trace@endmemoize@unmemoizable
617 \PackageInfo{memoize}{Marking this code as unmemoizable}%
618 \else
619 \ifmmz@abort

```

If memoization was aborted, we create an empty c-memo, to make sure that no leftover c-memo tricks Memoize into thinking that the code was successfully memoized.

```

620 \mmz@trace@endmemoize@aborted
621 \PackageInfo{memoize}{Memoization was aborted}%
622 \mmz@compute@context@mdfivesum
623 \mmz@write@cmemo
624 \else

```

If memoization was not aborted, we compute the  $\langle context\ md5sum \rangle$ , open and write out the memos, and shipout the externs (as pages into the document).

```

625 \mmz@compute@context@mdfivesum
626 \mmz@write@cmemo
627 \mmz@write@ccmemo
628 \mmz@shipout@externs
629 \mmz@trace@endmemoize@ok
630 \fi
631 \fi

```

After closing the group, we execute the final, after-memoization hook (we pre-expand the regular macro; the extra macro was assigned to globally). In the after-memoization code, `\mmzIncludeExtern` points to a macro which can include the extern from `\mmz@tbe@box`, which makes it possible to typeset the extern by dropping the contents of `\mmzCCMemo` into this hook — but note that this will only work if `\ifmmzkeepexterns` was in effect at the end of memoization.

```

632 \expandafter\endgroup
633 \expandafter\let
634 \expandafter\mmzIncludeExtern\expandafter\mmz@include@extern@from@tbe@box
635 \mmzAfterMemoization
636 \mmzAfterMemoizationExtra
637 }

```

`\memoizinggrouplevel` This macro stores the group level at the beginning of memoization. It is deployed by `\IfMemoizing`, normally used by integrated drivers.

```

638 \def\memoizinggrouplevel{-1}%

```

`\mmzAbort` Memoized code may execute this macro to abort memoization.

```

639 \def\mmzAbort{\global\mmz@aborttrue}

```

`\ifmmz@abort` This conditional serves as a signal that something went wrong during memoization (where it is set to true by `\mmzAbort`), or c(c)-memo processing. The assignment to this conditional should always be global (because it may be set during memoization).

```
640 \newif\ifmmz@abort
```

`\mmzUnmemoizable` Memoized code may execute `\mmzUnmemoizable` to abort memoization and mark (in the c-memo) that memoization should never be attempted again. The c-memo is composed by `\mmz@memoize`.

```
641 \def\mmzUnmemoizable{\global\mmzUnmemoizabletrue}
```

`\ifmmzUnmemoizable` This conditional serves as a signal that the code should never be memoized. It can be set (a) during memoization (that's why it should be assigned globally), after which it is inspected by `\mmz@memoize`, and (b) from the c-memo, in which case it is inspected by `\Memoize`.

```
642 \newif\ifmmzUnmemoizable
```

`\mmzAtBeginMemoization` The memoization hooks and their keys. The hook macros may be set either before or during memoization. In the former case, one should modify the primary `\mmzAtEndMemoization` macro (`\mmzAtBeginMemoization`, `\mmzAtEndMemoization`, `\mmzAfterMemoization`), `at begin memoization` and the assignment should be local. In the latter case, one should modify the extra `at end memoization` macro (`\mmzAtEndMemoizationExtra`, `\mmzAfterMemoizationExtra`; there is no `after memoization` `\mmzAtBeginMemoizationExtra`), and the assignment should be global. The keys automatically adapt to the situation, by appending either to the primary or the the extra macro; if `at begin memoization` is used during memoization, the given code is executed immediately. We will use this “extra” approach and the auto-adapting keys for other options, like `context`, as well.

```
643 \def\mmzAtBeginMemoization{}
644 \def\mmzAtEndMemoization{}
645 \def\mmzAfterMemoization{}
646 \mmzset{
647   at begin memoization/.code={%
648     \ifmemoizing
649       \expandafter\@firstofone
650     \else
651       \expandafter\appto\expandafter\mmzAtBeginMemoization
652     \fi
653     {#1}%
654   },
655   at end memoization/.code={%
656     \ifmemoizing
657       \expandafter\gappto\expandafter\mmzAtEndMemoizationExtra
658     \else
659       \expandafter\appto\expandafter\mmzAtEndMemoization
660     \fi
661     {#1}%
662   },
663   after memoization/.code={%
664     \ifmemoizing
665       \expandafter\gappto\expandafter\mmzAfterMemoizationExtra
666     \else
667       \expandafter\appto\expandafter\mmzAfterMemoization
668     \fi
669     {#1}%
670   },
671 }
```

`driver` This key sets the (formal) memoization driver. The function of the driver is to produce the memos and externs while executing the submitted code.

```

672 \mmzset{
673   driver/.store in=\mmzDriver,
674   driver=\mmzSingleExternDriver,
675 }

```

**\ifmmzkeepexterns** This conditional causes Memoize not to empty out `\mmz@tbe@box`, holding the externs collected during memoization, while shipping them out.

```

676 \newif\ifmmzkeepexterns

```

**\mmzSingleExternDriver** The default memoization driver externalizes the submitted code. It always produces exactly one extern, and including the extern will be the only effect of inputting the cc-memo (unless the memoized code contained some commands, like `\label`, which added extra instructions to the cc-memo.) The macro (i) adds `\quitvmode` to the cc-memo, if we're capturing into a horizontal box, and it puts it to the very front, so that it comes before any `\label` and `\index` replications, guaranteeing (hopefully) that they refer to the correct page; (ii) takes the code and typesets it in a box (`\mmz@box`); (iii) submits the box for externalization; (iv) adds the extern-inclusion code to the cc-memo, and (v) puts the box into the document (again prefixing it with `\quitvmode` if necessary). (The listing region markers help us present this code in the manual.)

```

677 \long\def\mmzSingleExternDriver#1{%
678   \xtoksapp\mmzCCMemo{\mmz@maybe@quitvmode}%
679   \setbox\mmz@box\mmz@capture{#1}%
680   \mmzExternalizeBox\mmz@box\mmz@temptoks
681   \xtoksapp\mmzCCMemo{\the\mmz@temptoks}%
682   \mmz@maybe@quitvmode\box\mmz@box
683 }

```

**capture** The default memoization driver uses `\mmz@capture` and `\mmz@maybe@quitvmode`, which are set by this key. `\mmz@maybe@quitvmode` will be expanded, but for  $\text{\TeX}$ , we have defined `\quitvmode` as a synonym for `\leavevmode`, which is a macro rather than a primitive, so we have to prevent its expansion in that case. It is easiest to just add `\noexpand`, regardless of the engine used.

```

684 \mmzset{
685   capture/.is choice,
686   capture/hbox/.code={%
687     \let\mmz@capture\hbox
688     \def\mmz@maybe@quitvmode{\noexpand\quitvmode}%
689   },
690   capture/vbox/.code={%
691     \let\mmz@capture\vbox
692     \def\mmz@maybe@quitvmode{}%
693   },
694   capture=hbox,
695 }

```

The memoized code may be memoization-aware; in such a case, we say that the driver is *integrated* into the code. Code containing an integrated driver must take care to execute it only when memoizing, and not during a regular compilation. The following key and macro can help here, see [M§4.4.4](#) for details.

**integrated driver** This is an advice key, residing in `/mmz/auto`. Given  $\langle suffix \rangle$  as the only argument, it declares conditional `\ifmemoizing<suffix>`, and sets the driver for the automemoized command to a macro which sets this conditional to true. The declared conditional is *internal* and should not be used directly, but only via `\IfMemoizing` — because it will not be declared when package NoMemoize or only Memoizable is loaded.

```

696 \mmzset{
697   auto/integrated driver/.style={
698     after setup={\expandafter\newif\csname ifmmz@memoizing#1\endcsname},
699     driver/.expand once={%
700       \csname mmz@memoizing#1true\endcsname

```

Without this, we would introduce an extra group around the memoized code.

```

701     \@firstofone
702   }%
703 },
704 }

```

**\IfMemoizing** Without the optional argument, the condition is satisfied when the internal conditional `\ifmemoizing<suffix>`, declared by `integrated driver`, is true. With the optional argument `<offset>`, the current group level must additionally match the memoizing group level, modulo `<offset>` — this makes sure that the conditional comes out as false in a regular compilation embedded in a memoization.

```

705 \newcommand\IfMemoizing[2][\mmz@ifmemoizing@nogrouplevel]{%>\fi
706 \csname ifmmz@memoizing#2\endcsname%>\if

```

One `\relax` is for the `\numexpr`, another for `\ifnum`. Complications arise when #1 is the optional argument default (defined below). In that case, the content of `\mmz@ifmemoizing@nogrouplevel` closes off the `\ifnum` conditional (with both the true and the false branch empty), and opens up a new one, `\iftrue`. Effectively, we're not testing for the group level match.

```

707 \ifnum\currentgrouplevel=\the\numexpr\memoizinggrouplevel+#1\relax\relax
708   \expandafter\expandafter\expandafter\@firstoftwo
709 \else
710   \expandafter\expandafter\expandafter\@secondoftwo
711 \fi
712 \else
713   \expandafter\@secondoftwo
714 \fi
715 }
716 \def\mmz@ifmemoizing@nogrouplevel{0\relax\relax\fi\iftrue}

```

**Tracing** We populate the hooks which send the tracing info to the terminal.

```

717 \def\mmz@trace#1{\advice@typeout{[tracing memoize] #1}}
718 \def\mmz@trace@context{\mmz@trace{\space\space
719   Context: "\expandonce{\mmz@context@key}" --> \mmz@context@mdfivesum}}
720 \def\mmz@trace@Memoize@on{%
721   \mmz@trace{%
722     Entering \noexpand\Memoize (%
723     \ifmemoize enabled\else disabled\fi,
724     \ifnum\mmz@mode=\mmz@mode@recompile recompile\fi
725     \ifnum\mmz@mode=\mmz@mode@readonly readonly\fi
726     \ifnum\mmz@mode=\mmz@mode@normal normal\fi
727     \space mode) on line \the\inputlineno
728   }%
729   \mmz@trace{\space\space Code: \the\mmz@mdfive@source}%
730 }
731 \def\mmz@trace@code@mdfive@on{\mmz@trace{\space\space
732   Code md5sum: \mmz@code@mdfivesum}}
733 \def\mmz@trace@compile@on{\mmz@trace{\space\space Compiling}}
734 \def\mmz@trace@memoize@on{\mmz@trace{\space\space Memoizing}}
735 \def\mmz@trace@endmemoize@ok@on{\mmz@trace{\space\space
736   Memoization completed}}%
737 \def\mmz@trace@endmemoize@aborted@on{\mmz@trace{\space\space
738   Memoization was aborted}}
739 \def\mmz@trace@endmemoize@unmemoizable@on{\mmz@trace{\space\space
740   Marking this code as unmemoizable}}

```

No need for `\mmz@trace@endmemoize@fail`, as abortion results in a package warning anyway.

```

741 \def\mmz@trace@process@cmemo@on{\mmz@trace{\space\space
742   Attempting to utilize c-memo \mmz@cmemo@path}}

```

```

743 \def\mmz@trace@process@no@cmemo@on{\mmz@trace{\space\space
744   C-memo does not exist}}
745 \def\mmz@trace@process@cmemo@ok@on{\mmz@trace{\space\space
746   C-memo was processed successfully}\mmz@trace@context}
747 \def\mmz@trace@process@cmemo@fail@on{\mmz@trace{\space\space
748   C-memo input failed}}
749 \def\mmz@trace@cmemo@unmemoizable@on{\mmz@trace{\space\space
750   This code was marked as unmemoizable}}
751 \def\mmz@trace@process@ccmemo@on{\mmz@trace{\space\space
752   Attempting to utilize cc-memo \mmz@ccmemo@path\space
753   (\ifmmz@direct@ccmemo@input\else in\fi direct input)}}
754 \def\mmz@trace@resource@on#1{\mmz@trace{\space\space
755   Extern file does not exist: #1}}
756 \def\mmz@trace@process@ccmemo@ok@on{%
757   \mmz@trace{\space\space Utilization successful}}
758 \def\mmz@trace@process@no@ccmemo@on{%
759   \mmz@trace{\space\space CC-memo does not exist}}
760 \def\mmz@trace@process@ccmemo@fail@on{%
761   \mmz@trace{\space\space Cc-memo input failed}}

```

**tracing** The user interface for switching the tracing on and off; initially, it is off. Note that there is no underlying conditional. The off version simply \lets all the tracing hooks to \relax, so that the overhead of having the tracing functionality available is negligible.

```

762 \mmzset{%
763   trace/.is choice,
764   trace/.default=true,
765   trace/true/.code=\mmzTracingOn,
766   trace/false/.code=\mmzTracingOff,
767 }
768 \def\mmzTracingOn{%
769   \let\mmz@trace@Memoize\mmz@trace@Memoize@on
770   \let\mmz@trace@code@mdfive\mmz@trace@code@mdfive@on
771   \let\mmz@trace@compile\mmz@trace@compile@on
772   \let\mmz@trace@memoize\mmz@trace@memoize@on
773   \let\mmz@trace@process@cmemo\mmz@trace@process@cmemo@on
774   \let\mmz@trace@endmemoize@ok\mmz@trace@endmemoize@ok@on
775   \let\mmz@trace@endmemoize@unmemoizable\mmz@trace@endmemoize@unmemoizable@on
776   \let\mmz@trace@endmemoize@aborted\mmz@trace@endmemoize@aborted@on
777   \let\mmz@trace@process@cmemo\mmz@trace@process@cmemo@on
778   \let\mmz@trace@process@cmemo@ok\mmz@trace@process@cmemo@ok@on
779   \let\mmz@trace@process@no@cmemo\mmz@trace@process@no@cmemo@on
780   \let\mmz@trace@process@cmemo@fail\mmz@trace@process@cmemo@fail@on
781   \let\mmz@trace@cmemo@unmemoizable\mmz@trace@cmemo@unmemoizable@on
782   \let\mmz@trace@process@ccmemo\mmz@trace@process@ccmemo@on
783   \let\mmz@trace@resource\mmz@trace@resource@on
784   \let\mmz@trace@process@ccmemo@ok\mmz@trace@process@ccmemo@ok@on
785   \let\mmz@trace@process@no@ccmemo\mmz@trace@process@no@ccmemo@on
786   \let\mmz@trace@process@ccmemo@fail\mmz@trace@process@ccmemo@fail@on
787 }
788 \def\mmzTracingOff{%
789   \let\mmz@trace@Memoize\relax
790   \let\mmz@trace@code@mdfive\relax
791   \let\mmz@trace@compile\relax
792   \let\mmz@trace@memoize\relax
793   \let\mmz@trace@process@cmemo\relax
794   \let\mmz@trace@endmemoize@ok\relax
795   \let\mmz@trace@endmemoize@unmemoizable\relax
796   \let\mmz@trace@endmemoize@aborted\relax
797   \let\mmz@trace@process@cmemo\relax
798   \let\mmz@trace@process@cmemo@ok\relax
799   \let\mmz@trace@process@no@cmemo\relax
800   \let\mmz@trace@process@cmemo@fail\relax

```



```

801 \let\mmz@trace@cmemo@unmemoizable\relax
802 \let\mmz@trace@process@ccmemo\relax
803 \let\mmz@trace@resource\@gobble
804 \let\mmz@trace@process@ccmemo@ok\relax
805 \let\mmz@trace@process@no@ccmemo\relax
806 \let\mmz@trace@process@ccmemo@fail\relax
807 }
808 \mmzTracingOff

```

### 3.3 Context

`\mmzContext` The context expression is stored in two token registers. Outside memoization, we will locally assign to `\mmzContext`; during memoization, we will globally assign to `\mmzContextExtra`.

```

809 \newtoks\mmzContext
810 \newtoks\mmzContextExtra

```

`context` The user interface keys for context manipulation hide the complexity underlying the context storage from the user.

```

811 \mmzset{%
812   context/.code={%
813     \ifmemoizing
814       \expandafter\gtoksapp\expandafter\mmzContextExtra
815     \else
816       \expandafter\toksapp\expandafter\mmzContext
817     \fi

```

We append a comma to the given context chunk, for disambiguation.

```

818   {#1,}%
819 },
820 clear context/.code={%
821   \ifmemoizing
822     \expandafter\global\expandafter\mmzContextExtra
823   \else
824     \expandafter\mmzContext
825   \fi
826   {}}%
827 },
828 clear context/.value forbidden,

```

`meaning to context` Utilities to put the meaning of various stuff into context.

```

csname meaning to context
key meaning to context 829 meaning to context/.code={\forcsvlist\mmz@mtoc{#1}},
key value to context 830 csname meaning to context/.code={\mmz@mtoc@csname{#1}},
/handlers/.meaning to context 831 key meaning to context/.code={%
832   \forcsvlist\mmz@mtoc\mmz@mtoc@keycmd{#1}},
/handlers/.value to context 833 key value to context/.code={\forcsvlist\mmz@mtoc@key{#1}},
834 /handlers/.meaning to context/.code={\expanded{%
835   \noexpand\mmz@mtoc@csname{pgfk@\pgfkeyscurrentpath/.@cmd}}},
836 /handlers/.value to context/.code={%
837   \expanded{\noexpand\mmz@mtoc@csname{pgfk@\pgfkeyscurrentpath}}},
838 }

```

```

839 \def\mmz@mtoc#1{%
840   \collargs@cs@cases{#1}%
841   {\mmz@mtoc@cmd{#1}}%
842   {\mmz@mtoc@error@notcsorenv{#1}}%
843   {%
844     \mmz@mtoc@csname{%
845 <context>      start%
846               #1}%

```



```

847      \mmz@mtoc@csname{%
848 <latex, plain>      end%
849 <context>          stop%
850                  #1}%
851      }%
852 }
853 \def\mmz@mtoc@cmd#1{%
854   \begingroup
855   \escapechar=-1
856   \expandafter\endgroup
857   \expandafter\mmz@mtoc@csname\expandafter{\string#1}%
858 }
859 \def\mmz@mtoc@csname#1{%
860   \pgfkeysvalueof{/mmz/context/.@cmd}%
861   \detokenize{#1}={\expandafter\meaning\csname#1\endcsname}%
862   \pgfeov
863 }
864 \def\mmz@mtoc@key#1{\mmz@mtoc@csname{pgfk@#1}}
865 \def\mmz@mtoc@keycmd#1{\mmz@mtoc@csname{pgfk@#1/.@cmd}}
866 \def\mmz@mtoc@error@notcsorenv#1{%
867   \PackageError{memoize}{'\detokenize{#1}' passed to key 'meaning to context'
868     is neither a command nor an environment}{}%
869 }

```

### 3.4 C-memos

The path to a c-memo consists of the path prefix, the MD5 sum of the memoized code, and suffix `.memo`.

```
870 \def\mmz@cmemo@path{\mmz@prefix\mmz@code@mdfivesum.memo}
```

`\mmzCMemo` The additional, free-form content of the c-memo is collected in this token register.

```
871 \newtoks\mmzCMemo
```

`include source in cmemo` Should we include the memoized code in the c-memo? By default, yes.

```
\ifmmz@include@source
```

```

872 \mmzset{%
873   include source in cmemo/.is if=mmz@include@source,
874 }
875 \newif\ifmmz@include@source
876 \mmz@include@sourcetrue

```

`\mmz@write@cmemo` This macro creates the c-memo from the contents of `\mmzContextExtra` and `\mmzCMemo`.

```
877 \def\mmz@write@cmemo{%
```

Open the file for writing.

```
878   \immediate\mmz@openout\mmz@out{\mmz@cmemo@path}%
```

The memo starts with the `\mmzMemo` marker (a signal that the memo is valid).

```
879   \immediate\write\mmz@out{\noexpand\mmzMemo}%
```

We store the content of `\mmzContextExtra` by writing out a command that will (globally) assign its content back into this register.

```

880   \immediate\write\mmz@out{%
881     \global\mmzContextExtra{\the\mmzContextExtra}\collargs@percentchar
882   }%

```

Write out the free-form part of the c-memo.

```
883   \immediate\write\mmz@out{\the\mmzCMemo\collargs@percentchar}%
```

When `include source` in `cmemo` is in effect, add the memoized code, hiding it behind the `\mmzSource` marker.

```
884 \ifmmz@include@source
885   \immediate\write\mmz@out{\noexpand\mmzSource}%
886   \immediate\write\mmz@out{\the\mmz@mdfive@source}%
887 \fi
```

Close the file.

```
888 \immediate\closeout\mmz@out
```

Record that we wrote a new c-memo.

```
889 \pgfkeysalso{/mmz/record/new cmemo={\mmz@cmemo@path}}%
890 }
```

`\mmzSource` The c-memo memoized code marker. This macro is synonymous with `\endinput`, so the source following it is ignored when inputting the c-memo.

```
891 \let\mmzSource\endinput
```

`\mmz@process@cmemo` This macro inputs the c-memo, which will update the context code, which we can then compute the MD5 sum of.

```
892 \def\mmz@process@cmemo{%
893   \mmz@trace@process@cmemo
```

`\ifmmz@abort` serves as a signal that the c-memo exists and is of correct form.

```
894   \global\mmz@aborttrue
```

If c-memo sets `\ifmmzUnmemoizable`, we will compile regularly.

```
895   \global\mmzUnmemoizablefalse
896   \def\mmzMemo{\global\mmz@abortfalse}%
```

Just a safeguard ... c-memo assigns to `\mmzContextExtra` anyway.

```
897   \global\mmzContextExtra{}%
```

Input the c-memo, if it exists, and record that we have used it.

```
898   \IfFileExists{\mmz@cmemo@path}{%
899     \input{\mmz@cmemo@path}%
900     \pgfkeysalso{/mmz/record/used cmemo={\mmz@cmemo@path}}%
901   }{%
902     \mmz@trace@process@no@cmemo
903   }%
```

Compute the context MD5 sum.

```
904   \mmz@compute@context@mdfivesum
905 }
```

`\mmz@compute@context@mdfivesum` This macro computes the MD5 sum of the concatenation of `\mmzContext` and `\mmzContextExtra`, and writes out the tracing info when `trace context` is in effect. The argument is the tracing note.

```
906 \def\mmz@compute@context@mdfivesum{%
907   \xdef\mmz@context@key{\the\mmzContext\the\mmzContextExtra}%
```

A special provision for padding, which occurs in the context by default, and may contain otherwise undefined macros referring to the extern dimensions. We make sure that when we expand the context key, `\mmz@paddings` contains the stringified `\width` etc., while these macros (which may be employed by the end user in the context expression), are returned to their original definitions.

```

908 \begingroup
909 \begingroup
910 \def\width{\string\width}%
911 \def\height{\string\height}%
912 \def\depth{\string\depth}%
913 \edef\mmz@paddings{\mmz@paddings}%
914 \expandafter\endgroup
915 \expandafter\def\expandafter\mmz@paddings\expandafter{\mmz@paddings}%

```

We pre-expand the concatenated context, for tracing/inclusion in the cc-memo. In  $\text{\LaTeX}$ , we protect the expansion, as the context expression may contain whatever.

```

916 <latex> \protected@xdef
917 <!latex> \xdef
918 \mmz@context@key{\mmz@context@key}%
919 \endgroup

```

Compute the MD5 sum. We have to assign globally, because this macro is (also) called after inputting the c-memo, while the resulting MD5 sum is used to input the cc-memo, which happens outside the `\Memoize` group. `\mmz@context@mdfivesum`.

```

920 \xdef\mmz@context@mdfivesum{\pdfmdfivesum{\expandonce\mmz@context@key}}%
921 }

```

### 3.5 Cc-memos

The path to a cc-memo consists of the path prefix, the hyphen-separated MD5 sums of the memoized code and the (evaluated) context, and suffix `.memo`.

```

922 \def\mmz@ccmemo@path{%
923 \mmz@prefix\mmz@code@mdfivesum-\mmz@context@mdfivesum.memo}

```

The structure of a cc-memo:

- the list of resources consisting of calls to `\mmzResource`;
- the core memo code (which includes the externs when executed), introduced by marker `\mmzMemo`; and,
- optionally, the context expansion, introduced by marker `\mmzThisContext`.

We begin the cc-memo with a list of extern files included by the core memo code so that we can check whether these files exist prior to executing the core memo code. Checking this on the fly, while executing the core memo code, would be too late, as that code is arbitrary (and also executed outside the `\Memoize` group).

`\mmzCCMemo` During memoization, the core content of the cc-memo is collected into this token register.

```

924 \newtoks\mmzCCMemo

```

`include context in ccmemo` Should we include the context expansion in the cc-memo? By default, no.

```
\ifmmz@include@context
```

```

925 \newif\ifmmz@include@context
926 \mmzset{%
927 include context in ccmemo/.is if=mmz@include@context,
928 }

```

`direct ccmemo input` When this conditional is false, the cc-memo is read indirectly, via a token register, `\ifmmz@direct@ccmemo@input` to facilitate inverse search.

```
929 \newif\ifmmz@direct@ccmemo@input
930 \mmzset{%
931   direct ccmemo input/.is if=mmz@direct@ccmemo@input,
932 }
```

`\mmz@write@ccmemo` This macro creates the cc-memo from the list of resources in `\mmz@ccmemo@resources` and the contents of `\mmzCCMemo`.

```
933 \def\mmz@write@ccmemo{%
```

Open the cc-memo file for writing. Note that the filename contains the context MD5 sum, which can only be computed after memoization, as the memoized code can update the context. This is one of the two reasons why we couldn't write the cc-memo directly into the file, but had to collect its contents into token register `\mmzCCMemo`.

```
934   \immediate\mmz@openout\mmz@out{\mmz@ccmemo@path}%
```

Token register `\mmz@ccmemo@resources` consists of calls to `\mmz@ccmemo@append@resource`, so the following code writes down the list of created externs into the cc-memo. Wanting to have this list at the top of the cc-memo is the other reason for the roundabout creation of the cc-memo — the resources become known only during memoization, as well.

```
935   \begingroup
936   \the\mmz@ccmemo@resources
937   \endgroup
```

Write down the content of `\mmzMemo`, but first introduce it by the `\mmzMemo` marker.

```
938   \immediate\write\mmz@out{\noexpand\mmzMemo}%
939   \immediate\write\mmz@out{\the\mmzCCMemo\collargs@percentchar}%
```

Write down the context tracing info when `include context in ccmemo` is in effect.

```
940   \ifmmz@include@context
941     \immediate\write\mmz@out{\noexpand\mmzThisContext}%
942     \immediate\write\mmz@out{\expandonce{\mmz@context@key}}%
943   \fi
```

Insert the end-of-file marker and close the file.

```
944   \immediate\write\mmz@out{\noexpand\mmzEndMemo}%
945   \immediate\closeout\mmz@out
```

Record that we wrote a new cc-memo.

```
946   \pgfkeysalso{/mmz/record/new ccmemo={\mmz@ccmemo@path}}%
947 }
```

`\mmz@ccmemo@append@resource` Append the resource to the cc-memo (we are nice to external utilities and put each resource on its own line). `#1` is the sequential number of the extern belonging to the memoized code; below, we assign it to `\mmz@seq`, which appears in `\mmz@extern@name`. Note that `\mmz@extern@name` only contains the extern filename — without the path, so that externs can be used by several projects, or copied around.

```
948 \def\mmz@ccmemo@append@resource#1{%
949   \mmz@seq=#1\relax
950   \immediate\write\mmz@out{%
951     \string\mmzResource{\mmz@extern@name}\collargs@percentchar}%
952 }
```

`\mmzResource` A list of these macros is located at the top of a cc-memo. The macro checks for the existence of the extern file, given as #1. If the extern does not exist, we redefine `\mmzMemo` to `\endinput`, so that the core content of the cc-memo is never executed; see also `\mmz@process@ccmemo` above.

```
953 \def\mmzResource#1{%
```

We check for existence using `\pdffilesize`, because an empty PDF, which might be produced by a failed T<sub>E</sub>X-based extraction, should count as no file. The 0 behind `\ifnum` is there because `\pdffilesize` returns an empty string when the file does not exist.

```
954 \ifnum0\pdf@filesize{\mmz@prefix@dir/#1}=0
955 \ifmmz@direct@ccmemo@input
956 \let\mmzMemo\endinput
957 \else
```

With indirect cc-memo input, we simulate end-of-input by grabbing everything up to the end-of-memo marker. In the indirect cc-memo input, a `\par` token shows up after `\mmzEndMemo`, I'm not sure why (`\everyeof={}` does not help).

```
958 \long\def\mmzMemo##1\mmzEndMemo\par{}}%
959 \fi
960 \mmz@trace@resource{#1}%
961 \fi
962 }
```

`\mmz@process@ccmemo` This macro processes the cc-memo.

```
\mmzThisContext
\mmzEndMemo 963 \def\mmz@process@ccmemo{%
964 \mmz@trace@process@ccmemo
```

The following conditional signals whether cc-memo was successfully utilized. If the cc-memo file does not exist, `\ifmmz@abort` will remain true. If it exists, it is headed by the list of resources. If a resource check fails, `\mmzMemo` (which follows the list of resources) is redefined to `\endinput`, so `\ifmmz@abort` remains true. However, if all resource checks are successful, `\mmzMemo` marker is reached with the below definition in effect, so `\ifmmz@abort` becomes false. Note that this marker also closes the `\Memoize` group, so that the core cc-memo content is executed in the original group — and that this does not happen if anything goes wrong!

```
965 \global\mmz@aborttrue
```

Note that `\mmzMemo` may be redefined by `\mmzResource` upon an unavailable extern file.

```
966 \def\mmzMemo{%
967 \endgroup
968 \global\mmz@abortfalse
```

We `\let` the control sequence used for extern inclusion in the cc-memo to the macro which includes the extern from the extern file.

```
969 \let\mmzIncludeExtern\mmz@include@extern
970 }%
```

Define `\mmzEndMemo` wrt `\ifmmz@direct@ccmemo@input`, whose value will be lost soon because `\mmzMemo` will close the group — that's also why this definition is global.

```
971 \xdef\mmzEndMemo{%
972 \ifmmz@direct@ccmemo@input
973 \noexpand\endinput
974 \else
```

In the indirect cc-memo input, a `\par` token shows up after `\mmzEndMemo`, I'm not sure why (`\everyeof={}` does not help).

```
975 \unexpanded{%
```

```

976     \def\mmz@temp\par{}%
977     \mmz@temp
978   }%
979   \fi
980 }%

```

The cc-memo context marker, again wrt `\ifmmz@direct@ccmemo@input` and globally. With direct cc-memo input, this macro is synonymous with `\endinput`, so the (expanded) context following it is ignored when inputting the cc-memo. With indirect input, we simulate end-of-input by grabbing everything up to the end-of-memo marker (plus gobble the `\par` mentioned above).

```

981 \xdef\mmzThisContext{%
982   \ifmmz@direct@ccmemo@input
983     \noexpand\endinput
984   \else
985     \unexpanded{%
986       \long\def\mmz@temp##1\mmzEndMemo\par{}%
987       \mmz@temp
988     }%
989   \fi
990 }%

```

Input the cc-memo if it exists.

```

991 \IfFileExists{\mmz@ccmemo@path}{%
992   \ifmmz@direct@ccmemo@input
993     \input{\mmz@ccmemo@path}%
994   \else

```

Indirect cc-memo input reads the cc-memo into a token register and executes the contents of this register.

```

995   \filetotoks\toks@{\mmz@ccmemo@path}%
996   \the\toks@
997   \fi

```

Record that we have used the cc-memo.

```

998   \pgfkeysalso{/mmz/record/used ccmemo={\mmz@ccmemo@path}}%
999 }{%
1000   \mmz@trace@process@no@ccmemo
1001 }%
1002 \ifmmz@abort

```

The cc-memo doesn't exist, or some of the resources don't. We need to memoize, but we'll do it only if `readonly` is not in effect, otherwise we'll perform a regular compilation. (Note that we are still in the group opened prior to executing `\Memoize`.)

```

1003   \mmz@trace@process@ccmemo@fail
1004   \ifnum\mmz@mode=\mmz@mode@readonly\relax
1005     \expandafter\expandafter\expandafter\mmz@compile
1006   \else
1007     \expandafter\expandafter\expandafter\mmz@memoize
1008   \fi
1009 \else
1010   \mmz@trace@process@ccmemo@ok
1011 \fi
1012 }

```

### 3.6 The externs

The [path](#) to an extern is like the path to a cc-memo, modulo suffix `.pdf`, of course. However, in case memoization of a chunk produces more than one extern, the filename of any non-first extern

includes `\mmz@seq`, the sequential number of the extern as well (we start the numbering at 0). We will have need for several parts of the full path to an extern: the basename, the filename, the path without the suffix, and the full path.

```

1013 \newcount\mmz@seq
1014 \def\mmz@extern@basename{%
1015   \mmz@prefix@name\mmz@code@mdfivesum-\mmz@context@mdfivesum
1016   \ifnum\mmz@seq>0 -\the\mmz@seq\fi
1017 }
1018 \def\mmz@extern@name{\mmz@extern@basename.pdf}
1019 \def\mmz@extern@basepath{\mmz@prefix@dir\mmz@extern@basename}
1020 \def\mmz@extern@path{\mmz@extern@basepath.pdf}

```

**padding left** These options set the amount of space surrounding the bounding box of the externalized graphics  
**padding right** in the resulting PDF, i.e. in the extern file. This allows the user to deal with TikZ overlays,  
**padding top** `\rlap` and `\llap`, etc.

**padding bottom**

```

1021 \mmzset{
1022   padding left/.store in=\mmz@padding@left,
1023   padding right/.store in=\mmz@padding@right,
1024   padding top/.store in=\mmz@padding@top,
1025   padding bottom/.store in=\mmz@padding@bottom,

```

**padding** A shortcut for setting all four paddings at once.

```

1026 padding/.style={
1027   padding left=#1, padding right=#1,
1028   padding top=#1, padding bottom=#1
1029 },

```

The default padding is what pdfTeX puts around the page anyway, 1 inch, but we'll use `1 in` rather than `1 true in`, which is the true default value of `\pdfhorigin` and `\pdfvorigin`, as we want the padding to adjust with magnification.

```

1030 padding=1in,

```

**padding to context** This key adds padding to the context. Note that we add the padding expression (`\mmz@paddings`, defined below, refers to all the individual padding macros), not the actual value (at the time of expansion). This is so because `\width`, `\height` and `\depth` are not defined outside extern shipout routines, and the context is evaluated elsewhere.

```

1031 padding to context/.style={
1032   context={padding=(\mmz@paddings)},
1033 },

```

Padding nearly always belongs into the context — the exception being memoized code which produces no externs (<sup>M</sup>§4.4.2) — so we execute this key immediately.

```

1034 padding to context,
1035 }
1036 \def\mmz@paddings{%
1037   \mmz@padding@left,\mmz@padding@bottom,\mmz@padding@right,\mmz@padding@top
1038 }

```

**\mmzExternalizeBox** This macro is the public interface to externalization. In Memoize itself, it is called from the default memoization driver, `\mmzSingleExternDriver`, but it should be called by any driver that wishes to produce an extern, see <sup>M</sup>§4.4 for details. It takes two arguments:

- #1 The box that we want to externalize. It's content will remain intact. The box may be given either as a control sequence, declared via `\newbox`, or as box number (say, 0).

#2 The token register which will receive the code that includes the extern into the document; it is the responsibility of the memoization driver to (globally) include the contents of the register in the cc-memo, i.e. in token register `\mmzCCMemo`. This argument may be either a control sequence, declared via `\newtoks`, or a `\toks`*(token register number)*.

```
1039 \def\mmzExternalizeBox#1#2{%
1040   \begingroup
```

A courtesy to the user, so they can define padding in terms of the size of the externalized graphics.

```
1041   \def\width{\wd#1 }%
1042   \def\height{\ht#1 }%
1043   \def\depth{\dp#1 }%
```

Store the extern-inclusion code in a temporary macro, which will be smuggled out of the group.

```
1044   \xdef\mmz@global@temp{%
```

Executing `\mmzIncludeExtern` from the cc-memo will include the extern into the document.

```
1045     \noexpand\mmzIncludeExtern
```

`\mmzIncludeExtern` identifies the extern by its sequence number, `\mmz@seq`.

```
1046     {\the\mmz@seq}%
```

What kind of box? We `\noexpand` the answer just in case someone redefined them.

```
1047     \ifhbox#1\noexpand\hbox\else\noexpand\vbox\fi
```

The dimensions of the extern.

```
1048     {\the\wd#1}%
1049     {\the\ht#1}%
1050     {\the\dp#1}%
```

The padding values.

```
1051     {\the\dimexpr\mmz@padding@left}%
1052     {\the\dimexpr\mmz@padding@bottom}%
1053     {\the\dimexpr\mmz@padding@right}%
1054     {\the\dimexpr\mmz@padding@top}%
1055   }%
```

Prepend the new extern box into the global extern box where we collect all the externs of this memo. Note that we `\copy` the extern box, retaining its content — we will also want to place the extern box in its regular place in the document.

```
1056   \global\setbox\mmz@tbe@box\vbox{\copy#1\unvbox\mmz@tbe@box}%
```

Add the extern to the list of resources, which will be included at the top of the cc-memo, to check whether the extern files exists at the time the cc-memo is utilized. In the cc-memo, the list will contain full extern filenames, which are currently unknown, but no matter; right now, providing the extern sequence number suffices, the full extern filename will be produced at the end of memoization, once the context MD5 sum is known.

```
1057   \xtoksapp\mmz@ccmemo@resources{%
1058     \noexpand\mmz@ccmemo@append@resource{\the\mmz@seq}%
1059   }%
```

Increment the counter containing the sequence number of the extern within this memo.

```
1060   \global\advance\mmz@seq1
```



Assign the extern-including code into the token register given in #2. This register may be given either as a control sequence or as `\toks<token register number>`, and this is why we have temporarily stored the code (into `\mmz@global@temp`) globally: a local storage with `\expandafter\endgroup\expandafter` here would fail with the receiving token register given as `\toks<token register number>`.

```
1061 \endgroup
1062 #2\expandafter{\mmz@global@temp}%
1063 }
```

`\mmz@ccmemo@resources` This token register, populated by `\mmz@externalize@box` and used by `\mmz@write@ccmemo`, holds the list of externs produced by memoization of the current chunk.

```
1064 \newtoks\mmz@ccmemo@resources
```

`\mmz@tbe@box` `\mmz@externalize@box` does not directly dump the extern into the document (as a special page). Rather, the externs are collected into `\mmz@tbe@box`, whose contents are dumped into the document at the end of memoization of the current chunk. In this way, we guarantee that aborted memoization does not pollute the document.

```
1065 \newbox\mmz@tbe@box
```

`\mmz@shipout@externs` This macro is executed at the end of memoization, when the externs are waiting for us in `\mmz@tbe@box` and need to be dumped into the document. It loops through the contents of `\mmz@tbe@box`,<sup>2</sup> putting each extern into `\mmz@box` and calling `\mmz@shipout@extern`. Note that the latter macro is executed within the group opened by `\vbox` below.

```
1066 \def\mmz@shipout@externs{%
1067   \global\mmz@seq 0
1068   \setbox\mmz@box\vbox{%
```

Set the macros below to the dimensions of the extern box, so that the user can refer to them in the padding specification (which is in turn used in the page setup in `\mmz@shipout@extern`).

```
1069   \def\width{\wd\mmz@box}%
1070   \def\height{\ht\mmz@box}%
1071   \def\depth{\dp\mmz@box}%
1072   \vskip1pt
1073   \ifmmzkeepexterns\expandafter\unvcopy\else\expandafter\unvbox\fi\mmz@tbe@box
1074   \@whiles\ifdimOpt=\lastskip\fi{%
1075     \setbox\mmz@box\lastbox
1076     \mmz@shipout@extern
1077   }%
1078 }%
1079 }
```

`\mmz@shipout@extern` This macro ships out a single extern, which resides in `\mmz@box`, and records the creation of the new extern.

```
1080 \def\mmz@shipout@extern{%
```

Calculate the expected width and height. We have to do this now, before we potentially adjust the box size and paddings for magnification.

```
1081 \edef\expectedwidth{\the\dimexpr
1082   (\mmz@padding@left) + \wd\mmz@box + (\mmz@padding@right)}%
1083 \edef\expectedheight{\the\dimexpr
1084   (\mmz@padding@top) + \ht\mmz@box + \dp\mmz@box + (\mmz@padding@bottom)}%
```

---

<sup>2</sup>The looping code is based on TeX.SE answer [tex.stackexchange.com/a/25142/16819](https://tex.stackexchange.com/a/25142/16819) by Bruno Le Floch.

Apply the inverse magnification, if `\mag` is not at the default value. We'll do this in a group, which will last until `shipout`.

```
1085 \begingroup
1086 \ifnum\mag=1000
1087 \else
1088   \mmz@shipout@mag
1089 \fi
```

Setup the geometry of the extern page. In plain  $\text{T}_{\text{E}}\text{X}$  and  $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$ , setting `\pdfpagewidth` and `\pdfpageheight` seems to do the trick of setting the extern page dimensions. In  $\text{ConT}_{\text{E}}\text{Xt}$ , however, the resulting extern page ends up with the PDF `/CropBox` specification of the current regular page, which is then used (ignoring our `mediabox` requirement) when we're including the extern into the document by `\mmzIncludeExtern`. Typically, this results in a page-sized extern. I'm not sure how to deal with this correctly. In the workaround below, we use Lua function `backends.codeinjections.setupcanvas` to set up page dimensions: we first remember the current page dimensions (`\edef\mmz@temp`), then set up the extern page dimensions (`\expanded{...}`), and finally, after shipping out the extern page, revert to the current page dimensions by executing `\mmz@temp` at the very end of this macro.

```
1090 <plain, latex>
1091 \pdfpagewidth\dimexpr
1092   (\mmz@padding@left) + \wd\mmz@box + (\mmz@padding@right)\relax
1093 \pdfpageheight\dimexpr
1094   (\mmz@padding@top) + \ht\mmz@box + \dp\mmz@box+ (\mmz@padding@bottom)\relax
1095 </plain, latex>
1096 <context>
1097 \edef\mmz@temp{%
1098   \noexpand\directlua{
1099     backends.codeinjections.setupcanvas({
1100       paperwidth=\the\numexpr\pagewidth,
1101       paperheight=\the\numexpr\pageheight
1102     })
1103   }%
1104 }%
1105 \expanded{%
1106   \noexpand\directlua{
1107     backends.codeinjections.setupcanvas({
1108       paperwidth=\the\numexpr\dimexpr
1109         \mmz@padding@left + \wd\mmz@box + \mmz@padding@right\relax,
1110       paperheight=\the\numexpr\dimexpr
1111         \mmz@padding@top + \ht\mmz@box + \dp\mmz@box+ \mmz@padding@bottom\relax
1112     })
1113   }%
1114 }%
1115 </context>
```

We complete the page setup by setting the content offset.

```
1116 \hoffset\dimexpr\mmz@padding@left - \pdfhorigin\relax
1117 \voffset\dimexpr\mmz@padding@top - \pdfvorigin\relax
```

We shipout the extern page using the `\shipout` primitive, so that the extern page is not modified, or even registered, by the shipout code of the format or some package. I can't imagine those shipout routines ever needing to know about the extern page. In fact, most often knowing about it would be undesirable. For example,  $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$  and  $\text{ConT}_{\text{E}}\text{Xt}$  count the “real” pages, but usually to know whether they are shipping out an odd or an even page, or to make the total number of pages available to subsequent compilations. Taking the extern pages into account would disrupt these mechanisms.

Another thing: delayed `\writes`. We have to make sure that any  $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$ -style protected stuff in those is not expanded. We don't bother introducing a special group, as we'll close the `\mag` group right after the shipout anyway.

```

1118 <latex> \let\protect\noexpand
1119         \pdf@primitive\shipout\box\mmz@box
1120 <context> \mmz@temp
1121         \endgroup

```

Advance the counter of shipped-out externs. We do this before preparing the recording information below, because the extern extraction tools expect the extern page numbering to start with 1.

```
1122 \global\advance\mmzExternPages1
```

Prepare the macros which may be used in `record/<type>/new extern` code.

```
1123 \edef\externbasepath{\mmz@extern@basepath}%
```

Adding up the counters below should result in the real page number of the extern. Macro `\mmzRegularPages` holds the number of pages which were shipped out so far using the regular shipout routine of the format; `\mmzExternPages` holds the number of shipped-out extern pages; and `\mmzExtraPages` holds, or at least should hold, the number of pages shipped out using any other means.

```

1124 \edef\pagenumber{%
1125     \the\numexpr\mmzRegularPages

```

In L<sup>A</sup>T<sub>E</sub>X, the `\mmzRegularPages` holds to number of pages already shipped out. In ConT<sub>E</sub>Xt, the counter is already increased while processing the page, so we need to subtract 1.

```

1126 <context>     -1%
1127             +\mmzExternPages+\mmzExtraPages
1128             }%

```

Record the creation of the new extern. We do this after shipping out the extern page, so that the recording mechanism can serve as an after-shipout hook, for the unlikely situation that some package really needs to do something when our shipout happens. Note that we absolutely refuse to provide a before-shipout hook, because we can't allow anyone messing with our extern, and that using this after-shipout “hook” is unnecessary for counting extern shipouts, as we already provide this information in the public counter `\mmzExternPages`.

```
1129 \mmzset{record/new extern/.expanded=\mmz@extern@path}%
```

Advance the sequential number of the extern, in the context of the current memoized code chunk. This extern numbering starts at 0, so we only do this after we wrote the cc-memo and called `record/new extern`.

```

1130 \global\advance\mmz@seq1
1131 }

```

`\mmz@shipout@mag` This macro applies the inverse magnification, so that the extern ends up with its natural size on the extern page.

```
1132 \def\mmz@shipout@mag{%
```

We scale the extern box using the PDF primitives: `q` and `Q` save and restore the current graphics state; `cm` applies the given coordinate transformation matrix. ( $a\ b\ c\ d\ e\ f$  `cm` transforms  $(x, y)$  into  $(ax + cy + e, bx + dy + f)$ .)

```

1133 \setbox\mmz@box\hbox{%
1134     \pdfliteral{q \mmz@inverse@mag\space 0 0 \mmz@inverse@mag\space 0 0 cm}%
1135     \copy\mmz@box\relax
1136     \pdfliteral{Q}%
1137 }%

```

We first have to scale the paddings, as they might refer to the `\width` etc. of the extern.

```

1138 \dimen0=\dimexpr\mmz@padding@left\relax
1139 \edef\mmz@padding@left{\the\dimexpr\mmz@inverse@mag\dimen0}%
1140 \dimen0=\dimexpr\mmz@padding@bottom\relax
1141 \edef\mmz@padding@bottom{\the\dimexpr\mmz@inverse@mag\dimen0}%
1142 \dimen0=\dimexpr\mmz@padding@right\relax
1143 \edef\mmz@padding@right{\the\dimexpr\mmz@inverse@mag\dimen0}%
1144 \dimen0=\dimexpr\mmz@padding@top\relax
1145 \edef\mmz@padding@top{\the\dimexpr\mmz@inverse@mag\dimen0}%

```

Scale the extern box.

```

1146 \wd\mmz@box=\mmz@inverse@mag\wd\mmz@box\relax
1147 \ht\mmz@box=\mmz@inverse@mag\ht\mmz@box\relax
1148 \dp\mmz@box=\mmz@inverse@mag\dp\mmz@box\relax
1149 }

```

`\mmz@inverse@mag` The inverse magnification factor, i.e. the number we have to multiply the extern dimensions with so that they will end up in their natural size. We compute it, once and for all, at the beginning of the document. To do that, we borrow the little macro `\Pgfg@geT` from `pgfutil-common` (but rename it).

```

1150 {\catcode`\p=12\catcode`\t=12\gdef\mmz@Pgfg@geT#1pt{#1}}
1151 \mmzset{begindocument/.append code={%
1152   \edef\mmz@inverse@mag{\expandafter\mmz@Pgfg@geT\the\dimexpr 1000pt/\mag}%
1153 }}

```

`\mmzRegularPages` This counter holds the number of pages shipped out by the format's shipout routine.  $\text{\LaTeX}$  and  $\text{\ConTeXt}$  keep track of this in dedicated counters, so we simply use those. In plain  $\text{\TeX}$ , we have to hack the `\shipout` macro to install our own counter. In fact, we already did this while loading the required packages, in order to avoid it being redefined by `atbegshi` first. All that is left to do here is to declare the counter.

```

1154 <latex>\let\mmzRegularPages\ReadonlyShipoutCounter
1155 <context>\let\mmzRegularPages\realpageno
1156 <plain>\newcount\mmzRegularPages

```

`\mmzExternPages` This counter holds the number of extern pages shipped out so far.

```

1157 \newcount\mmzExternPages

```

The total number of new externs is announced at the end of the compilation, so that  $\text{\TeX}$  editors, `latexmk` and such can propose recompilation.

```

1158 \mmzset{
1159   enddocument/afterlastpage/.append code={%
1160     \ifnum\mmzExternPages>0
1161       \PackageWarning{memoize}{The compilation produced \the\mmzExternPages\space
1162         new extern\ifnum\mmzExternPages>1 s\fi}%
1163     \fi
1164   },
1165 }

```

`\mmzExtraPages` This counter will probably remain at zero forever. It should be advanced by any package which (like `Memoize`) ships out pages bypassing the regular shipout routine of the format.

```

1166 \newcount\mmzExtraPages

```

`\mmz@include@extern` This macro, called from cc-memos as `\mmzIncludeExtern`, inserts an extern file into the document. #1 is the sequential number, #2 is either `\hbox` or `\vbox`, #3, #4 and #5 are the (expected) width, height and the depth of the externalized box; #6–#9 are the paddings (left, bottom, right, and top).

```
1167 \def\mmz@include@extern#1#2#3#4#5#6#7#8#9{%
```

Set the extern sequential number, so that we open the correct extern file (`\mmz@extern@basename`).

```
1168 \mmz@seq=#1\relax
```

Use the primitive PDF graphics inclusion commands to include the extern file. Set the correct depth or the resulting box, and shift it as specified by the padding.

```
1169 \setbox\mmz@box=#2{%
1170 \setbox0=\hbox{%
1171 \lower\dimexpr #5+#7\relax\hbox{%
1172 \hskip -#6\relax
1173 \setbox0=\hbox{%
1174 \mmz@insertpdfpage{\mmz@extern@path}{1}%
1175 }%
1176 \unhbox0
1177 }%
1178 }%
1179 \wd0 \dimexpr\wd0-#8\relax
1180 \ht0 \dimexpr\ht0-#9\relax
1181 \dp0 #5\relax
1182 \box0
1183 }%
```

Check whether the size of the included extern is as expected. There is no need to check `\dp`, we have just set it. (`\mmz@if@roughly@equal` is defined in section 4.3.)

```
1184 \mmz@tempfalse
1185 \mmz@if@roughly@equal{\mmz@tolerance}{#3}{\wd\mmz@box}{%
1186 \mmz@if@roughly@equal{\mmz@tolerance}{#4}{\ht\mmz@box}{%
1187 \mmz@temptrue
1188 }{}{}%
1189 \ifmmz@temp
1190 \else
1191 \mmz@use@memo@warning{\mmz@extern@path}{#3}{#4}{#5}%
1192 \fi
```

Use the extern box, with the precise size as remembered at memoization.

```
1193 \wd\mmz@box=#3\relax
1194 \ht\mmz@box=#4\relax
1195 \box\mmz@box
```

Record that we have used this extern.

```
1196 \pgfkeysalso{/mmz/record/used extern={\mmz@extern@path}}%
1197 }
```

```
1198 \def\mmz@use@memo@warning#1#2#3#4{%
1199 \PackageWarning{memoize}{Unexpected size of extern "#1";
1200 expected #2\space x \the\dimexpr #3+#4\relax,
1201 got \the\wd\mmz@box\space x \the\dimexpr\the\ht\mmz@box+\the\dp\mmz@box\relax}%
1202 }
```

`\mmz@insertpdfpage` This macro inserts a page from the PDF into the document. We define it according to which engine is being used. Note that ConT<sub>E</sub>Xt always uses LuaT<sub>E</sub>X.

```
1203 <latex,plain>\ifdef\luatexversion{%
```

```

1204 \def\mmz@insertpdfpage#1#2{% #1 = filename, #2 = page number
1205     \saveimageresource page #2 mediabox {#1}%
1206     \useimageresource\lastsavedimageresourceindex
1207 }%
1208 <*\latex,plain>
1209 }{%
1210 \ifdef\XeTeXversion{%
1211     \def\mmz@insertpdfpage#1#2{%
1212         \XeTeXpdffile #1 page #2 media
1213     }%
1214 }{% pdfLaTeX
1215     \def\mmz@insertpdfpage#1#2{%
1216         \pdfximage page #2 mediabox {#1}%
1217         \pdfrefximage\pdflastximage
1218     }%
1219 }%
1220 }
1221 </\latex,plain>

```

**\mmz@include@extern@from@tbe@box** Include the extern number #1 residing in \mmz@tbe@box into the document.

It may be called as \mmzIncludeExtern from after memoization hook if \ifmmzkeepexterns was set to true during memoization. The macro takes the same arguments as \mmzIncludeExtern but disregards all but the first one, the extern sequential number. Using this macro, a complex memoization driver can process the cc-memo right after memoization, by issuing \global\mmzkeepexternstrue\xtoksapp\mmzAfterMemoizationExtra{\the\mmzCCMemo}.

```

1222 \def\mmz@include@extern@from@tbe@box#1#2#3#4#5#6#7#8#9{%
1223     \setbox0\vbox{%
1224         \@tempcnta#1\relax
1225         \vskip1pt
1226         \unvcopy\mmz@tbe@box
1227         \@whilenum\@tempcnta>0\do{%
1228             \setbox0\lastbox
1229             \advance\@tempcnta-1\relax
1230         }%
1231         \global\setbox1\lastbox
1232         \@whilesw\ifdim0pt=\lastskip\fi{%
1233             \setbox0\lastbox
1234         }%
1235         \box\mmz@box
1236     }%
1237     \box1
1238 }

```

## 4 Extraction

### 4.1 Extraction mode and method

**extract** This key selects the extraction mode and method. It normally occurs in the package options list, less commonly in the preamble, and never in the document body.

```

1239 \def\mmzvalueof#1{\pgfkeysvalueof{/mmz/#1}}
1240 \mmzset{
1241     extract/.estore in=\mmz@extraction@method,
1242     extract/.value required,
1243     begindocument/.append style={extract/.code=\mmz@preamble@only@error},

```

**extract/perl** Any other value will select internal extraction with the given method. Memoize ships with two extraction scripts, a Perl script and a Python script, which are selected by **extract=perl** (the default) and **extract=python**, respectively. We run the scripts in verbose mode (without -q), and keep the .mmz file as is (without -k), i.e. we're not commenting out the \mmzNewExtern

lines, because we're about to overwrite it anyway. We inform the script about the format of the document (-F).

```

1244 extract/perl/.code={%
1245   \mmz@clear@extraction@log
1246   \pdf@system{%
1247     \mmzvalueof{perl extraction command}\space
1248     \mmzvalueof{perl extraction options}%
1249   }%
1250   \mmz@check@extraction@log{perl}%
1251   \def\mmz@mknkdir@command{\mmzvalueof{perl extraction command} --mkdir}%
1252 },
1253 perl extraction command/.initial=memoize-extract.pl,
1254 perl extraction options/.initial={\space
1255 <latex> -F latex
1256 <plain> -F plain
1257 <context> -F context
1258   \jobname\space
1259 },
1260 extract=perl,
1261 extract/python/.code={%
1262   \mmz@clear@extraction@log
1263   \pdf@system{%
1264     \mmzvalueof{python extraction command}\space
1265     \mmzvalueof{python extraction options}%
1266   }%
1267   \mmz@check@extraction@log{python}%
1268   \def\mmz@mknkdir@command{\mmzvalueof{python extraction command} --mkdir}%
1269 },
1270 python extraction command/.initial=memoize-extract.py,
1271 python extraction options/.initial={\space
1272 <latex> -F latex
1273 <plain> -F plain
1274 <context> -F context
1275   \jobname\space
1276 },
1277 }
1278 \def\mmz@preamble@only@error{%
1279   \PackageError{memoize}{%
1280     Ignoring the invocation of "\pgfkeyscurrentkey".
1281     This key may only be executed in the preamble}{}%
1282 }

```

**The extraction log** — As we cannot access the exit status of a system command in T<sub>E</sub>X, we communicate with the system command via the “extraction log file,” produced by both T<sub>E</sub>X-based extraction and the Perl and Python extraction script. This file signals whether the embedded extraction was successful — if it is, the file ends if `\endinput` — and also contains any warnings and errors thrown by the script. As the log is really a T<sub>E</sub>X file, the idea is to simply input it after extracting each extern (for T<sub>E</sub>X-based extraction) or after the extraction of all externs (for the external scripts).

```

1283 \def\mmz@clear@extraction@log{%
1284   \begingroup
1285   \immediate\mmz@openout0{\jobname.mmz.log}%
1286   \immediate\closeout0
1287   \endgroup
1288 }

```

#1 is the extraction method.

```

1289 \def\mmz@check@extraction@log#1{%
1290   \begingroup \def\extractionmethod{#1}%
1291   \mmz@tempfalse \let\mmz@orig@endinput\endinput

```



```

1292 \def\endinput{\mmz@temptrue\mmz@orig@endinput}%
1293 \@input{\jobname.mmz.log}%
1294 \ifmmz@temp \else \mmz@extraction@error \fi \endgroup }
1295 \def\mmz@extraction@error{%
1296 \PackageError{memoize}{Extraction of externs from document
1297 "\jobname.pdf" using method "\extractionmethod" was
1298 unsuccessful}{The extraction script "\mmzvalueof{\extractionmethod\space
1299 extraction command}" wasn't executed or didn't finish execution
1300 properly.}}

```

## 4.2 The record files

**record** This key activates a record *<type>*: the hooks defined by that record *<type>* will henceforth be executed at the appropriate places.

A *<hook>* of a particular *<type>* resides in `pgfkeys` path `/mmz/record/<type>/<hook>`, and is invoked via `/mmz/record/<hook>`. Record type activation thus appends a call of the former to the latter. It does so using handler `.try`, so that unneeded hooks may be left undefined.

```

1301 \mmzset{
1302   record/.style={%
1303     record/begin/.append style={
1304       /mmz/record/#1/begin/.try,

```

The `begin` hook also executes the `prefix` hook, so that `\mmzPrefix` surely occurs at the top of the `.mmz` file. Listing each prefix type separately in this hook ensures that `prefix` of a certain type is executed after that type's `begin`.

```

1305     /mmz/record/#1/prefix/.try/.expanded=\mmz@prefix,
1306   },
1307   record/prefix/.append style={/mmz/record/#1/prefix/.try={##1}},
1308   record/new extern/.append style={/mmz/record/#1/new extern/.try={##1}},
1309   record/used extern/.append style={/mmz/record/#1/used extern/.try={##1}},
1310   record/new cmemo/.append style={/mmz/record/#1/new cmemo/.try={##1}},
1311   record/new ccmemo/.append style={/mmz/record/#1/new ccmemo/.try={##1}},
1312   record/used cmemo/.append style={/mmz/record/#1/used cmemo/.try={##1}},
1313   record/used ccmemo/.append style={/mmz/record/#1/used ccmemo/.try={##1}},
1314   record/end/.append style={/mmz/record/#1/end/.try},
1315 },
1316 }

```

**no record** This key deactivates all record types. Below, we use it to initialize the relevant keys; in the user code, it may be used to deactivate the preactivated `mmz` record type.

```

1317 \mmzset{
1318   no record/.style={%

```

The `begin` hook clears itself after invocation, to prevent double execution. Consequently, `record/begin` may be executed by the user in the preamble, without any ill effects.

```

1319   record/begin/.style={record/begin/.style={}},

```

The `prefix` key invokes itself again when the group closes. This way, we can correctly track the path prefix changes in the `.mmz` even if `path` is executed in a group.

```

1320   record/prefix/.code={\aftergroup\mmz@record@prefix},
1321   record/new extern/.code={},
1322   record/used extern/.code={},
1323   record/new cmemo/.code={},
1324   record/new ccmemo/.code={},
1325   record/used cmemo/.code={},
1326   record/used ccmemo/.code={},

```



The `end` hook clears itself after invocation, to prevent double execution. Consequently, `record/end` may be executed by the user before the end of the document, without any ill effects.

```
1327   record/end/.style={record/end/.code={}},
1328 }
1329 }
```

We define this macro because `\aftergroup`, used in `record/prefix`, only accepts a token.

```
1330 \def\mmz@record@prefix{%
1331   \mmzset{/mmz/record/prefix/.expanded=\mmz@prefix}%
1332 }
```

**Initialize** the hook keys, preactivate `mmz` record type, and execute hooks `begin` and `end` at the edges of the document.

```
1333 \mmzset{
1334   no record,
1335   record=mmz,
1336   begindocument/.append style={record/begin},
1337   enddocument/afterlastpage/.append style={record/end},
1338 }
```

#### 4.2.1 The .mmz file

Think of the `.mmz` record file as a  $\text{\TeX}$ -readable log file, which lets the extraction procedure know what happened in the previous compilation. The file is in  $\text{\TeX}$  format, so that we can trigger internal  $\text{\TeX}$ -based extraction by simply inputting it. The commands it contains are intentionally as simple as possible (just a macro plus braced arguments), to facilitate parsing by the external scripts.

`record/mmz/...` These hooks simply put the calls of the corresponding macros into the file. All but hooks but `begin` and `end` receive the full path to the relevant file as the only argument (ok, `prefix` receives the full path prefix, as set by key `path`).

```
1339 \mmzset{
1340   record/mmz/begin/.code={%
1341     \newwrite\mmz@mmzout
```

The record file has a fixed name (the jobname plus the `.mmz` suffix) and location (the current directory, i.e. the directory where  $\text{\TeX}$  is executed from; usually, this will be the directory containing the  $\text{\TeX}$  source).

```
1342     \immediate\mmz@openout\mmz@mmzout{\jobname.mmz}%
1343   },
```

The `\mmzPrefix` is used by the clean-up script, which will remove all files with the given path prefix but (unless called with `--all`) those mentioned in the `.mmz`. Now this script could in principle figure out what to remove by inspecting the paths to utilized/created memos/externs in the `.mmz` file, but this method could lead to problems in case of an incomplete (perhaps empty) `.mmz` file created by a failed compilation. Recording the path prefix in the `.mmz` radically increases the chances of a successful clean-up, which is doubly important, because a clean-up is sometimes precisely what we need to do to recover after a failed compilation.

```
1344   record/mmz/prefix/.code={%
1345     \immediate\write\mmz@mmzout{\noexpand\mmzPrefix{#1}}}%
1346   },
1347   record/mmz/new extern/.code={%
```

While this key receives a single formal argument, Memoize also prepares macros `\externbasepath` (`#1` without the `.pdf` suffix), `\pagenumber` (of the extern page in the document PDF), and `\expectedwidth` and `\expectedheight` (of the extern page).

```

1348 \immediate\write\mmz@mmzout{%
1349 \noexpand\mmzNewExtern{#1}{\pagenumber}{\expectedwidth}{\expectedheight}%
1350 }%
1351 },
1352 record/mmz/new cmemo/.code={%
1353 \immediate\write\mmz@mmzout{\noexpand\mmzNewCMemo{#1}}%
1354 },
1355 record/mmz/new ccmemo/.code={%
1356 \immediate\write\mmz@mmzout{\noexpand\mmzNewCCMemo{#1}}%
1357 },
1358 record/mmz/used extern/.code={%
1359 \immediate\write\mmz@mmzout{\noexpand\mmzUsedExtern{#1}}%
1360 },
1361 record/mmz/used cmemo/.code={%
1362 \immediate\write\mmz@mmzout{\noexpand\mmzUsedCMemo{#1}}%
1363 },
1364 record/mmz/used ccmemo/.code={%
1365 \immediate\write\mmz@mmzout{\noexpand\mmzUsedCCMemo{#1}}%
1366 },
1367 record/mmz/end/.code={%

```

Add the `\endinput` marker to signal that the file is complete.

```

1368 \immediate\write\mmz@mmzout{\noexpand\endinput}%
1369 \immediate\closeout\mmz@mmzout
1370 },

```

#### 4.2.2 The shell scripts

We define two shell script record types: `sh` for Linux, and `bat` for Windows.

`sh` These keys set the shell script filenames.  
`bat`

```

1371 sh/.store in=\mmz@shname,
1372 sh=memoize-extract.\jobname.sh,
1373 bat/.store in=\mmz@batname,
1374 bat=memoize-extract.\jobname.bat,

```

`record/sh/...` Define the Linux shell script record type.

```

1375 record/sh/begin/.code={%
1376 \newwrite\mmz@shout
1377 \immediate\mmz@openout\mmz@shout{\mmz@shname}%
1378 },
1379 record/sh/new extern/.code={%
1380 \begingroup

```

Macro `\mmz@tex@extraction@systemcall` is customizable through `tex extraction` command, `tex extraction` options and `tex extraction` script.

```

1381 \immediate\write\mmz@shout{\mmz@tex@extraction@systemcall}%
1382 \endgroup
1383 },
1384 record/sh/end/.code={%
1385 \immediate\closeout\mmz@shout
1386 },

```

`record/bat/...` Rinse and repeat for Windows.

```
1387 record/bat/begin/.code={%
1388   \newwrite\mmz@batout
1389   \immediate\mmz@openout\mmz@batout{\mmz@batname}%
1390 },
1391 record/bat/new extern/.code={%
1392   \begingroup
1393   \immediate\write\mmz@batout{\mmz@tex@extraction@systemcall}%
1394   \endgroup
1395 },
1396 record/bat/end/.code={%
1397   \immediate\closeout\mmz@batout
1398 },
```

### 4.2.3 The Makefile

The implementation of the Makefile record type is the most complex so far, as we need to keep track of the targets.

`makefile` This key sets the makefile filename.

```
1399 makefile/.store in=\mmz@makefilename,
1400 makefile=memoize-extract.\jobname.makefile,
1401 }
```

We need to define a macro which expands to the tab character of catcode “other”, to use as the recipe prefix.

```
1402 \begingroup
1403 \catcode\^^I=12
1404 \gdef\mmz@makefile@recipe@prefix{^^I}%
1405 \endgroup
```

`record/makefile/...` Define the Makefile record type.

```
1406 \mmzset{
1407   record/makefile/begin/.code={%
```

We initialize the record type by opening the file and setting makefile variables `.DEFAULT_GOAL` and `.PHONY`.

```
1408   \newwrite\mmz@makefileout
1409   \newtoks\mmz@makefile@externs
1410   \immediate\mmz@openout\mmz@makefileout{\mmz@makefilename}%
1411   \immediate\write\mmz@makefileout{.DEFAULT_GOAL = externs}%
1412   \immediate\write\mmz@makefileout{.PHONY: externs}%
1413 },
```

The crucial part, writing out the extraction rule. The target comes first, then the recipe, which is whatever the user has set by `tex extraction command`, `tex extraction options` and `tex extraction script`.

```
1414   record/makefile/new extern/.code={%
```

The target extern file:

```
1415   \immediate\write\mmz@makefileout{#1:}%
1416   \begingroup
```

The recipe is whatever the user set by `tex extraction command`, `tex extraction options` and `tex extraction script`.

```
1417   \immediate\write\mmz@makefileout{%
1418     \mmz@makefile@recipe@prefix\mmz@tex@extraction@systemcall}%
1419   \endgroup
```

Append the extern file to list of targets.

```
1420 \xtoksapp\mmz@makefile@externs{#1\space}%
1421 },
1422 record/makefile/end/.code={%
```

Before closing the file, we list the extern files as the prerequisites of our phony default target, `externs`.

```
1423 \immediate\write\mmz@makefileout{externs: \the\mmz@makefile@externs}%
1424 \immediate\closeout\mmz@makefileout
1425 },
1426 }
```

### 4.3 T<sub>E</sub>X-based extraction

`extract/tex` We trigger the T<sub>E</sub>X-based extraction by inputting the `.mmz` record file.

```
1427 \mmzset{
1428   extract/tex/.code={%
1429     \begingroup
1430     \@input{\jobname.mmz}%
1431     \endgroup
1432   },
1433 }
```

`\mmzUsedCMemo` We can ignore everything but `\mmzNewExterns`. All these macros receive a single argument.

```
\mmzUsedCCMemo 1434 \def\mmzUsedCMemo#1{}
\mmzUsedExtern 1435 \def\mmzUsedCCMemo#1{}
\mmzNewCMemo    1436 \def\mmzUsedExtern#1{}
\mmzNewCCMemo   1437 \def\mmzNewCMemo#1{}
\mmzPrefix     1438 \def\mmzNewCCMemo#1{}
               1439 \def\mmzPrefix#1{}
```

`\mmzNewExtern` Command `\mmzNewExtern` takes four arguments. It instructs us to extract page #2 of document `\jobname.pdf` to file #1. During the extraction, we will check whether the size of the extern matches the given expected width (#3) and total height (#4).

We perform the extraction by an embedded T<sub>E</sub>X call. The system command that gets executed is stored in `\mmz@tex@extraction@systemcall`, which is set by `tex extraction command` and friends; by default, we execute `pdftex`.

```
1440 \def\mmzNewExtern#1{%
```

The T<sub>E</sub>X executable expects the basename as the argument, so we strip away the `.pdf` suffix.

```
1441 \mmz@new@extern@i#1\mmz@temp
1442 }
1443 \def\mmz@new@extern@i#1.pdf\mmz@temp#2#3#4{%
1444   \begingroup
```

Define the macros used in `\mmz@tex@extraction@systemcall`.

```
1445 \def\externbasepath{#1}%
1446 \def\pagenumber{#2}%
1447 \def\expectedwidth{#3}%
1448 \def\expectedheight{#4}%
```

Empty out the extraction log.

```
1449 \mmz@clear@extraction@log
```

Extract.

```
1450 \pdf@system{\mmz@tex@extraction@systemcall}%
```

Was the extraction successful? We temporarily redefine the extraction error message macro (suited for the external extraction scripts, which extract all externs in one go) to report the exact problematic extern page.

```

1451 \let\mmz@extraction@error\mmz@pageextraction@error
1452 \mmz@check@extraction@log{tex}%
1453 \endgroup
1454 }

1455 \def\mmz@pageextraction@error{%
1456 \PackageError{memoize}{Extraction of extern page \pagenumber\space from
1457 document "jobname.pdf" using method "\extractionmethod" was
1458 unsuccessful.}{Check the log file to see if the extraction script was
1459 executed at all, and if it finished successfully. You might also want to
1460 inspect "\externbasepath.log", the log file of the embedded TeX compilation
1461 which ran the extraction script}}

```

**tex extraction command** Using these keys, we set the system call which will be invoked for each extern page. The **tex extraction options** value of this key is expanded when executing the system command. The user may deploy **tex extraction script** the following macros in the value of these keys:

- `\externbasepath`: the extern PDF that should be produced, minus the `.pdf` suffix;
- `\pagenumber`: the page number to be extracted;
- `\expectedwidth`: the expected width of the extracted page;
- `\expectedheight`: the expected total height of the extracted page;

```

1462 \def\mmz@tex@extraction@systemcall{%
1463 \mmzvalueof{tex extraction command}\space
1464 \mmzvalueof{tex extraction options}\space
1465 "\mmzvalueof{tex extraction script}"%
1466 }

```

The default system call for T<sub>E</sub>X-based extern extraction. As this method, despite being T<sub>E</sub>X-based, shares no code with the document, we're free to implement it with any engine and format we want. For reasons of speed, we clearly go for the plain pdfT<sub>E</sub>X.<sup>3</sup> We perform the extraction by a little T<sub>E</sub>X script, `memoize-extract-one`, inputted at the end of the value given to `tex extraction script`.

```

1467 \mmzset{
1468 tex extraction command/.initial=pdfTeX,
1469 tex extraction options/.initial={%
1470 -halt-on-error
1471 -interaction=batchmode
1472 -jobname "\externbasepath"
1473 },
1474 tex extraction script/.initial={%
1475 \def\noexpand\fromdocument{\jobname.pdf}%
1476 \def\noexpand\pagenumber{\pagenumber}%
1477 \def\noexpand\expectedwidth{\expectedwidth}%
1478 \def\noexpand\expectedheight{\expectedheight}%
1479 \def\noexpand\logfile{\jobname.mmz.log}%
1480 \unexpanded{%
1481 \def\warningtemplate{%
1482 <latex> \noexpand\PackageWarning{memoize}{\warningtext}%
1483 <plain> \warning{memoize: \warningtext}%
1484 <context> \warning{memoize: \warningtext}%
1485 }}%
1486 \ifdef\XeTeXversion{}{%
1487 \def\noexpand\mmzpdfmajorversion{\the\pdfmajorversion}%
1488 \def\noexpand\mmzpdfminorversion{\the\pdfminorversion}%
1489 }%
1490 \noexpand\input memoize-extract-one

```

<sup>3</sup>I implemented the first version of T<sub>E</sub>X-based extraction using L<sup>A</sup>T<sub>E</sub>X and package `graphicx`, and it was (running with pdfT<sub>E</sub>X engine) almost four times slower than the current plain T<sub>E</sub>X implementation.

```

1491 },
1492 }
1493 </mmz>

```

### 4.3.1 memoize-extract-one.tex

The rest of the code of this section resides in file `memoize-extract-one.tex`. It is used to extract a single extern page from the document; it also checks whether the extern page dimensions are as expected, and passes a warning to the main job if that is not the case. For the reason of speed, the extraction script is in plain  $\text{\TeX}$  format. For the same reason, it is compiled by pdf $\text{\TeX}$  engine by default, but we nevertheless take care that it will work with other (supported) engines as well.

```

1494 <*extract-one>
1495 \catcode`\@11\relax
1496 \def\@firstoftwo#1#2{#1}
1497 \def\@secondoftwo#1#2{#2}

```

Set the PDF version (maybe) passed to the script via `\mmzpdfmajorversion` and `\mmzpdfminorversion`.

```

1498 \ifdefined\XeTeXversion
1499 \else
1500   \ifdefined\luatexversion
1501     \def\pdfmajorversion{\pdfvariable majorversion}%
1502     \def\pdfminorversion{\pdfvariable minorversion}%
1503   \fi
1504   \ifdefined\mmzpdfmajorversion
1505     \pdfmajorversion\mmzpdfmajorversion\relax
1506   \fi
1507   \ifdefined\mmzpdfminorversion
1508     \pdfminorversion\mmzpdfminorversion\relax
1509   \fi
1510 \fi

```

Allocate a new output stream, always — `\newwrite` is `\outer` and thus cannot appear in a conditional.

```

1511 \newwrite\extractionlog

```

Are we requested to produce a log file?

```

1512 \ifdefined\logfile
1513   \immediate\openout\extractionlog{\logfile}%

```

Define a macro which both outputs the warning message and writes it to the extraction log.

```

1514   \def\doublewarning#1{%
1515     \message{#1}%
1516     \def\warningtext{#1}%

```

This script will be called from different formats, so it is up to the main job to tell us, by defining macro `\warningtemplate`, how to throw a warning in the log file.

```

1517     \immediate\write\extractionlog{%
1518       \ifdefined\warningtemplate\warningtemplate\else\warningtext\fi
1519     }%
1520   }%
1521 \else
1522   \let\doublewarning\message
1523 \fi
1524 \newif\ifforce
1525 \ifdefined\force
1526   \csname force\force\endcsname
1527 \fi

```

`\mmz@if@roughly@equal` This macro checks whether the given dimensions (#2 and #3) are equal within the tolerance given by #1. We use the macro both in the extraction script and in the main package. (We don't use `\ifpdfabsdim`, because it is unavailable in  $\text{\LaTeX}$ .)

```

1528 \extract-one)
1529 *mmz,extract-one)
1530 \def\mmz@tolerance{0.01pt}
1531 \def\mmz@if@roughly@equal#1#2#3{%
1532   \dimen0=\dimexpr#2-#3\relax
1533   \ifdim\dimen0<0pt
1534     \dimen0=-\dimen0\relax
1535   \fi
1536   \ifdim\dimen0>#1\relax
1537     \expandafter\@secondoftwo
1538   \else

```

The exact tolerated difference is, well, tolerated. This is a must to support `tolerance=0pt`.

```

1539   \expandafter\@firstoftwo
1540   \fi
1541 }%
1542 \mmz,extract-one)
1543 *extract-one)

```

Grab the extern page from the document and put it in a box.

```

1544 \ifdefined\XeTeXversion
1545   \setbox0=\hbox{\XeTeXpdffile \fromdocument\space page \pagenumber media}%
1546 \else
1547   \ifdefined\luatexversion
1548     \saveimageresource page \pagenumber mediabox {\fromdocument}%
1549     \setbox0=\hbox{\useimageresource\lastsavedimageresourceindex}%
1550   \else
1551     \pdfximage page \pagenumber mediabox {\fromdocument}%
1552     \setbox0=\hbox{\pdfrefximage\pdflastximage}%
1553   \fi
1554 \fi

```

Check whether the extern page is of the expected size.

```

1555 \newif\ifbaddimensions
1556 \ifdefined\expectedwidth
1557   \ifdefined\expectedheight
1558     \mmz@if@roughly@equal{\mmz@tolerance}{\wd0}{\expectedwidth}{%
1559       \mmz@if@roughly@equal{\mmz@tolerance}{\ht0}{\expectedheight}%
1560     }%
1561     {\baddimensionstrue}%
1562   }{\baddimensionstrue}%
1563 \fi
1564 \fi

```

We'll setup the page geometry of the extern file and shipout the extern — if all is well, or we're forced to do it.

```

1565 \ifdefined\luatexversion
1566   \let\pdfpagewidth\pagewidth
1567   \let\pdfpageheight\pageheight
1568   \def\pdfhorigin{\pdfvariable horigin}%
1569   \def\pdfvorigin{\pdfvariable vorigin}%
1570 \fi
1571 \def\do@shipout{%
1572   \pdfpagewidth=\wd0
1573   \pdfpageheight=\ht0
1574   \ifdefined\XeTeXversion

```

```

1575 \hoffset -1 true in
1576 \voffset -1 true in
1577 \else
1578 \pdfhorigin=0pt
1579 \pdfvorigin=0pt
1580 \fi
1581 \shipout\box0
1582 }
1583 \ifbaddimensions
1584 \doublewarning{I refuse to extract page \pagenumber\space from
1585 "\fromdocument", because its size (\the\wd0 \space x \the\ht0) is not
1586 what I expected (\expectedwidth\space x \expectedheight)}%
1587 \ifforce\do@shipout\fi
1588 \else
1589 \do@shipout
1590 \fi

```

If logging is in effect and the extern dimensions were not what we expected, write a warning into the log.

```

1591 \ifdefined\logfile
1592 \immediate\write\extractionlog{\noexpand\endinput}%
1593 \immediate\closeout\extractionlog
1594 \fi
1595 \bye
1596 </extract-one>

```

## 5 Automemoization

**Install** the advising framework implemented by our auxiliary package Advice, which automemoization depends on. This will define keys `auto`, `activate` etc. in our keypath.

```

1597 <*mmz>
1598 \mmzset{
1599 .install advice={setup key=auto, activation=deferred},

```

We switch to the immediate activation at the end of the preamble.

```

1600 begindocument/before/.append style={activation=immediate},
1601 }

```

**manual** Unless the user switched on `manual`, we perform the deferred (de)activations at the beginning of the document (and then clear the style, so that any further deferred activations will start with a clean slate). In L<sup>A</sup>T<sub>E</sub>X, we will use the latest possible hook, `begindocument/end`, as we want to hack into commands defined by other packages. (The T<sub>E</sub>X conditional needs to be defined before using it in `.append` code below.

```

1602 \newif\ifmmz@manual
1603 \mmzset{
1604 manual/.is if=mmz@manual,
1605 begindocument/end/.append code={%
1606 \ifmmz@manual
1607 \else
1608 \pgfkeysalso{activate deferred,activate deferred/.code={}}%
1609 \fi
1610 },

```

**Announce** Memoize's run conditions and handlers.

```

1611 auto/.cd,
1612 run if memoization is possible/.style={
1613 run conditions=\mmz@auto@rc@if@memoization@possible

```



```

1614 },
1615 run if memoizing/.style={run conditions=\mmz@auto@rc@if@memoizing},
1616 apply options/.style={
1617     bailout handler=\mmz@auto@bailout,
1618     outer handler=\mmz@auto@outer,
1619 },
1620 memoize/.style={
1621     run if memoization is possible,
1622     apply options,
1623     inner handler=\mmz@auto@memoize
1624 },
1625 <*/latex>
1626 noop/.style={run if memoization is possible, noop \AdviceType},
1627 noop command/.style={apply options, inner handler=\mmz@auto@noop},
1628 noop environment/.style={
1629     outer handler=\mmz@auto@noop@env, bailout handler=\mmz@auto@bailout},
1630 </latex>
1631 <plain, context> noop/.style={inner handler=\mmz@auto@noop},
1632 nomemoize/.style={noop, options=disable},
1633 replicate/.style={run if memoizing, inner handler=\mmz@auto@replicate},
1634 to context/.style={run if memoizing, outer handler=\mmz@auto@tocontext},
1635 }

```

**Abortion** We cheat and let the `run conditions` do the work — it is cheaper to just always abort than to invoke the outer handler. (As we don't set `\AdviceRuntrue`, the run conditions will never be satisfied.)

```

1636 \mmzset{
1637     auto/abort/.style={run conditions=\mmzAbort},
1638 }

```

And the same for unmemoizable:

```

1639 \mmzset{
1640     auto/unmemoizable/.style={run conditions=\mmzUnmemoizable},
1641 }

```

For one, we abort upon `\pdfsavepos` (called `\savepos` in LuaTeX). Second, unless in LuaTeX, we submit `\errmessage`, which allows us to detect at least some errors — in LuaTeX, we have a more bullet-proof system of detecting errors, see `\mmz@memoize` in §3.2.

```

1642 \ifdef\luatexversion{%
1643     \mmzset{auto=\savepos{abort}}
1644 }{%
1645     \mmzset{
1646         auto=\pdfsavepos{abort},
1647         auto=\errmessage{abort},
1648     }
1649 }

```

**run if memoization is possible** These run conditions are used by `memoize` and `noop`: Memoize should be `\mmz@auto@rc@if@memoization@possible` enabled, but we should not be already within Memoize, i.e. memoizing or normally compiling some code submitted to memoization.

```

1650 \def\mmz@auto@rc@if@memoization@possible{%
1651     \ifmemoize
1652         \ifinmemoize
1653         \else
1654             \AdviceRuntrue
1655         \fi
1656     \fi
1657 }

```

`run if memoizing` These run conditions are used by `\label` and `\ref`: they should be handled only during `\mmz@auto@rc@if@memoizing` memoization (which implies that Memoize is enabled).

```
1658 \def\mmz@auto@rc@if@memoizing{%
1659   \ifmemoizing\AdviceRuntrue\fi
1660 }
```

`\mmznxt` The next-options, set by this macro, will be applied to the next, and only next instance of automemoization. We set the next-options globally, so that only the linear order of the invocation matters. Note that `\mmznxt`, being a user command, must also be defined in package `nomemoize`.

```
1661 </mmz>
1662 <nommz> \def\mmznxt#1{\ignorespaces}
1663 <*mmz>
1664 \def\mmznxt#1{\gdef\mmz@next{#1}\ignorespaces}
1665 \mmznxt{}}%
```

`apply options` The outer and the bailout handler defined here work as a team. The outer handler's job is to `\mmz@auto@outer` apply the auto- and the next-options; therefore, the bailout handler must consume the next- `\mmz@auto@bailout` options as well. To keep the option application local, the outer handler opens a group, which is expected to be closed by the inner handler. This key is used by `memoize` and `noop` command.

```
1666 \def\mmz@auto@outer{%
1667   \begingroup
1668   \mmzAutoInit
1669   \AdviceCollector
1670 }
1671 \def\mmz@auto@bailout{%
1672   \mmznxt{}}%
1673 }
```

`\mmzAutoInit` Apply first the auto-options, and then the next-options (and clear the latter). Finally, if we have any extra collector options (set by the `verbatim` keys), append them to Advice's (raw) collector options.

```
1674 \def\mmzAutoInit{%
1675   \ifdefempty\AdviceOptions{}\expandafter\mmzset\expandafter{\AdviceOptions}}%
1676   \ifdefempty\mmz@next{}\expandafter\mmzset\expandafter{\mmz@next}\mmznxt{}}%
1677   \eappto\AdviceRawCollectorOptions{\expandonce\mmzRawCollectorOptions}%
1678 }
```

`memoize` This key installs the inner handler for memoization. If you compare this handler to the definition `\mmz@auto@memoize` of `\mmz` in section 3.1, you will see that the only thing left to do here is to start memoization with `\Memoize`, everything else is already done by the advising framework, as customized by Memoize.

The first argument to `\Memoize` is the memoization key (which the code `md5sum` is computed off of); it consists of the handled code (the contents of `\AdviceReplaced`) and its arguments, which were collected into `##1`. The second argument is the code which the memoization driver will execute. `\AdviceOriginal`, if invoked right away, would execute the original command; but as this macro is only guaranteed to refer to this command within the advice handlers, we expand it before calling `\Memoize`. that command.

Note that we don't have to define different handlers for commands and environments, and for different T<sub>E</sub>X formats. When memoizing command `\foo`, `\AdviceReplaced` contains `\foo`. When memoizing environment `foo`, `\AdviceReplaced` contains `\begin{foo}`, `\foo` or `\startfoo`, depending on the format, while the closing tag (`\end{foo}`, `\endfoo` or `\stopfoo`) occurs at the end of the collected arguments, because `apply options` appended `\collargsEndTagtrue` to raw collector options.

This macro has no formal parameters, because the collected arguments will be grabbed by `\mmz@marshal`, which we have to go through because executing `\Memoize` closes the memoization

group and we lose the current value of `\ifmmz@ignorespaces`. (We also can't use `\aftergroup`, because closing the group is not the final thing `\Memoize` does.)

```
1679 \long\def\mmz@auto@memoize#1{%
1680   \expanded{%
1681     \noexpand\Memoize
1682     {\expandonce\AdviceReplaced\unexpanded{#1}}%
1683     {\expandonce\AdviceOriginal\unexpanded{#1}}%
1684     \ifmmz@ignorespaces\ignorespaces\fi
1685   }%
1686 }
```

**noop** The no-operation handler can be used to apply certain options for the span of the execution of the handled command or environment. This is exploited by `auto/nomemoize`, which sets `\mmz@auto@noop@env` disable as an auto-option.

The handler for commands and non-L<sup>A</sup>T<sub>E</sub>X environments is implemented as an inner handler. On its own, it does nothing except honor `verbatim` and `ignore spaces` (only takes care of `verbatim` and `ignore spaces` (in the same way as the memoization handler above), but it is intended to be used alongside the default outer handler, which applies the auto- and the next-options. As that handler opens a group (and this handler closes it), we have effectively delimited the effect of those options to this invocation of the handled command or environment.

```
1687 \long\def\mmz@auto@noop#1{%
1688   \expandafter\mmz@maybe@scantokens\expandafter{\AdviceOriginal#1}%
1689   \expandafter\endgroup
1690   \ifmmz@ignorespaces\ignorespaces\fi
1691 }
```

In L<sup>A</sup>T<sub>E</sub>X, and only there, commands and environments need separate treatment. As L<sup>A</sup>T<sub>E</sub>X environments introduce a group of their own, we can simply hook our initialization into the beginning of the environment (as a one-time hook). Consequently, we don't need to collect the environment body, so this can be an outer handler.

```
1692 <*\latex>
1693 \def\mmz@auto@noop@env{%
1694   \AddToHookNext{env/\AdviceName/begin}{%
1695     \mmzAutoInit
1696     \ifmmz@ignorespaces\ignorespacesafterend\fi
1697   }%
1698   \AdviceOriginal
1699 }
1700 </\latex>
```

**replicate** This inner handler writes a copy of the handled command or environment's invocation into the cc-memo (and then executes it). As it is used alongside `run if memoizing`, the replicated command in the cc-memo will always execute the original command. The system works even if replication is off when the cc-memo is input; in that case, the control sequence in the cc-memo directly executes the original command.

This handler takes an option, `expanded` — if given, the collected arguments will be expanded (under protection) before being written into the cc-memo.

```
1701 \def\mmz@auto@replicate#1{%
1702   \begingroup
1703   \let\mmz@auto@replicate@expansion\unexpanded
1704   \expandafter\pgfqkeys\expandafter{\mmz/auto/replicate}{\AdviceOptions}}%
1705 <\latex> \let\protect\noexpand
1706   \expanded{%
1707     \endgroup
1708     \noexpand\gtoksapp\noexpand\mmzCCMemo{%
1709       \expandonce\AdviceReplaced\mmz@auto@replicate@expansion{#1}}%
1710       \expandonce\AdviceOriginal\unexpanded{#1}%
1711     }
```

```

1711 }%
1712 }
1713 \pgfqkeys{/mmz/auto/replicate}{
1714   expanded/.code={\let\mmz@auto@replicate@expansion\@firstofone},
1715 }

```

**to context** This outer handler appends the original definition of the handled command to the `\mmz@auto@tocontext` text. The `\expandafter` are there to expand `\AdviceName` once before fully expanding `\AdviceGetOriginalCname`.

```

1716 \def\mmz@auto@tocontext{%
1717   \expanded{%
1718     \noexpand\pgfkeysvalueof{/mmz/context/.@cmd}%
1719     original "\AdviceNamespace" cname "\AdviceCname"={%
1720       \noexpand\expanded{%
1721         \noexpand\noexpand\noexpand\meaning
1722         \noexpand\AdviceCnameGetOriginal{\AdviceNamespace}{\AdviceCname}%
1723       }%
1724     }%
1725   }%
1726   \pgfeov
1727   \AdviceOriginal
1728 }

```

## 5.1 L<sup>A</sup>T<sub>E</sub>X-specific handlers

We handle cross-referencing (both the `\label` and the `\ref` side) and indexing. Note that the latter is a straightforward instance of replication.

```

1729 <(*latex)
1730 \mmzset{
1731   auto/.cd,
1732   ref/.style={outer handler=\mmz@auto@ref\mmzNoRef, run if memoizing},
1733   force ref/.style={outer handler=\mmz@auto@ref\mmzForceNoRef, run if memoizing},
1734 }
1735 \mmzset{
1736   auto=\ref{ref},
1737   auto=\pageref{ref},
1738   auto=\label{run if memoizing, outer handler=\mmz@auto@label},
1739   auto=\index{replicate, args=m, expanded},
1740 }

```

**ref** These keys install an outer handler which appends a cross-reference to the context. **force ref** does this even if the reference key is undefined, while **ref** aborts memoization in such a case — `\mmz@auto@ref` the idea is that it makes no sense to memoize when we expect the context to change in the next compilation anyway.

Any command taking a mandatory braced reference key argument potentially preceded by optional arguments of (almost) any kind may be submitted to these keys. This follows from the parameter list of `\mmz@auto@ref@i`, where `#2` grabs everything up to the first opening brace. The downside of the flexibility regarding the optional arguments is that unbraced single-token reference keys will cause an error, but as such usages of `\ref` and friends should be virtually inexistent, we let the bug stay.

`#1` should be either `\mmzNoRef` or `\mmzForceNoRef`. `#2` will receive any optional arguments of `\ref` (or `\pageref`, or whatever), and `#3` in `\mmz@auto@ref@i` is the cross-reference key.

```

1741 \def\mmz@auto@ref#1#2#{\mmz@auto@ref@i#1{#2}}
1742 \def\mmz@auto@ref@i#1#2#3{%
1743   #1{#3}%
1744   \AdviceOriginal#2{#3}%
1745 }

```

`\mmzForceNoRef` These macros do the real job in the outer handlers for cross-referencing, but it might be useful to have them publicly available. `\mmzForceNoRef` appends the reference key to the context. `\mmzNoRef` only does that if the reference is defined, otherwise it aborts the memoization.

```

1746 \def\mmzForceNoRef#1{%
1747   \mmz@mtoc@csname{r@#1}%
1748   \ignorespaces
1749 }
1750 \def\mmzNoRef#1{%
1751   \ifcsundef{r@#1}{\mmzAbort}{\mmzForceNoRef{#1}}%
1752   \ignorespaces
1753 }

```

`refrange` Let's rinse and repeat for reference ranges. The code is virtually the same as above, but we grab two reference key arguments (#3 and #4) in the final macro.

```

\mmz@auto@refrange
1754 \mmzset{
1755   auto/.cd,
1756   refrange/.style={outer handler=\mmz@auto@refrange\mmzNoRef,
1757     bailout handler=\relax, run if memoizing},
1758   force refrange/.style={outer handler=\mmz@auto@refrange\mmzForceNoRef,
1759     bailout handler=\relax, run if memoizing},
1760 }

1761 \def\mmz@auto@refrange#1#2#{\mmz@auto@refrange@i#1{#2}}
1762 \def\mmz@auto@refrange@i#1#2#3#4{%
1763   #1{#3}%
1764   #1{#4}%
1765   \AdviceOriginal#2{#3}{#4}%
1766 }

```

`multiref` And one final time, for “multi-references”, such as `cleveref`'s `\cref`, which can take a comma-separated list of reference keys in the sole argument. Again, only the final macro is any different, this time distributing #1 (`\mmzNoRef` or `\mmzForceNoRef`) over #3 by `\forcsvlist`.

```

1767 \mmzset{
1768   auto/.cd,
1769   multiref/.style={outer handler=\mmz@auto@multiref\mmzNoRef,
1770     bailout handler=\relax, run if memoizing},
1771   force multiref/.style={outer handler=\mmz@auto@multiref\mmzForceNoRef,
1772     bailout handler=\relax, run if memoizing},
1773 }
1774 \def\mmz@auto@multiref#1#2#{\mmz@auto@multiref@i#1{#2}}
1775 \def\mmz@auto@multiref@i#1#2#3{%
1776   \forcsvlist{#1}{#3}%
1777   \AdviceOriginal#2{#3}%
1778 }

```

`\mmz@auto@label` The outer handler for `\label` must be defined specifically for this command. The generic replicating handler is not enough here, as we need to replicate both the invocation of `\label` and the definition of `\@currentlabel`.

```

1779 \def\mmz@auto@label#1{%
1780   \xtoksapp\mmzCCMemo{%
1781     \noexpand\mmzLabel{#1}{\expandonce\@currentlabel}%
1782   }%
1783   \AdviceOriginal{#1}%
1784 }

```

`\mmzLabel` This is the macro that `\label`'s handler writes into the cc-memo. The first argument is the reference key; the second argument is the value of `\@currentlabel` at the time of invocation `\label` during memoization, which this macro temporarily restores.

```

1785 \def\mmzLabel#1#2{%
1786   \begingroup
1787   \def\@currentlabel{#2}%
1788   \label{#1}%
1789   \endgroup
1790 }
1791 \<*/latex>

```

## 6 Support for various classes and packages

```

1792 \<*/latex>
1793 \AddToHook{shipout/before}[memoize]{\global\advance\mmzExtraPages-1\relax}
1794 \AddToHook{shipout/after}[memoize]{\global\advance\mmzExtraPages1\relax}
1795 \mmzset{auto=\DiscardShipoutBox{
1796   outer handler=\global\advance\mmzExtraPages1\relax\AdviceOriginal}}
1797 \</latex>

```

### 6.1 TikZ

In this section, we activate TikZ support (the collector is defined by Advice). All the action happens at the end of the preamble, so that we can detect whether TikZ was loaded (regardless of whether Memoize was loaded before TikZ, or vice versa), but still input the definitions.

```

1798 \mmzset{
1799   begindocument/before/.append code={%
1800 \<*/latex>   \@ifpackageloaded{tikz}{%
1801 \<plain, context>   \ifdefined\tikz
1802   \input advice-tikz.code.tex
1803 \<*/latex>   }{}%
1804 \<plain, context>   \fi

```

We define and activate the automemoization handlers for the TikZ command and environment.

```

1805   \mmzset{%
1806     auto/memoize tikz/.style={
1807       memoize,
1808       at begin memoization=\edef\mmz@pgfpictureid{%
1809         \the\pgf@picture@serial@count
1810       },
1811       at end memoization=\xtoksapp\mmzCCMemo{%
1812         \unexpanded{%
1813           \global\expandafter\advance\csname pgf@picture@serial@count\endcsname
1814         }%
1815         \the\numexpr\pgf@picture@serial@count-\mmz@pgfpictureid\relax\relax
1816       },
1817     },
1818     auto=\tikz{memoize tikz, collector=\AdviceCollectTikZArguments},
1819     auto={tikzpicture}{memoize tikz},
1820   }%
1821 },
1822 }

```

### 6.2 Forest

Forest will soon feature extensive memoization support, but for now, let's just enable the basic, single extern externalization.

```

1823 \<*/latex>
1824 \mmzset{
1825   begindocument/before/.append code={%
1826     \@ifpackageloaded{forest}{%
1827       \mmzset{
1828         auto={forest}{memoize},

```

Yes, `\Forest` is defined using `xparse`.

```

1829     auto=\Forest{memoize},
1830     }%
1831   }{}%
1832 },
1833 }
1834 </latex>

```

### 6.3 Beamer

The Beamer code is explained in <sup>M</sup>[§4.2.4](#).

```

1835 <(*latex)>
1836 \AddToHook{begindocument/before}{\@ifclassloaded{beamer}{%
1837   \mmzset{per overlay/.style={
1838     /mmz/context={%
1839       overlay=\csname beamer@overlaynumber\endcsname,
1840       pauses=\ifmemoizing
1841         \mmzBeamerPauses
1842       \else
1843         \expandafter\the\csname c@beamerpauses\endcsname
1844       \fi
1845     },
1846     /mmz/at begin memoization={%
1847       \xdef\mmzBeamerPauses{\the\c@beamerpauses}%
1848       \xtoksapp\mmzCMemo{%
1849         \noexpand\mmzSetBeamerOverlays{\mmzBeamerPauses}{\beamer@overlaynumber}}%
1850       \gtoksapp\mmzCCMemo{%
1851         \only<\mmzBeamerOverlays>{}}%
1852     },
1853     /mmz/at end memoization={%
1854       \xtoksapp\mmzCCMemo{%
1855         \noexpand\setcounter{beamerpauses}{\the\c@beamerpauses}}%
1856     },
1857     /mmz/per overlay/.code={},
1858   }}
1859 \def\mmzSetBeamerOverlays#1#2{%
1860   \ifnum\c@beamerpauses=#1\relax
1861     \gdef\mmzBeamerOverlays{#2}%
1862     \ifnum\beamer@overlaynumber<#2\relax \mmz@temptrue \else \mmz@tempfalse \fi
1863   \else
1864     \mmz@temptrue
1865   \fi
1866   \ifmmz@temp
1867     \appto\mmzAtBeginMemoization{%
1868       \gtoksapp\mmzCMemo{\mmzSetBeamerOverlays{#1}{#2}}}%
1869   \fi
1870 }%
1871 }{}%
1872 </latex>

```

### 6.4 Morewrites

Use the old grammar for `\openin` and `\openout` as a temporary workaround. `prefixes` containing spaces must be quoted manually.

```

1873 <(*latex)>
1874 \AddToHook{begindocument/before}{%
1875   \@ifpackageloaded{morewrites}{%
1876     \def\mmz@openin#1#2{\openin#1=#2\relax}%
1877     \def\mmz@openout#1#2{\openout#1=#2\relax}%
1878   }{}%

```



```

1879 }
1880 </latex>

```

## 6.5 Biblatex

```

1881 <*latex>
1882 \mmzset{
1883   begindocument/before/.append style={%
1884     auto=\blx@bbl@entry{outer handler=\mmz@biblatex@entry},
1885     auto/cite/.style={run if memoizing, outer handler=\mmz@biblatex@cite},
1886     auto/cites/.style={run if memoizing, outer handler=\mmz@biblatex@cites},
1887     auto=\cite{cite},
1888     auto=\cites{cites},
1889   }%
1890 }

```

`\mmz@biblatex@entry` This macro stores the MD5 sum of the `\entry` when reading the `.bbl` file.

```

1891 \def\mmz@biblatex@entry#1#2\endentry{%
1892   \csxdef{mmz@bbl@#1}{\pdf@mdfivesum{#2}}%
1893   \AdviceOriginal{#1}#2\endentry
1894 }

```

`\mmz@biblatex@cite` This macro puts the cites reference keys into the context, and adds the handled `\cite` command to the cc-memo.

```

1895 \def\mmz@biblatex@cite#1#{\mmz@biblatex@cite@i{#1}}
1896 \def\mmz@biblatex@cite@i#1#2{%
1897   \forcsvlist\mmz@biblatex@cite@do@key{#2}%
1898   \xtoksapp\mmzCCMemo{%
1899     \noexpand\setbox0\noexpand\hbox{%
1900       \expandonce\AdviceOriginal\unexpanded{#1}{#2}%
1901     }}%
1902   \AdviceOriginal#1{#2}%
1903 }
1904 \def\mmz@biblatex@cite@do@key#1{%
1905   \mmz@mtoc@csname{mmz@bbl@#1}%
1906   \ifcsdef{mmz@bbl@#1}{-}{\mmzAbort}%
1907 }

```

`\mmz@biblatex@cites` This macro puts the cites reference keys into the context, and adds the handled `\cites` command to the cc-memo.

```

1908 \def\mmz@biblatex@cites{%
1909   \mmz@temptoks{}%
1910   \mmz@biblatex@cites@i
1911 }
1912 \def\mmz@biblatex@cites@i{%
1913   \futurelet\mmz@temp\mmz@biblatex@cites@ii
1914 }
1915 \def\mmz@biblatex@cites@ii{%
1916   \mmz@tempfalse
1917   \ifx\mmz@temp\bgroup
1918     \mmz@temptrue
1919   \else
1920     \ifx\mmz@temp[%
1921       \mmz@temptrue
1922     \fi
1923   \fi
1924   \ifmmz@temp
1925     \expandafter\mmz@biblatex@cites@iii
1926   \else
1927     \expandafter\mmz@biblatex@cites@z

```



```

1928 \fi
1929 }
1930 \def\mmz@biblatex@cites@iii#1#{\mmz@biblatex@cites@iv{#1}}
1931 \def\mmz@biblatex@cites@iv#1#2{%
1932 \forcsvlist\mmz@biblatex@cite@do@key{#2}%
1933 \toksapp\mmz@temptoks{#1{#2}}}%
1934 \mmz@biblatex@cites@i
1935 }
1936 \def\mmz@biblatex@cites@z{%
1937 \xtoksapp\mmzCCMemo{%
1938 \noexpand\setbox0\noexpand\hbox{%
1939 \expandonce\AdviceOriginal\the\mmz@temptoks
1940 }}%
1941 \expandafter\AdviceOriginal\the\mmz@temptoks
1942 }
1943 \end{latex}

```

## 7 Initialization

`begindocument/before` These styles contain the initialization and the finalization code. They were populated throughout the source. Hook `begindocument/before` contains the package support code, which must be loaded while still in the preamble. Hook `begindocument` contains the initialization code whose execution doesn't require any particular timing, as long as it happens at the beginning of the document. Hook `begindocument/end` is where the commands are activated; this must crucially happen as late as possible, so that we successfully override foreign commands (like `hyperref`'s definitions). In  $\text{\LaTeX}$ , we can automatically execute these hooks at appropriate places:

```

1944 \begin{latex}
1945 \AddToHook{begindocument/before}{\mmzset{begindocument/before}}
1946 \AddToHook{begindocument}{\mmzset{begindocument}}
1947 \AddToHook{begindocument/end}{\mmzset{begindocument/end}}
1948 \AddToHook{enddocument/afterlastpage}{\mmzset{enddocument/afterlastpage}}
1949 \end{latex}

```

In plain  $\text{\TeX}$ , the user must execute these hooks manually; but at least we can group them together and given them nice names. Provisionally, manual execution is required in  $\text{\ConTeXt}$  as well, as I'm not sure where to execute them — please help!

```

1950 \begin{plain, context}
1951 \mmzset{
1952   begin document/.style={begindocument/before, begindocument, begindocument/end},
1953   end document/.style={enddocument/afterlastpage},
1954 }
1955 \end{plain, context}

```

Formats other than plain  $\text{\TeX}$  need a way to prevent extraction during package-loading.

```

1956 \ifplain\mmzset{extract/no/.code={}}

```

`memoize.cfg` Load the configuration file. Note that `nomemoize` must input this file as well, because any special memoization-related macros defined by the user should be available; for example, my `memoize.cfg` defines `\ifregion` (see [M§2.6](#)).

```

1957 \end{mmz}
1958 \ifmmz\input{memoize.cfg}{}{}
1959 \end{mmz}

```

For formats other than plain  $\text{\TeX}$ , we also save the current (initial or `memoize.cfg`-set) value of `extract`, so that we can restore it when package options include `extract=no`. Then, `extract`

can be called without an argument in the preamble, triggering extraction using this method; this is useful e.g. if Memoize is compiled into a format.

```
1960 <!\plain>\let\mmz@initial@extraction@method\mmz@extraction@method
```

Process the package options (except in plain T<sub>E</sub>X).

```
1961 <*\latex>
1962 \DeclareUnknownKeyHandler[mmz]{%
1963   \expanded{\noexpand\pgfqkeys{/mmz}{#1\IfBlankF{#2}{={#2}}}}
1964 \ProcessKeyOptions[mmz]
1965 </\latex>
1966 <context>\expandafter\mmzset\expandafter{\currentmoduleparameters}
```

In L<sup>A</sup>T<sub>E</sub>X, nomemoize has to process package options as well, otherwise L<sup>A</sup>T<sub>E</sub>X will complain.

```
1967 </mmz>
1968 <*\latex & nommz>
1969 \DeclareUnknownKeyHandler[mmz]{}
1970 \ProcessKeyOptions[mmz]
1971 </\latex & nommz>
```

**Extern extraction** We redefine `extract` to immediately trigger extraction. This is crucial in plain T<sub>E</sub>X, where extraction must be invoked after loading the package, but also potentially useful in other formats when package options include `extract=no`.

```
1972 <*\mmz>
1973 \mmzset{
1974   extract/.is choice,
1975   extract/.default=\mmz@extraction@method,
```

But only once:

```
1976   extract/.append style={
1977     extract/.code={\PackageError{memoize}{Key "extract" was invoked twice.}{In
1978       principle, externs should be extracted only once. If you really want
1979       to extract again, execute "extract/<method>".}},
1980   },
```

In formats other than plain T<sub>E</sub>X, we remember the current `extract` code and then trigger the extraction.

```
1981 <!\plain> /utils/exec={\pgfkeysgetvalue{/mmz/extract/.@cmd}\mmz@temp@extract},
1982 <!\plain> extract=\mmz@extraction@method,
1983 }
```

Option `extract=no` (which only exists in formats other than plain T<sub>E</sub>X) should allow for an explicit invocation of `extract` in the preamble.

```
1984 <*\plain>
1985 \def\mmz@temp{no}
1986 \ifx\mmz@extraction@method\mmz@temp
1987   \pgfkeyslet{/mmz/extract/.@cmd}\mmz@temp@extract
1988   \let\mmz@extraction@method\mmz@initial@extraction@method
1989 \fi
1990 \let\mmz@temp@extract\relax
1991 </!\plain>
```

Memoize was not really born for the draft mode, as it cannot produce new externs there. But we don't want to disable the package, as utilization and pure memoization are still perfectly valid in this mode, so let's just warn the user.

```
1992 \ifnum\pdf@draftmode=1
1993   \PackageWarning{memoize}{No externalization will be performed in the draft mode}%
1994 \fi
1995 </mmz>
```

Several further things which need to be defined as dummies in `nomemoize/memoizable`.

```
1996 < *nommz, mmzable & generic >
1997 \pgfkeys{%
1998   /handlers/.meaning to context/.code={},
1999   /handlers/.value to context/.code={},
2000 }
2001 \let\mmzAbort\relax
2002 \let\mmzUnmemoizable\relax
2003 \newcommand\IfMemoizing[2] [] {\@secondoftwo}
2004 \let\mmzNoRef\@gobble
2005 \let\mmzForceNoRef\@gobble
2006 \newtoks\mmzContext
2007 \newtoks\mmzContextExtra
2008 \newtoks\mmzCMemo
2009 \newtoks\mmzCCMemo
2010 \newcount\mmzExternPages
2011 \newcount\mmzExtraPages
2012 \let\mmzTracingOn\relax
2013 \let\mmzTracingOff\relax
2014 < /nommz, mmzable & generic >
```

The end of `memoize`, `nomemoize` and `memoizable`.

```
2015 < *mmz, nommz, mmzable >
2016 < plain > \resetatcatcode
2017 < context > \stopmodule
2018 < context > \protect
2019 < /mmz, nommz, mmzable >
```

That's all, folks!

## 8 Auxiliary packages

### 8.1 Extending commands and environments with Advice

```
2020 < *main >
2021 < latex > \ProvidesPackage{advice}[2024/01/02 v1.1.0 Extend commands and environments]
2022 < context > %D \module[
2023 < context > %D   file=t-advice.tex,
2024 < context > %D   version=1.1.0,
2025 < context > %D   title=Advice,
2026 < context > %D   subtitle=Extend commands and environments,
2027 < context > %D   author=Saso Zivanovic,
2028 < context > %D   date=2024-01-02,
2029 < context > %D   copyright=Saso Zivanovic,
2030 < context > %D   license=LPPL,
2031 < context > %D ]
2032 < context > \writestatus{loading}{ConTeXt User Module / advice}
2033 < context > \unprotect
2034 < context > \startmodule[advice]
```

#### Required packages

```
2035 < plain, context > \input miniltx
2036 < latex > \RequirePackage{collargs}
2037 < plain > \input collargs
2038 < context > \input t-collargs
```

In  $\text{\LaTeX}$ , we also require `xparse`. Even though `\NewDocumentCommand` and friends are integrated into the  $\text{\LaTeX}$  kernel, `\GetDocumentCommandArgSpec` is only available through `xparse`.

```
2039 < latex > \RequirePackage{xparse}
```

#### 8.1.1 Installation into a keypath

**.install advice** This handler installs the advising mechanism into the handled path, which we shall henceforth also call the (advice) namespace.

```

2040 \pgfkeys{
2041   /handlers/.install advice/.code={%
2042     \edef\auto@install@namespace{\pgfkeyscurrentpath}%
2043     \def\advice@install@setupkey{advice}%
2044     \def\advice@install@activation{immediate}%
2045     \pgfqkeys{/advice/install}{#1}%
2046     \expanded{\noexpand\advice@install
2047       {\auto@install@namespace}%
2048       {\advice@install@setupkey}%
2049       {\advice@install@activation}%
2050     }%
2051   },

```

**setup key** These keys can be used in the argument of **.install advice** to configure the installation. By **activation** default, the setup key is advice and activation is immediate.

```

2052   /advice/install/.cd,
2053   setup key/.store in=\advice@install@setupkey,
2054   activation/.is choice,
2055   activation/.append code=\def\advice@install@activation{#1},
2056   activation/immediate/.code={},
2057   activation/deferred/.code={},
2058 }

```

#1 is the installation keypath (in Memoize, /mmz); #2 is the setup key name (in Memoize, auto, and this is why we document it as such); #3 is the initial activation regime.

```

2059 \def\advice@install#1#2#3{%

```

Switch to the installation keypath.

```

2060   \pgfqkeys{#1}{%

```

**auto** These keys submit a command or environment to advising. The namespace is hard-coded into these keys via #1; their arguments are the command/environment (cs)name, and setup keys belonging to path *<installation keypath>/\meta{setup key name}*.

```

auto'
auto csname' 2061   #2/.code 2 args={%
auto key'

```

Call the internal setup macro, wrapping the received keylist into a **pgfkeys** invocation.

```

2062   \AdviceSetup{#1}{#2}{##1}{\pgfqkeys{#1/#2}{##2}}%

```

Activate if not already activated (this can happen when updating the configuration). Note we don't call **\advice@activate** directly, but use the public keys; in this way, activation is automatically deferred if so requested. (We don't use **\pgfkeysalso** to allow **auto** being called from any path.)

```

2063   \pgfqkeys{#1}{try activate, activate={##1}}%
2064   },

```

A variant without activation.

```

2065   #2'/.code 2 args={%
2066     \AdviceSetup{#1}{#2}{##1}{\pgfqkeys{#1/#2}{##2}}%
2067   },
2068   #2 csname/.style 2 args={
2069     #2/.expand once=\expandafter{\csname ##1\endcsname}{##2},
2070   },
2071   #2 csname'/.style 2 args={
2072     #2'/.expand once=\expandafter{\csname ##1\endcsname}{##2},
2073   },

```

```

2074 #2 key/.style 2 args={
2075 #2/.expand once=%
2076 \expandafter{\csname pgfk###1/.@cmd\endcsname}%
2077 {collector=\advice@pgfkeys@collector,##2},
2078 },
2079 #2 key'/.style 2 args={
2080 #2'/.expand once=%
2081 \expandafter{\csname pgfk###1/.@cmd\endcsname}%
2082 {collector=\advice@pgfkeys@collector,##2},
2083 },

```

**activation** This key, residing in the installation keypath, forwards the request to the /advice path activation subkeys, which define activate and friends in the installation keypath. Initially, the activation regime is whatever the user has requested using the .install advice argument (here #3).

```

2084 activation/.style={/advice/activation/##1={#1}},
2085 activation=#3,

```

**activate deferred** The deferred activations are collected in this style, see section refsec:code:advice:activation for details.

```

2086 activate deferred/.code={},

```

**activate csname** For simplicity of implementation, the csname versions of activate and deactivate accept a single *csname*. This way, they can be defined right away, as they don't change with the type of activation (immediate vs. deferred).

```

2087 activate csname/.style={activate/.expand once={\csname###1\endcsname}},
2088 deactivate csname/.style={deactivate/.expand once={\csname###1\endcsname}},

```

**activate key** (De)activation of pgfkeys keys. Accepts a list of key names, requires full key names.

**deactivate key**

```

2089 activate key/.style={activate@key={#1/activate}{##1}},
2090 deactivate key/.style={activate@key={#1/deactivate}{##1}},
2091 activate@key/.code n args=2{%
2092 \def\advice@temp{%
2093 \def\advice@do####1{%
2094 \eappto\advice@temp{,\expandonce{\csname pgfk#####1/.@cmd\endcsname}}}%
2095 \forcsvlist\advice@do{##2}%
2096 \pgfkeysalso{##1/.expand once=\advice@temp}%
2097 },

```

The rest of the keys defined below reside in the auto subfolder of the installation keypath.

```

2098 #2/.cd,

```

**run conditions** These keys are used to setup the handling of the command or environment. The **outer handler** storage macros (\AdviceRunConditions etc.) have public names as they also play a crucial role in the handler definitions, see section 8.1.3.

```

collector
  args
collector options
clear collector options
raw collector options
clear raw collector options
inner handler
  options
clear options
2099 run conditions/.store in=\AdviceRunConditions,
2100 bailout handler/.store in=\AdviceBailoutHandler,
2101 outer handler/.store in=\AdviceOuterHandler,
2102 collector/.store in=\AdviceCollector,
2103 collector options/.code={\appto\AdviceCollectorOptions{,##1}},
2104 clear collector options/.code={\def\AdviceCollectorOptions{}},
2105 raw collector options/.code={\appto\AdviceRawCollectorOptions{,##1}},
2106 clear raw collector options/.code={\def\AdviceRawCollectorOptions{}},
2107 args/.store in=\AdviceArgs,
2108 inner handler/.store in=\AdviceInnerHandler,
2109 options/.code={\appto\AdviceOptions{,##1}},
2110 clear options/.code={\def\AdviceOptions{}},

```

A user-friendly way to set options: any unknown key is an option.

```
2111 .unknown/.code={%
2112   \eappto{\AdviceOptions}{,\pgfkeyscurrentname={\unexpanded{##1}}}%
2113 },
```

The default values of the keys, which equal the initial values for commands, as assigned by `\advice@setup@init@command`.

```
2114 run conditions/.default=\AdviceRuntrue,
2115 bailout handler/.default=\relax,
2116 outer handler/.default=\advice@default@outer@handler,
2117 collector/.default=\advice@CollectArgumentsRaw,
2118 collector options/.value required,
2119 raw collector options/.value required,
2120 args/.default=\advice@noargs,
2121 inner handler/.default=\advice@error@noinnerhandler,
2122 options/.value required,
```

**reset** This key resets the advice settings to their initial values, which depend on whether we're handling a command or environment.

```
2123 reset/.code={\csname\advice@setup@init@\AdviceType\endcsname},
```

**after setup** The code given here will be executed once we exit the setup group. `integrated driver` of Memoize uses it to declare a conditional.

```
2124 after setup/.code={\appto\AdviceAfterSetup{##1}},
```

In  $\text{\LaTeX}$ , we finish the installation by submitting `\begin`; the submission is funky, because the run conditions handler actually hacks the standard handling procedure. Note that if `\begin` is not activated, environments will not be handled, and that the automatic activation might be deferred.

```
2125 <latex> #1/#2=\begin{run conditions=\advice@begin@rc},
2126 }%
2127 }
```

### 8.1.2 Submitting a command or environment

**\AdviceSetup** Macro `\advice@setup` is called by key `auto` to submit a command or environment to advising.  
**\AdviceName** It receives four arguments: `#1` is the installation keypath / storage namespace; `#2` is the name of  
**\AdviceType** the setup key; `#3` is the submitted command or environment; `#4` is the setup code (which is only grabbed by `\advice@setup@i`).

Executing this macro defines macros `\AdviceName`, holding the control sequence of the submitted command or the environment name, and `\AdviceType`, holding `command` or `environment`; they are used to set up some initial values, and may be used by user-defined keys in the `auto` path, as well (see `/mmz/auto/noop` for an example). The macro then performs internal initialization, and finally calls the second part, `\advice@setup@i`, with the command's *storage* name as the first argument.

This macro also serves as the programmer's interface to `auto`, the idea being that an advanced user may write code `#4` which defined the settings macros (`\AdviceOuterHandler` etc.) without deploying `pgfkeys`. (Also note that activation at the end only occurs through the `auto` interface.)

```
2128 \def\AdviceSetup#1#2#3{%
```

Open a group, so that we allow for embedded `auto` invocations.

```
2129 \begingroup
2130 \def\AdviceName{#3}%
2131 \advice@def@AdviceCname
```

Command, complain, or environment?

```

2132 \collargs@cs@cases{#3}{%
2133 \def\AdviceType{command}%
2134 \advice@setup@init@command
2135 \advice@setup@i{#3}{#1}{#3}%
2136 }{%
2137 \advice@error@advice@notcs{#1/#2}{#3}%
2138 }{%
2139 \def\AdviceType{environment}%
2140 \advice@setup@init@environment
2141 <latex> \advice@setup@i{#3}%
2142 <plain> \expandafter\advice@setup@i\expandafter{\csname #3\endcsname}%
2143 <context> \expandafter\advice@setup@i\expandafter{\csname start#3\endcsname}%
2144 {#1}{#3}%
2145 }%
2146 }

```

The arguments of `\advice@setup@i` are a bit different than for `\advice@setup`, because we have inserted the storage name as `#1` above, and we lost the setup key name `#2`. Here, `#2` is the installation keypath / storage namespace, `#3` is the submitted command or environment; and `#4` is the setup code.

What is the difference between the storage name (`#1`) and the command/environment name (`#3`, and also the contents of `\AdviceName`), and why do we need both? For commands, there is actually no difference; for example, when submitting command `\foo`, we end up with `#1=#3=\foo`. And there is also no difference for  $\text{\LaTeX}$  environments; when submitting environment `foo`, we get `#1=#3=foo`. But in plain  $\text{\TeX}$ , `#1=\foo` and `#3=foo`, and in  $\text{\ConTeXt}$ , `#1=\startfoo` and `#3=foo` — which should explain the guards and `\expandafters` above.

And why both `#1` and `#3`? When a handled command is executed, it loads its configuration from a macro determined by the storage namespace and the (`\stringified`) storage name, e.g. `/mmz` and `\foo`. In plain  $\text{\TeX}$  and  $\text{\ConTeXt}$ , each environment is started by a dedicated command, `\foo` or `\startfoo`, so these control sequences (`\stringified`) must act as storage names. (Not so in  $\text{\LaTeX}$ , where an environment configuration is loaded by `\begin`'s handler, which can easily work with storage name `foo`. Even more, having `\foo` as an environment storage name would conflict with the storage name for the (environment-internal) command `\foo` — yes, we can submit either `foo` or `\foo`, or both, to `advising`.)

```

2147 \def\advice@setup@i#1#2#3#4{%

```

Load the current configuration of the handled command or environment — if it exists.

```

2148 \advice@setup@init@i{#2}{#1}%
2149 \advice@setup@init@I{#2}{#1}%
2150 \def\AdviceAfterSetup{}%

```

Apply the setup code/keys.

```

2151 #4%

```

Save the resulting configuration. This closes the group, because the config is saved outside it.

```

2152 \advice@setup@save{#2}{#1}%
2153 }

```

**Initialize** the configuration of a command or environment. Note that the default values of the keys equal the initial values for commands. Nothing would go wrong if these were not the same, but it's nice that the end-user can easily revert to the initial values.

```

2154 \def\advice@setup@init@common{%
2155 \def\AdviceRunConditions{\AdviceRuntrue}%
2156 \def\AdviceBailoutHandler{\relax}%
2157 \def\AdviceOuterHandler{\advice@default@outer@handler}%

```



```

2158 \def\AdviceCollector{\advice@CollectArgumentsRaw}%
2159 \def\AdviceCollectorOptions{}%
2160 \def\AdviceInnerHandler{\advice@error@noinnerhandler}%
2161 \def\AdviceOptions{}%
2162 }
2163 \def\advice@setup@init@command{%
2164 \advice@setup@init@common
2165 \def\AdviceRawCollectorOptions{}%
2166 \def\AdviceArgs{\advice@noargs}%
2167 }
2168 \def\advice@setup@init@environment{%
2169 \advice@setup@init@common
2170 \edef\AdviceRawCollectorOptions{%
2171 \noexpand\collargsEnvironment{\AdviceName}%

```

When grabbing an environment body, the end-tag will be included. This makes it possible to have the same inner handler for commands and environments.

```

2172 \noexpand\collargsEndTagtrue
2173 }%
2174 \def\AdviceArgs{+b}%
2175 }

```

We need to initialize `\AdviceOuterHandler` etc. so that `\advice@setup@store` will work.

```

2176 \advice@setup@init@command

```

**The configuration storage** The remaining macros in this subsection deal with the configuration storage space, which is set up in a way to facilitate fast loading during the execution of handled commands and environments.

The configuration of a command or environment is stored in two parts: the first stage settings comprise the run conditions, the bailout handler and the outer handler; the second stage settings contain the rest. When a handled command is invoked, only the first stage settings are immediately loaded, for speed; the second stage settings are only loaded if the run conditions are satisfied.

`\advice@init@i` The two-stage settings are stored in control sequences `\advice@i<namespace>///<storage name>` and `\advice@I<namespace>///<storage name>`, respectively, and accessed using macros `\advice@init@i` and `\advice@init@I`.

Each setting storage macro contains a sequence of items, where each item is either of form `\def\AdviceSetting{<value>}`. This allows us store multiple settings in a single macro (rather than define each control-sequence-valued setting separately, which would use more string memory), and also has the consequence that we don't require the handlers to be defined when submitting a command (whether that's good or bad could be debated: as things stand, any typos in handler declarations will only yield an error once the handled command is executed).

```

2177 \def\advice@init@i#1#2{\csname advice@i#1//\string#2\endcsname}
2178 \def\advice@init@I#1#2{\csname advice@I#1//\string#2\endcsname}

```

We make a copy of these for setup; the originals might be swapped for tracing purposes.

```

2179 \let\advice@setup@init@i\advice@init@i
2180 \let\advice@setup@init@I\advice@init@I

```

`\advice@setup@save` To save the configuration at the end of the setup, we construct the storage macros out of `\AdviceRunConditions` and friends. Stage-one contains only `\AdviceRunConditions` and `\AdviceBailoutHandler`, so that `\advice@handle` can bail out as quickly as possible if the run conditions are not met.

```

2181 \def\advice@setup@save#1#2{%
2182 \expanded{%

```

Close the group before saving. Note that `\expanded` has already expanded the settings macros.

```

2183 \endgroup
2184 \noexpand\csdef{advice@i#1//\string#2}{%
2185   \def\noexpand\AdviceRunConditions{\expandonce\AdviceRunConditions}%
2186   \def\noexpand\AdviceBailoutHandler{\expandonce\AdviceBailoutHandler}%
2187 }%
2188 \noexpand\csdef{advice@I#1//\string#2}{%
2189   \def\noexpand\AdviceOuterHandler{\expandonce\AdviceOuterHandler}%
2190   \def\noexpand\AdviceCollector{\expandonce\AdviceCollector}%
2191   \def\noexpand\AdviceRawCollectorOptions{%
2192     \expandonce\AdviceRawCollectorOptions}%
2193   \def\noexpand\AdviceCollectorOptions{\expandonce\AdviceCollectorOptions}%
2194   \def\noexpand\AdviceArgs{\expandonce\AdviceArgs}%
2195   \def\noexpand\AdviceInnerHandler{\expandonce\AdviceInnerHandler}%
2196   \def\noexpand\AdviceOptions{\expandonce\AdviceOptions}%
2197 }%
2198 \expandonce{\AdviceAfterSetup}%
2199 }%
2200 }

```

**activation/immediate** These two subkeys of `/advice/activation` install the immediate and the deferred activation code into the installation keypath. They are invoked by key `<installation keypath>/activation=<type>`.

Under the deferred activation regime, the commands are not (de)activated right away. Rather, the (de)activation calls are collected in style `activate deferred`, which should be executed by the installation keypath owner, if and when they so desire. (Be sure to switch to `activation=immediate` before executing `activate deferred`, otherwise the activation will only be deferred once again.)

```

2201 \pgfkeys{
2202   /advice/activation/deferred/.style={
2203     #1/activate/.style={%
2204       activate deferred/.append style={#1/activate={##1}}},
2205     #1/deactivate/.style={%
2206       activate deferred/.append style={#1/deactivate={##1}}},
2207     #1/force activate/.style={%
2208       activate deferred/.append style={#1/force activate={##1}}},
2209     #1/try activate/.style={%
2210       activate deferred/.append style={#1/try activate={##1}}},
2211   },

```

**activate** The “real,” immediate `activate` and `deactivate` take a comma-separated list of commands or environments and (de)activate them. If `try activate` is in effect, no error is thrown upon failure.

**deactivate**

**force activate** If `force activate` is in effect, activation proceeds even if we already had the original definition;

**try activate** it does not apply to deactivation. These conditionals are set to false after every invocation of key (de)activate, so that they only apply to the immediately following (de)activate. (`#1` below is the `<namespace>`; `##1` is the list of commands to be (de)activated.)

```

2212 /advice/activation/immediate/.style={
2213   #1/activate/.code={%
2214     \forcsvlist{\advice@activate{#1}}{##1}%
2215     \advice@activate@forcefalse
2216     \advice@activate@tryfalse
2217   },
2218   #1/deactivate/.code={%
2219     \forcsvlist{\advice@deactivate{#1}}{##1}%
2220     \advice@activate@forcefalse
2221     \advice@activate@tryfalse
2222   },
2223   #1/force activate/.is if=advice@activate@force,
2224   #1/try activate/.is if=advice@activate@try,

```

```

2225 },
2226 }
2227 \newif\ifadvice@activate@force
2228 \newif\ifadvice@activate@try

```

**\advice@original@csname** Activation replaces the original meaning of the handled command with our definition. We **\advice@original@cs** store the original definition into control sequence **\advice@o{namespace}/{storage name}** **\AdviceGetOriginal** (with a **\stringified {storage name}**). Internally, during (de)activation and handling, we access it using **\advice@original@csname** and **\advice@original@cs**. Publicly it should always be accessed by **\AdviceGetOriginal**, which returns the argument control sequence if that control sequence is not handled.

Using the internal command outside the handling context, we could fall victim to scenario such as the following. When we memoize something containing a **\label**, the produced cc-memo contains code eventually executing the original **\label**. If we called the original **\label** via the internal macro there, and the user **deactivated** **\label** on a subsequent compilation, the cc-memo would not call **\label** anymore, but **\relax**, resulting in a silent error. Using **\AdviceGetOriginal**, the original **\label** will be executed even when not activated.

However, not all is bright with **\AdviceGetOriginal**. Given an activated control sequence (#2), a typo in the namespace argument (#1) will lead to an infinite loop upon the execution of **\AdviceGetOriginal**. In the manual, we recommend defining a namespace-specific macro to avoid such typos.

```

2229 \def\advice@original@csname#1#2{advice@o#1//\string#2}
2230 \def\advice@original@cs#1#2{\csname advice@o#1//\string#2\endcsname}
2231 \def\AdviceGetOriginal#1#2{%
2232   \ifcsname advice@o#1//\string#2\endcsname
2233     \expandonce{\csname advice@o#1//\string#2\expandafter\endcsname\expandafter}%
2234   \else
2235     \expandafter\noexpand\expandafter#2%
2236   \fi
2237 }

```

**\AdviceCnameGetOriginal** A version of **\AdviceGetOriginal** which accepts a control sequence name as the second argument.

```

2238 \begingroup
2239 \catcode`\/=0
2240 \catcode`\=12
2241 /gdef/advice@backslash@other{\}%
2242 /endgroup
2243 \def\AdviceCnameGetOriginal#1#2{%
2244   \ifcsname advice@o#1//\advice@backslash@other#2\endcsname
2245     \expandonce{\csname advice@o#1//\advice@backslash@other#2\expandafter\endcsname
2246       \expandafter}%
2247   \else
2248     \expandonce{\csname#2\expandafter\endcsname\expandafter}%
2249   \fi
2250 }

```

**\advice@activate** These macros execute either the command, or the environment (de)activator.  
**\advice@deactivate**

```

2251 \def\advice@activate#1#2{%
2252   \collargs@cs@cases{#2}%
2253   {\advice@activate@cmd{#1}{#2}}%
2254   {\advice@error@activate@notcsorenv{#1}}%
2255   {\advice@activate@env{#1}{#2}}%
2256 }
2257 \def\advice@deactivate#1#2{%
2258   \collargs@cs@cases{#2}%
2259   {\advice@deactivate@cmd{#1}{#2}}%
2260   {\advice@error@activate@notcsorenv{de}{#1}}%

```

```

2261     {\advice@deactivate@env{#1}{#2}}%
2262 }

```

`\advice@activate@cmd` We are very careful when we're activating a command, because activating means rewriting its original definition. Configuration by `auto` did not touch the original command; activation will. So, the leitmotif of this macro: safety first. (`#1` is the namespace, and `#2` is the command to be activated.)

```

2263 \def\advice@activate@cmd#1#2{%

```

Is the command defined?

```

2264   \ifdef{#2}{%

```

Yes, the command is defined. Let's see if it's safe to activate it. We'll do this by checking whether we have its original definition in our storage. If we do, this means that we have already activated the command. Activating it twice would lead to the loss of the original definition (because the second activation would store our own redefinition as the original definition) and consequently an infinite loop (because once — well, if — the handler tries to invoke the original command, it will execute itself all over).

```

2265     \ifcsdef{\advice@original@csname{#1}{#2}}{%

```

Yes, we have the original definition, so the safety check failed, and we shouldn't activate again. Unless ... how does its current definition look like?

```

2266     \advice@if@our@definition{#1}{#2}{%

```

Well, the current definition of the command matches what we would put there ourselves. The command is definitely activated, and we refuse to activate again, as that would destroy the original definition.

```

2267         \advice@activate@error@activated{#1}{#2}{Command}{already}%
2268     }{%

```

We don't recognize the current definition as our own code (despite the fact that we have surely activated the command before, given the result of the first safety check). It appears that someone else was playing fast and loose with the same command, and redefined it after our activation. (In fact, if that someone else was another instance of `Advice`, from another namespace, forcing the activation will result in the loss of the original definition and the infinite loop.) So it *should* be safe to activate it (again) ... but we won't do it unless the user specifically requested this using `force activate`. Note that without `force activate`, we would be stuck in this branch, as we could neither activate (again) nor deactivate the command.

```

2269         \ifadvice@activate@force
2270         \advice@activate@cmd@do{#1}{#2}%
2271     \else
2272         \advice@activate@error@activated{#1}{#2}{Command}{already}%
2273     \fi
2274 }%
2275 }{%

```

No, we don't have the command's original definition, so it was not yet activated, and we may activate it.

```

2276     \advice@activate@cmd@do{#1}{#2}%
2277 }%
2278 }{%
2279     \advice@activate@error@undefined{#1}{#2}{Command}{}%
2280 }%
2281 }

```

`\advice@deactivate@cmd` The deactivation of a command follows the same template as activation, but with a different logic, and of course a different effect. In order to deactivate a command, both safety checks discussed above must be satisfied: we must have the command’s original definition, *and* our redefinition must still reside in the command’s control sequence — the latter condition prevents overwriting someone else’s redefinition with the original command. As both conditions must be unavoidably fulfilled, `force activate` has no effect in deactivation (but `try activate` has).

```

2282 \def\advice@deactivate@cmd#1#2{%
2283   \ifdef{#2}{%
2284     \ifcsdef{\advice@original@csname{#1}{#2}}{%
2285       \advice@if@our@definition{#1}{#2}{%
2286         \advice@deactivate@cmd@do{#1}{#2}%
2287       }{%
2288         \advice@deactivate@error@changed{#1}{#2}%
2289       }%
2290     }{%
2291       \advice@activate@error@activated{#1}{#2}{Command}{not yet}%
2292     }%
2293   }{%
2294     \advice@activate@error@undefined{#1}{#2}{Command}{de}%
2295   }%
2296 }

```

`\advice@if@our@definition` This macro checks whether control sequence #2 was already activated (in namespace #1) in the sense that its current definition contains the code our activation would put there: `\advice@handle{#1}{#2}` (protected).

```

2297 \def\advice@if@our@definition#1#2{%
2298   \protected\def\advice@temp{\advice@handle{#1}{#2}}%
2299   \ifx#2\advice@temp
2300     \expandafter\@firstoftwo
2301   \else
2302     \expandafter\@secondoftwo
2303   \fi
2304 }

```

`\advice@activate@cmd@do` This macro saves the original command, and redefines its control sequence. Our redefinition must be `\protected` — even if the original command wasn’t fragile, our replacement certainly is. (Note that as we require  $\varepsilon$ -TeX anyway, we don’t have to pay attention to L<sup>A</sup>T<sub>E</sub>X’s robust commands by redefining their “inner” command. Protecting our replacement suffices.)

```

2305 \def\advice@activate@cmd@do#1#2{%
2306   \cslet{\advice@original@csname{#1}{#2}}#2%
2307   \protected\def#2{\advice@handle{#1}{#2}}%
2308   \PackageInfo{advice (#1)}{Activated command "\string#2"}%
2309 }

```

`\advice@deactivate@cmd@do` This macro restores the original command, and removes its definition from our storage — this also serves as a signal that the command is not activated anymore.

```

2310 \def\advice@deactivate@cmd@do#1#2{%
2311   \letcs#2{\advice@original@csname{#1}{#2}}%
2312   \csundef{\advice@original@csname{#1}{#2}}%
2313   \PackageInfo{advice (#1)}{Deactivated command "\string#2"}%
2314 }

```

### 8.1.3 Executing a handled command

`\advice@handle` An invocation of this macro is what replaces the original command and runs the whole shebang. The system is designed to bail out as quickly as necessary if the run conditions are not met (plus L<sup>A</sup>T<sub>E</sub>X’s `\begin` will receive a very special treatment for this reason).

We first check the run conditions, and bail out if they are not satisfied. Note that only the stage-one config is loaded at this point. It sets up the following macros (while they are public, neither the end user nor the installation keypath owner should ever have to use them):

- `\AdviceRunConditions` executes `\AdviceRuntrue` if the command should be handled; set by `run conditions`.
- `\AdviceBailoutHandler` will be executed if the command will not be handled, after all; set by `bailout handler`.

```
2315 \def\advice@handle#1#2{%
2316   \advice@init@i{#1}{#2}%
2317   \AdviceRunfalse
2318   \AdviceRunConditions
2319   \advice@handle@rc{#1}{#2}%
2320 }
```

`\advice@handle@rc` We continue the handling in a new macro, because this is the point where the handler for `\begin` will hack into the regular flow of events.

```
2321 \def\advice@handle@rc#1#2{%
2322   \ifAdviceRun
2323     \expandafter\advice@handle@outer
2324   \else
```

Bailout is simple: we first execute the handler, and then the original command.

```
2325     \AdviceBailoutHandler
2326     \expandafter\advice@original@cs
2327   \fi
2328   {#1}{#2}%
2329 }
```

`\advice@handle@outer` To actually handle the command, we first setup some macros:

- `\AdviceNamespace` holds the installation keypath / storage name space.
- `\AdviceName` holds the control sequence of the handled command, or the environment name.
- `\AdviceReplaced` holds the “substituted” code. For commands, this is the same as `\AdviceName`. For environment `foo`, it equals `\begin{foo}` in `LATEX`, `\foo` in plain `TEX` and `\startfoo` in `ConTEXt`.
- `\AdviceOriginal` executes the original definition of the handled command or environment.

```
2330 \def\advice@handle@outer#1#2{%
2331   \def\AdviceNamespace{#1}%
2332   \def\AdviceName{#2}%
2333   \advice@def@AdviceCname
2334   \let\AdviceReplaced\AdviceName
2335   \def\AdviceOriginal{\AdviceGetOriginal{#1}{#2}}%
```

We then load the stage-two settings. This defines the following macros:

- `\AdviceOuterHandler` will effectively replace the command, if it will be handled; set by `outer handler`.
- `\AdviceCollector` collects the arguments of the handled command, perhaps consulting `\AdviceArgs` to learn about its argument structure.
- `\AdviceRawCollectorOptions` contains the options which will be passed to the argument collector, in the “raw” format.
- `\AdviceCollectorOptions` contains the additional, user-specified options which will be passed to the argument collector.
- `\AdviceArgs` contains the `xparse`-style argument specification of the command, or equals `\advice@noargs` to signal that command was defined using `xparse` and that the argument specification should be retrieved automatically.
- `\AdviceInnerHandler` is called by the argument collector once it finishes its work. It receives all the collected arguments as a single (braced) argument.



- `\AdviceOptions` holds options which may be used by the outer or the inner handler; Advice does not need or touch them.

```
2336 \advice@init@I{#1}{#2}%
```

All prepared, we execute the outer handler.

```
2337 \AdviceOuterHandler
2338 }
2339 \def\advice@def@AdviceCname{%
2340 \begingroup
2341 \escapechar=-1
2342 \expandafter\expandafter\expandafter\endgroup
2343 \expandafter\expandafter\expandafter\def
2344 \expandafter\expandafter\expandafter\AdviceCname
2345 \expandafter\expandafter\expandafter{\expandafter\string\AdviceName}%
2346 }
```

`\ifAdviceRun` This conditional is set by the run conditions macro to signal whether we should run the outer (true) or the bailout (false) handler.

```
2347 \newif\ifAdviceRun
```

`\advice@default@outer@handler` The default outer handler merely executes the argument collector. Note that it works for both commands and environments.

```
2348 \def\advice@default@outer@handler{%
2349 \AdviceCollector
2350 }
```

`\advice@CollectArgumentsRaw` This is the default collector, which will collect the argument using `\CollArgs`' command `\CollectArgumentsRaw`. It will provide that command with:

- the collector options, given in the raw format:
  - the caller (`\collargsCaller`),
  - the raw options (`\AdviceRawCollectorOptions`), and
  - the user options (`\AdviceRawCollectorOptions`, wrapped in `\collargsSet`;
- the argument specification `\AdviceArgs` of the handled command; and
- the inner handler `\AdviceInnerHandler` to execute after collecting the arguments; the inner handler receives the collected arguments as a single braced argument.

If the argument specification is not defined (either the user did not set it, or has reset it by writing `args` without a value), it is assumed that the handled command was defined by `xparse` and `\AdviceArgs` will be retrieved by `\GetDocumentCommandArgSpec`.

```
2351 \def\advice@CollectArgumentsRaw{%
2352 \AdviceIfArgs{}{%
2353 \expandafter\GetDocumentCommandArgSpec\expandafter{\AdviceName}%
2354 \let\AdviceArgs\ArgumentSpecification
2355 }%
2356 \expanded{%
2357 \noexpand\CollectArgumentsRaw{%
2358 \noexpand\collargsCaller{\expandonce\AdviceName}%
2359 \expandonce\AdviceRawCollectorOptions
2360 \ifdefempty\AdviceCollectorOptions{}{%
2361 \noexpand\collargsSet{\expandonce\AdviceCollectorOptions}%
2362 }%
2363 }%
2364 {\expandonce\AdviceArgs}%
2365 {\expandonce\AdviceInnerHandler}%
2366 }%
2367 }
```



`\AdviceIfArgs` If the value of `args` is “real”, i.e. an `xparse` argument specification, execute the first argument. If `args` was set to the special value `\advice@noargs`, signaling a command defined by `\NewDocumentCommand` or friends, execute the second argument. (Ok, in reality anything other than `\advice@noargs` counts as real “real”.)

```

2368 \def\advice@noargs@text{\advice@noargs}
2369 \def\AdviceIfArgs{%
2370   \ifx\AdviceArgs\advice@noargs@text
2371     \expandafter\@secondoftwo
2372   \else
2373     \expandafter\@firstoftwo
2374   \fi
2375 }
```

`\advice@pgfkeys@collector` A `pgfkeys` collector is very simple: the sole argument of the any key macro, regardless of the argument structure of the key, is everything up to `\pgfeov`.

```

2376 \def\advice@pgfkeys@collector#1\pgfeov{%
2377   \AdviceInnerHandler{#1}%
2378 }
```

### 8.1.4 Environments

`\advice@activate@env` Things are simple in  $\text{\TeX}$  and  $\text{\ConTeXt}$ , as their environments are really commands. So `\advice@deactivate@env` rather than activating environment name `#2`, we (de)activate command `\#2` or `\start#2`, depending on the format.

```

2379 (*plain, context)
2380 \def\advice@activate@env#1#2{%
2381   \expanded{%
2382     \noexpand\advice@activate@cmd{#1}{\expandonce{\csname
2383 (context)      start%
2384               #2\endcsname}}}%
2385   }%
2386 }
2387 \def\advice@deactivate@env#1#2{%
2388   \expanded{%
2389     \noexpand\advice@deactivate@cmd{#1}{\expandonce{\csname
2390 (context)      start%
2391               #2\endcsname}}}%
2392   }%
2393 }
2394 (/plain, context)
```

We activate commands by redefining them; that’s the only way to do it. But we won’t activate a  $\text{\LaTeX}$  environment `foo` by redefining command `\foo`, where the user’s definition for the start of the environment actually resides, as such a redefinition would be executed too late, deep within the group opened by `\begin`, following many internal operations and public hooks. We handle  $\text{\LaTeX}$  environments by defining an outer handler for `\begin` (consequently,  $\text{\LaTeX}$  environment support can be (de)activated by the user by saying `(de)activate=\begin`), and activating an environment will be nothing but setting a mark, by defining a dummy control sequence `\advice@original@csname{#1}{#2}`, which that handler will inspect. Note that `force activate` has no effect here.

```

2395 (*latex)
2396 \def\advice@activate@env#1#2{%
2397   \ifcsdef{\advice@original@csname{#1}{#2}}{%
2398     \advice@activate@error@activated{#1}{#2}{Environment}{already}%
2399   }{%
2400     \csdef{\advice@original@csname{#1}{#2}}{%
2401       \PackageInfo{advice}{#1}{Activated environment "#2"}%
2402     }%
2403   }
```

```

2403 }
2404 \def\advice@deactivate@env#1#2{%
2405   \ifcsdef{\advice@original@csname{#1}{#2}}{%
2406     \csundef{\advice@original@csname{#1}{#2}}{%
2407   }{%
2408     \advice@activate@error@activated{#1}{#2}{Environment}{not yet}%
2409     \PackageInfo{advice}{#1}{Dectivated environment "#2"}%
2410   }%
2411 }

```

`\advice@begin@rc` This is the handler for `\begin`. It is very special, for speed. It is meant to be declared as the run conditions component, and it hacks into the normal flow of handling. It knows that after executing the run conditions macro, `\advice@handle` eventually (the tracing info may interrupt here as #1) continues by `\advice@handle@rc{\<namespace>}{\<handled control sequence>}`, so it grabs all these (#2 is the `\<namespace>` and #3 is the `\<handled control sequence>`, i.e. `\begin`) plus the environment name (#4).

```

2412 \def\advice@begin@rc#1\advice@handle@rc#2#3#4{%

```

We check whether environment #4 is activated (in namespace #2) by inspecting whether activation dummy is defined. If it is not, we execute the original `\begin` (`\advice@original@cs{#2}{#3}`), followed by the environment name (#4). Note that we *don't* execute the environment's bailout handler here: we haven't checked its run conditions yet, as the environment is simply not activated.

```

2413   \ifcsname\advice@original@csname{#2}{#4}\endcsname
2414     \expandafter\advice@begin@env@rc
2415   \else
2416     \expandafter\advice@original@cs
2417   \fi
2418   {#2}{#3}{#4}%
2419 }

```

`\advice@begin@env@rc` Starting from this point, we essentially replicate the workings of `\advice@handle`, adapted to L<sup>A</sup>T<sub>E</sub>X environments.

```

2420 \def\advice@begin@env@rc#1#2#3{%

```

We first load the stage-one configuration for environment #3 in namespace #1.

```

2421   \advice@init@i{#1}{#3}%

```

This defined `\AdviceRunConditions` for the environment. We can now check its run conditions. If they are not satisfied, we bail out by executing the environment's bailout handler followed by the original `\begin` (`\advice@original@cs{#1}{#2}`) plus the environment name (#3).

```

2422   \AdviceRunConditions
2423   \ifAdviceRun
2424     \expandafter\advice@begin@env@outer
2425   \else
2426     \AdviceBailoutHandler
2427     \expandafter\advice@original@cs
2428   \fi
2429   {#1}{#2}{#3}%
2430 }

```

`\advice@begin@env@outer` We define the macros expected by the outer handler, see `\advice@handle@outer`, load the second-stage configuration, and execute the environment's outer handler.

```

2431 \def\advice@begin@env@outer#1#2#3{%
2432   \def\AdviceNamespace{#1}%
2433   \def\AdviceName{#3}%

```

```

2434 \let\AdviceCsname\advice@undefined
2435 \def\AdviceReplaced{#2{#3}}%
2436 \def\AdviceOriginal{\AdviceGetOriginal{#1}{#2}{#3}}%
2437 \advice@init@I{#1}{#3}%
2438 \AdviceOuterHandler
2439 }
2440 </latex>

```

### 8.1.5 Error messages

Define error messages for the entire package. Note that `\advice@(de)activate@error@...` implement try activate.

```

2441 \def\advice@activate@error@activated#1#2#3#4{%
2442   \ifadvice@activate@try
2443   \else
2444     \PackageError{advice (#1)}{#3 "\string#2" is #4 activated}{}%
2445   \fi
2446 }
2447 \def\advice@activate@error@undefined#1#2#3#4{%
2448   \ifadvice@activate@try
2449   \else
2450     \PackageError{advice (#1)}{%
2451       #3 "\string#2" you are trying to #4activate is not defined}{}%
2452   \fi
2453 }
2454 \def\advice@deactivate@error@changed#1#2{%
2455   \ifadvice@activate@try
2456   \else
2457     \PackageError{advice (#1)}{The definition of "\string#2" has changed since we
2458       have activated it. Has somebody overridden our command?}{If you have tried
2459       to deactivate so that you could immediately reactivate, you may want to try
2460       "force activate".}%
2461   \fi
2462 }
2463 \def\advice@error@advice@notcs#1#2{%
2464   \PackageError{advice}{The first argument of key "#1" should be either a single
2465     control sequence or an environment name, not "#2"}{}%
2466 }
2467 \def\advice@error@activate@notcsorenv#1#2{%
2468   \PackageError{advice}{Each item in the value of key "#1activate" should be
2469     either a control sequence or an environment name, not "#2".}{}%
2470 }
2471 \def\advice@error@storecs@notcs#1#2{%
2472   \PackageError{advice}{The value of key "#1" should be a single control sequence,
2473     not "\string#2"}{}%
2474 }
2475 \def\advice@error@noinnerhandler#1{%
2476   \PackageError{advice (\AdviceNamespace)}{The inner handler for
2477     "\expandafter\string\AdviceName" is not defined}{}%
2478 }

```

### 8.1.6 Tracing

We implement tracing by adding the tracing information to the handlers after we load them. So it is the handlers themselves which, if and when they are executed, will print out that this is happening.

`\AdviceTracingOn` Enable and disable tracing.

`\AdviceTracingOff`

```

2479 \def\AdviceTracingOn{%
2480   \let\advice@init@i\advice@trace@init@i
2481   \let\advice@init@I\advice@trace@init@I

```

```

2482 }
2483 \def\AdviceTracingOff{%
2484   \let\advice@init@i\advice@setup@init@i
2485   \let\advice@init@I\advice@setup@init@I
2486 }

```

`\advice@typeout` The tracing output routine; the typeout macro depends on the format. In  $\text{\LaTeX}$ , we use stream `\advice@trace` `\@unused`, which is guaranteed to be unopened, so that the output will go to the terminal and the log.  $\text{\ConTeXt}$ , we don't muck about with write streams but simply use Lua function `texio.write_nl`. In plain  $\text{\TeX}$ , we use either Lua or the stream, depending on the engine; we use a high stream number 128 although the good old 16 would probably work just as well.

```

2487 (plain) \ifdefined\luatexversion
2488 (!latex) \long\def\advice@typeout#1{\directlua{texio.write_nl("\luaescapestring{#1}")}}
2489 (plain) \else
2490 (latex)  \def\advice@typeout{\immediate\write\@unused}
2491 (plain)  \def\advice@typeout{\immediate\write128}
2492 (plain) \fi
2493 \def\advice@trace#1{\advice@typeout{[tracing advice] #1}}

```

`\advice@trace@init@i` Install the tracing code.

```

\advice@trace@init@I
2494 \def\advice@trace@init@i#1#2{%
2495   \advice@trace{Advising \detokenize\expandafter{\string#2} (\detokenize{#1})}%
2496   \advice@trace{\space\space Original command meaning:
2497     \expandafter\expandafter\expandafter\meaning\advice@original@cs{#1}{#2}}%
2498   \advice@setup@init@i{#1}{#2}%
2499   \edef\AdviceRunConditions{%

```

We first execute the original run conditions, so that we can show the result.

```

2500     \expandonce\AdviceRunConditions
2501     \noexpand\advice@trace{\space\space
2502       Executing run conditions:
2503       \detokenize\expandafter{\AdviceRunConditions}
2504       -->
2505       \noexpand\ifAdviceRun true\noexpand\else false\noexpand\fi
2506     }%
2507   }%
2508   \edef\AdviceBailoutHandler{%
2509     \noexpand\advice@trace{\space\space
2510       Executing bailout handler:
2511       \detokenize\expandafter{\AdviceBailoutHandler}}%
2512     \expandonce\AdviceBailoutHandler
2513   }%
2514 }
2515 \def\advice@trace@init@I#1#2{%
2516   \advice@setup@init@I{#1}{#2}%
2517   \edef\AdviceOuterHandler{%
2518     \noexpand\advice@trace{\space\space
2519       Executing outer handler:
2520       \detokenize\expandafter{\AdviceOuterHandler}}%
2521     \expandonce\AdviceOuterHandler
2522   }%
2523   \edef\AdviceCollector{%
2524     \noexpand\advice@trace{\space\space
2525       Executing collector:
2526       \detokenize\expandafter{\AdviceCollector}}%
2527     \noexpand\advice@trace{\space\space\space\space
2528       Argument specification:
2529       \detokenize\expandafter{\AdviceArgs}}%
2530     \noexpand\advice@trace{\space\space\space\space
2531       Options:

```

```

2532 \detokenize\expandafter{\AdviceCollectorOptions}}%
2533 \noexpand\advice@trace{\space\space\space\space
2534 Raw options:
2535 \detokenize\expandafter{\AdviceRawCollectorOptions}}%
2536 \expandonce\AdviceCollector
2537 }%

```

The tracing inner handler must grab the provided argument, if it's to show what it is.

```

2538 \edef\advice@inner@handler@trace##1{%
2539 \noexpand\advice@trace{\space\space
2540 Executing inner handler:
2541 \detokenize\expandafter{\AdviceInnerHandler}}%
2542 \noexpand\advice@trace{\space\space\space\space
2543 Received arguments:
2544 \noexpand\detokenize{##1}}%
2545 \noexpand\advice@trace{\space\space\space\space
2546 Options:
2547 \detokenize\expandafter{\AdviceOptions}}%
2548 \expandonce{\AdviceInnerHandler}{##1}%
2549 }%
2550 \def\AdviceInnerHandler{\advice@inner@handler@trace}%
2551 }

```

```

2552 <plain>\resetatcatcode
2553 <context>\stopmodule
2554 <context>\protect
2555 </main>

```

### 8.1.7 The TikZ collector

In this section, we implement the argument collector for command `\tikz`, which has idiosyncratic syntax, see §12.2.2 of the [TikZ & PGF manual](#):

- `\tikz<animation spec>[<options>]{<picture code>}`
- `\tikz<animation spec>[<options>]<picture command>;`

where `<animation spec> = (:<key>={<value>})*`.

The TikZ code resides in a special file. It is meant to be `\input` at any time, so we need to temporarily assign @ category code 11.

```

2556 <*tikz>
2557 \edef\advice\resetatcatcode{\catcode`\noexpand\@the\catcode`\@relax}%
2558 \catcode`\@=11
2559 \def\AdviceCollectTikZArguments{%

```

We initialize the token register which will hold the collected arguments, and start the collection. Nothing of note happens until ...

```

2560 \toks0={}%
2561 \advice@tikz@anim
2562 }
2563 \def\advice@tikz@anim{%
2564 \pgfutil@ifnextchar[{\advice@tikz@opt}{%
2565 \pgfutil@ifnextchar:{\advice@tikz@anim@a}{%
2566 \advice@tikz@code}}}%
2567 }
2568 \def\advice@tikz@anim@a#1=#2{%
2569 \toksapp0{#1={#2}}%
2570 \advice@tikz@anim
2571 }
2572 \def\advice@tikz@opt[#1]{%
2573 \toksapp0{[#1]}%
2574 \advice@tikz@code
2575 }

```

```

2576 \def\advice@tikz@code{%
2577   \pgfutil@ifnextchar\bgroup\advice@tikz@braced\advice@tikz@single
2578 }
2579 \long\def\advice@tikz@braced#1{\toksapp0{\#1}}\advice@tikz@done}
2580 \def\advice@tikz@single#1;\{\toksapp0{\#1;}\advice@tikz@done}

```

... we finish collecting the arguments, when we execute the inner handler, with the (braced) collected arguments is its sole argument.

```

2581 \def\advice@tikz@done{%
2582   \expandafter\AdviceInnerHandler\expandafter{\the\toks0}%
2583 }
2584 \adviceresetatcatcode
2585 \tikz

```

Local Variables: TeX-engine: luatex TeX-master: "doc/memoize-code.tex" TeX-auto-save: nil End:

## 8.2 Argument collection with CollArgs

Package CollArgs provides commands `\CollectArguments` and `\CollectArgumentsRaw`, which (what a surprise!) collect the arguments conforming to the given (slightly extended) `xparse` argument specification. The package was developed to help out with automemoization (see section 5). It started out as a few lines of code, but had grown once I realized I want automemoization to work for verbatim environments as well — the environment-collecting code is based on Bruno Le Floch’s package `cprotect` — and had then grown some more once I decided to support the `xparse` argument specification in full detail, and to make the verbatim mode flexible enough to deal with a variety of situations.

The implementation of this package does not depend on `xparse`. Perhaps this is a mistake, especially as the `xparse` code is now included in the base `LATEX`, but the idea was to have a light-weight package (not sure this is the case anymore, given all the bells and whistles), to have its functionality available in plain `TEX` and `ConTEXt` as well (same as Memoize), and, perhaps most importantly, to have the ability to collect the arguments verbatim.

### Identification

```

2586 \latex\ProvidesPackage{collargs}[2024/01/02 v1.1.0 Collect arguments of any command]
2587 \context%D \module[
2588 \context%D   file=t-collargs.tex,
2589 \context%D   version=1.1.0,
2590 \context%D   title=CollArgs,
2591 \context%D   subtitle=Collect arguments of any command,
2592 \context%D   author=Saso Zivanovic,
2593 \context%D   date=2024-01-02,
2594 \context%D   copyright=Saso Zivanovic,
2595 \context%D   license=LPPL,
2596 \context%D ]
2597 \context\writestatus{loading}{ConTEXt User Module / collargs}
2598 \context\unprotect
2599 \context\startmodule[collargs]

```

### Required packages

```

2600 \latex\RequirePackage{pgfkeys}
2601 \plain\input pgfkeys
2602 \context\input t-pgfkey
2603 \latex\RequirePackage{etoolbox}
2604 \plain,context\input etoolbox-generic
2605 \plain\edef\resetatcatcode{\catcode`\noexpand\@the\catcode`\@the\relax}
2606 \plain\catcode`\@11\relax

```

`\toksapp` Macros for appending to a token register. We don't have to define them in LuaTeX, where they exist as primitives. Same as these primitives, our macros accept either a register number or a `\etoksapp` `\toksdeffed` control sequence as the (unbraced) #1; #2 is the text to append.

```
\xtoksapp
2607 \ifdefined\luatexversion
2608 \else
2609   \def\toksapp{\toks@cs@or@num\@toksapp}
2610   \def\gtoksapp{\toks@cs@or@num\@gtoksapp}
2611   \def\etoksapp{\toks@cs@or@num\@etoksapp}
2612   \def\xtoksapp{\toks@cs@or@num\@xtoksapp}
2613   \def\toks@cs@or@num#1#2#{%
```

Test whether #2 (the original #1) is a number or a control sequence.

```
2614     \ifnum-2>-1#2
```

It is a number. `\toks@cs@or@num@num` will gobble `\toks@cs@or@num@cs` below.

```
2615     \expandafter\toks@cs@or@num@num
```

The register control sequence in #2 is skipped over in the false branch.

```
2616     \fi
2617     \toks@cs@or@num@cs{#1}{#2}%
2618 }
```

#1 is one of `\@toksapp` and friends. The second macro prefixes the register number by `\toks`.

```
2619   \def\toks@cs@or@num@cs#1#2{#1{#2}}
2620   \def\toks@cs@or@num@num\toks@cs@or@num@cs#1#2{#1{\toks#2 }}
```

Having either `\tokscs` or `\toks<number>` in #1, we can finally do the real job.

```
2621   \long\def\@toksapp#1#2{#1\expandafter{\the#1#2}}%
2622   \long\def\@etoksapp#1#2{#1\expandafter{\expanded{\the#1#2}}}%
2623   \long\def\@gtoksapp#1#2{\global#1\expandafter{\the#1#2}}%
2624   \long\def\@xtoksapp#1#2{\global#1\expandafter{\expanded{\the#1#2}}}%
2625 \fi
```

`\CollectArguments` These are the only public commands provided by the package. `\CollectArguments` takes three arguments: the optional #1 is the option list, processed by `\pgfkeys` (given the grouping structure, these options will apply to all arguments); the mandatory #2 is the `xparse`-style argument specification; the mandatory #3 is the “next” command (or a sequence of commands). The argument list is expected to start immediately after the final argument; `\CollectArguments` parses it, effectively figuring out its extent, and then passes the entire argument list to the “next” command (as a single argument).

`\CollectArgumentsRaw` differs only in how it takes and processes the options. For one, these should be given as a mandatory argument. Furthermore, they do not take the form of a keylist, but should deploy the “programmer’s interface.” #1 should thus be a sequence of invocations of the macro counterparts of the keys defined in section 8.2.1, which can be recognized as starting with `\collargs` followed by a capital letter, e.g. `\collargsCaller`. Note that `\collargsSet` may also be used in #1. (The “optional,” i.e. bracketed, argument of `\CollectArgumentsRaw` is in fact mandatory.)

```
2626 \protected\def\CollectArguments{%
2627   \pgf@keys@utilifnextchar[\CollectArguments@i{\CollectArgumentsRaw{}}}%
2628 }
2629 \def\CollectArguments@i[#1]{\CollectArgumentsRaw{\collargsSet{#1}}}
2630 \protected\def\CollectArgumentsRaw#1#2#3{%
```

This group will be closed by `\collargs@`. once we grinded through the argument specification.

```
2631   \begingroup
```



Initialize category code fixing; see section 8.2.6 for details. We have to do this before applying the settings, so that `\collargsFixFromNoVerbatim` et al can take effect.

```
2632 \global\let\ifcollargs@last@verbatim\ifcollargs@verbatim
2633 \global\let\ifcollargs@last@verbatimbraces\ifcollargs@verbatimbraces
2634 \global\collargs@double@fixfalse
```

Apply the settings.

```
2635 \collargs@verbatim@wrap{#1}%
```

Initialize the space-grabber.

```
2636 \collargs@init@grabspaces
```

Remember the code to execute after collection.

```
2637 \def\collargs@next{#3}%
```

Initialize the token register holding the collected arguments.

```
2638 \global\collargs@toks{}%
```

Execute the central loop macro, which expects the argument specification #2 to be delimited from the following argument tokens by a dot.

```
2639 \collargs@#2.%
2640 }
```

**`\collargsSet`** This macro processes the given keys in the `/collargs` keypath. When it is used to process options given by the end user (the optional argument to `\CollectArguments`, and the options given within the argument specification, using the new modifier `&`), its invocation should be wrapped in `\collargs@verbatim@wrap` to correctly deal with the changes of the verbatim mode.

```
2641 \def\collargsSet#1{\pgfqkeys{/collargs}{#1}}
```

### 8.2.1 The keys

**`\collargs@cs@cases`** If the first argument of this auxiliary macro is a single control sequence, then the second argument is executed. If the first argument starts with a control sequence but this control sequence does not form the entire argument, the third argument is executed. Otherwise, the fourth argument is executed.

This macro is defined in package `CollArgs` because we use it in key `caller` below, but it is really useful in package `Auto`, where having it we don't have to bother the end-user with a separate keys for commands and environments, but automatically detect whether the argument of `auto` and `(de)activate` is a command or an environment.

```
2642 \def\collargs@cs@cases#1{\collargs@cs@cases@i#1\collargs@cs@cases@end}
2643 \let\collargs@cs@cases@end\relax
2644 \def\collargs@cs@cases@i{\futurelet\collargs@temp\collargs@cs@cases@ii}
2645 \def\collargs@cs@cases@ii#1#2\collargs@cs@cases@end{%
2646   \ifcat\noexpand\collargs@temp\relax
2647     \ifx\relax#2\relax
2648       \expandafter\expandafter\expandafter\@firstofthree
2649     \else
2650       \expandafter\expandafter\expandafter\@secondofthree
2651     \fi
2652   \else
2653     \expandafter\@thirdofthree
2654   \fi
2655 }
2656 \def\@firstofthree#1#2#3{#1}
2657 \def\@secondofthree#1#2#3{#2}
2658 \def\@thirdofthree#1#2#3{#3}
```

`caller` Every macro which grabs a part of the argument list will be accessed through the “caller” control sequence, so that  $\TeX$ ’s reports of any errors in the argument structure can contain a command name familiar to the author.<sup>4</sup> For example, if the argument list “originally” belonged to command `\foo` with argument structure `r()`, but no parentheses follow in the input, we want  $\TeX$  to complain that `Use of \foo doesn't match its definition`. This can be achieved by setting `caller=\foo`; the default is `caller=\CollectArguments`, which is still better than seeing an error involving some random internal control sequence. It is also ok to set an environment name as the caller, see below.

The key and macro defined below store the caller control sequence into `\collargs@caller`, e.g. when we say `caller=\foo`, we effectively execute `\def\collargs@caller{\foo}`.

```

2659 \collargsSet{
2660   caller/.code={\collargsCaller{#1}},
2661 }
2662 \def\collargsCaller#1{%
2663   \collargs@cs@cases{#1}{%
2664     \let\collargs@temp\collargs@caller@cs
2665   }{%
2666     \let\collargs@temp\collargs@caller@csandmore
2667   }{%
2668     \let\collargs@temp\collargs@caller@env
2669   }%
2670   \collargs@temp{#1}%
2671 }
2672 \def\collargs@caller@cs#1{%

```

If `#1` is a single control sequence, just use that as the caller.

```

2673   \def\collargs@caller{#1}%
2674 }
2675 \def\collargs@caller@csandmore#1{%

```

If `#1` starts with a control sequence, we don’t complain, but convert the entire `#1` into a control sequence.

```

2676   \begingroup
2677   \escapechar -1
2678   \expandafter\endgroup
2679   \expandafter\def\expandafter\collargs@caller\expandafter{%
2680     \csname\string#1\endcsname
2681   }%
2682 }
2683 \def\collargs@caller@env#1{%

```

If `#1` does not start with a control sequence, we assume that is an environment name, so we prepend `start` in  $\ConTeXt$ , and dress it up into `\begin{#1}` in  $\LaTeX$ .

```

2684   \expandafter\def\expandafter\collargs@caller\expandafter{%
2685     \csname
2686 <context>      start%
2687 <latex>       begin{%
2688               #1%
2689 <latex>       }%
2690               \endcsname
2691             }%
2692 }
2693 \collargsCaller\CollectArguments

```

`\ifcollargs@verbatim` The first of these conditional signals that we’re collecting the arguments in one of the `\ifcollargs@verbatimbraces` verbatim modes; the second one signals the `verb` mode in particular.

---

<sup>4</sup>The idea is borrowed from package `environ`, which is in turn based on code from `amsmath`.

```

2694 \newif\ifcollargs@verbatim
2695 \newif\ifcollargs@verbatimbraces

```

**verbatim** These keys set the verbatim mode macro which will be executed by `\collargsSet` after **verb** processing all keys. The verbatim mode macros `\collargsVerbatim`, `\collargsVerb` **no verbatim** and `\collargsNoVerbatim` are somewhat complex; we postpone their definition until section 8.2.5. Their main effect is to set conditionals `\ifcollargs@verbatim` and `\ifcollargs@verbatimbraces`, which are inspected by the argument type handlers — and to make the requested category code changes, of course.

Here, note that the verbatim-selection code is not executed while the keylist is being processed. Rather, the verbatim keys simply set the macro which will be executed *after* the keylist is processed, and this is why processing of a keylist given by the user must be always wrapped in `\collargs@verbatim@wrap`.

```

2696 \collargsSet{
2697   verbatim/.code={\let\collargs@apply@verbatim\collargsVerbatim},
2698   verb/.code={\let\collargs@apply@verbatim\collargsVerb},
2699   no verbatim/.code={\let\collargs@apply@verbatim\collargsNoVerbatim},
2700 }
2701 \def\collargs@verbatim@wrap#1{%
2702   \let\collargs@apply@verbatim\relax
2703   #1%
2704   \collargs@apply@verbatim
2705 }

```

**fix from verbatim** These keys and macros should be used to request a category code fix, when the offending **fix from verb** tokenization took place prior to invoking `\CollectArguments`; see section 8.2.6 for **fix from no verbatim** details. While I assume that only `\collargsFixFromNoVerbatim` will ever be used `\collargsFixFromVerbatim` (and it is used by `\mmz`), we provide macros for all three transitions, for completeness.

```

\collargsFixFromVerb
\collargsFixFromNoVerbatim
2706 \collargsSet{
2707   fix from verbatim/.code={\collargsFixFromVerbatim},
2708   fix from verb/.code={\collargsFixFromVerb},
2709   fix from no verbatim/.code={\collargsFixFromNoVerbatim},
2710 }

```

```

2711 \def\collargsFixFromNoVerbatim{%
2712   \global\collargs@fix@requestedtrue
2713   \global\let\ifcollargs@last@verbatim\iffalse
2714 }
2715 \def\collargsFixFromVerbatim{%
2716   \global\collargs@fix@requestedtrue
2717   \global\let\ifcollargs@last@verbatim\iftrue
2718   \global\let\ifcollargs@last@verbatimbraces\iftrue
2719 }
2720 \def\collargsFixFromVerb{%
2721   \global\collargs@fix@requestedtrue
2722   \global\let\ifcollargs@last@verbatim\iftrue
2723   \global\let\ifcollargs@last@verbatimbraces\iffalse
2724 }

```

**braces** Set the characters which are used as the grouping characters in the full verbatim mode. The user is only required to do this when multiple character pairs serve as the grouping characters. The underlying macro, `\collargsBraces`, will be defined in section 8.2.5.

```

2725 \collargsSet{
2726   braces/.code={\collargsBraces{#1}}%
2727 }

```

**environment** Set the environment name.  
`\collargsEnvironment`

```

2728 \collargsSet{

```

```

2729 environment/.estore in=\collargs@b@envname
2730 }
2731 \def\collargsEnvironment#1{\edef\collargs@b@envname{#1}}
2732 \collargsEnvironment{}

```

**begin tag** When **begin tag**/**end tag** is in effect, the **begin**/**end-tag** will be will be prepended/ap-  
**end tag** pended to the environment body. **tags** is a shortcut for setting **begin tag** and **end tag**  
**tags** simultaneously.

```

\ifcollargsBeginTag
\ifcollargsEndTag
\ifcollargsAddTags
2733 \collargsSet{
2734   begin tag/.is if=collargsBeginTag,
2735   end tag/.is if=collargsEndTag,
2736   tags/.style={begin tag=#1, end tag=#1},
2737   tags/.default=true,
2738 }
2739 \newif\ifcollargsBeginTag
2740 \newif\ifcollargsEndTag

```

**ignore nesting** When this key is in effect, we will ignore any **\begin**{*<name>*}s and simply grab  
**\ifcollargsIgnoreNesting** everything up to the first **\end**{*<name>*} (again, the markers are automatically adapted  
to the format).

```

2741 \collargsSet{
2742   ignore nesting/.is if=collargsIgnoreNesting,
2743 }
2744 \newif\ifcollargsIgnoreNesting

```

**ignore other tags** This key is only relevant in the non-verbatim and partial verbatim modes in L<sup>A</sup>T<sub>E</sub>X.  
**\ifcollargsIgnoreOtherTags** When it is in effect, CollArgs checks the environment name following each **\begin**  
and **\end**, ignoring the tags with an environment name other than **\collargs@b@envname**.

```

2745 \collargsSet{
2746   ignore other tags/.is if=collargsIgnoreOtherTags,
2747 }
2748 \newif\ifcollargsIgnoreOtherTags

```

**(append/prepend) (pre/post)processor** These keys and macros populate the list of preprocessors,  
**\collargs(Append/Prepend)(Pre/Post)processor** **\collargs@preprocess@arg**, and the list of post-processors,  
**\collargs@postprocess@arg**, executed in **\collargs@appendarg**.

```

2749 \collargsSet{
2750   append preprocessor/.code={\collargsAppendPreprocessor{#1}},
2751   prepend preprocessor/.code={\collargsPrependPreprocessor{#1}},
2752   append postprocessor/.code={\collargsAppendPostprocessor{#1}},
2753   prepend postprocessor/.code={\collargsPrependPostprocessor{#1}},
2754 }
2755 \def\collargsAppendPreprocessor{%
2756   \collargs@addprocessor\appto\collargs@preprocess@arg}
2757 \def\collargsPrependPreprocessor{%
2758   \collargs@addprocessor\preto\collargs@preprocess@arg}
2759 \def\collargsAppendPostprocessor{%
2760   \collargs@addprocessor\appto\collargs@postprocess@arg}
2761 \def\collargsPrependPostprocessor{%
2762   \collargs@addprocessor\preto\collargs@postprocess@arg}

```

Here, **#1** will be either **\appto** or **\preto**, and **#2** will be either **\collargs@preprocess@arg** or  
**\collargs@postprocess@arg**. **#3** is the processor code.

```

2763 \def\collargs@addprocessor#1#2#3{%
2764   #1#2{%
2765     \expanded{%
2766       \unexpanded{#3}{\the\collargsArg}%

```

```

2767 }%
2768 }%
2769 }

```

**clear (pre/post)processors** These keys and macros clear the pre- and post-processor lists, which are **\collargsClear(Pre/Post)processors** initially empty as well.

```

2770 \def\collargs@preprocess@arg{}
2771 \def\collargs@postprocess@arg{}
2772 \collargsSet{
2773   clear preprocessors/.code={\collargsClearPreprocessors},
2774   clear postprocessors/.code={\collargsClearPostprocessors},
2775 }
2776 \def\collargsClearPreprocessors{\def\collargs@preprocess@arg{}}%
2777 \def\collargsClearPostprocessors{\def\collargs@postprocess@arg{}}%

```

**(append/prepend) expandable (pre/post)processor** These keys and macros simplify the definition of fully **\collargs(Append/Prepend)Expandable(Pre/Post)processor** expandable processors. Note that expandable processors are added to the same list as non-expandable processors.

```

2778 \collargsSet{
2779   append expandable preprocessor/.code={%
2780     \collargsAppendExpandablePreprocessor{#1}},
2781   prepend expandable preprocessor/.code={%
2782     \collargsPrependExpandablePreprocessor{#1}},
2783   append expandable postprocessor/.code={%
2784     \collargsAppendExpandablePostprocessor{#1}},
2785   prepend expandable postprocessor/.code={%
2786     \collargsPrependExpandablePostprocessor{#1}},
2787 }
2788 \def\collargsAppendExpandablePreprocessor{%
2789   \collargs@addeprocessor\appto\collargs@preprocess@arg}
2790 \def\collargsPrependExpandablePreprocessor{%
2791   \collargs@addeprocessor\preto\collargs@preprocess@arg}
2792 \def\collargsAppendExpandablePostprocessor{%
2793   \collargs@addeprocessor\appto\collargs@postprocess@arg}
2794 \def\collargsPrependExpandablePostprocessor{%
2795   \collargs@addeprocessor\preto\collargs@postprocess@arg}
2796 \def\collargs@addeprocessor#1#2#3{%
2797   #1#2{%
2798     \expanded{%
2799       \edef\noexpand\collargs@temp{\unexpanded{#3}{\the\collargsArg}}%
2800       \unexpanded{\expandafter\collargsArg\expandafter{\collargs@temp}}}%
2801     }%
2802   }%
2803 }

```

**(append/prepend) (pre/post)wrap** These keys and macros simplify the definition of processors which yield **\collargs(Append/Prepend)(Pre/Post)wrap** the result after a single expansion. Again, they are added to the same list as other processors.

```

2804 \collargsSet{
2805   append prewrap/.code={\collargsAppendPrewrite{#1}},
2806   prepend prewrap/.code={\collargsPrependPrewrite{#1}},
2807   append postwrap/.code={\collargsAppendPostwrap{#1}},
2808   prepend postwrap/.code={\collargsPrependPostwrap{#1}},
2809 }
2810 \def\collargsAppendPrewrite{\collargs@addwrap\appto\collargs@preprocess@arg}
2811 \def\collargsPrependPrewrite{\collargs@addwrap\preto\collargs@preprocess@arg}
2812 \def\collargsAppendPostwrap{\collargs@addwrap\appto\collargs@postprocess@arg}
2813 \def\collargsPrependPostwrap{\collargs@addwrap\preto\collargs@postprocess@arg}
2814 \def\collargs@addwrap#1#2#3{%

```

```

2815 #1#2{%
2816   \long\def\collargs@temp##1{#3}%
2817   \expandafter\expandafter\expandafter\collargsArg
2818   \expandafter\expandafter\expandafter{%
2819     \expandafter\collargs@temp\expandafter{\the\collargsArg}%
2820   }%
2821 }%
2822 }

```

**no delimiters** When this conditional is in effect, the delimiter wrappers set by `\collargs@wrap` are `\ifcollargsNoDelimiters` ignored by `\collargs@appendarg`.

```

2823 \collargsSet{%
2824   no delimiters/.is if=collargsNoDelimiters,
2825 }
2826 \newif\ifcollargsNoDelimiters

```

**brace collected** When this conditional is set to false, the collected arguments are not enclosed in braces `\ifcollargsBraceCollected` when passed on to *<next-code>*.

```

2827 \collargsSet{%
2828   brace collected/.is if=collargsBraceCollected,
2829 }
2830 \newif\ifcollargsBraceCollected
2831 \collargsBraceCollectedtrue

```

## 8.2.2 The central loop

The central loop is where we grab the next *<token>* from the argument specification and execute the corresponding argument type or modifier handler, `\collargs@<token>`. The central loop consumes the argument type *<token>*; the handler will see the remainder of the argument specification (which starts with the arguments to the argument type, if any, e.g. by `()` of `d()`), followed by a dot, and then the tokens list from which the arguments are to be collected. It is the responsibility of handler to preserve the rest of the argument specification and reexecute the central loop once it is finished.

**\collargs@** Each argument is processed in a group to allow for local settings. This group is closed by `\collargs@appendarg`.

```

2832 \def\collargs@{%
2833   \begingroup
2834   \collargs@@@
2835 }

```

**\collargs@@@** This macro is where modifier handlers reenter the central loop — we don't want modifiers to open a group, because their settings should remain in effect until the next argument. Furthermore, modifiers do not trigger category code fixes.

```

2836 \def\collargs@@@#1{%
2837   \collargs@in@{#1}{&+!>.%}%
2838   \ifcollargs@in@
2839     \expandafter\collargs@@@iii
2840   \else
2841     \expandafter\collargs@@@i
2842   \fi
2843   #1%
2844 }
2845 \def\collargs@@@i#1.{%

```

Fix the category code of the next argument token, if necessary, and then proceed with the main loop.

```

2846   \collargs@fix{\collargs@@@i#1.}%
2847 }

```

Reset the fix request and set the last verbatim conditionals to the current state.

```

2848 \def\collargs@@@iif{%
2849   \global\collargs@fix@requestedfalse
2850   \global\let\ifcollargs@last@verbatim\ifcollargs@verbatim
2851   \global\let\ifcollargs@last@verbatimbraces\ifcollargs@verbatimbraces
2852   \collargs@@@iii
2853 }

```

Call the modifier or argument type handler denoted by the first token of the remainder of the argument specification.

```

2854 \def\collargs@@@iii#1{%
2855   \ifcsname collargs@#1\endcsname
2856     \csname collargs@#1\expandafter\endcsname
2857   \else

```

We throw an error if the token refers to no argument type or modifier.

```

2858     \collargs@error@badtype{#1}%
2859   \fi
2860 }

```

Throwing an error stops the processing of the argument specification, and closes the group opened in `\collargs@i`.

```

2861 \def\collargs@error@badtype#1#2.{%
2862   \PackageError{collargs}{Unknown xparse argument type or modifier "#1"
2863     for "\expandafter\string\collargs@caller\space"}{}%
2864   \endgroup
2865 }

```

`\collargs@&` We extend the `xparse` syntax with modifier `&`, which applies the given options to the following (and only the following) argument. If `&` is followed by another `&`, the options are expected to occur in the raw format, like the options given to `\CollectArgumentsRaw`. Otherwise, the options should take the form of a keylist, which will be processed by `\collargsSet`. In any case, the options should be given within the argument specification, immediately following the (single or double) `&`.

```

2866 \csdef{collargs@&}{%
2867   \futurelet\collargs@temp\collargs@amp@i
2868 }
2869 \def\collargs@amp@i{%

```

In ConTeXt, `&` has character code “other” in the text.

```

2870 <context> \ifx\collargs@temp&%
2871 <context> \expandafter\ifx\detokenize{&}\collargs@temp
2872   \expandafter\collargs@amp@raw
2873 \else
2874   \expandafter\collargs@amp@set
2875 \fi
2876 }
2877 \def\collargs@amp@raw#1#2{%
2878   \collargs@verbatim@wrap{#2}%
2879   \collargs@@@
2880 }
2881 \def\collargs@amp@set#1{%
2882   \collargs@verbatim@wrap{\collargsSet{#1}}%
2883   \collargs@@@
2884 }

```



**\collargs@+** This modifier makes the next argument long, i.e. accept paragraph tokens.

```
2885 \csdef{collargs@+}{%
2886   \collargs@longtrue
2887   \collargs@@@
2888 }
2889 \newif\ifcollargs@long
```

**\collargs@>** We can simply ignore the processor modifier. (This, **xparse**'s processor, should not be confused with CollArgs's processors, which are set using keys **append** **preprocessor** etc.)

```
2890 \csdef{collargs@>}#1{\collargs@@@}
```

**\collargs@!** Should we accept spaces before an optional argument following a mandatory argument (**xparse** manual, §1.1)? By default, yes. This modifier is only applicable to types **d** and **t**, and derived types, but, unlike **xparse**, we don't bother to enforce this; when used with other types, **!** simply has no effect.

```
2891 \csdef{collargs@!}{%
2892   \collargs@grabspacesfalse
2893   \collargs@@@
2894 }
```

**\collargs@toks** This token register is where we store the collected argument tokens. All assignments to this register are global, because it needs to survive the groups opened for individual arguments.

```
2895 \newtoks\collargs@toks
```

**\collargsArg** An auxiliary, but publicly available token register, used for processing the argument, and by some argument type handlers.

```
2896 \newtoks\collargsArg
```

**\collargs@.** This fake argument type is used to signal the end of the argument list. Note that this really counts as an extension of the **xparse** argument specification.

```
2897 \csdef{collargs@.}{%
```

Close the group opened in **\collargs@.**

```
2898   \endgroup
```

Close the main **\CollectArguments** group, fix the category code of the next token if necessary, and execute the next-code, followed by the collected arguments in braces. Any over-grabbed spaces are reinserted into the input stream, non-verbatim.

```
2899   \expanded{%
2900     \endgroup
2901     \noexpand\collargs@fix{%
2902       \expandonce\collargs@next
2903       \ifcollargsBraceCollected
2904         {\the\collargs@toks}%
2905       \else
2906         \the\collargs@toks
2907       \fi
2908     \collargs@spaces
2909   }%
2910 }%
2911 }
```

### 8.2.3 Auxiliary macros

`\collargs@appendarg` This macro is used by the argument type handlers to append the collected argument to the storage (`\collargs@toks`).

```
2912 \long\def\collargs@appendarg#1{%
```

Temporarily store the collected argument into a token register. The processors will manipulate the contents of this register.

```
2913   \collargsArg={#1}%
```

This will clear the double-fix conditional, and potentially request a normal, single fix. We can do this here because this macro is only called when something is actually collected. For details, see section 8.2.6.

```
2914   \ifcollargs@double@fix
2915     \collargs@cancel@double@fix
2916   \fi
```

Process the argument with user-definable preprocessors, the wrapper defined by the argument type, and user-definable postprocessors.

```
2917   \collargs@preprocess@arg
2918   \ifcollargsNoDelimiters
2919   \else
2920     \collargs@process@arg
2921   \fi
2922   \collargs@postprocess@arg
```

Append the processed argument, preceded by any grabbed spaces (in the correct mode), to the storage.

```
2923   \xtoksapp\collargs@toks{\collargs@grabbed@spaces\the\collargsArg}%
```

Initialize the space-grabber.

```
2924   \collargs@init@grabspaces
```

Once the argument was appended to the list, we can close its group, opened by `\collargs@`.

```
2925   \endgroup
2926 }
```

`\collargs@wrap` This macro is used by argument type handlers to declare their delimiter wrap, like square brackets around the optional argument of type o. It uses `\collargs@addwrap`, defined in section 8.2.1, but adds to `\collargs@process@arg`, which holds the delimiter wrapper defined by the argument type handler. Note that this macro *appends* a wrapper, so multiple wrappers are allowed — this is used by type e handler.

```
2927 \def\collargs@wrap{\collargs@addwrap\appto\collargs@process@arg}
2928 \def\collargs@process@arg{}
```

`\collargs@defcollector` These macros streamline the usage of the “caller” control sequence. They are like a `\collargs@defusecollector` `\def`, but should not be given the control sequence to define, as they will automatically define the control sequence residing in `\collargs@caller`; the usage is thus `\collargs@defcollector<parameters>{<definition>}`. For example, if `\collargs@caller` holds `\foo`, `\collargs@defcollector#1{(#1)}` is equivalent to `\def\foo#1{(#1)}`. Macro `\collargs@defcollector` will only define the caller control sequence to be the collector, while `\collargs@defusecollector` will also immediately execute it.

```
2929 \def\collargs@defcollector#1#1{%
2930   \ifcollargs@long\long\fi
```

```

2931 \expandafter\def\collargs@caller#1%
2932 }
2933 \def\collargs@defusecollector#1#{%
2934 \afterassignment\collargs@caller
2935 \ifcollargs@long\long\fi
2936 \expandafter\def\collargs@caller#1%
2937 }
2938 \def\collargs@letusecollector#1{%
2939 \expandafter\let\collargs@caller#1%
2940 \collargs@caller
2941 }
2942 \newif\ifcollargs@grabspaces
2943 \collargs@grabspacestrue

```

**\collargs@init@grabspaces** The space-grabber macro **\collargs@grabspaces** should be initialized by executing this macro. If **\collargs@grabspaces** is called twice without an intermediate initialization, it will assume it is in the same position in the input stream and simply bail out.

```

2944 \def\collargs@init@grabspaces{%
2945 \gdef\collargs@gs@state{0}%
2946 \gdef\collargs@spaces{}%
2947 \gdef\collargs@otherspaces{}%
2948 }

```

**\collargs@grabspaces** This auxiliary macro grabs any following spaces, and then executes the next-code given as the sole argument. The spaces will be stored into two macros, **\collargs@spaces** and **\collargs@otherspaces**, which store the spaces in the non-verbatim and the verbatim form. With the double storage, we can grab the spaces in the verbatim mode and use them non-verbatim, or vice versa. The macro takes a single argument, the code to execute after maybe grabbing the spaces.

```

2949 \def\collargs@grabspaces#1{%
2950 \edef\collargs@gs@next{\unexpanded{#1}}%
2951 \ifnum\collargs@gs@state=0
2952 \gdef\collargs@gs@state{1}%
2953 \expandafter\collargs@gs@i
2954 \else
2955 \expandafter\collargs@gs@next
2956 \fi
2957 }
2958 \def\collargs@gs@i{%
2959 \futurelet\collargs@temp\collargs@gs@g
2960 }

```

We check for grouping characters even in the verbatim mode, because we might be in the partial verbatim.

```

2961 \def\collargs@gs@g{%
2962 \ifcat\noexpand\collargs@temp\bgroup
2963 \expandafter\collargs@gs@next
2964 \else
2965 \ifcat\noexpand\collargs@temp\egroup
2966 \expandafter\expandafter\expandafter\collargs@gs@next
2967 \else
2968 \expandafter\expandafter\expandafter\collargs@gs@ii
2969 \fi
2970 \fi
2971 }
2972 \def\collargs@gs@ii{%
2973 \ifcollargs@verbatim
2974 \expandafter\collargs@gs@iii
2975 \else

```

```

2976 \expandafter\collargs@gs@iii
2977 \fi
2978 }

```

This works because the character code of a space token is always 32.

```

2979 \def\collargs@gs@iii{%
2980 \expandafter\ifx\space\collargs@temp
2981 \expandafter\collargs@gs@iv
2982 \else
2983 \expandafter\collargs@gs@next
2984 \fi
2985 }
2986 \expandafter\def\expandafter\collargs@gs@iv\space{%
2987 \gappto\collargs@spaces{ }%
2988 \xappto\collargs@otherspaces{\collargs@otherspace}%
2989 \collargs@gs@i
2990 }

```

We need the space of category 12 above.

```

2991 \begingroup\catcode\ =12\relax\gdef\collargs@otherspace{ }\endgroup
2992 \def\collargs@gs@iii#1{%

```

Macro `\collargs@cc` recalls the “outside” category code of character `#1`; see section [8.2.5](#).

```

2993 \ifnum\collargs@cc{#1}=10

```

We have a space.

```

2994 \expandafter\collargs@gs@iv
2995 \else
2996 \ifnum\collargs@cc{#1}=5

```

We have a newline.

```

2997 \expandafter\expandafter\expandafter\collargs@gs@v
2998 \else
2999 \expandafter\expandafter\expandafter\collargs@gs@next
3000 \fi
3001 \fi
3002 #1%
3003 }
3004 \def\collargs@gs@iv#1{%
3005 \gappto\collargs@otherspaces{#1}%

```

No matter how many verbatim spaces we collect, they equal a single non-verbatim space.

```

3006 \gdef\collargs@spaces{ }%
3007 \collargs@gs@i
3008 }
3009 \def\collargs@gs@v{%

```

Only add the first newline.

```

3010 \ifnum\collargs@gs@state=2
3011 \expandafter\collargs@gs@next
3012 \else
3013 \expandafter\collargs@gs@vi
3014 \fi
3015 }
3016 \def\collargs@gs@vi#1{%
3017 \gdef\collargs@gs@state{2}%
3018 \gappto\collargs@otherspaces{#1}%
3019 \gdef\collargs@spaces{ }%
3020 \collargs@gs@i
3021 }

```

`\collargs@maybegrabspace` This macro grabs any following spaces, but it will do so only when conditional `\ifcollargs@grabspace`, which can be *unset* by modifier `!`, is in effect. The macro is used by handlers for types `d` and `t`.

```

3022 \def\collargs@maybegrabspace{%
3023   \ifcollargs@grabspace
3024     \expandafter\collargs@grabspace
3025   \else
3026     \expandafter\@firstofone
3027   \fi
3028 }

```

`\collargs@grabbed@space` This macro expands to either the verbatim or the non-verbatim variant of the grabbed spaces, depending on the verbatim mode in effect at the time of expansion.

```

3029 \def\collargs@grabbed@space{%
3030   \ifcollargs@verbatim
3031     \collargs@otherspace
3032   \else
3033     \collargs@space
3034   \fi
3035 }

```

`\collargs@reinsert@space` Inserts the grabbed spaces back into the input stream, but with the category code appropriate for the verbatim mode then in effect. After the insertion, the space-grabber is initialized and the given next-code is executed in front of the inserted spaces.

```

3036 \def\collargs@reinsert@space#1{%
3037   \expanded{%
3038     \unexpanded{%
3039       \collargs@init@grabspace
3040       #1%
3041     }%
3042     \collargs@grabbed@space
3043   }%
3044 }

```

`\collargs@ifnextcat` An adaptation of `\pgf@keys@utilifnextchar` which checks whether the *category* code of the next non-space character matches the category code of `#1`.

```

3045 \long\def\collargs@ifnextcat#1#2#3{%
3046   \let\pgf@keys@utilreserved@d=#1%
3047   \def\pgf@keys@utilreserved@a{#2}%
3048   \def\pgf@keys@utilreserved@b{#3}%
3049   \futurelet\pgf@keys@utillet@token\collargs@ifncat}
3050 \def\collargs@ifncat{%
3051   \ifx\pgf@keys@utillet@token\pgf@keys@utilsp@token
3052     \let\pgf@keys@utilreserved@c\collargs@ifncat
3053   \else
3054     \ifcat\noexpand\pgf@keys@utillet@token\pgf@keys@utilreserved@d
3055       \let\pgf@keys@utilreserved@c\pgf@keys@utilreserved@a
3056     \else
3057       \let\pgf@keys@utilreserved@c\pgf@keys@utilreserved@b
3058     \fi
3059   \fi
3060   \pgf@keys@utilreserved@c}
3061 {%
3062   \def\:\{\collargs@ifncat}
3063   \expandafter\gdef\:\ {\futurelet\pgf@keys@utillet@token\collargs@ifncat}
3064 }

```

`\collargs@forrange` This macro executes macro `\collargs@do` for every integer from #1 and #2, both inclusive. `\collargs@do` should take a single parameter, the current number.

```

3065 \def\collargs@forrange#1#2{%
3066   \expanded{%
3067     \noexpand\collargs@forrange@i{\number#1}{\number#2}%
3068   }%
3069 }
3070 \def\collargs@forrange@i#1#2{%
3071   \ifnum#1>#2 %
3072     \expandafter\@gobble
3073   \else
3074     \expandafter\@firstofone
3075   \fi
3076   {%
3077     \collargs@do{#1}%
3078     \expandafter\collargs@forrange@i\expandafter{\number\numexpr#1+1\relax}{#2}%
3079   }%
3080 }

```

`\collargs@forranges` This macro executes macro `\collargs@do` for every integer falling into the ranges specified in #1. The ranges should be given as a comma-separated list of from-to items, e.g. 1-5,10-11.

```

3081 \def\collargs@forranges{\forcsvlist\collarg@forrange@i}
3082 \def\collarg@forrange@i#1{\collarg@forrange@ii#1-}
3083 \def\collarg@forrange@ii#1-#2-{\collargs@forrange{#1}{#2}}

```

`\collargs@percentchar` This macro holds the percent character of category 12.

```

3084 \begingroup
3085 \catcode`\%=12
3086 \gdef\collargs@percentchar{%}
3087 \endgroup

```

## 8.2.4 The handlers

`\collargs@l` We will first define the handler for the very funky argument type 1, which corresponds to TeX's `\def\foo#1#{...}`, which grabs (into #1) everything up to the first opening brace — not because this type is important or even recommended to use, but because the definition of the handler is very simple, at least for the non-verbatim case.

```

3088 \def\collargs@l#1.{%

```

Any pre-grabbed spaces in fact belong into the argument.

```

3089   \collargs@reinsert@spaces{\collargs@l@i#1.}%
3090 }
3091 \def\collargs@l@i{%

```

We request a correction of the category code of the delimiting brace if the verbatim mode changes for the next argument; for details, see section 8.2.6.

```

3092   \global\collargs@fix@requestedtrue

```

Most handlers will branch into the verbatim and the non-verbatim part using conditional `\ifcollargs@verbatim`. This handler is a bit special, because it needs to distinguish verbatim and non-verbatim *braces*, and braces are verbatim only in the full verbatim mode, i.e. when `\ifcollargs@verbatimbraces` is true.

```

3093   \ifcollargs@verbatimbraces
3094     \expandafter\collargs@l@verb
3095   \else
3096     \expandafter\collargs@l@ii
3097   \fi
3098 }

```

We grab the rest of the argument specification (`#1`), to be reinserted into the token stream when we reexecute the central loop.

```
3099 \def\collargs@l@ii#1.{%
```

In the non-verbatim mode, we merely have to define and execute the collector macro. The parameter text `##1##` (note the doubled hashes), which will put everything up to the first opening brace into the first argument, looks funky, but that's all.

```
3100 \collargs@defusecollector##1##{%
```

We append the collected argument, `##1`, to `\collargs@toks`, the token register holding the collected argument tokens.

```
3101 \collargs@appendarg{##1}%
```

Back to the central loop, with the rest of the argument specification reinserted.

```
3102 \collargs@#1.%
```

```
3103 }%
```

```
3104 }
```

```
3105 \def\collargs@l@verb#1.{%
```

In the verbatim branch, we need to grab everything up to the first opening brace of category code 12, so we want to define the collector with parameter text `##1{`, with the opening brace of category 12. We have stored this token in macro `\collargs@other@bgroup`, which we now need to expand.

```
3106 \expandafter\collargs@defusecollector
```

```
3107 \expandafter##\expandafter1\collargs@other@bgroup{%
```

Appending the argument works the same as in the non-verbatim case.

```
3108 \collargs@appendarg{##1}%
```

Reexecuting the central loop macro is a bit more involved, as we need to reinsert the verbatim opening brace (contrary to the regular brace above, the verbatim brace is consumed by the collector macro) back into the token stream, behind the reinserted argument specification.

```
3109 \expanded{%
```

```
3110 \noexpand\collargs@\unexpanded{#1.}%
```

```
3111 \collargs@other@bgroup
```

```
3112 }%
```

```
3113 }%
```

```
3114 }
```

`\collargs@u` Another weird type — `u⟨tokens⟩` reads everything up to the given `⟨tokens⟩`, i.e. this is  $\text{\TeX}$ 's `\def\foo#1⟨tokens⟩{...}` — but again, simple enough to allow us to showcase solutions to two recurring problems.

We start by branching into the verbatim mode (full or partial) or the non-verbatim mode.

```
3115 \def\collargs@u{%
```

```
3116 \ifcollargs@verbatim
```

```
3117 \expandafter\collargs@u@verb
```

```
3118 \else
```

```
3119 \expandafter\collargs@u@i
```

```
3120 \fi
```

```
3121 }
```

To deal with the verbatim mode, we only need to convert the above `⟨tokens⟩` (i.e. the argument of `u` in the argument specification) to category 12, i.e. we have to `\detokenize` them. Then, we may proceed as in the non-verbatim branch, `\collargs@u@ii`.

```
3122 \def\collargs@u@verb#1{%
```



The `\string` here is a temporary solution to a problem with spaces. Our verbatim mode has them of category “other”, but `\detokenize` produces a space of category “space” behind control words.

```
3123 \expandafter\collargs@u@i\expandafter{\detokenize\expandafter{\string#1}}%
3124 }
```

We then reinsert any pre-grabbed spaces into the stream, but we take care not to destroy the braces around our delimiter in the argument specification.

```
3125 \def\collargs@u@i#1#2.{%
3126 \collargs@reinsert@spaces{\collargs@u@ii{#1}#2.}%
3127 }
3128 \def\collargs@u@ii#1#2.{%
```

`#1` contains the delimiter tokens, so `##1` below will receive everything in the token stream up to these. But we have a problem: if we defined the collector as for the non-verbatim `1`, and the delimiter happened to be preceded by a single brace group, we would lose the braces. For example, if the delimiter was `-` and we received `{foo}-`, we would collect `foo-`. We solve this problem by inserting `\collargs@empty` (with an empty definition) into the input stream (at the end of this macro) — this way, the delimiter can never be preceded by a single brace group — and then expanding it away before appending to storage (within the argument of `\collargs@defusecollector`).

```
3129 \collargs@defusecollector##1#1{%
```

Define the wrapper which will add the delimiter tokens (`#1`) after the collected argument. The wrapper will be applied during argument processing in `\collargs@appendarg` (sandwiched between used-definable pre- and post-processors).

```
3130 \collargs@wrap{####1#1}%
```

Expand the first token in `##1`, which we know to be `\collargs@empty`, with empty expansion.

```
3131 \expandafter\collargs@appendarg\expandafter{##1}%
3132 \collargs@#2.%
3133 }%
```

Insert `\collargs@empty` into the input stream, in front of the “real” argument tokens.

```
3134 \collargs@empty
3135 }
3136 \def\collargs@empty{}
```

`\collargs@r` Finally, a real argument type: required delimited argument.

```
3137 \def\collargs@r{%
3138 \ifcollargs@verbatim
3139 \expandafter\collargs@r@verb
3140 \else
3141 \expandafter\collargs@r@i
3142 \fi
3143 }
3144 \def\collargs@r@verb#1#2{%
3145 \expandafter\collargs@r@i\detokenize{#1#2}%
3146 }
3147 \def\collargs@r@i#1#2#3.{%
```

We will need to use the `\collargs@empty` trick from type `u`, but with an additional twist: we need to insert it *after* the opening delimiter `#1`. To do this, we consume the opening delimiter by the “outer” collector below — we need to use the collector so that we get a nice error message when the opening delimiter is not present — and have this collector define the “inner” collector in the spirit of type `u`.

The outer collector has no parameters, it just requires the presence of the opening delimiter.

```
3148 \collargs@defcollector#1{%
```

The inner collector will grab everything up to the closing delimiter.

```
3149 \collargs@defusecollector####1#2{%
```

Append the collected argument `####1` to the list, wrapping it into the delimiters (`#1` and `#2`), but not before expanding its first token, which we know to be `\collargs@empty`.

```
3150 \collargs@wrap{#1#####1#2}%
3151 \expandafter\collargs@appendarg\expandafter{####1}%
3152 \collargs@#3.%
3153 }%
3154 \collargs@empty
3155 }%
```

Another complication: our delimited argument may be preceded by spaces. To replicate the argument tokens faithfully, we need to collect them before trying to grab the argument itself.

```
3156 \collargs@grabspaces\collargs@caller
3157 }
```

`\collargs@R` Discard the default and execute `r`.

```
3158 \def\collargs@R#1#2#3{\collargs@r#1#2}
```

`\collargs@d` Optional delimited argument. Very similar to `r`.

```
3159 \def\collargs@d{%
3160 \ifcollargs@verbatim
3161 \expandafter\collargs@d@verb
3162 \else
3163 \expandafter\collargs@d@i
3164 \fi
3165 }
3166 \def\collargs@d@verb#1#2{%
3167 \expandafter\collargs@d@i\detokenize{#1#2}%
3168 }
3169 \def\collargs@d@i#1#2#3.{%
```

This macro will be executed when the optional argument is not present. It simply closes the argument's group and reexecutes the central loop.

```
3170 \def\collargs@d@noopt{%
3171 \global\collargs@fix@requestedtrue
3172 \endgroup
3173 \collargs@#3.%
3174 }%
```

The collector(s) are exactly as for `r`.

```
3175 \collargs@defcollector#1{%
3176 \collargs@defusecollector####1#2{%
3177 \collargs@wrap{#1#####1#2}%
3178 \expandafter\collargs@appendarg\expandafter{####1}%
3179 \collargs@#3.%
3180 }%
3181 \collargs@empty
3182 }%
```

This macro will check, in conjunction with `\futurelet` below, whether the optional argument is present or not.

```

3183 \def\collargs@d@ii{%
3184   \ifx#1\collargs@temp
3185     \expandafter\collargs@caller
3186   \else
3187     \expandafter\collargs@d@noopt
3188   \fi
3189 }%
```

Whether spaces are allowed in front of this type of argument depends on the presence of modifier `!`.

```

3190 \collargs@maybegrabspaces{\futurelet\collargs@temp\collargs@d@ii}%
3191 }
```

`\collargs@D` Discard the default and execute `d`.

```

3192 \def\collargs@D#1#2#3{\collargs@d#1#2}
```

`\collargs@o` `o` is just `d` with delimiters `[` and `]`.

```

3193 \def\collargs@o{\collargs@d[]}
```

`\collargs@O` `O` is just `d` with delimiters `[` and `]` and the discarded default.

```

3194 \def\collargs@O#1{\collargs@d[]}
```

`\collargs@t` An optional token. Similar to `d`.

```

3195 \def\collargs@t{%
3196   \ifcollargs@verbatim
3197     \expandafter\collargs@t@verb
3198   \else
3199     \expandafter\collargs@t@i
3200   \fi
3201 }
3202 \def\collargs@t@space{ }
3203 \def\collargs@t@verb#1{%
3204   \let\collargs@t@space\collargs@otherspace
3205   \expandafter\collargs@t@i\expandafter{\detokenize{#1}}%
3206 }
3207 \def\collargs@t@i#1{%
3208   \expandafter\ifx\space#1%
3209     \expandafter\collargs@t@s
3210   \else
3211     \expandafter\collargs@t@I\expandafter#1%
3212   \fi
3213 }
3214 \def\collargs@t@s#1.{%
3215   \collargs@grabspaces{%
3216     \ifcollargs@grabspaces
3217       \collargs@appendarg{}}%
3218   \else
3219     \expanded{%
3220       \noexpand\collargs@init@grabspaces
3221       \noexpand\collargs@appendarg{\collargs@grabbed@spaces}%
3222     }%
3223   \fi
3224   \collargs@#1.%
3225 }%
3226 }
```

```

3227 \def\collargs@t@I#1#2.{%
3228   \def\collargs@t@noopt{%
3229     \global\collargs@fix@requestedtrue
3230     \endgroup
3231     \collargs@#2.%
3232   }%
3233   \def\collargs@t@opt##1{%
3234     \collargs@appendarg{#1}%
3235     \collargs@#2.%
3236   }%
3237   \def\collargs@t@ii{%
3238     \ifx#1\collargs@temp
3239       \expandafter\collargs@t@opt
3240     \else
3241       \expandafter\collargs@t@noopt
3242     \fi
3243   }%
3244   \collargs@maybegrabspaces{\futurelet\collargs@temp\collargs@t@ii}%
3245 }
3246 \def\collargs@t@opt@space{%
3247   \expanded{\noexpand\collargs@t@opt{\space}\expandafter}\romannumeral-0%
3248 }%

```

**\collargs@s** The optional star is just a special case of t.

```

3249 \def\collargs@s{\collargs@t*}

```

**\collargs@m** Mandatory argument. Interestingly, here's where things get complicated, because we have to take care of several T<sub>E</sub>X quirks.

```

3250 \def\collargs@m{%
3251   \ifcollargs@verbatim
3252     \expandafter\collargs@m@verb
3253   \else
3254     \expandafter\collargs@m@i
3255   \fi
3256 }

```

The non-verbatim mode. First, collect any spaces in front of the argument.

```

3257 \def\collargs@m@i#1.{%
3258   \collargs@grabspaces{\collargs@m@checkforgroup#1.}%
3259 }

```

Is the argument in braces or not?

```

3260 \def\collargs@m@checkforgroup#1.{%
3261   \edef\collargs@action{\unexpanded{\collargs@m@checkforgroup@i#1.}}%
3262   \futurelet\collargs@token\collargs@action
3263 }
3264 \def\collargs@m@checkforgroup@i{%
3265   \ifcat\noexpand\collargs@token\bgroup
3266     \expandafter\collargs@m@group
3267   \else
3268     \expandafter\collargs@m@token
3269   \fi
3270 }

```

The argument is given in braces, so we put them back around it (**\collargs@wrap**) when appending to the storage.

```

3271 \def\collargs@m@group#1.{%
3272   \collargs@defusecollector##1{%

```

```

3273 \collargs@wrap{####1}}%
3274 \collargs@appendarg{##1}%
3275 \collargs@#1.%
3276 }%
3277 }

```

The argument is a single token, we append it to the storage as is.

```

3278 \def\collargs@m@token#1.{%
3279 \collargs@defusecollector##1{%
3280 \collargs@appendarg{##1}%
3281 \collargs@#1.%
3282 }%
3283 }

```

The verbatim mode. Again, we first collect any spaces in front of the argument.

```

3284 \def\collargs@m@verb#1.{%
3285 \collargs@grabspaces{\collargs@m@verb@checkforgroup#1.}%
3286 }

```

We want to check whether we're dealing with a braced argument. We're in the verbatim mode, but are braces verbatim as well? In other words, are we in `verbatim` or `verb` mode? In the latter case, braces are regular, so we redirect to the regular mode.

```

3287 \def\collargs@m@verb@checkforgroup{%
3288 \ifcollargs@verbatimbraces
3289 \expandafter\collargs@m@verb@checkforgroup@i
3290 \else
3291 \expandafter\collargs@m@checkforgroup
3292 \fi
3293 }

```

Is the argument in verbatim braces?

```

3294 \def\collargs@m@verb@checkforgroup@i#1.{%
3295 \def\collargs@m@verb@checkforgroup@ii{\collargs@m@verb@checkforgroup@iii#1.}%
3296 \futurelet\collargs@temp\collargs@m@verb@checkforgroup@ii
3297 }
3298 \def\collargs@m@verb@checkforgroup@iii#1.{%
3299 \expandafter\ifx\collargs@other@bgroup\collargs@temp

```

Yes, the argument is in (verbatim) braces.

```

3300 \expandafter\collargs@m@verb@group
3301 \else

```

We need to manually check whether the following token is a (verbatim) closing brace, and throw an error if it is.

```

3302 \expandafter\ifx\collargs@other@egroup\collargs@temp
3303 \expandafter\expandafter\expandafter\collargs@m@verb@egrouperror
3304 \else

```

The argument is a single token.

```

3305 \expandafter\expandafter\expandafter\collargs@m@v@token
3306 \fi
3307 \fi
3308 #1.%
3309 }
3310 \def\collargs@m@verb@egrouperror#1.{%
3311 \PackageError{collargs}{%
3312 Argument of \expandafter\string\collargs@caller\space has an extra
3313 \iffalse{\else\string}}}%
3314 }

```

A single-token verbatim argument.

```
3315 \def\collargs@m@v@token#1.#2{%
```

Is it a control sequence? (Macro `\collargs@cc` recalls the “outside” category code of character `#1`; see section 8.2.5.)

```
3316 \ifnum\collargs@cc{#2}=0
3317   \expandafter\collargs@m@v@token@cs
3318 \else
3319   \expandafter\collargs@m@token
3320 \fi
3321 #1.#2%
3322 }
```

Is it a one-character control sequence?

```
3323 \def\collargs@m@v@token@cs#1.#2#3{%
3324   \ifnum\collargs@cc{#3}=11
3325     \expandafter\collargs@m@v@token@cs@letter
3326   \else
3327     \expandafter\collargs@m@v@token@cs@nonletter
3328   \fi
3329   #1.#2#3%
3330 }
```

Store `\<token>`.

```
3331 \def\collargs@m@v@token@cs@nonletter#1.#2#3{%
3332   \collargs@appendarg{#2#3}%
3333   \collargs@#1.%
3334 }
```

Store `\` to a temporary register, we’ll parse the control sequence name now.

```
3335 \def\collargs@m@v@token@cs@letter#1.#2{%
3336   \collargsArg{#2}%
3337   \def\collargs@tempa{#1}%
3338   \collargs@m@v@token@cs@letter@i
3339 }
```

Append a letter to the control sequence.

```
3340 \def\collargs@m@v@token@cs@letter@i#1{%
3341   \ifnum\collargs@cc{#1}=11
3342     \toksapp\collargsArg{#1}%
3343     \expandafter\collargs@m@v@token@cs@letter@i
3344   \else
```

Finish, returning the non-letter to the input stream.

```
3345     \expandafter\collargs@m@v@token@cs@letter@ii\expandafter#1%
3346   \fi
3347 }
```

Store the verbatim control sequence.

```
3348 \def\collargs@m@v@token@cs@letter@ii{%
3349   \expanded{%
3350     \unexpanded{%
3351       \expandafter\collargs@appendarg\expandafter{\the\collargsArg}%
3352     }%
3353     \noexpand\collargs@\expandonce\collargs@tempa.%
3354   }%
3355 }
```

The verbatim mandatory argument is delimited by verbatim braces. We have to use the heavy machinery adapted from `cprotect`.

```

3356 \def\collargs@m@verb@group#1.#2{%
3357   \let\collargs@begintag\collargs@other@bgroup
3358   \let\collargs@endtag\collargs@other@egroup
3359   \def\collargs@tagarg{%
3360     \def\collargs@commandatend{\collargs@m@verb@group@i#1.}%
3361     \collargs@readContent
3362   }

```

This macro appends the result given by the heavy machinery, waiting for us in macro `\collargsArg`, to `\collargs@toks`, but not before dressing it up (via `\collargs@wrap`) in a pair of verbatim braces.

```

3363 \def\collargs@m@verb@group@i{%
3364   \edef\collargs@temp{%
3365     \collargs@other@bgroup\unexpanded{##1}\collargs@other@egroup}%
3366   \expandafter\collargs@wrap\expandafter{\collargs@temp}%
3367   \expandafter\collargs@appendarg\expandafter{\the\collargsArg}%
3368   \collargs@
3369 }

```

`\collargs@g` An optional group: same as `m`, but we simply bail out if we don't find the group character.

```

3370 \def\collargs@g{%
3371   \def\collargs@m@token{%
3372     \global\collargs@fix@requestedtrue
3373     \endgroup
3374     \collargs@
3375   }%
3376   \let\collargs@m@v@token\collargs@m@token
3377   \collargs@m
3378 }

```

`\collargs@G` Discard the default and execute `g`.

```

3379 \def\collargs@G#1{\collargs@g}

```

`\collargs@v` Verbatim argument. The code is executed in the group, deploying `\collargsVerbatim`. The grouping characters are always set to braces, to mimic `xparse` perfectly.

```

3380 \def\collargs@v#1.{%
3381   \begingroup
3382   \collargsBraces{}}%
3383   \collargsVerbatim
3384   \collargs@grabspaces{\collargs@v@i#1.}%
3385 }
3386 \def\collargs@v@i#1.#2{%
3387   \expandafter\ifx\collargs@other@bgroup#2%

```

If the first token we see is an opening brace, use the `cprotect` adaptation to grab the group.

```

3388   \let\collargs@begintag\collargs@other@bgroup
3389   \let\collargs@endtag\collargs@other@egroup
3390   \def\collargs@tagarg{%
3391     \def\collargs@commandatend{%
3392       \edef\collargs@temp{%
3393         \collargs@other@bgroup\unexpanded{####1}\collargs@other@egroup}%
3394       \expandafter\collargs@wrap\expandafter{\collargs@temp}%
3395       \expandafter\collargs@appendarg\expandafter{\the\collargsArg}%
3396       \endgroup
3397       \collargs@#1.%

```



```

3398     }%
3399     \expandafter\collargs@readContent
3400 \else

```

Otherwise, the verbatim argument is delimited by two identical characters (#2).

```

3401     \collargs@defcollector##1#2{%
3402         \collargs@wrap{#2###1#2}%
3403         \collargs@appendarg{##1}%
3404         \endgroup
3405         \collargs@#1.%
3406     }%
3407     \expandafter\collargs@caller
3408 \fi
3409 }

```

`\collargs@b` Environments. Here's where all hell breaks loose. We survive by adapting some code from Bruno Le Floch's `cprotect`. We first define the environment-related keys, then provide the handler code, and finish with the adaptation of `cprotect`'s environment-grabbing code.

The argument type `b` token may be followed by a braced environment name (in the argument specification).

```

3410 \def\collargs@b{%
3411     \collargs@ifnextcat\bgroup\collargs@bg\collargs@bi
3412 }
3413 \def\collargs@bg#1{%
3414     \edef\collargs@b@envname{#1}%
3415     \collargs@bi
3416 }
3417 \def\collargs@bi#1.{%

```

Convert the environment name to verbatim if necessary.

```

3418     \ifcollargs@verbatim
3419         \edef\collargs@b@envname{\detokenize\expandafter{\collargs@b@envname}}%
3420     \fi

```

This is a format-specific macro which sets up `\collargs@begintag` and `\collargs@endtag`.

```

3421     \collargs@bi@defCPTbeginend
3422     \edef\collargs@tagarg{%
3423         \ifcollargs@verbatimbraces
3424         \else
3425             \ifcollargsIgnoreOtherTags
3426                 \collargs@b@envname
3427             \fi
3428         \fi
3429     }%

```

Run this after collecting the body.

```

3430     \def\collargs@commandatend{%

```

In  $\text{\LaTeX}$ , we might, depending on the verbatim mode, need to check whether the environment name is correct.

```

3431 \<latex> \collargs@bii

```

In plain  $\text{\TeX}$  and  $\text{\ConTeXt}$ , we can skip directly to `\collargs@biii`.

```

3432 \<plain,context> \collargs@biii
3433     #1.%
3434 }%

```

Collect the environment body, but first, put any grabbed spaces back into the input stream.

```
3435 \collargs@reinsert@spaces\collargs@readContent
3436 }
3437 <*/latex>
```

In L<sup>A</sup>T<sub>E</sub>X in the regular and the partial verbatim mode, we search for `\begin/\end` — as we cannot search for braces — either as control sequences in the regular mode, or as strings in the partial verbatim mode. (After search, we will have to check whether the argument of `\begin/\end` matches our environment name.) In the full verbatim mode, we can search for the entire string `\begin/\end{<name>}`.

```
3438 \def\collargs@bi@defCPTbeginend{%
3439   \edef\collargs@begintag{%
3440     \ifcollargs@verbatim
3441       \expandafter\string
3442     \else
3443       \expandafter\noexpand
3444     \fi
3445     \begin
3446     \ifcollargs@verbatimbraces
3447       \collargs@other@bgroup\collargs@b@envname\collargs@other@egroup
3448     \fi
3449   }%
3450   \edef\collargs@endtag{%
3451     \ifcollargs@verbatim
3452       \expandafter\string
3453     \else
3454       \expandafter\noexpand
3455     \fi
3456     \end
3457     \ifcollargs@verbatimbraces
3458       \collargs@other@bgroup\collargs@b@envname\collargs@other@egroup
3459     \fi
3460   }%
3461 }
3462 </latex>
3463 <*plain, context>
```

We can search for the entire `\<name>/\end<name>` (in T<sub>E</sub>X) or `\start<name>/\stop<name>` (in ConT<sub>E</sub>Xt), either as a control sequence (in the regular mode), or as a string (in the verbatim modes).

```
3464 \def\collargs@bi@defCPTbeginend{%
3465   \edef\collargs@begintag{%
3466     \ifcollargs@verbatim
3467       \expandafter\expandafter\expandafter\string
3468     \else
3469       \expandafter\expandafter\expandafter\noexpand
3470     \fi
3471     \csname
3472 <context>      start%
3473       \collargs@b@envname
3474     \endcsname
3475   }%
3476   \edef\collargs@endtag{%
3477     \ifcollargs@verbatim
3478       \expandafter\expandafter\expandafter\string
3479     \else
3480       \expandafter\expandafter\expandafter\noexpand
3481     \fi
3482     \csname
3483 <plain>      end%
```

```

3484 <context>      stop%
3485              \collargs@b@envname
3486              \endcsname
3487      }%
3488 }
3489 </plain, context>
3490 <*latex>

```

Check whether we're in front of the (braced) environment name (in L<sup>A</sup>T<sub>E</sub>X), and consume it.

```

3491 \def\collargs@bii{%
3492   \ifcollargs@verbatimbraces
3493     \expandafter\collargs@biii
3494   \else
3495     \ifcollargsIgnoreOtherTags

```

We shouldn't check the name in this case, because it was already checked, and consumed.

```

3496     \expandafter\expandafter\expandafter\collargs@biii
3497   \else
3498     \expandafter\expandafter\expandafter\collargs@b@checkend
3499   \fi
3500 \fi
3501 }
3502 \def\collargs@b@checkend#1.{%
3503   \collargs@grabspaces{\collargs@b@checkend@i#1.}%
3504 }
3505 \def\collargs@b@checkend@i#1.#2{%
3506   \def\collargs@temp{#2}%
3507   \ifx\collargs@temp\collargs@b@envname
3508   \else
3509     \collargs@b@checkend@error
3510   \fi
3511   \collargs@biii#1.%
3512 }
3513 \def\collargs@b@checkend@error{%
3514   \PackageError{collargs}{Environment "\collargs@b@envname" ended as
3515     "\collargs@temp"}{ }%
3516 }
3517 </latex>

```

This macro stores the collected body.

```

3518 \def\collargs@biii{%

```

Define the wrapper macro (`\collargs@temp`).

```

3519   \collargs@b@def@wrapper

```

Execute `\collargs@appendarg` to append the body to the list. Expand the wrapper in `\collargs@temp` first and the body in `\collargsArg` next.

```

3520   \expandafter\collargs@appendarg\expandafter{\the\collargsArg}%

```

Reexecute the central loop.

```

3521   \collargs@
3522 }
3523 \def\collargs@b@def@wrapper{%
3524 <latex>   \edef\collargs@temp{\collargs@b@envname}}%
3525   \edef\collargs@temp{%

```

Was the begin-tag requested?

```

3526   \ifcollargsBeginTag

```

`\collargs@begintag` is already adapted to the format and the verbatim mode.

```
3527 \expandonce\collargs@begintag
```

Add the braced environment name in  $\text{\LaTeX}$  in the regular and partial verbatim mode.

```
3528 *latex>
3529 \ifcollargs@verbatimbraces\else\collargs@temp\fi
3530 /latex>
3531 \fi
```

This is the body.

```
3532 #####1%
```

Rinse and repeat for the end-tag.

```
3533 \ifcollargsEndTag
3534 \expandonce\collargs@endtag
3535 *latex>
3536 \ifcollargs@verbatimbraces\else\collargs@temp\fi
3537 /latex>
3538 \fi
3539 }%
3540 \expandafter\collargs@wrap\expandafter{\collargs@temp}%
3541 }
```

\collargs@readContent This macro, which is an adaptation of `cprotect`'s environment-grabbing code, collects some delimited text, leaving the result in `\collargsArg`. Before calling it, one must define the following macros: `\collargs@begintag` and `\collargs@endtag` are the content delimiters; `\collargs@tagarg`, if non-empty, is the token or grouped text which must follow a delimiter to be taken into account; `\collargs@commandatend` is the command that will be executed once the content is collected.

```
3542 \def\collargs@readContent{%
```

Define macro which will search for the first begin-tag.

```
3543 \ifcollargs@long\long\fi
3544 \collargs@CPT@def\collargs@gobbleOneB\collargs@begintag{%
```

Assign the collected tokens into a register. The first token in `##1` will be `\collargs@empty`, so we expand to get rid of it.

```
3545 \toks0\expandafter{##1}%
```

`cprotect` simply grabs the token following the `\collargs@begintag` with a parameter. We can't do this, because we need the code to work in the non-verbatim mode, as well, and we might stumble upon a brace there. So we take a peek.

```
3546 \futurelet\collargs@temp\collargs@gobbleOneB@i
3547 }%
```

Define macro which will search for the first end-tag. We make it long if so required (by +).

```
3548 \ifcollargs@long\long\fi
3549 \collargs@CPT@def\collargs@gobbleUntilE\collargs@endtag{%
```

Expand `\collargs@empty` at the start of `##1`.

```
3550 \expandafter\toksapp\expandafter0\expandafter{##1}%
3551 \collargs@gobbleUntilE@i
3552 }%
```

Initialize.

```
3553 \collargs@begins=0\relax
3554 \collargsArg{}%
3555 \toks0{}%
```

We will call `\collargs@gobbleUntilE` via the caller control sequence.

```
3556 \collargs@letusecollector\collargs@gobbleUntilE
```

We insert `\collargs@empty` to avoid the potential debracing problem.

```
3557 \collargs@empty
3558 }
```

How many begin-tags do we have opened?

```
3559 \newcount\collargs@begins
```

An auxiliary macro which `\defs #1` so that it will grab everything up until `#2`. Additional parameters may be present before the definition.

```
3560 \def\collargs@CPT@def#1#2{%
3561 \expandafter\def\expandafter#1%
3562 \expandafter##\expandafter1#2%
3563 }
```

A quark guard.

```
3564 \def\collargs@qend{\collargs@qend}
```

This macro will collect the “environment”, leaving the result in `\collargsArg`. It expects `\collargs@begintag`, `\collargs@endtag` and `\collargs@commandatend` to be set.

```
3565 \def\collargs@gobbleOneB@i{%
3566 \def\collargs@begins@increment{1}%
3567 \ifx\collargs@qend\collargs@temp
```

We have reached the fake begin-tag. Note that we found the end-tag.

```
3568 \def\collargs@begins@increment{-1}%
```

Gobble the quark guard.

```
3569 \expandafter\collargs@gobbleOneB@v
3570 \else
```

Append the real begin-tag to the temporary tokens.

```
3571 \etoksapp0{\expandonce\collargs@begintag}%
3572 \expandafter\collargs@gobbleOneB@ii
3573 \fi
3574 }%
```

Do we have to check the tag argument (i.e. the environment name after `\begin`)?

```
3575 \def\collargs@gobbleOneB@ii{%
3576 \expandafter\ifx\expandafter\relax\collargs@tagarg\relax
3577 \expandafter\collargs@gobbleOneB@vi
3578 \else
```

Yup, so let's (carefully) collect the tag argument.

```
3579 \expandafter\collargs@gobbleOneB@iii
3580 \fi
3581 }
3582 \def\collargs@gobbleOneB@iii{%
3583 \collargs@grabspaces{%
3584 \collargs@letusecollector\collargs@gobbleOneB@iv
3585 }%
3586 }
3587 \def\collargs@gobbleOneB@iv#1{%
3588 \def\collargs@temp{#1}%
3589 \ifx\collargs@temp\collargs@tagarg
```

This is the tag argument we've been waiting for!

```
3590 \else
```

Nope, this `\begin` belongs to someone else.

```
3591 \def\collargs@begins@increment{0}%
3592 \fi
```

Whatever the result was, we have to append the gobbled group to the temporary toks.

```
3593 \etoksapp0{\collargs@grabbed@spaces\unexpanded{{#1}}}%
3594 \collargs@init@grabspaces
3595 \collargs@gobbleOneB@vi
3596 }
3597 \def\collargs@gobbleOneB@v#1{\collargs@gobbleOneB@vi}
3598 \def\collargs@gobbleOneB@vi{%
```

Store.

```
3599 \etoksapp\collargsArg{\the\toks0}%
```

Advance the begin-tag counter.

```
3600 \advance\collargs@begins\collargs@begins@increment\relax
```

Find more begin-tags, unless this was the final one.

```
3601 \ifnum\collargs@begins@increment=-1
3602 \else
3603 \expandafter\collargs@gobbleOneB\expandafter\collargs@empty
3604 \fi
3605 }
3606 \def\collargs@gobbleUntilE@i{%
```

Do we have to check the tag argument (i.e. the environment name after `\end`)?

```
3607 \expandafter\ifx\expandafter\relax\collargs@tagarg\relax
3608 \expandafter\collargs@gobbleUntilE@iv
3609 \else
```

Yup, so let's (carefully) collect the tag argument.

```
3610 \expandafter\collargs@gobbleUntilE@ii
3611 \fi
3612 }
3613 \def\collargs@gobbleUntilE@ii{%
3614 \collargs@grabspaces{%
3615 \collargs@letusecollector\collargs@gobbleUntilE@iii
3616 }%
3617 }
```

```

3618 \def\collargs@gobbleUntilE@iii#1{%
3619   \etoksapp0{\collargs@grabbed@spaces}%
3620   \collargs@init@grabspaces
3621   \def\collargs@tempa{#1}%
3622   \ifx\collargs@tempa\collargs@tagarg

```

This is the tag argument we've been waiting for!

```

3623     \expandafter\collargs@gobbleUntilE@iv
3624   \else

```

Nope, this `\end` belongs to someone else. Insert the end tag plus the tag argument, and collect until the next `\end`.

```

3625     \expandafter\toksapp\expandafter0\expandafter{\collargs@endtag{#1}}%
3626     \expandafter\collargs@letusecollector\expandafter\collargs@gobbleUntilE
3627   \fi
3628 }
3629 \def\collargs@gobbleUntilE@iv{%

```

Invoke `\collargs@gobbleOneB` with the collected material, plus a fake begin-tag and a quark guard.

```

3630   \ifcollargsIgnoreNesting
3631     \expandafter\collargsArg\expandafter{\the\toks0}%
3632     \expandafter\collargs@commandatend
3633   \else
3634     \expandafter\collargs@gobbleUntilE@v
3635   \fi
3636 }
3637 \def\collargs@gobbleUntilE@v{%
3638   \expanded{%
3639     \noexpand\collargs@letusecollector\noexpand\collargs@gobbleOneB
3640     \noexpand\collargs@empty
3641     \the\toks0

```

Add a fake begin-tag and a quark guard.

```

3642     \expandonce\collargs@begintag
3643     \noexpand\collargs@qend
3644   }%
3645   \ifnum\collargs@begins<0
3646     \expandafter\collargs@commandatend
3647   \else
3648     \etoksapp\collargsArg{%
3649       \expandonce\collargs@endtag
3650       \expandafter\ifx\expandafter\relax\collargs@tagarg\relax\else{%
3651         \expandonce\collargs@tagarg}\fi
3652     }%
3653     \toks0={}%
3654     \expandafter\collargs@letusecollector\expandafter\collargs@gobbleUntilE
3655     \expandafter\collargs@empty
3656   \fi
3657 }

```

`\collargs@e` Embellishments. Each embellishment counts as an argument, in the sense that we will execute `\collargs@appendarg`, with all the processors, for each embellishment separately.

```

3658 \def\collargs@e{%

```

We open an extra group, because `\collargs@appendarg` will close a group for each embellishment.

```

3659   \global\collargs@fix@requestedtrue
3660   \begingroup

```



```

3661 \ifcollargs@verbatim
3662 \expandafter\collargs@e@verbatim
3663 \else
3664 \expandafter\collargs@e@i
3665 \fi
3666 }

```

Detokenize the embellishment tokens in the verbatim mode.

```

3667 \def\collargs@e@verbatim#1{%
3668 \expandafter\collargs@e@i\expandafter{\detokenize{#1}}%
3669 }

```

Ungroup the embellishment tokens, separating them from the rest of the argument specification by a dot.

```

3670 \def\collargs@e@i#1{\collargs@e@ii#1.}

```

We now have embellishment tokens in #1 and the rest of the argument specification in #2. Let's grab spaces first.

```

3671 \def\collargs@e@ii#1.#2.{%
3672 \collargs@grabspaces{\collargs@e@iii#1.#2.}%
3673 }

```

What's the argument token?

```

3674 \def\collargs@e@iii#1.#2.{%
3675 \def\collargs@e@iv{\collargs@e@v#1.#2.}%
3676 \futurelet\collargs@temp\collargs@e@iv
3677 }

```

If it is a open or close group character, we surely don't have an embellishment.

```

3678 \def\collargs@e@v{%
3679 \ifcat\noexpand\collargs@temp\bgroup\relax
3680 \let\collargs@marshal\collargs@e@z
3681 \else
3682 \ifcat\noexpand\collargs@temp\egroup\relax
3683 \let\collargs@marshal\collargs@e@z
3684 \else
3685 \let\collargs@marshal\collargs@e@vi
3686 \fi
3687 \fi
3688 \collargs@marshal
3689 }

```

We borrow the “Does #1 occur within #2?” macro from `pgfutil-common`, but we fix it by executing `\collargs@in@@` in a braced group. This will prevent an `&` in an argument to function as an alignment character; the minor price to pay is that we assign the conditional globally.

```

3690 \newif\ifcollargs@in@
3691 \def\collargs@in@#1#2{%
3692 \def\collargs@in@@##1#1##2##3\collargs@in@@{%
3693 \ifx\collargs@in@@##2\global\collargs@in@false\else\global\collargs@in@true\fi
3694 }%
3695 {\collargs@in@@##2#1\collargs@in@\collargs@in@@}%
3696 }

```

Let's see whether the following token, now #3, is an embellishment token.

```

3697 \def\collargs@e@vi#1.#2.#3{%
3698 \collargs@in@{#3}{#1}%
3699 \ifcollargs@in@

```

```

3700 \expandafter\collargs@e@vii
3701 \else
3702 \expandafter\collargs@e@z
3703 \fi
3704 #1.#2.#3%
3705 }

```

#3 is the current embellishment token. We'll collect its argument using `\collargs@m`, but to do that, we have to (locally) redefine `\collargs@appendarg` and `\collargs@`, which get called by `\collargs@m`.

```

3706 \def\collargs@e@vii#1.#2.#3{%

```

We'll have to execute the original `\collargs@appendarg` later, so let's remember it. The temporary `\collargs@appendarg` simply stores the collected argument into `\collargsArg` — we'll do the processing etc. later.

```

3707 \let\collargs@real@appendarg\collargs@appendarg
3708 \def\collargs@appendarg##1{\collargsArg{##1}}%

```

Once `\collargs@m` is done, it will call the redefined `\collargs@` and thereby get us back into this handler.

```

3709 \def\collargs@{\collargs@e@viii#1.#3}%
3710 \collargs@m#2.%
3711 }

```

The parameters here are as follows. #1 are the embellishment tokens, and #2 is the current embellishment token; these get here via our local redefinition of `\collargs@` in `\collargs@e@vii`. #3 are the rest of the argument specification, which is put behind control sequence `\collargs@` by the `m` handler.

```

3712 \def\collargs@e@viii#1.#2#3.{%

```

Our wrapper puts the current embellishment token in front of the collected embellishment argument. Note that if the embellishment argument was in braces, `\collargs@m` has already set one wrapper (which will apply first).

```

3713 \collargs@wrap{#2##1}%

```

We need to get rid of the current embellishment from embellishments, not to catch the same embellishment twice.

```

3714 \def\collargs@e@ix##1#2{\collargs@e@x##1}%
3715 \collargs@e@ix#1.#3.%
3716 }

```

When this is executed, the input stream starts with the (remaining) embellishment tokens, followed by a dot, then the rest of the argument specification, also followed by a dot.

```

3717 \def\collargs@e@x{%

```

Process the argument and append it to the storage.

```

3718 \expandafter\collargs@real@appendarg\expandafter{\the\collargsArg}%

```

`\collargs@real@appendarg` has closed a group, so we open it again, and start looking for another embellishment token in the input stream.

```

3719 \begingroup
3720 \collargs@e@ii
3721 }

```

The first argument token is not an embellishment token. We finish by consuming the list of embellishment tokens, closing the two groups opened by this handler, and reexecuting the central loop.

```
3722 \def\collargs@e#1.{\endgroup\endgroup\collargs@}
```

`\collargs@E` Discard the defaults and execute `e`.

```
3723 \def\collargs@E#1#2{\collargs@e{#1}}
```

### 8.2.5 The verbatim modes

`\collargsVerbatim` These macros set the two verbatim-related conditionals, `\ifcollargs@verbatim` and `\collargsVerb` `\ifcollargs@verbatimbraces`, and then call `\collargs@make@verbatim` to effect the requested category code changes (among other things). A group should be opened prior to executing either of them. After execution, they are redefined to minimize the effort needed to enter into another mode in an embedded group. Below, we first define all the possible transitions.

```
3724 \let\collargs@NoVerbatimAfterNoVerbatim\relax
3725 \def\collargs@VerbAfterNoVerbatim{%
3726   \collargs@verbatimtrue
3727   \collargs@verbatimbracesfalse
3728   \collargs@make@verbatim
3729   \collargs@after{Verb}%
3730 }
3731 \def\collargs@VerbatimAfterNoVerbatim{%
3732   \collargs@verbatimtrue
3733   \collargs@verbatimbracestrue
3734   \collargs@make@verbatim
3735   \collargs@after{Verbatim}%
3736 }
3737 \def\collargs@NoVerbatimAfterVerb{%
3738   \collargs@verbatimfalse
3739   \collargs@verbatimbracesfalse
3740   \collargs@make@other@groups
3741   \collargs@make@no@verbatim
3742   \collargs@after{NoVerbatim}%
3743 }
3744 \def\collargs@VerbAfterVerb{%
3745   \collargs@make@other@groups
3746 }
3747 \def\collargs@VerbatimAfterVerb{%
3748   \collargs@verbatimbracestrue
3749   \collargs@make@other@groups
```

Process the lists of grouping characters, created by `\collargs@make@verbatim`, making these characters of category “other”.

```
3750 \def\collargs@do##1{\catcode##1=12 }%
3751 \collargs@bgroups
3752 \collargs@egroups
3753 \collargs@after{Verbatim}%
3754 }%
3755 \let\collargs@NoVerbatimAfterVerbatim\collargs@NoVerbatimAfterVerb
3756 \def\collargs@VerbAfterVerbatim{%
3757   \collargs@verbatimbracesfalse
3758   \collargs@make@other@groups
```

Process the lists of grouping characters, created by `\collargs@make@verbatim`, making these characters be of their normal category.

```
3759 \def\collargs@do##1{\catcode##1=1 }%
3760 \collargs@bgroups
```

```

3761 \def\collargs@do##1{\catcode##1=2 }%
3762 \collargs@egroups
3763 \collargs@after{Verb}%
3764 }%
3765 \let\collargs@VerbatimAfterVerbatim\collargs@VerbAfterVerb

```

This macro expects #1 to be the mode just entered (Verbatim, Verb or NoVerbatim), and points macros \collargsVerbatim, \collargsVerb and \collargsNoVerbatim to the appropriate transition macro.

```

3766 \def\collargs@after#1{%
3767   \letcs\collargsVerbatim{collargs@VerbatimAfter#1}%
3768   \letcs\collargsVerb{collargs@VerbAfter#1}%
3769   \letcs\collargsNoVerbatim{collargs@NoVerbatimAfter#1}%
3770 }

```

The first transition is always from the non-verbatim mode.

```

3771 \collargs@after{NoVerbatim}

```

**\collargs@bgroups** Initialize the lists of the current grouping characters used in the redefinitions of macros **\collargs@egroups** \collargsVerbatim and \collargsVerb above. Each entry is of form \collargs@do{*character code*}. These lists will be populated by \collargs@make@verbatim. They may be local, as they only used within the group opened for a verbatim environment.

```

3772 \def\collargs@bgroups{%
3773 \def\collargs@egroups{%

```

**\collargs@cc** This macro recalls the category code of character #1. In LuaTeX, we simply look up the category code in the original category code table; in other engines, we have stored the original category code into \collargs@cc@*character code* by \collargs@make@verbatim. (Note that #1 is a character, not a number.)

```

3774 \ifdefined\luatexversion
3775   \def\collargs@cc#1{%
3776     \directlua{tex.sprint(tex.getcatcode(\collargs@catcodetable@original,
3777       \the\numexpr\expandafter`\csname#1\endcsname\relax))}%
3778   }
3779 \else
3780   \def\collargs@cc#1{%
3781     \ifcsname collargs@cc@\the\numexpr\expandafter`\csname#1\endcsname\endcsname
3782       \csname collargs@cc@\the\numexpr\expandafter`\csname#1\endcsname\endcsname
3783     \else
3784       12%
3785     \fi
3786   }
3787 \fi

```

**\collargs@other@bgroup** Macros \collargs@other@bgroup and \collargs@other@egroup hold the characters **\collargs@other@egroup** of category code “other” which will play the role of grouping characters in the **\collargsBraces** full verbatim mode. They are usually defined when entering a verbatim mode in \collargs@make@verbatim, but may be also set by the user via \collargsBraces (it is not even necessary to select characters which indeed have the grouping function in the outside category code regime). The setting process is indirect: executing \collargsBraces merely sets \collargs@make@other@groups, which gets executed by the subsequent \collargsVerbatim, \collargsVerb or \collargsNoVerbatim (either directly or via \collargs@make@verbatim).

```

3788 \def\collargsBraces#1{%
3789   \expandafter\collargs@braces@i\detokenize{#1}\relax
3790 }
3791 \def\collargs@braces@i#1#2#3\relax{%

```

```

3792 \def\collargs@make@other@groups{%
3793   \def\collargs@other@bgroup{#1}%
3794   \def\collargs@other@egroup{#2}%
3795 }%
3796 }
3797 \def\collargs@make@other@groups{}

```

`\collargs@catcodetable@verbatim` We declare several new catcode tables in LuaTeX, the most important `\catcodetable@atletter` one being `\collargs@catcodetable@verbatim`, where all characters have `\collargs@catcodetable@initex` category code 12. We only need the other two tables in some formats: `\collargs@catcodetable@atletter` holds the catcode in effect at the time of loading the package, and `\collargs@catcodetable@initex` is the iniTeX table.

```

3798 \ifdefined\luatexversion
3799 (*latex, context)
3800 \newcatcodetable\collargs@catcodetable@verbatim
3801 (latex) \let\collargs@catcodetable@atletter\catcodetable@atletter
3802 (context) \newcatcodetable\collargs@catcodetable@atletter
3803 (/latex, context)
3804 (*plain)
3805 \ifdefined\collargs@catcodetable@verbatim\else
3806   \chardef\collargs@catcodetable@verbatim=4242
3807 \fi
3808 \chardef\collargs@catcodetable@atletter=%
3809   \number\numexpr\collargs@catcodetable@verbatim+1\relax
3810 \chardef\collargs@catcodetable@initex=%
3811   \number\numexpr\collargs@catcodetable@verbatim+2\relax
3812 \initcatcodetable\collargs@catcodetable@initex
3813 (/plain)
3814 (plain, context) \savecatcodetable\collargs@catcodetable@atletter
3815 \begingroup
3816 \@firstofone{%
3817 (latex) \catcodetable\catcodetable@initex
3818 (plain) \catcodetable\collargs@catcodetable@initex
3819 (context) \catcodetable\inicatcodes
3820 \catcode`\=12
3821 \catcode13=12
3822 \catcode0=12
3823 \catcode32=12
3824 \catcode`\%=12
3825 \catcode127=12
3826 \def\collargs@do#1{\catcode#1=12 }%
3827 \collargs@forrange{`a}{`z}%
3828 \collargs@forrange{`A}{`Z}%
3829 \savecatcodetable\collargs@catcodetable@verbatim
3830 \endgroup
3831 }%
3832 \fi

```

`verbatim ranges` This key and macro set the character ranges to which the verbatim mode will apply (in `\collargsVerbatimRanges` pdfTeX and XeTeX), or which will be inspected for grouping and comment characters `\collargs@verbatim@ranges` (in LuaTeX). In pdfTeX, the default value 0–255 should really remain unchanged.

```

3833 \collargsSet{
3834   verbatim ranges/.store in=\collargs@verbatim@ranges,
3835 }
3836 \def\collargsVerbatimRanges#1{\def\collargs@verbatim@ranges{#1}}
3837 \def\collargs@verbatim@ranges{0-255}

```

`\collargs@make@verbatim` This macro changes the category code of all characters to “other” — except the grouping characters in the partial verbatim mode. While doing that, it also stores (unless we’re in LuaTeX) the current category codes into `\collargs@cc@{character code}` (easily recallable by

`\collargs@cc`), redefines the “primary” grouping characters `\collargs@make@other@bgroup` and `\collargs@make@other@egroup` if necessary, and “remembers” the grouping characters (storing them into `\collargs@bgroups` and `\collargs@egroups`) and the comment characters (storing them into `\collargs@comments`).

In LuaTeX, we can use catcode tables, so we change the category codes by switching to category code table `\collargs@catcodetable@verbatim`. In other engines, we have to change the codes manually. In order to offer some flexibility in XeTeX, we perform the change for characters in `verbatim` ranges.

```

3838 \ifdefined\luatexversion
3839   \def\collargs@make@verbatim{%
3840     \directlua{%
3841       for from, to in string.gmatch(
3842         "\luaescapestring{\collargs@verbatim@ranges}",
3843         "(\collargs@percentchar d+)-(\collargs@percentchar d+)"
3844       ) do
3845         for char = tex.round(from), tex.round(to) do
3846           catcode = tex.catcode[char]

```

For category codes 1, 2 and 14, we have to call macros `\collargs@make@verbatim@bgroup`, `\collargs@make@verbatim@egroup` and `\collargs@make@verbatim@comment`, same as for engines other than LuaTeX.

```

3847       if catcode == 1 then
3848         tex.sprint(
3849           \number\collargs@catcodetable@atletter,
3850           "\noexpand\collargs@make@verbatim@bgroup{" .. char .. "}")
3851       elseif catcode == 2 then
3852         tex.sprint(
3853           \number\collargs@catcodetable@atletter,
3854           "\noexpand\collargs@make@verbatim@egroup{" .. char .. "}")
3855       elseif catcode == 14 then
3856         tex.sprint(
3857           \number\collargs@catcodetable@atletter,
3858           "\noexpand\collargs@make@verbatim@comment{" .. char .. "}")
3859       end
3860     end
3861   end
3862 }%
3863 \edef\collargs@catcodetable@original{\the\catcodetable}%
3864 \catcodetable\collargs@catcodetable@verbatim

```

Even in LuaTeX, we switch between the `verbatim` braces regimes by hand.

```

3865   \ifcollargs@verbatimbraces
3866   \else
3867     \def\collargs@do##1{\catcode##1=1\relax}%
3868     \collargs@bgroups
3869     \def\collargs@do##1{\catcode##1=2\relax}%
3870     \collargs@egroups
3871   \fi
3872 }
3873 \else

```

The non-LuaTeX version:

```

3874   \def\collargs@make@verbatim{%
3875     \ifdefempty\collargs@make@other@groups{}\fi

```

The user has executed `\collargsBraces`. We first apply that setting by executing macro `\collargs@make@other@groups`, and then disable our automatic setting of the primary grouping characters.

```

3876 \collargs@make@other@groups
3877 \def\collargs@make@other@groups{%
3878 \let\collargs@make@other@bgroup\@gobble
3879 \let\collargs@make@other@egroup\@gobble
3880 }%

```

Initialize the list of current comment characters. Each entry is of form `\collargs@do{⟨character code⟩}`. The definition must be global, because the macro will be used only once we exit the current group (by `\collargs@fix@cc@from@other@comment`, if at all).

```

3881 \gdef\collargs@comments{%
3882 \let\collargs@do\collargs@make@verbatim@char
3883 \expandafter\collargs@forranges\expandafter{\collargs@verbatim@ranges}%
3884 }
3885 \def\collargs@make@verbatim@char#1{%

```

Store the current category code of the current character.

```

3886 \ifnum\catcode#1=12
3887 \else
3888 \csedef{collargs@cc@#1}{\the\catcode#1}%
3889 \fi
3890 \ifnum\catcode#1=1
3891 \collargs@make@verbatim@bgroup{#1}%
3892 \else
3893 \ifnum\catcode#1=2
3894 \collargs@make@verbatim@egroup{#1}%
3895 \else
3896 \ifnum\catcode#1=14
3897 \collargs@make@verbatim@comment{#1}%
3898 \fi

```

Change the category code of the current character (including the comment characters).

```

3899 \ifnum\catcode#1=12
3900 \else
3901 \catcode#1=12\relax
3902 \fi
3903 \fi
3904 \fi
3905 }
3906 \fi

```

`\collargs@make@verbatim@bgroup` This macro changes the category of the opening group character to “other”, but only in the full verbatim mode. Next, it populates `\collargs@bgroups`, to facilitate the potential transition into the other verbatim mode. Finally, it executes `\collargs@make@other@bgroup`, which stores the “other” variant of the current character into `\collargs@other@bgroup`, and automatically disables itself, so that it is only executed for the first encountered opening group character — unless it was already `\relaxed` at the top of `\collargs@make@verbatim` as a consequence of the user executing `\collargsBraces`.

```

3907 \def\collargs@make@verbatim@bgroup#1{%
3908 \ifcollargs@verbatimbraces
3909 \catcode#1=12\relax
3910 \fi
3911 \appto\collargs@bgroups{\collargs@do{#1}}%
3912 \collargs@make@other@bgroup{#1}%
3913 }
3914 \def\collargs@make@other@bgroup#1{%
3915 \collargs@make@char\collargs@other@bgroup{#1}{12}%
3916 \let\collargs@make@other@bgroup\@gobble
3917 }

```



`\collargs@make@verbatim@egroup` Ditto for the closing group character.

```
3918 \def\collargs@make@verbatim@egroup#1{%
3919   \ifcollargs@verbatimbraces
3920     \catcode#1=12\relax
3921   \fi
3922   \appto\collargs@egroups{\collargs@do{#1}}%
3923   \collargs@make@other@egroup{#1}%
3924 }
3925 \def\collargs@make@other@egroup#1{%
3926   \collargs@make@char\collargs@other@egroup{#1}{12}%
3927   \let\collargs@make@other@egroup\@gobble
3928 }
```

`\collargs@make@verbatim@comment` This macro populates `\collargs@make@comments@other`.

```
3929 \def\collargs@make@verbatim@comment#1{%
3930   \gappto\collargs@comments{\collargs@do{#1}}%
3931 }
```

`\collargs@make@no@verbatim` This macro switches back to the non-verbatim mode: in LuaTeX, by switching to the original catcode table; in other engines, by recalling the stored category codes.

```
3932 \ifdefined\luatexversion
3933   \def\collargs@make@no@verbatim{%
3934     \catcodetable\collargs@catcodetable@original\relax
3935   }%
3936 \else
3937   \def\collargs@make@no@verbatim{%
3938     \let\collargs@do\collargs@make@no@verbatim@char
3939     \expandafter\collargs@forranges\expandafter{\collargs@verbatim@ranges}%
3940   }
3941   \fi
3942   \def\collargs@make@no@verbatim@char#1{%
```

The original category code of a characted was stored into `\collargs@cc@⟨character code⟩` by `\collargs@make@verbatim`. (We don't use `\collargs@cc`, because we have a number.)

```
3943   \ifcsname collargs@cc@#1\endcsname
3944     \catcode#1=\csname collargs@cc@#1\endcsname\relax
```

We don't have to restore category code 12.

```
3945   \fi
3946 }
```

## 8.2.6 Transition between the verbatim and the non-verbatim mode

At the transition from verbatim to non-verbatim mode, and vice versa, we sometimes have to fix the category code of the next argument token. This happens when we have an optional argument type in one mode followed by an argument type in another mode, but the optional argument is absent, or when an optional, but absent, verbatim argument is the last argument in the specification. The problem arises because the presence of optional arguments is determined by looking ahead in the input stream; when the argument is absent, this means that we have fixed the category code of the next token. CollArgs addresses this issue by noting the situations where a token receives the wrong category code, and then does its best to replace that token with the same character of the appropriate category code.

`\ifcollargs@fix@requested` This conditional is set, globally, by the optional argument handlers when the argument is in fact absent, and reset in the central loop after applying the fix if necessary.

```
3947 \newif\ifcollargs@fix@requested
```

`\collargs@fix` This macro selects the fixer appropriate to the transition between the previous verbatim mode (determined by `\ifcollargs@last@verbatim` and `\ifcollargs@last@verbatimbraces`) and the current verbatim mode (which is determined by macros `\ifcollargs@verbatim` and `\ifcollargs@verbatimbraces`); if the category code `fix` was not requested (for this, we check `\ifcollargs@fix@requested`), the macro simply executes the next-code given as the sole argument. The name of the fixer macro has the form `\collargs@fix@<last mode>to<current mode>`, where the modes are given by mnemonic codes: `V` = full verbatim, `v` = partial verbatim, and `N` = non-verbatim.

```
3948 \long\def\collargs@fix#1{%
```

Going through `\edef + \unexpanded` avoids doubling the hashes.

```
3949 \edef\collargs@fix@next{\unexpanded{#1}}%
3950 \ifcollargs@fix@requested
3951   \letcs\collargs@action{collargs@fix@%
3952     \ifcollargs@last@verbatim
3953       \ifcollargs@last@verbatimbraces V\else v\fi
3954   \else
3955     N%
3956   \fi
3957   to%
3958   \ifcollargs@verbatim
3959     \ifcollargs@verbatimbraces V\else v\fi
3960   \else
3961     N%
3962   \fi
3963 }%
3964 \else
3965   \let\collargs@action\collargs@fix@next
3966 \fi
3967 \collargs@action
3968 }
```

`\collargs@fix@NtoN` Nothing to do, continue with the next-code.

```
\collargs@fix@vtov
\collargs@fix@VtoV 3969 \def\collargs@fix@NtoN{\collargs@fix@next}
3970 \let\collargs@fix@vtov\collargs@fix@NtoN
3971 \let\collargs@fix@VtoV\collargs@fix@NtoN
```

`\collargs@fix@Ntov` We do nothing for the group tokens; for other tokens, we redirect to `\collargs@fix@NtoV`.

```
3972 \def\collargs@fix@Ntov{%
3973   \futurelet\collargs@temp\collargs@fix@cc@to@other@ii
3974 }
3975 \def\collargs@fix@cc@to@other@ii{%
3976   \ifcat\noexpand\collargs@temp\bgroup
3977     \let\collargs@action\collargs@fix@next
3978   \else
3979     \ifcat\noexpand\collargs@temp\egroup
3980     \let\collargs@action\collargs@fix@next
3981   \else
3982     \let\collargs@action\collargs@fix@NtoV
3983   \fi
3984 \fi
3985 \collargs@action
3986 }
```

`\collargs@fix@NtoV` The only complication here is that we might be in front of a control sequence that was a result of a previous fix in the other direction.

```
3987 \def\collargs@fix@NtoV{%
```

```

3988 \ifcollargs@double@fix
3989   \ifcollargs@in@second@fix
3990     \expandafter\expandafter\expandafter\collargs@fix@NtoV@secondfix
3991   \else
3992     \expandafter\expandafter\expandafter\collargs@fix@NtoV@onemore
3993   \fi
3994 \else
3995   \expandafter\collargs@fix@NtoV@singlefix
3996 \fi
3997 }

```

This is the usual situation of a single fix. We just use `\string` on the next token here (but note that some situations can't be saved: noone can bring a comment back to life, or distinguish a newline and a space)

```

3998 \def\collargs@fix@NtoV@singlefix{%
3999   \expandafter\collargs@fix@next\string
4000 }

```

If this is the first fix of two, we know #1 is a control sequence, so it is safe to grab it.

```

4001 \def\collargs@fix@NtoV@onemore#1{%
4002   \collargs@do@one@more@fix{%
4003     \expandafter\collargs@fix@next\string#1%
4004   }%
4005 }

```

If this is the second fix of the two, we have to check whether the next token is a control sequence, and if it is, we need to remember it. Afterwards, we redirect to the single-fix.

```

4006 \def\collargs@fix@NtoV@secondfix{%
4007   \if\noexpand\collargs@temp\relax
4008     \expandafter\collargs@fix@NtoV@secondfix@i
4009   \else
4010     \expandafter\collargs@fix@NtoV@singlefix
4011   \fi
4012 }
4013 \def\collargs@fix@NtoV@secondfix@i#1{%
4014   \gdef\collargs@double@fix@cs@ii{#1}%
4015   \collargs@fix@NtoV@singlefix#1%
4016 }

```

`\collargs@fix@vtoN` Do nothing for the grouping tokens, redirect to `\collargs@fix@VtoN` for other tokens.

```

4017 \def\collargs@fix@vtoN{%
4018   \futurelet\collargs@token\collargs@fix@vtoN@i
4019 }
4020 \def\collargs@fix@vtoN@i{%
4021   \ifcat\noexpand\collargs@token\bgroup
4022     \expandafter\collargs@fix@next
4023   \else
4024     \ifcat\noexpand\collargs@token\egroup
4025       \expandafter\expandafter\expandafter\collargs@fix@next
4026     \else
4027       \expandafter\expandafter\expandafter\collargs@fix@VtoN
4028     \fi
4029   \fi
4030 }

```

`\collargs@fix@vtoV` Redirect group tokens to `\collargs@fix@NtoV`, and do nothing for other tokens.

```

4031 \def\collargs@fix@vtoV{%
4032   \futurelet\collargs@token\collargs@fix@vtoV@i

```

```

4033 }
4034 \def\collargs@fix@vtoV@i{%
4035   \ifcat\noexpand\collargs@token\bgroup
4036     \expandafter\collargs@fix@NtoV
4037   \else
4038     \ifcat\noexpand\collargs@token\egroup
4039     \expandafter\expandafter\expandafter\collargs@fix@NtoV
4040   \else
4041     \expandafter\expandafter\expandafter\collargs@fix@next
4042   \fi
4043 \fi
4044 }

```

**\collargs@fix@Vtov** Redirect group tokens to \collargs@fix@VtoN, and do nothing for other tokens. #1 is surely of category 12, so we can safely grab it.

```

4045 \def\collargs@fix@catcode@of@braces@fromverbatim#1{%
4046   \ifnum\catcode`#1=1
4047     \expandafter\collargs@fix@VtoN
4048     \expandafter#1%
4049   \else
4050     \ifnum\catcode`#1=2
4051       \expandafter\expandafter\expandafter\collargs@fix@cc@VtoN
4052       \expandafter\expandafter\expandafter#1%
4053     \else
4054       \expandafter\expandafter\expandafter\collargs@fix@next
4055     \fi
4056   \fi
4057 }

```

**\collargs@fix@VtoN** This is the only complicated part. Control sequences and comments (but not grouping characters!) require special attention. We're fine to grab the token right away, as we know it is of category 12.

```

4058 \def\collargs@fix@VtoN#1{%
4059   \ifnum\catcode`#1=0
4060     \expandafter\collargs@fix@VtoN@escape
4061   \else
4062     \ifnum\catcode`#1=14
4063       \expandafter\expandafter\expandafter\collargs@fix@VtoN@comment
4064     \else
4065       \expandafter\expandafter\expandafter\collargs@fix@VtoN@token
4066     \fi
4067   \fi
4068   #1%
4069 }

```

**\collargs@fix@VtoN@token** We create a new character with the current category code behind the next-code. This works even for grouping characters.

```

4070 \def\collargs@fix@VtoN@token#1{%
4071   \collargs@insert@char\collargs@fix@next{`#1}{\the\catcode`#1}%
4072 }

```

**\collargs@fix@VtoN@comment** This macro defines a macro which will, when placed at a comment character, remove the tokens until the end of the line. The code is adapted from the TeX.SE answer at [tex.stackexchange.com/a/10454/16819](https://tex.stackexchange.com/a/10454/16819) by Bruno Le Floch.

```

4073 \def\collargs@defcommentstripper#1#2{%

```

We chuck a parameter into the following definition, to grab the (verbatim) comment character. This is why this macro must be executed precisely before the (verbatim) comment character.

```

4074 \def#1##1{%
4075   \begingroup%
4076   \escapechar=`\%
4077   \catcode\endlinechar=\active%

```

We assign the “other” category code to comment characters. Without this, comment characters behind the first one make trouble: there would be no `^^M` at the end of the line, so the comment stripper would gobble the following line as well; in fact, it would gobble all subsequent lines containing a comment character. We also make sure to change the category code of *all* comment characters, even if there is usually just one.

```

4078   \def\collargs@do####1{\catcode####1=12 }%
4079   \collargs@comments
4080   \csname\string#1\endcsname%
4081 }%
4082 \begingroup%
4083 \escapechar=`\%
4084 \lccode`\~=\endlinechar%
4085 \lowercase{%
4086   \expandafter\endgroup
4087   \expandafter\def\csname\string#1\endcsname##1~%
4088 }f%

```

I have removed `\space` from the end of the following line. We don’t want it for our application.

```

4089   \endgroup#2%
4090 }%
4091 }
4092 \collargs@defcommentstripper\collargs@fix@VtoN@comment{%
4093   \collargs@fix@next
4094 }

```

We don’t need the generator any more.

```

4095 \let\collargs@defcommentstripper\relax

```

`\collargs@fix@VtoN@escape` An escape character of category code 12 is the most challenging — and we won’t get things completely right — as we have swim further down the input stream to create a control sequence. This macro will throw away the verbatim escape character `#1`.

```

4096 \def\collargs@fix@VtoN@escape#1{%
4097   \ifcollargs@double@fix

```

We need to do things in a special way if we’re in the double-fix situation triggered by the previous fixing of a control sequence (probably this very one). In that case, we can’t collect it in the usual way because the entire control sequence is spelled out in verbatim.

```

4098   \expandafter\collargs@fix@VtoN@escape@d
4099   \else

```

This here is the usual situation where the escape character was tokenized verbatim, but the control sequence name itself will be collected (right away) in the non-verbatim regime.

```

4100   \expandafter\collargs@fix@VtoN@escape@i
4101   \fi
4102 }
4103 \def\collargs@fix@VtoN@escape@i{%

```

The sole character forming a control symbol name may be of any category. Temporarily redefining the category codes of the craziest characters allows `\collargs@fix@VtoN@escape@ii` to simply grab the following character.

```

4104   \begingroup

```

```

4105 \catcode`\ =12
4106 \catcode`\{=12
4107 \catcode`\}=12
4108 \catcode`\_ =12
4109 \collargs@fix@VtoN@escape@ii
4110 }

```

The argument is the first character of the control sequence name.

```

4111 \def\collargs@fix@VtoN@escape@ii#1{%
4112 \endgroup
4113 \def\collargs@csname{#1}%

```

Only if #1 is a letter may the control sequence name continue.

```

4114 \ifnum\catcode`#1=11
4115 \expandafter\collargs@fix@VtoN@escape@iii
4116 \else

```

In the case of a control space, we have to throw away the following spaces.

```

4117 \ifnum\catcode`#1=10
4118 \expandafter\expandafter\expandafter\collargs@fix@VtoN@escape@s
4119 \else

```

We have a control symbol. That means that we haven't peeked ahead and can thus skip  
`\collargs@fix@VtoN@escape@z`.

```

4120 \expandafter\expandafter\expandafter\collargs@fix@VtoN@escape@z@i
4121 \fi
4122 \fi
4123 }

```

We still have to collect the rest of the control sequence name. Braces have their usual meaning again, so we have to check for them explicitly (and bail out if we stumble upon them).

```

4124 \def\collargs@fix@VtoN@escape@iii{%
4125 \futurelet\collargs@temp\collargs@fix@VtoN@escape@iv
4126 }
4127 \def\collargs@fix@VtoN@escape@iv{%
4128 \ifcat\noexpand\collargs@temp\bgroup
4129 \let\collargs@action\collargs@fix@VtoN@escape@z
4130 \else
4131 \ifcat\noexpand\collargs@temp\egroup
4132 \let\collargs@action\collargs@fix@VtoN@escape@z
4133 \else
4134 \expandafter\ifx\space\collargs@temp
4135 \let\collargs@action\collargs@fix@VtoN@escape@s
4136 \else
4137 \let\collargs@action\collargs@fix@VtoN@escape@v
4138 \fi
4139 \fi
4140 \fi
4141 \collargs@action
4142 }

```

If we have a letter, store it and loop back, otherwise finish.

```

4143 \def\collargs@fix@VtoN@escape@v#1{%
4144 \ifcat\noexpand#1a%
4145 \appto\collargs@csname{#1}%
4146 \expandafter\collargs@fix@VtoN@escape@iii
4147 \else
4148 \expandafter\collargs@fix@VtoN@escape@z\expandafter#1%
4149 \fi
4150 }

```

Throw away the following spaces.

```

4151 \def\collargs@fix@VtoN@escape@s{%
4152   \futurelet\collargs@temp\collargs@fix@VtoN@escape@s@i
4153 }
4154 \def\collargs@fix@VtoN@escape@s@i{%
4155   \expandafter\ifx\space\collargs@temp
4156     \expandafter\collargs@fix@VtoN@escape@s@ii
4157   \else
4158     \expandafter\collargs@fix@VtoN@escape@z
4159   \fi
4160 }
4161 \def\collargs@fix@VtoN@escape@s@ii{%
4162   \expandafter\collargs@fix@VtoN@escape@z\romannumeral-0%
4163 }

```

Once we have collected the control sequence name into `\collargs@csname`, we will create the control sequence behind the next-code. However, we have two complications. The minor one is that `\csname` defines an unexisting control sequence to mean `\relax`, so we have to check whether the control sequence we will create is defined, and if not, “undefine” it in advance.

```

4164 \def\collargs@fix@VtoN@escape@z@i{%
4165   \collargs@fix@VtoN@escape@z@maybe@undefine@cs@begin
4166   \collargs@fix@VtoN@escape@z@ii
4167 }%
4168 \def\collargs@fix@VtoN@escape@z@maybe@undefine@cs@begin{%
4169   \ifcsname\collargs@csname\endcsname
4170     \@tempswatrue
4171   \else
4172     \@tempswafalse
4173   \fi
4174 }
4175 \def\collargs@fix@VtoN@escape@z@maybe@undefine@cs@end{%
4176   \if@tempswa
4177   \else
4178     \cslet{\collargs@csname}\collargs@undefined
4179   \fi
4180 }
4181 \def\collargs@fix@VtoN@escape@z@ii{%
4182   \expandafter\collargs@fix@VtoN@escape@z@maybe@undefine@cs@end
4183   \expandafter\collargs@fix@next\csname\collargs@csname\endcsname
4184 }

```

The second complication is much greater, but it only applies to control words and spaces, and that’s why control symbols went directly to the macro above. Control words and spaces will only get there via a detour through the following macro.

The problem is that collecting the control word/space name peeked ahead in the stream, so the character following the control sequence (name) is already tokenized. We will (at least partially) address this by requesting a “double-fix”: until the control sequence we’re about to create is consumed into some argument, each category code fix will fix two “tokens” rather than one.

```

4185 \def\collargs@fix@VtoN@escape@z{%
4186   \collargs@if@one@more@fix{%

```

Some previous fixing has requested a double fix, so let’s do it. Afterwards, redirect to the control symbol code `\collargs@fix@VtoN@escape@z@i`. It will surely use the correct `\collargs@csname` because we do the second fix in a group.

```

4187     \collargs@do@one@more@fix\collargs@fix@VtoN@escape@z@i
4188   }-{}%

```



Remember the collected control sequence. It will be used in `\collargs@cancel@double@fix`.

```
4189 \collargs@fix@VtoN@escape@z@maybe@undefine@cs@begin
4190 \xdef\collargs@double@fix@cs@i{\expandonce{\csname\collargs@csname\endcsname}}%
4191 \collargs@fix@VtoN@escape@z@maybe@undefine@cs@end
```

Request the double-fix.

```
4192 \global\collargs@double@fixtrue
```

The complication is addressed, redirect to the control symbol finish.

```
4193 \collargs@fix@VtoN@escape@z@ii
4194 }%
4195 }
```

When we have to “redo” a control sequence, because it was ping-ponged back into the verbatim mode, we cannot collect it by `\collargs@fix@VtoN@escape@i`, because it is spelled out entirely in verbatim. However, we have seen this control sequence before, and remembered it, so we’ll simply grab it. Another complication is that we might be either at the “first” control sequence, whose fixing created all these double-fix trouble, or at the “second” control sequence, if the first one was immediately followed by another one. But we have remembered both of them: the first one in `\collargs@fix@VtoN@escape@z`, the second one in `\collargs@fix@NtoV@secondfix`.

```
4196 \def\collargs@fix@VtoN@escape@d{%
4197 \ifcollargs@in@second@fix
4198 \expandafter\collargs@fix@VtoN@escape@d@i
4199 \expandafter\collargs@double@fix@cs@ii
4200 \else
4201 \expandafter\collargs@fix@VtoN@escape@d@i
4202 \expandafter\collargs@double@fix@cs@i
4203 \fi
4204 }
```

We have the contents of either `\collargs@double@fix@cs@i` or `\collargs@double@fix@cs@ii` here, a control sequence in both cases.

```
4205 \def\collargs@fix@VtoN@escape@d@i#1{%
4206 \expandafter\expandafter\expandafter\collargs@fix@VtoN@escape@d@ii
4207 \expandafter\string#1\relax
4208 }
```

We have the verbatimized control sequence name in #2 (#1 is the escape character). By storing it into `\collargs@csname`, we pretend we have collected it. By defining and executing `\collargs@fix@VtoN@escape@d@iii`, we actually gobble it from the input stream. Finally, we reroute to `\collargs@fix@VtoN@escape@z`.

```
4209 \def\collargs@fix@VtoN@escape@d@ii#1#2\relax{%
4210 \def\collargs@csname{#2}%
4211 \def\collargs@fix@VtoN@escape@d@iii#2{%
4212 \collargs@fix@VtoN@escape@z
4213 }%
4214 \collargs@fix@VtoN@escape@d@iii
4215 }
```

This conditional signals a double-fix request. It should be always set globally, because it is cleared by `\collargs@double@fixfalse` in a group.

```
4216 \newif\ifcollargs@double@fix
```

This conditional signals that we’re currently performing the second fix.

```
4217 \newif\ifcollargs@in@second@fix
```

Inspect the two conditionals above to decide whether we have to perform another fix: if so, execute the first argument, otherwise the second one. This macro is called only from `\collargs@fix@VtoN@escape@z` and `\collargs@fix@NtoV`, because these are the only two places where we might need the second fix, ping-ponging a control sequence between the verbatim and the non-verbatim mode.

```

4218 \def\collargs@if@one@more@fix{%
4219   \ifcollargs@double@fix
4220     \ifcollargs@in@second@fix
4221       \expandafter\expandafter\expandafter\@secondoftwo
4222     \else
4223       \expandafter\expandafter\expandafter\@firstoftwo
4224     \fi
4225   \else
4226     \expandafter\@secondoftwo
4227   \fi
4228 }
4229 \def\collargs@do@one@more@fix#1{%

```

We perform the second fix in a group, signalling that we’re performing it.

```

4230   \begingroup
4231   \collargs@in@second@fixtrue

```

Reexecute the fixing routine, at the end, close the group and execute the given code afterwards.

```

4232   \collargs@fix{%
4233     \endgroup
4234     #1%
4235   }%
4236 }

```

This macro is called from `\collargs@appendarg` to cancel the double-fix request.

```

4237 \def\collargs@cancel@double@fix{%

```

`\collargs@appendarg` is only executed when something was actually consumed. We thus know that at least one of the problematic “tokens” is gone, so the double fix is not necessary anymore.

```

4238   \global\collargs@double@fixfalse

```

What we have to figure out, still, is whether both problematic “tokens” we consumed. If so, no more fixing is required. But if only one of them was consumed, we need to request the normal, single, fix for the remaining “token”.

```

4239   \begingroup

```

This will attach the delimiters directly to the argument, so we’ll see what was actually consumed.

```

4240   \collargs@process@arg

```

We compare what was consumed when collecting the current argument with the control word that triggered double-fixing. If they match, only the offending control word was consumed, so we need to set the fix request to true for the following token.

```

4241   \edef\collargs@temp{\the\collargsArg}%
4242   \edef\collargs@tempa{\expandafter\string\collargs@double@fix@cs@i}%
4243   \ifx\collargs@temp\collargs@tempa
4244     \global\collargs@fix@requestedtrue
4245   \fi
4246   \endgroup
4247 }

```

`\collargs@insert@char` These macros create a character of character code `#2` and category code `#3`. The first macro `\collargs@make@char` inserts it into the stream behind the code in `#1`; the second one defines the control sequence in `#1` to hold the created character (clearly, it should not be used for categories 1 and 2).

We use the facilities of Lua<sub>TEX</sub>, X<sub>Y</sub><sub>TEX</sub> and L<sup>A</sup><sub>TEX</sub> where possible. In the end, we only have to implement our own macros for plain pdf<sub>TEX</sub>.

```

4248 (!context) \ifdefined\luatexversion
4249   \def\collargs@insert@char#1#2#3{%
4250     \edef\collargs@temp{\unexpanded{#1}}%
4251     \expandafter\collargs@temp\directlua{%
4252       tex.cprint(\number#3,string.char(\number#2))}%
4253   }%
4254   \def\collargs@make@char#1#2#3{%
4255     \edef#1{\directlua{tex.cprint(\number#3,string.char(\number#2))}}%
4256   }%
4257 (*!context)
4258 \else
4259   \ifdefined\XeTeXversion
4260     \def\collargs@insert@char#1#2#3{%
4261       \edef\collargs@temp{\unexpanded{#1}}%
4262       \expandafter\collargs@temp\Ucharcat #2 #3
4263     }%
4264     \def\collargs@make@char#1#2#3{%
4265       \edef#1{\Ucharcat#2 #3}%
4266     }%
4267   \else
4268 (*!latex)
4269     \ExplSyntaxOn
4270     \def\collargs@insert@char#1#2#3{%
4271       \edef\collargs@temp{\unexpanded{#1}}%
4272       \expandafter\expandafter\expandafter\collargs@temp\char_generate:nn{#2}{#3}%
4273     }%
4274     \def\collargs@make@char#1#2#3{%
4275       \edef#1{\char_generate:nn{#2}{#3}}%
4276     }%
4277     \ExplSyntaxOff
4278 (/!latex)
4279 (*!plain)

```

The implementation is inspired by `expl3`'s implementation of `\char_generate:nn`, but our implementation is not expandable, for simplicity. We first store an (arbitrary) character `^^@` of category code `n` into control sequence `\collargs@charofcat@n`, for every (implementable) category code.

```

4280   \begingroup
4281   \catcode`^^@=1 \csgdef{collargs@charofcat@1}{%
4282     \noexpand\expandafter^^@\iffalse}\fi}
4283   \catcode`^^@=2 \csgdef{collargs@charofcat@2}{\iffalse{\fi^^@}}
4284   \catcode`^^@=3 \csgdef{collargs@charofcat@3}{^^@}
4285   \catcode`^^@=4 \csgdef{collargs@charofcat@4}{^^@}

```

As we have grabbed the spaces already, a remaining newline should surely be fixed into a `\par`.

```

4286           \csgdef{collargs@charofcat@5}{\par}
4287   \catcode`^^@=6 \csxdef{collargs@charofcat@6}{\unexpanded{^^@}}
4288   \catcode`^^@=7 \csgdef{collargs@charofcat@7}{^^@}
4289   \catcode`^^@=8 \csgdef{collargs@charofcat@8}{^^@}
4290           \csgdef{collargs@charofcat@10}{\noexpand\space}
4291   \catcode`^^@=11 \csgdef{collargs@charofcat@11}{^^@}
4292   \catcode`^^@=12 \csgdef{collargs@charofcat@12}{^^@}
4293   \catcode`^^@=13 \csgdef{collargs@charofcat@13}{^^@}
4294   \endgroup
4295   \def\collargs@insert@char#1#2#3{%

```

Temporarily change the lowercase code of  $\sim\sim\sim$  to the requested character #2.

```
4296 \begingroup
4297 \lccode`~\sim=#2\relax
```

We'll have to close the group before executing the next-code.

```
4298 \def\collargs@temp{\endgroup#1}%
```

$\backslash\text{collargs@charofcat@}$ *requested category code* is f-expanded first, leaving us to lowercase  $\backslash\text{expandafter}\backslash\text{collargs@temp}\sim\sim\sim$ . Clearly, lowercasing  $\backslash\text{expandafter}\backslash\text{collargs@temp}$  is a no-op, but lowercasing  $\sim\sim\sim$  gets us the requested character of the requested category.  $\backslash\text{expandafter}$  is executed next, and this gets rid of the conditional for category codes 1 and 2.

```
4299 \expandafter\lowercase\expandafter{%
4300 \expandafter\expandafter\expandafter\collargs@temp
4301 \romannumeral-`0\csname collargs@charofcat@the\numexpr#3\relax\endcsname
4302 }%
4303 }
```

This macro cannot not work for category code 6 (because we assign the result to a macro), but no matter, we only use it for category code 12 anyway.

```
4304 \def\collargs@make@char#1#2#3{%
4305 \begingroup
4306 \lccode`~\sim=#2\relax
```

Define  $\backslash\text{collargs@temp}$  to hold  $\sim\sim\sim$  of the appropriate category.

```
4307 \edef\collargs@temp{%
4308 \csname collargs@charofcat@the\numexpr#3\relax\endcsname}%
```

Preexpand the second  $\backslash\text{collargs@temp}$  so that we lowercase  $\backslash\text{def}\backslash\text{collargs@temp}\{\sim\sim\sim\}$ , with  $\sim\sim\sim$  of the appropriate category.

```
4309 \expandafter\lowercase\expandafter{%
4310 \expandafter\def\expandafter\collargs@temp\expandafter{\collargs@temp}%
4311 }%
4312 \expandafter\endgroup
4313 \expandafter\def\expandafter#1\expandafter{\collargs@temp}%
4314 }
4315 </plain>
4316 \fi
4317 \fi
4318 </!context>
```

```
4319 <plain>\resetatcatcode
4320 <context>\stopmodule
4321 <context>\protect
```

Local Variables: TeX-engine: luatex TeX-master: "doc/memoize-code.tex" TeX-auto-save:  
nil End:

## 9 The scripts

### 9.1 The Perl extraction script memoize-extract.pl

```
4322 my $PROG = 'memoize-extract.pl';
4323 my $VERSION = '2024/01/02 v1.1.0';
4324
4325 use strict;
4326 use File::Basename qw/basename/;
4327 use Getopt::Long;
```

```

4328 use File::Spec::Functions
4329     qw/splitpath catpath splitdir rootdir file_name_is_absolute/;
4330 use File::Path qw(make_path);

```

We will only try to import the PDF processing library once we set up the error log. Declare variables for command-line arguments and for `kpathsea` variables. They are defined here so that they are global in the subs which use them.

```

4331 our ($pdf_file, $prune, $keep, $format, $force, $quiet,
4332     $pdf_library, $print_version, $mkdir, $help,
4333     $openin_any, $openout_any, $texmfoutput, $texmf_output_directory);

```

**Messages** The messages are written both to the extraction log and the terminal (we output to stdout rather than stderr so that messages on the TeX terminal and document `.log` appear in chronological order). Messages are automatically adapted to the TeX `--format`. The format of the messages. It depends on the given `--format`; the last entry is for the terminal output.

```

4334 my %ERROR = (
4335     latex => '\PackageError{memoize (perl-based extraction)}{$short}{$long}',
4336     plain => '\errhelp{$long}\errmessage{memoize (perl-based extraction): $short}',
4337     context => '\errhelp{$long}\errmessage{memoize (perl-based extraction): $short}',
4338     '' => '$header$short. $long');
4339
4340 my %WARNING = (
4341     latex => '\PackageWarning{memoize (perl-based extraction)}{$texindent$text}',
4342     plain => '\message{memoize (perl-based extraction) Warning: $texindent$text}',
4343     context => '\message{memoize (perl-based extraction) Warning: $texindent$text}',
4344     '' => '$header$indent$text.');
4345
4346 my %INFO = (
4347     latex => '\PackageInfo{memoize (perl-based extraction)}{$texindent$text}',
4348     plain => '\message{memoize (perl-based extraction): $texindent$text}',
4349     context => '\message{memoize (perl-based extraction): $texindent$text}',
4350     '' => '$header$indent$text.');

```

Some variables used in the message routines; note that `header` will be redefined once we parse the arguments.

```

4351 my $exit_code = 0;
4352 my $log;
4353 my $header = '';
4354 my $indent = '';
4355 my $texindent = '';

```

The message routines.

```

4356 sub error {
4357     my ($short, $long) = @_;
4358     if (! $quiet) {
4359         $_ = $ERROR{' '};
4360         s/\$header/\$header/;
4361         s/\$short/\$short/;
4362         s/\$long/\$long/;
4363         print(STDOUT "$_\n");
4364     }
4365     if ($log) {
4366         $long =~ s/\\/\\string\\/g;
4367         $_ = $ERROR{$format};
4368         s/\$short/\$short/;
4369         s/\$long/\$long/;
4370         print(LOG "$_\n");
4371     }
4372     $exit_code = 11;
4373     endinput();
4374 }
4375

```

```

4376 sub warning {
4377     my $text = shift;
4378     if ($log) {
4379         $_ = $WARNING{$format};
4380         s/\$texindent/$texindent/;
4381         s/\$text/$text/;
4382         print(LOG "$_\n");
4383     }
4384     if (! $quiet) {
4385         $_ = $WARNING{' '};
4386         s/\$header/$header/;
4387         s/\$indent/$indent/;
4388         s/\$text/$text/;
4389         print(STDOUT "$_\n");
4390     }
4391     $exit_code = 10;
4392 }
4393
4394 sub info {
4395     my $text = shift;
4396     if ($text && ! $quiet) {
4397         $_ = $INFO{' '};
4398         s/\$header/$header/;
4399         s/\$indent/$indent/;
4400         s/\$text/$text/;
4401         print(STDOUT "$_\n");
4402         if ($log) {
4403             $_ = $INFO{$format};
4404             s/\$texindent/$texindent/;
4405             s/\$text/$text/;
4406             print(LOG "$_\n");
4407         }
4408     }
4409 }

```

Mark the log as complete and exit.

```

4410 sub endinput {
4411     if ($log) {
4412         print(LOG "\\endinput\n");
4413         close(LOG);
4414     }
4415     exit $exit_code;
4416 }
4417
4418 sub die_handler {
4419     stderr_to_warning();
4420     my $text = shift;
4421     chomp($text);
4422     error("Perl error: $text", ' ');
4423 }
4424
4425 sub warn_handler {
4426     my $text = shift;
4427     chomp($text);
4428     warning("Perl warning: $text");
4429 }

```

This is used to print warning messages from PDF::Builder, which are output to STDERR.

```

4430 my $stderr;
4431 sub stderr_to_warning {
4432     if ($stderr) {
4433         my $w = ' Perl info: ';
4434         my $nl = ' ';

```

```

4435     for (split(/\n/, $stderr)) {
4436         /(^\s*)(.*?)(\s*)$/;
4437         $w .= ($1 ? ' ' : $nl) . $2;
4438         $nl = "\n";
4439     }
4440     warning("$w");
4441     $stderr = '';
4442 }
4443 }

```

[Permission-related functions](#) We will need these variables below. Note that we only support Unix and Windows.

```

4444 my $on_windows = $^O eq 'MSWin32';
4445 my $dirsep = $on_windows ? '\\' : '/';

```

`paranoia_in/out` should work exactly as `kpsewhich -safe-in-name/-safe-out-name`.

```

4446 sub paranoia_in {
4447     my ($f, $remark) = @_ ;
4448     error("I'm not allowed to read from '$f' (openin_any = $openin_any)",
4449         $remark) unless _paranoia($f, $openin_any);
4450 }
4451
4452 sub paranoia_out {
4453     my ($f, $remark) = @_ ;
4454     error("I'm not allowed to write to '$f' (openin_any = $openout_any)",
4455         $remark) unless _paranoia($f, $openout_any);
4456 }
4457
4458 sub _paranoia {

```

`f` is the path to the file (it should not be empty), and `mode` is the value of `openin_any` or `openout_any`.

```

4459     my ($f, $mode) = @_ ;
4460     return if (! $f);

```

We split the filename into the directory and the basename part, and the directory into components.

```

4461     my ($volume, $dir, $basename) = splitpath($f);
4462     my @dir = splitdir($dir);
4463     return (

```

In mode ‘any’ (a, y or 1), we may access any file.

```

4464         $mode =~ /^[ay1]$/
4465         || (

```

Otherwise, we are at least in the restricted mode, so we should not open dot files on Unix-like systems (except file called `.tex`).

```

4466         ! (!$on_windows && $basename =~ /\./ && !($basename =~ /\.\.tex$/))
4467         && (

```

If we are precisely in the restricted mode (r, n, 0), then there are no further restrictions.

```

4468         $mode =~ /^[rn0]$/

```

Otherwise, we are in the paranoid mode (officially p, but any other value is interpreted as p as well). There are two further restrictions in the paranoid mode.

```

4469         || (

```

We’re not allowed to go to a parent directory.

```

4470         ! grep(/^\.\/, @dir) && $basename ne '...'
4471         &&

```

If the given path is absolute, it should be a descendant of either `TEXMF_OUTPUT_DIRECTORY` or `TEXMFOUTPUT`.

```

4472         (!file_name_is_absolute($f)
4473         ||

```



```

4474             is_ancestor($texmf_output_directory, $f)
4475             ||
4476             is_ancestor($texmfoutput, $f)
4477         ))));
4478 }

```

Only removes final `"/`s. This is unlike `File::Spec`'s `canonpath`, which also removes `.` components, collapses multiple `/` — and unfortunately also goes up for `..` on Windows.

```

4479 sub normalize_path {
4480     my $path = shift;
4481     my ($v, $d, $n) = splitpath($path);
4482     if ($n eq '' && $d =~ /[^\Q$dirsep\E]\Q$dirsep\E+$/ ) {
4483         $path =~ s/\Q$dirsep\E+$/ /;
4484     }
4485     return $path;
4486 }

```

On Windows, we disallow “semi-absolute” paths, i.e. paths starting with the `\` but lacking the drive. `File::Spec`'s function `file_name_is_absolute` returns 2 if the path is absolute with a volume, 1 if it's absolute with no volume, and 0 otherwise. After a path was sanitized using this function, `file_name_is_absolute` will work as we want it to.

```

4487 sub sanitize_path {
4488     my $f = normalize_path(shift);
4489     my ($v, $d, $n) = splitpath($f);
4490     if ($on_windows) {
4491         my $a = file_name_is_absolute($f);
4492         if ($a == 1 || ($a == 0 && $v) ) {
4493             error("\Semi-absolute\" paths are disallowed: " . $f,
4494                 "The path must either both contain the drive letter and " .
4495                 "start with '\\', or none of these; paths like 'C:foo\\bar' " .
4496                 "and '\\foo\\bar' are disallowed");
4497         }
4498     }
4499 }
4500
4501 sub access_in {
4502     return -r shift;
4503 }
4504
4505 sub access_out {
4506     my $f = shift;
4507     my $exists;
4508     eval { $exists = -e $f };

```

Presumably, we get this error when the parent directory is not executable.

```

4509     return if ($@);
4510     if ($exists) {

```

An existing file should be writable, and if it's a directory, it should also be executable.

```

4511         my $rw = -w $f; my $rd = -d $f; my $rx = -x $f;
4512         return -w $f && (! -d $f || -x $f);
4513     } else {

```

For a non-existing file, the parent directory should be writable. (This is the only place where function `parent` is used, so it's ok that it returns the logical parent.)

```

4514         my $p = parent($f);
4515         return -w $p;
4516     }
4517 }

```

This function finds the location for an input file, respecting `TEXMF_OUTPUT_DIRECTORY` and `TEXMFOUTPUT`, and the permissions in the filesystem. It returns an absolute file as-is. For a

relative file, it tries `TEXMF_OUTPUT_DIRECTORY` (if defined), the current directory (always), and `TEXMFOUTPUT` directory (if defined), in this order. The first readable file found is returned; if no readable file is found, the file in the current directory is returned.

```

4518 sub find_in {
4519     my $f = shift;
4520     sanitize_path($f);
4521     return $f if file_name_is_absolute($f);
4522     for my $df (
4523         $texmf_output_directory ? join_paths($texmf_output_directory, $f) : undef,
4524         $f,
4525         $texmfoutput ? join_paths($texmfoutput, $f) : undef) {
4526         return $df if $df && -r $df;
4527     }
4528     return $f;
4529 }

```

This function finds the location for an output file, respecting `TEXMF_OUTPUT_DIRECTORY` and `TEXMFOUTPUT`, and the permissions in the filesystem. It returns an absolute file as-is. For a relative file, it tries `TEXMF_OUTPUT_DIRECTORY` (if defined), the current directory (unless `TEXMF_OUTPUT_DIRECTORY` is defined), and `TEXMFOUTPUT` directory (if defined), in this order. The first writable file found is returned; if no writable file is found, the file in either the current or the output directory is returned.

```

4530 sub find_out {
4531     my $f = shift;
4532     sanitize_path($f);
4533     return $f if file_name_is_absolute($f);
4534     for my $df (
4535         $texmf_output_directory ? join_paths($texmf_output_directory, $f) : undef,
4536         $texmf_output_directory ? undef : $f,
4537         $texmfoutput ? join_paths($texmfoutput, $f) : undef) {
4538         return $df if $df && access_out($df);
4539     }
4540     return $texmf_output_directory ? join_paths($texmf_output_directory, $f) : $f;
4541 }

```

We next define some filename-related utilities matching what Python offers out of the box. We avoid using `File::Spec`'s `canonpath`, because on Windows, which has no concept of symlinks, this function resolves `..` to the parent.

```

4542 sub name {
4543     my $path = shift;
4544     my ($volume, $dir, $filename) = splitpath($path);
4545     return $filename;
4546 }
4547
4548 sub suffix {
4549     my $path = shift;
4550     my ($volume, $dir, $filename) = splitpath($path);
4551     $filename =~ /\.[^.]*$/;
4552     return $&;
4553 }
4554
4555 sub with_suffix {
4556     my ($path, $suffix) = @_ ;
4557     my ($volume, $dir, $filename) = splitpath($path);
4558     if ($filename =~ s/\.[^.]*$/$suffix/) {
4559         return catpath($volume, $dir, $filename);
4560     } else {
4561         return catpath($volume, $dir, $filename . $suffix);
4562     }
4563 }
4564
4565 sub with_name {

```

```

4566     my ($path, $name) = @_;
4567     my ($volume, $dir, $filename) = splitpath($path);
4568     my ($v,$d,$f) = splitpath($name);
4569     die "Runtime error in with_name: " .
4570 "'$name' should not contain the directory component"
4571     unless $v eq '' && $d eq '' && $f eq $name;
4572     return catpath($volume, $dir, $name);
4573 }
4574
4575 sub join_paths {
4576     my $path1 = normalize_path(shift);
4577     my $path2 = normalize_path(shift);
4578     return $path2 if !$path1 || file_name_is_absolute($path2);
4579     my ($volume1, $dir1, $filename1) = splitpath($path1, 'no_file');
4580     my ($volume2, $dir2, $filename2) = splitpath($path2);
4581     die if $volume2;
4582     return catpath($volume1,
4583                    join($dirsep, ($dir1 eq $dirsep ? '' : $dir1, $dir2)),
4584                    $filename2);
4585 }

```

The logical parent. The same as `pathlib.parent` in Python.

```

4586 sub parent {
4587     my $f = normalize_path(shift);
4588     my ($v, $dn, $_dummy) = splitpath($f, 1);
4589     my $p_dn = $dn =~ s/[^\Q$dirsep\E]+$//r;
4590     if ($p_dn eq '') {
4591         $p_dn = $dn =~ /\^\Q$dirsep\E/ ? $dirsep : '.';
4592     }
4593     my $p = catpath($v, $p_dn, '');
4594     $p = normalize_path($p);
4595     return $p;
4596 }

```

This function assumes that both paths are absolute; ancestor may be "", signaling a non-path.

```

4597 sub is_ancestor {
4598     my $ancestor = normalize_path(shift);
4599     my $descendant = normalize_path(shift);
4600     return if !$ancestor;
4601     $ancestor .= $dirsep unless $ancestor =~ /\Q$dirsep\E$/;
4602     return $descendant =~ /\^\Q$ancestor/;
4603 }

```

A paranoid `Path.mkdir`. The given folder is preprocessed by `find_out`.

```

4604 sub make_directory {
4605     my $folder = find_out(shift);
4606     if (! -d $folder) {
4607         paranoia_out($folder);

```

Using `make_path` is fine because we know that `TEXMF_OUTPUT_DIRECTORY/TEXMFOUTPUT`, if given, exists, and that “folder” contains no ...

```

4608     make_path($folder);

```

This does not get logged when the function is invoked via `--mkdir`, as it is not clear what the log name should be.

```

4609     info("Created directory $folder");
4610 }
4611 }
4612
4613 sub unquote {
4614     shift =~ s/"(.*)"\/\1/rg;
4615 }

```

[Kpathsea](#) Get the values of `openin_any`, `openout_any`, `TEXMFOUTPUT` and `TEXMF_OUTPUT_DIRECTORY`.

```
4616 my $maybe_backslash = $on_windows ? '\\' : '\\';
4617 my $query = 'kpsewhich -expand-var=' .
4618     "openin_any=$maybe_backslash\$openin_any," .
4619     "openout_any=$maybe_backslash\$openout_any," .
4620     "TEXMFOUTPUT=$maybe_backslash\$TEXMFOUTPUT";
4621 my $kpsewhich_output = `$query`;
4622 if (! $kpsewhich_output) {
```

No TeX? (Note that `kpsewhich` should exist in MiKTeX as well.) In absence of `kpathsea` information, we get very paranoid.

```
4623     ($openin_any, $openout_any) = ('p', 'p');
4624     ($texmfoutput, $texmf_output_directory) = ('', '');
```

Unfortunately, this warning can't make it into the log. But then again, the chances of a missing `kpsewhich` are very slim, and its absence would show all over the place anyway.

```
4625     warning('I failed to execute "kpsewhich", is there no TeX system installed? ' .
4626         'Assuming openin_any = openout_any = "p" ' .
4627         '(i.e. restricting all file operations to non-hidden files ' .
4628         'in the current directory of its subdirectories).');
4629 } else {
4630     $kpsewhich_output =~ /^openin_any=(.*/),openout_any=(.*/),TEXMFOUTPUT=(.*/);
4631     ($openin_any, $openout_any, $texmfoutput) = @{^CAPTURE};
4632     $texmf_output_directory = $ENV{'TEXMF_OUTPUT_DIRECTORY'};
4633     if ($openin_any =~ '^\\$openin_any') {
```

When the `open*_any` variables are not expanded, we assume we're running MiKTeX. The two config settings below correspond to TeXLive's `openin_any` and `openout_any`; afaik, there is no analogue to `TEXMFOUTPUT`.

```
4634     $query = 'initexmf --show-config-value=[Core]AllowUnsafeInputFiles ' .
4635         '--show-config-value=[Core]AllowUnsafeOutputFiles';
4636     my $initexmf_output = `$query`;
4637     $initexmf_output =~ /^(.*)\n(.*)\n/m;
4638     $openin_any = $1 eq 'true' ? 'a' : 'p';
4639     $openout_any = $2 eq 'true' ? 'a' : 'p';
4640     $texmfoutput = '';
4641     $texmf_output_directory = '';
4642 }
4643 }
```

An output directory should exist, and may not point to the root on Linux. On Windows, it may point to the root, because being absolute also implies containing the drive; see `sanitize_filename`.

```
4644 sub sanitize_output_dir {
4645     return unless my $d = shift;
4646     sanitize_path($d);
```

On Windows, `rootdir` returns `\`, so it cannot possibly match `$d`.

```
4647     return $d if -d $d && $d ne rootdir();
4648 }
4649
4650 $texmfoutput = sanitize_output_dir($texmfoutput);
4651 $texmf_output_directory = sanitize_output_dir($texmf_output_directory);
```

We don't delve into the real script when loaded from the testing code.

```
4652 return 1 if caller;
```

## Arguments

```
4653 my $usage = "usage: $PROG [-h] [-P PDF] [-p] [-k] [-F {latex,plain,context}] [-f] " .
4654     "[-L {PDF::API2,PDF::Builder}] [-q] [-m] [-V] mmz\n";
4655 my $Help = <<END;
4656 Extract extern pages produced by package Memoize out of the document PDF.
4657
```

```

4658 positional arguments:
4659 mmz                the record file produced by Memoize:
4660                    doc.mmz when compiling doc.tex
4661                    (doc and doc.tex are accepted as well)
4662
4663 options:
4664 -h, --help          show this help message and exit
4665 -P PDF, --pdf PDF   extract from file PDF
4666 -p, --prune         remove the extern pages after extraction
4667 -k, --keep          do not mark externs as extracted
4668 -F, --format {latex,plain,context}
4669                    the format of the TeX document invoking extraction
4670 -f, --force         extract even if the size-check fails
4671 -q, --quiet         describe what's happening
4672 -L, --library {PDF::API2, PDF::Builder}
4673                    which PDF library to use for extraction (default: PDF::API2)
4674 -m, --mkdir         create a directory (and exit);
4675                    mmz argument is interpreted as directory name
4676 -V, --version       show program's version number and exit
4677
4678 For details, see the man page or the Memoize documentation.
4679 END
4680
4681 my @valid_libraries = ('PDF::API2', 'PDF::Builder');
4682 Getopt::Long::Configure ("bundling");
4683 GetOptions(
4684     "pdf|P=s"    => \$pdf_file,
4685     "prune|p"    => \$prune,
4686     "keep|k"     => \$keep,
4687     "format|F=s" => \$format,
4688     "force|f"    => \$force,
4689     "quiet|q"    => \$quiet,
4690     "library|L=s" => \$pdf_library,
4691     "mkdir|m"    => \$mkdir,
4692     "version|V"  => \$print_version,
4693     "help|h|?"  => \$help,
4694     ) or die $usage;
4695
4696 if ($help) {print("$usage\n$Help"); exit 0}
4697
4698 if ($print_version) { print("$PROG of Memoize $VERSION\n"); exit 0 }
4699
4700 die "${usage}$PROG: error: the following arguments are required: mmz\n"
4701     unless @ARGV == 1;
4702
4703 die "${usage}$PROG: error: argument -F/--format: invalid choice: '$format' " .
4704     "(choose from 'latex', 'plain', 'context')\n"
4705     unless grep $_ eq $format, ('', 'latex', 'plain', 'context');
4706
4707 die "${usage}$PROG: error: argument -L/--library: invalid choice: '$pdf_library' " .
4708     "(choose from " . join(", ", @valid_libraries) . ")\n"
4709     if $pdf_library && ! grep $_ eq $pdf_library, @valid_libraries;
4710
4711 $header = $format ? basename($0) . ': ' : '';

```

start a new line in the TeX terminal output

```

4712 print("\n") if $format;

```

**Initialization** With `--mkdir`, argument `mmz` is interpreted as the directory to create.

```

4713 if ($mkdir) {
4714     make_directory($ARGV[0]);
4715     exit 0;
4716 }

```

Normalize the mmz argument into a .mmz filename.

```
4717 my $mmz_file = $ARGV[0];
4718 $mmz_file = with_suffix($mmz_file, '.mmz')
4719     if suffix($mmz_file) eq '.tex';
4720 $mmz_file = with_name($mmz_file, name($mmz_file) . '.mmz')
4721     if suffix($mmz_file) ne '.mmz';
```

Once we have the .mmz filename, we can open the log.

```
4722 if ($format) {
4723     my $_log = find_out(with_suffix($mmz_file, '.mmz.log'));
4724     paranoia_out($_log);
4725     info("Logging to '$_log'");
4726     $log = $_log;
4727     open LOG, ">$log";
4728 }
```

Now that we have opened the log file, we can try loading the PDF processing library.

```
4729 if ($pdf_library) {
4730     eval "use $pdf_library";
4731     error("Perl module '$pdf_library' was not found",
4732         'Have you followed the instructions in section 1.1 of the manual?')
4733     if ($@);
4734 } else {
4735     for (@valid_libraries) {
4736         eval "use $_";
4737         if (!$@) {
4738             $pdf_library = $_;
4739             last;
4740         }
4741     }
4742     if (!$pdf_library) {
4743         error("No suitable Perl module for PDF processing was found, options are " .
4744             join(", ", @valid_libraries),
4745             'Have you followed the instructions in section 1.1 of the manual?');
4746     }
4747 }
```

Catch any errors in the script and output them to the log.

```
4748 $SIG{__DIE__} = \&die_handler;
4749 $SIG{__WARN__} = \&warn_handler;
4750 close(STDERR);
4751 open(STDERR, ">", \&stderr);
```

Find the .mmz file we will read, but retain the original filename in \$given\_mmz\_file, as we will still need it.

```
4752 my $given_mmz_file = $mmz_file;
4753 $mmz_file = find_in($mmz_file, 1);
4754 if (! -e $mmz_file) {
4755     info("File '$given_mmz_file' does not exist, assuming there's nothing to do");
4756     endinput();
4757 }
4758 paranoia_in($mmz_file);
4759 paranoia_out($mmz_file,
4760     'I would have to rewrite this file unless option --keep is given.')
4761     unless $keep;
```

Determine the PDF filename: it is either given via --pdf, or constructed from the .mmz filename.

```
4762 $pdf_file = with_suffix($given_mmz_file, '.pdf') if !$pdf_file;
4763 $pdf_file = find_in($pdf_file);
4764 paranoia_in($pdf_file);
4765 paranoia_out($pdf_file,
4766     'I would have to rewrite this file because option --prune was given.')
4767     if $prune;
```

Various initializations.

```
4768 my $pdf;
4769 my %extern_pages;
4770 my $new_mmz;
4771 my $tolerance = 0.01;
4772 info("Extracting new externs listed in '$mmz_file' " .
4773       "from '$pdf_file' using Perl module $pdf_library");
4774 my $done_message = "Done (there was nothing to extract)";
4775 $indent = ' ';
4776 $texindent = '\space\space ';
4777 my $dir_to_make;
```

**Process .mmz** We cannot process the .mmz file using in-place editing. It would fail when the file is writable but its parent directory is not.

```
4778 open (MMZ, $mmz_file);
4779 while (<MMZ>) {
4780     my $mmz_line = $_;
4781     if (/^\mmzPrefix *{(?P<prefix>)}/) {
```

Found \mmzPrefix: create the extern directory, but only later, if an extern file is actually produced. We parse the prefix in two steps because we have to unquote the entire prefix.

```
4782     my $prefix = unquote($+{prefix});
4783     warning("Cannot parse line '$mmz_line'") unless
4784         $prefix =~ /(P<dir_prefix>.*\/)?(P<name_prefix>.*?)/;
4785     $dir_to_make = $+{dir_prefix};
4786 } elsif (/^\mmzNewExtern\ *{(?P<extern_path>.*?)}{(?P<page_n>[0-9]+)}#
4787         {(P<expected_width>[0-9.]*pt){(P<expected_height>[0-9.]*pt)/x} {
```

Found \mmzNewExtern: extract the extern page into an extern file.

```
4788     $done_message = "Done";
4789     my $ok = 1;
4790     my %m_ne = %+;
```

The extern filename, as specified in .mmz:

```
4791     my $extern_file = unquote($m_ne{extern_path});
```

We parse the extern filename in a separate step because we have to unquote the entire path.

```
4792     warning("Cannot parse line '$mmz_line'") unless
4793         $extern_file =~ /(P<dir_prefix>.*\/)?(P<name_prefix>.*?)#
4794         (P<code_md5sum>[0-9A-F]{32})-#
4795         (P<context_md5sum>[0-9A-F]{32})(?:-[0-9]+)?\.pdf/x;
```

The actual extern filename:

```
4796     my $extern_file_out = find_out($extern_file);
4797     paranoia_out($extern_file_out);
4798     my $page = $m_ne{page_n};
```

Check whether c-memo and cc-memo exist (in any input directory).

```
4799     my $c_memo = with_name($extern_file,
4800                             $+{name_prefix} . $+{code_md5sum} . '.memo');
4801     my $cc_memo = with_name($extern_file,
4802                             $+{name_prefix} . $+{code_md5sum} .
4803                             '-' . $+{context_md5sum} . '.memo');
4804     my $c_memo_in = find_in($c_memo);
4805     my $cc_memo_in = find_in($cc_memo);
4806     if ((! access_in($c_memo_in) || ! access_in($cc_memo_in)) && !$force) {
4807         warning("I refuse to extract page $page into extern '$extern_file', " .
4808                "because the associated c-memo '$c_memo' and/or " .
4809                "cc-memo '$cc_memo' does not exist");
4810         $ok = '';
4811     }
```

Load the PDF. We only do this now so that we don't load it if there is nothing to extract.

```

4812     if ($ok && ! $pdf) {
4813         if (!access_in($pdf_file)) {
4814             warning("Cannot open '$pdf_file'", '');
4815             endinput();
4816         }

```

Temporarily disable error handling, so that we can catch the error ourselves.

```

4817     $SIG{__DIE__} = undef; $SIG{__WARN__} = undef;

```

All safe, paranoia\_in was already called above.

```

4818     eval { $pdf = $pdf_library->open($pdf_file, msgver => 0) };
4819     $SIG{__DIE__} = \&die_handler; $SIG{__WARN__} = \&warn_handler;
4820     error("File '$pdf_file' seems corrupted. " .
4821         "Perhaps you have to load Memoize earlier in the preamble",
4822         "In particular, Memoize must be loaded before TikZ library " .
4823         "'fadings' and any package deploying it, and in Beamer, " .
4824         "load Memoize by writing \\RequirePackage{memoize} before " .
4825         "\\documentclass{beamer}." .
4826         "This was the error thrown by Perl:" . "\n$0") if $0;
4827 }

```

Does the page exist?

```

4828     if ($ok && $page > (my $n_pages = $pdf->page_count())) {
4829         error("I cannot extract page $page from '$pdf_file', " .
4830             "as it contains only $n_pages page" .
4831             ($n_pages > 1 ? 's' : ''), '');
4832     }
4833     if ($ok) {

```

Import the page into the extern PDF (no disk access yet).

```

4834         my $extern = $pdf_library->new(outver => $pdf->version);
4835         $extern->import_page($pdf, $page);
4836         my $extern_page = $extern->open_page(1);

```

Check whether the page size matches the .mmz expectations.

```

4837         my ($x0, $y0, $x1, $y1) = $extern_page->get_mediabox();
4838         my $width_pt = ($x1 - $x0) / 72 * 72.27;
4839         my $height_pt = ($y1 - $y0) / 72 * 72.27;
4840         my $expected_width_pt = $m_ne{expected_width};
4841         my $expected_height_pt = $m_ne{expected_height};
4842         if ((abs($width_pt - $expected_width_pt) > $tolerance
4843             || abs($height_pt - $expected_height_pt) > $tolerance) && !$force) {
4844             warning("I refuse to extract page $page from $pdf_file, " .
4845                 "because its size (${width_pt}pt x ${height_pt}pt) " .
4846                 "is not what I expected " .
4847                 "(${expected_width_pt}pt x ${expected_height_pt}pt)");
4848         } else {

```

All tests were successful, let's create the extern file. First, the containing directory, if necessary.

```

4849         if ($dir_to_make) {
4850             make_directory($dir_to_make);
4851             $dir_to_make = undef;
4852         }

```

Now the extern file. Note that paranoia\_out was already called above.

```

4853         info("Page $page --> $extern_file_out");
4854         $extern->saveas($extern_file_out);

```

This page will get pruned.

```

4855         $extern_pages{$page} = 1 if $prune;

```

Comment out this \mmzNewExtern.

```

4856         $new_mmz .= '%' unless $keep;

```



```

4857     }
4858   }
4859 }
4860 $new_mmz .= $mmz_line unless $keep;
4861 stderr_to_warning();
4862 }
4863 close(MMZ);
4864 $indent = '';
4865 $texindent = '';
4866 info($done_message);

```

Write out the .mmz file with \mmzNewExtern lines commented out. (All safe, paranoia\_out was already called above.)

```

4867 if (!$keep) {
4868   open(MMZ, ">", $mmz_file);
4869   print MMZ $new_mmz;
4870   close(MMZ);
4871 }

```

Remove the extracted pages from the original PDF. (All safe, paranoia\_out was already called above.)

```

4872 if ($prune and keys(%extern_pages) != 0) {
4873   my $pruned_pdf = $pdf_library->new();
4874   for (my $n = 1; $n <= $pdf->page_count(); $n++) {
4875     if (! $extern_pages{$n}) {
4876       $pruned_pdf->import_page($pdf, $n);
4877     }
4878   }
4879   $pruned_pdf->save($pdf_file);
4880   info("The following extern pages were pruned out of the PDF: " .
4881     join(", ", sort(keys(%extern_pages))));
4882 }
4883
4884 endinput();

```

## 9.2 The Python extraction script memoize-extract.py

```

4885 __version__ = '2024/01/02 v1.1.0'
4886
4887 import argparse, re, sys, os, subprocess, itertools, traceback, platform
4888 from pathlib import Path, PurePath

```

**Messages** We will only try to import the PDF processing library once we set up the error log. The messages are written both to the extraction log and the terminal (we output to stdout rather than stderr so that messages on the TeX terminal and document .log appear in chronological order). Messages are automatically adapted to the TeX --format. The format of the messages. It depends on the given --format; the last entry is for the terminal output.

```

4889 ERROR = {
4890   'latex':   r'\PackageError{{{package_name}}}{short}{long}',
4891   'plain':   r'\errhelp{{{long}}}\errmessage{{{package_name}: {short}}}',
4892   'context': r'\errhelp{{{long}}}\errmessage{{{package_name}: {short}}}',
4893   None:      '{header}{short}.\n{long}',
4894 }
4895
4896 WARNING = {
4897   'latex':   r'\PackageWarning{{{package_name}}}{texindent}{text}',
4898   'plain':   r'\message{{{package_name}: {texindent}{text}}}',
4899   'context': r'\message{{{package_name}: {texindent}{text}}}',
4900   None:      r'{header}{indent}{text}.',
4901 }
4902
4903 INFO = {
4904   'latex':   r'\PackageInfo{{{package_name}}}{texindent}{text}',

```

```

4905     'plain':    r'\message{{{package_name}: {texindent}{text}}}',
4906     'context': r'\message{{{package_name}: {texindent}{text}}}',
4907     None:      r'{header}{indent}{text}.',
4908 }

```

Some variables used in the message routines; note that `header` will be redefined once we parse the arguments.

```

4909 package_name = 'memoize (python-based extraction)'
4910 exit_code = 0
4911 log = None
4912 header = ''
4913 indent = ''
4914 texindent = ''

```

The message routines.

```

4915 def error(short, long):
4916     if not args.quiet:
4917         print(ERROR[None].format(short = short, long = long, header = header))
4918     if log:
4919         long = long.replace('\n', '\\string\\n')
4920         print(
4921             ERROR[args.format].format(
4922                 short = short, long = long, package_name = package_name),
4923             file = log)
4924     global exit_code
4925     exit_code = 11
4926     endinput()
4927
4928 def warning(text):
4929     if log:
4930         print(
4931             WARNING[args.format].format(
4932                 text = text, texindent = texindent, package_name = package_name),
4933             file = log)
4934     if not args.quiet:
4935         print(WARNING[None].format(text = text, header = header, indent = indent))
4936     global exit_code
4937     exit_code = 10
4938
4939 def info(text):
4940     if text and not args.quiet:
4941         print(INFO[None].format(text = text, header = header, indent = indent))
4942     if log:
4943         print(
4944             INFO[args.format].format(
4945                 text = text, texindent = texindent, package_name = package_name),
4946             file = log)

```

Mark the log as complete and exit.

```

4947 def endinput():
4948     if log:
4949         print(r'\endinput', file = log)
4950         log.close()
4951     sys.exit(exit_code)

```

[Permission-related functions](#) `paranoia_in/out` should work exactly as `kpsewhich -safe-in-name/-safe-out-name`.

```

4952 def paranoia_in(f, remark = ''):
4953     if f and not _paranoia(f, openin_any):
4954         error(f"I'm not allowed to read from '{f}' (openin_any = {openin_any})",
4955             remark)
4956
4957 def paranoia_out(f, remark = ''):

```

```

4958     if f and not _paranoia(f, openout_any):
4959         error(f"I'm not allowed to write to '{f}' (openout_any = {openout_any})",
4960             remark)
4961
4962 def _paranoia(f, mode):

    mode is the value of openin_any or openout_any. f is a pathlib.Path object.
4963     return (

        In mode 'any' (a, y or 1), we may access any file.
4964         mode in 'ay1'
4965         or (

            Otherwise, we are at least in the restricted mode, so we should not open dot files on Unix-like
            systems (except file called .tex).
4966             not (os.name == 'posix' and f.stem.startswith('.') and f.stem != '.tex')
4967             and (

                If we are precisely in the restricted mode (r, n, 0), then there are no further restrictions.
4968                 mode in 'rn0'

                Otherwise, we are in the paranoid mode (officially p, but any other value is interpreted as p as
                well). There are two further restrictions in the paranoid mode.
4969                 or (

                    We're not allowed to go to a parent directory.
4970                     '..' not in f.parts
4971                     and

                        If the given path is absolute, it should be a descendant of either TEXMF_OUTPUT_DIRECTORY or
                        TEXMFOUTPUT.
4972                         (not f.is_absolute()
4973                         or
4974                         is_ancestor(texmf_output_directory, f)
4975                         or
4976                         is_ancestor(texmfoutput, f)
4977                         ))))

                On Windows, we disallow "semi-absolute" paths, i.e. paths starting with the \ but lacking the
                drive. On Windows, pathlib's is_absolute returns True only for paths starting with \ and
                containing the drive.
4978 def sanitize_filename(f):
4979     if f and platform.system() == 'Windows' and not (f.is_absolute() or not f.drive):
4980         error(f "\"Semi-absolute\" paths are disallowed: '{f}', r\"The path must \"
4981             r\"either contain both the drive letter and start with '\\', \"
4982             r\"or none of these; paths like 'C:foo' and '\\foo' are disallowed\"")
4983
4984 def access_in(f):
4985     return os.access(f, os.R_OK)

    This function can fail on Windows, reporting a non-writable file or dir as writable, because
    os.access does not work with Windows' iclacs permissions. Consequence: we might try to
    write to a read-only current or output directory instead of switching to the temporary directory.
    Paranoia is unaffected, as it doesn't use access_* functions.
4986 def access_out(f):
4987     try:
4988         exists = f.exists()

        Presumably, we get this error when the parent directory is not executable.
4989     except PermissionError:
4990         return
4991     if exists:

```

An existing file should be writable, and if it's a directory, it should also be executable.

```
4992     return os.access(f, os.W_OK) and (not f.is_dir() or os.access(f, os.X_OK))
4993     else:
```

For a non-existing file, the parent directory should be writable. (This is the only place where function `pathlib.parent` is used, so it's ok that it returns the logical parent.)

```
4994     return os.access(f.parent, os.W_OK)
```

This function finds the location for an input file, respecting `TEXMF_OUTPUT_DIRECTORY` and `TEXMFOUTPUT`, and the permissions in the filesystem. It returns an absolute file as-is. For a relative file, it tries `TEXMF_OUTPUT_DIRECTORY` (if defined), the current directory (always), and `TEXMFOUTPUT` directory (if defined), in this order. The first readable file found is returned; if no readable file is found, the file in the current directory is returned.

```
4995 def find_in(f):
4996     sanitize_filename(f)
4997     if f.is_absolute():
4998         return f
4999     for df in (texmf_output_directory / f if texmf_output_directory else None,
5000              f,
5001              texmfoutput / f if texmfoutput else None):
5002         if df and access_in(df):
5003             return df
5004     return f
```

This function finds the location for an output file, respecting `TEXMF_OUTPUT_DIRECTORY` and `TEXMFOUTPUT`, and the permissions in the filesystem. It returns an absolute file as-is. For a relative file, it tries `TEXMF_OUTPUT_DIRECTORY` (if defined), the current directory (unless `TEXMF_OUTPUT_DIRECTORY` is defined), and `TEXMFOUTPUT` directory (if defined), in this order. The first writable file found is returned; if no writable file is found, the file in either the current or the output directory is returned.

```
5005 def find_out(f):
5006     sanitize_filename(f)
5007     if f.is_absolute():
5008         return f
5009     for df in (texmf_output_directory / f if texmf_output_directory else None,
5010              f if not texmf_output_directory else None,
5011              texmfoutput / f if texmfoutput else None):
5012         if df and access_out(df):
5013             return df
5014     return texmf_output_directory / f if texmf_output_directory else f
```

This function assumes that both paths are absolute; ancestor may be `None`, signaling a non-path.

```
5015 def is_ancestor(ancestor, descendant):
5016     if not ancestor:
5017         return
5018     a = ancestor.parts
5019     d = descendant.parts
5020     return len(a) < len(d) and a == d[0:len(a)]
```

A paranoid `Path.mkdir`. The given folder is preprocessed by `find_out`.

```
5021 def mkdir(folder):
5022     folder = find_out(Path(folder))
5023     if not folder.exists():
5024         paranoia_out(folder)
```

Using `folder.mkdir` is fine because we know that `TEXMF_OUTPUT_DIRECTORY/TEXMFOUTPUT`, if given, exists, and that “folder” contains no ...

```
5025     folder.mkdir(parents = True, exist_ok = True)
```

This does not get logged when the function is invoked via `--mkdir`, as it is not clear what the log name should be.

```
5026     info(f"Created directory {folder}")
```

```

5027
5028 _re_unquote = re.compile(r'\"(.*)\"')
5029 def unquote(fn):
5030     return _re_unquote.sub(r'\1', fn)

```

**Kpathsea** Get the values of `openin_any`, `openout_any`, `TEXMFOUTPUT` and `TEXMF_OUTPUT_DIRECTORY`.

```

5031 kpsewhich_output = subprocess.run(['kpsewhich',
5032                                     f'--expand-var='
5033                                     f'openin_any=$openin_any,',
5034                                     f'openout_any=$openout_any,',
5035                                     f'TEXMFOUTPUT=$TEXMFOUTPUT'],
5036                                   capture_output = True
5037                                   ).stdout.decode().strip()
5038 if not kpsewhich_output:

```

No TeX? (Note that `kpsewhich` should exist in MiKTeX as well.) In absence of `kpathsea` information, we get very paranoid, but still try to get `TEXMFOUTPUT` from an environment variable.

```

5039     openin_any, openout_any = 'p', 'p'
5040     texmfoutput, texmf_output_directory = None, None

```

Unfortunately, this warning can't make it into the log. But then again, the chances of a missing `kpsewhich` are very slim, and its absence would show all over the place anyway.

```

5041     warning('I failed to execute "kpsewhich"; , is there no TeX system installed? '
5042             'Assuming openin_any = openout_any = "p" '
5043             '(i.e. restricting all file operations to non-hidden files '
5044             'in the current directory of its subdirectories).')
5045 else:
5046     m = re.fullmatch(r'openin_any=(.*),openout_any=(.*),TEXMFOUTPUT=(.*)',
5047                     kpsewhich_output)
5048     openin_any, openout_any, texmfoutput = m.groups()
5049     texmf_output_directory = os.environ.get('TEXMF_OUTPUT_DIRECTORY', None)
5050     if openin_any == '$openin_any':

```

When the `open*_any` variables are not expanded, we assume we're running MiKTeX. The two config settings below correspond to TeXLive's `openin_any` and `openout_any`; afaik, there is no analogue to `TEXMFOUTPUT`.

```

5051     initexmf_output = subprocess.run(
5052         ['initexmf', '--show-config-value=[Core]AllowUnsafeInputFiles',
5053          '--show-config-value=[Core]AllowUnsafeOutputFiles'],
5054         capture_output = True).stdout.decode().strip()
5055     openin_any, openout_any = initexmf_output.split()
5056     openin_any = 'a' if openin_any == 'true' else 'p'
5057     openout_any = 'a' if openout_any == 'true' else 'p'
5058     texmfoutput = None
5059     texmf_output_directory = None

```

An output directory should exist, and may not point to the root on Linux. On Windows, it may point to the root, because we only allow absolute filenames containing the drive, e.g. `F:\`; see `is_absolute`.

```

5060 def sanitize_output_dir(d_str):
5061     d = Path(d_str) if d_str else None
5062     sanitize_filename(d)
5063     return d if d and d.is_dir() and \
5064         (not d.is_absolute() or len(d.parts) != 1 or d.drive) else None
5065
5066 texmfoutput = sanitize_output_dir(texmfoutput)
5067 texmf_output_directory = sanitize_output_dir(texmf_output_directory)
5068
5069 class NotExtracted(UserWarning):
5070     pass

```

We don't delve into the real script when loaded from the testing code.

```
5071 if __name__ == '__main__':
```

## Arguments

```
5072     parser = argparse.ArgumentParser(
5073         description = "Extract extern pages produced by package Memoize "
5074             "out of the document PDF.",
5075         epilog = "For details, see the man page or the Memoize documentation.",
5076         prog = 'memoize-extract.py',
5077     )
5078     parser.add_argument('-P', '--pdf', help = 'extract from file PDF')
5079     parser.add_argument('-p', '--prune', action = 'store_true',
5080         help = 'remove the extern pages after extraction')
5081     parser.add_argument('-k', '--keep', action = 'store_true',
5082         help = 'do not mark externs as extracted')
5083     parser.add_argument('-F', '--format', choices = ['latex', 'plain', 'context'],
5084         help = 'the format of the TeX document invoking extraction')
5085     parser.add_argument('-f', '--force', action = 'store_true',
5086         help = 'extract even if the size-check fails')
5087     parser.add_argument('-q', '--quiet', action = 'store_true',
5088         help = "describe what's happening")
5089     parser.add_argument('-m', '--mkdir', action = 'store_true',
5090         help = 'create a directory (and exit); '
5091             "'mmz argument is interpreted as directory name'")
5092     parser.add_argument('-V', '--version', action = 'version',
5093         version = f"%(prog)s of Memoize " + __version__)
5094     parser.add_argument('mmz', help = 'the record file produced by Memoize: '
5095         'doc.mmz when compiling doc.tex '
5096         '(doc and doc.tex are accepted as well)')
5097
5098     args = parser.parse_args()
5099
5100     header = parser.prog + ': ' if args.format else ''
```

Start a new line in the TeX terminal output.

```
5101     if args.format:
5102         print()
```

**Initialization** With `--mkdir`, argument `mmz` is interpreted as the directory to create.

```
5103     if args.mkdir:
5104         mkdir(args.mmz)
5105         sys.exit()
```

Normalize the `mmz` argument into a `.mmz` filename.

```
5106     mmz_file = Path(args.mmz)
5107     if mmz_file.suffix == '.tex':
5108         mmz_file = mmz_file.with_suffix('.mmz')
5109     elif mmz_file.suffix != '.mmz':
5110         mmz_file = mmz_file.with_name(mmz_file.name + '.mmz')
```

Once we have the `.mmz` filename, we can open the log.

```
5111     if args.format:
5112         log_file = find_out(mmz_file.with_suffix('.mmz.log'))
5113         paranoia_out(log_file)
5114         info(f"Logging to '{log_file}");
5115         log = open(log_file, 'w')
```

Now that we have opened the log file, we can try loading the PDF processing library.

```
5116     try:
5117         import pdfwr
5118     except ModuleNotFoundError:
5119         error("Python module 'pdfwr' was not found",
5120             'Have you followed the instructions in section 1.1 of the manual?')
```

Catch any errors in the script and output them to the log.

5121       try:

Find the .mmz file we will read, but retain the original filename in `given_mmz_file`, as we will still need it.

```
5122       given_mmz_file = mmz_file
5123       mmz_file = find_in(mmz_file)
5124       paranoia_in(mmz_file)
5125       if not args.keep:
5126           paranoia_out(mmz_file,
5127                remark = 'This file is rewritten unless option --keep is given.')
5128       try:
5129           mmz = open(mmz_file)
5130       except FileNotFoundError:
5131           info(f"File '{given_mmz_file}' does not exist, "
5132               f"assuming there's nothing to do")
5133       endinput()
```

Determine the PDF filename: it is either given via `--pdf`, or constructed from the .mmz filename.

```
5134       pdf_file = find_in(Path(args.pdf)
5135                           if args.pdf else given_mmz_file.with_suffix('.pdf'))
5136       paranoia_in(pdf_file)
5137       if args.prune:
5138           paranoia_out(pdf_file,
5139                remark = 'I would have to rewrite this file '
5140                'because option --prune was given.')
```

Various initializations.

```
5141       re_prefix = re.compile(r'\\mmzPrefix *{(?P<prefix>.*?)}')
5142       re_split_prefix = re.compile(r'(?P<dir_prefix>.*\/)?(?P<name_prefix>.*?)')
5143       re_newextern = re.compile(
5144           r'\\mmzNewExtern *{(?P<extern_path>.*?)}{(?P<page_n>[0-9]+)}'
5145           r'{(?P<expected_width>[0-9.]*pt){(?P<expected_height>[0-9.]*pt)}')
5146       re_extern_path = re.compile(
5147           r'(?P<dir_prefix>.*\/)?(?P<name_prefix>.*?)'
5148           r'(?P<code_md5sum>[0-9A-F]{32})-'
5149           r'(?P<context_md5sum>[0-9A-F]{32})(?:-[0-9]+)?.pdf')
5150       pdf = None
5151       extern_pages = []
5152       new_mmz = []
5153       tolerance = 0.01
5154       dir_to_make = None
5155       info(f"Extracting new externs listed in '{mmz_file}' from '{pdf_file}'")
5156       done_message = "Done (there was nothing to extract)"
5157       indent = ' '
5158       texindent = '\space\space '
```

## Process .mmz

```
5159       for line in mmz:
5160           try:
5161               if m_p := re_prefix.match(line):
```

Found `\mmzPrefix`: create the extern directory, but only later, if an extern file is actually produced. We parse the prefix in two steps because we have to unquote the entire prefix.

```
5162               prefix = unquote(m_p['prefix'])
5163               if not (m_sp := re_split_prefix.match(prefix)):
5164                   warning(f"Cannot parse line {line.strip()}")
5165               dir_to_make = m_sp['dir_prefix']
5166               elif m_ne := re_newextern.match(line):
```

Found `\mmzNewExtern`: extract the extern page into an extern file.

```
5167               done_message = "Done"
```

The extern filename, as specified in .mmz:

```

5168         unquoted_extern_path = unquote(m_ne['extern_path'])
5169         extern_file = Path(unquoted_extern_path)

```

We parse the extern filename in a separate step because we have to unquote the entire path.

```

5170         if not (m_ep := re_extern_path.match(unquoted_extern_path)):
5171             warning(f"Cannot parse line {line.strip()}")

```

The actual extern filename:

```

5172         extern_file_out = find_out(extern_file)
5173         paranoia_out(extern_file_out)
5174         page_n = int(m_ne['page_n'])-1

```

Check whether c-memo and cc-memo exist (in any input directory).

```

5175         c_memo = extern_file.with_name(
5176             m_ep['name_prefix'] + m_ep['code_md5sum'] + '.memo')
5177         cc_memo = extern_file.with_name(
5178             m_ep['name_prefix'] + m_ep['code_md5sum']
5179             + '-' + m_ep['context_md5sum'] + '.memo')
5180         c_memo_in = find_in(c_memo)
5181         cc_memo_in = find_in(cc_memo)
5182         if not (access_in(c_memo_in) and access_in(cc_memo_in)) \
5183             and not args.force:
5184             warning(f"I refuse to extract page {page_n+1} into extern "
5185                     f"'{extern_file}', because the associated c-memo "
5186                     f"'{c_memo}' and/or cc-memo '{cc_memo}' "
5187                     f"does not exist")
5188             raise NotExtracted()

```

Load the PDF. We only do this now so that we don't load it if there is nothing to extract.

```

5189         if not pdf:
5190             if not access_in(pdf_file):
5191                 warning(f"Cannot open '{pdf_file}'")
5192                 endinput()
5193         try:

```

All safe, paranoia\_in was already called above.

```

5194             pdf = pdfmw.PdfReader(pdf_file)
5195             except pdfmw.errors.PdfParseError as err:
5196                 error(rf"File '{pdf_file}' seems corrupted. Perhaps you "
5197                       rf"have to load Memoize earlier in the preamble",
5198                       f"In particular, Memoize must be loaded before "
5199                       f"TikZ library 'fadings' and any package "
5200                       f"deploying it, and in Beamer, load Memoize "
5201                       f"by writing \RequirePackage{{{memoize}}} before "
5202                       f"\documentclass{{{beamer}}}. "
5203                       f"This was the error thrown by Python: \n{err}")

```

Does the page exist?

```

5204         if page_n >= len(pdf.pages):
5205             error(rf"I cannot extract page {page_n} from '{pdf_file}', "
5206                   rf"as it contains only {len(pdf.pages)} page" +
5207                   ('s' if len(pdf.pages) > 1 else ''), '')

```

Check whether the page size matches the .mmz expectations.

```

5208         page = pdf.pages[page_n]
5209         expected_width_pt = float(m_ne['expected_width'])
5210         expected_height_pt = float(m_ne['expected_height'])
5211         mb = page['/MediaBox']
5212         width_bp = float(mb[2]) - float(mb[0])
5213         height_bp = float(mb[3]) - float(mb[1])
5214         width_pt = width_bp / 72 * 72.27
5215         height_pt = height_bp / 72 * 72.27
5216         if (abs(width_pt - expected_width_pt) > tolerance

```



```

5217         or abs(height_pt - expected_height_pt) > tolerance) \
5218         and not args.force:
5219     warning(
5220         f"I refuse to extract page {page_n+1} from '{pdf_file}' "
5221         f"because its size ({width_pt}pt x {height_pt}pt) "
5222         f"is not what I expected "
5223         f"({expected_width_pt}pt x {expected_height_pt}pt)")
5224     raise NotExtracted()

```

All tests were successful, let's create the extern file. First, the containing directory, if necessary.

```

5225         if dir_to_make:
5226             mkdir(dir_to_make)
5227             dir_to_make = None

```

Now the extern file. Note that `paranoia_out` was already called above.

```

5228         info(f"Page {page_n+1} --> {extern_file_out}")
5229         extern = pdfmw.PdfWriter(extern_file_out)
5230         extern.addpage(page)
5231         extern.write()

```

This page will get pruned.

```

5232         if args.prune:
5233             extern_pages.append(page_n)

```

Comment out this `\mmzNewExtern`.

```

5234         if not args.keep:
5235             line = '%' + line
5236     except NotExtracted:
5237         pass
5238     finally:
5239         if not args.keep:
5240             new_mmz.append(line)
5241     mmz.close()
5242     indent = ''
5243     texindent = ''
5244     info(done_message)

```

Write out the `.mmz` file with `\mmzNewExtern` lines commented out. (All safe, `paranoia_out` was already called above.)

```

5245         if not args.keep:
5246             with open(mmz_file, 'w') as mmz:
5247                 for line in new_mmz:
5248                     print(line, file = mmz, end = '')

```

Remove the extracted pages from the original PDF. (All safe, `paranoia_out` was already called above.)

```

5249         if args.prune and extern_pages:
5250             pruned_pdf = pdfmw.PdfWriter(pdf_file)
5251             pruned_pdf.addpages(
5252                 page for n, page in enumerate(pdf.pages) if n not in extern_pages)
5253             pruned_pdf.write()
5254             info(f"The following extern pages were pruned out of the PDF: " +
5255                 ", ".join(str(page+1) for page in extern_pages))

```

Report that extraction was successful.

```

5256     endinput()

```

Catch any errors in the script and output them to the log.

```

5257     except Exception as err:
5258         error(f'Python error: {err}', traceback.format_exc())

```

### 9.3 The Perl clean-up script `memoize-clean.pl`

```

5259 my $PROG = 'memoize-clean.pl';

```

```

5260 my $VERSION = '2024/01/02 v1.1.0';
5261
5262 use strict;
5263 use Getopt::Long;
5264 use Cwd 'realpath';
5265 use File::Spec;
5266 use File::Basename;
5267
5268 my $usage = "usage: $PROG [-h] [--yes] [--all] [--quiet] [--prefix PREFIX] " .
5269             "[mmz ...]\n";
5270 my $Help = <<END;
5271 Remove (stale) memo and extern files produced by package Memoize.
5272
5273 positional arguments:
5274     mmz                .mmz record files
5275
5276 options:
5277     -h, --help          show this help message and exit
5278     --version, -V       show version and exit
5279     --yes, -y           Do not ask for confirmation.
5280     --all, -a           Remove *all* memos and externs.
5281     --quiet, -q
5282     --prefix PREFIX, -p PREFIX
5283                         A path prefix to clean;
5284                         this option can be specified multiple times.
5285
5286 For details, see the man page or the Memoize documentation.
5287 END
5288
5289 my ($yes, $all, @prefixes, $quiet, $help, $print_version);
5290 GetOptions(
5291     "yes|y"    => \$yes,
5292     "all|a"    => \$all,
5293     "prefix|p=s" => \@prefixes,
5294     "quiet|q|?" => \$quiet,
5295     "help|h|?" => \$help,
5296     "version|V" => \$print_version,
5297     ) or die $usage;
5298 $help and die "$usage\n$Help";
5299 if ($print_version) { print("memoize-clean.pl of Memoize $VERSION\n"); exit 0 }
5300
5301 my (%keep, %prefixes);
5302
5303 my $curdir = Cwd::getcwd();
5304
5305 for my $prefix (@prefixes) {
5306     $prefixes{Cwd::realpath(File::Spec->catfile($curdir, $prefix))} = '';
5307 }
5308
5309 my @mmzs = @ARGV;
5310
5311 for my $mmz (@mmzs) {
5312     my ($mmz_filename, $mmz_dir) = File::Basename::fileparse($mmz);
5313     @ARGV = ($mmz);
5314     my $endinput = 0;
5315     my $empty = -1;
5316     my $prefix = "";
5317     while (<>) {
5318 if (/^ *$/) {
5319 } elsif ($endinput) {
5320     die "Bailing out, \\endinput is not the last line of file $mmz.\n";
5321 } elsif (/^ *\mmzPrefix *{(.*)}/) {
5322     $prefix = $1;

```

```

5323     $prefixes{Cwd::realpath(File::Spec->catfile(($curdir,$mmz_dir), $prefix))} = '';
5324     $empty = 1 if $empty == -1;
5325 } elsif (/^%? *\mmz(?:New|Used)(?:CC?Memo|Extern) *{(.*)}/) {
5326     my $fn = $1;
5327     if ($prefix eq '') {
5328 die "Bailing out, no prefix announced before file $fn.\n";
5329     }
5330     $keep{Cwd::realpath(File::Spec->catfile(($mmz_dir), $fn))} = 1;
5331     $empty = 0;
5332     if (rindex($fn, $prefix, 0) != 0) {
5333 die "Bailing out, prefix of file $fn does not match " .
5334     "the last announced prefix ($prefix).\n";
5335     }
5336 } elsif (/^ *\endinput *$/) {
5337     $endinput = 1;
5338 } else {
5339     die "Bailing out, file $mmz contains an unrecognized line: $_\n";
5340 }
5341 }
5342 die "Bailing out, file $mmz is empty.\n" if $empty && !$all;
5343 die "Bailing out, file $mmz does not end with \endinput; this could mean that " .
5344 "the compilation did not finish properly. You can only clean with --all.\n"
5345 if $endinput == 0 && !$all;
5346 }
5347
5348 my @tbdeleted;
5349 sub populate_tbdeleted {
5350     my ($basename_prefix, $dir, $suffix_dummy) = @_;
5351     opendir(MD, $dir) or die "Cannot open directory '$dir'";
5352     while( (my $fn = readdir(MD)) ) {
5353 my $path = File::Spec->catfile(($dir),$fn);
5354 if ($fn =~
5355     /\Q$basename_prefix\E[0-9A-F]{32}(?:-[0-9A-F]{32})?(?:-[0-9]{+})?#
5356     (\.memo|(?:-[0-9]{+})?\.\pdf|\.log)/x
5357     and ($all || !exists($keep{$path}))) {
5358         push @tbdeleted, $path;
5359     }
5360 }
5361     closedir(MD);
5362 }
5363 for my $prefix (keys %prefixes) {
5364     my ($basename_prefix, $dir, $suffix);
5365     if (-d $prefix) {
5366 populate_tbdeleted('', $prefix, '');
5367     }
5368     populate_tbdeleted(File::Basename::fileparse($prefix));
5369 }
5370 @tbdeleted = sort(@tbdeleted);
5371
5372 my @allowed_dirs = ($curdir);
5373 my @deletion_not_allowed;
5374 for my $f (@tbdeleted) {
5375     my $f_allowed = 0;
5376     for my $dir (@allowed_dirs) {
5377 if ($f =~ /\Q$dir\E/) {
5378         $f_allowed = 1;
5379         last;
5380     }
5381     }
5382     push(@deletion_not_allowed, $f) if ! $f_allowed;
5383 }
5384 die "Bailing out, I was asked to delete these files outside the current directory:\n" .
5385     join("\n", @deletion_not_allowed) if (@deletion_not_allowed);

```

```

5386
5387 if (scalar(@tbdeleted) != 0) {
5388     my $a;
5389     unless ($yes) {
5390         print("I will delete the following files:\n" .
5391             join("\n",@tbdeleted) . "\n" .
5392             "Proceed (y/n)? ");
5393         $a = lc(<>);
5394         chomp $a;
5395     }
5396     if ($yes || $a eq 'y' || $a eq 'yes') {
5397         foreach my $fn (@tbdeleted) {
5398             print "Deleting ", $fn, "\n" unless $quiet;
5399             unlink $fn;
5400         }
5401     } else {
5402         die "Bailing out.\n";
5403     }
5404 } elsif (!$quiet) {
5405     print "Nothing to do, the directory seems clean.\n";
5406 }

```

## 9.4 The Python clean-up script memoize-clean.py

```

5407 __version__ = '2024/01/02 v1.1.0'
5408
5409 import argparse, re, sys, pathlib, os
5410
5411 parser = argparse.ArgumentParser(
5412     description="Remove (stale) memo and extern files.",
5413     epilog = "For details, see the man page or the Memoize documentation "
5414             "(https://ctan.org/pkg/memoize).")
5415 )
5416 parser.add_argument('--yes', '-y', action = 'store_true',
5417     help = 'Do not ask for confirmation.')
5418 parser.add_argument('--all', '-a', action = 'store_true',
5419     help = 'Remove *all* memos and externs.')
5420 parser.add_argument('--quiet', '-q', action = 'store_true')
5421 parser.add_argument('--prefix', '-p', action = 'append', default = [],
5422     help = 'A path prefix to clean; this option can be specified multiple times.')
5423 parser.add_argument('mmz', nargs= '*', help='.mmz record files')
5424 parser.add_argument('--version', '-V', action = 'version',
5425     version = f"%(prog)s of Memoize " + __version__)
5426 args = parser.parse_args()
5427
5428 re_prefix = re.compile(r'\\mmzPrefix *{(.*)}')
5429 re_memo = re.compile(r'%? *\\mmz(?:New|Used)(?:CC?Memo|Extern) *{(.*)}')
5430 re_endinput = re.compile(r' *\\endinput *$')
5431
5432 prefixes = set(pathlib.Path(prefix).resolve() for prefix in args.prefix)
5433 keep = set()

```

We loop through the given .mmz files, adding prefixes to whatever manually specified by the user, and collecting the files to keep.

```

5434 for mmz_fn in args.mmz:
5435     mmz = pathlib.Path(mmoz_fn)
5436     mmz_parent = mmz.parent.resolve()
5437     try:
5438         with open(mmoz) as mmz_fh:
5439             prefix = ''
5440             endinput = False
5441             empty = None
5442             for line in mmz_fh:

```

```

5443         line = line.strip()
5444
5445     if not line:
5446         pass
5447
5448     elif endinput:
5449         raise RuntimeError(
5450             rf'Bailing out, '
5451             rf'\endinput is not the last line of file {mmz_fn}.' )
5452
5453     elif m := re_prefix.match(line):
5454         prefix = m[1]
5455         prefixes.add( (mmz_parent/prefix).resolve() )
5456         if empty is None:
5457             empty = True
5458
5459     elif m := re_memo.match(line):
5460         if not prefix:
5461             raise RuntimeError(
5462                 f'Bailing out, no prefix announced before file "{m[1]}".')
5463         if not m[1].startswith(prefix):
5464             raise RuntimeError(
5465                 f'Bailing out, prefix of file "{m[1]}" does not match '
5466                 f'the last announced prefix ({prefix}).')
5467         keep.add((mmz_parent / m[1]))
5468         empty = False
5469
5470     elif re_endinput.match(line):
5471         endinput = True
5472         continue
5473
5474     else:
5475         raise RuntimeError(fr"Bailing out, "
5476                             fr"file {mmz_fn} contains an unrecognized line: {line}")
5477
5478     if empty and not args.all:
5479         raise RuntimeError(fr'Bailing out, file {mmz_fn} is empty.')
5480
5481     if not endinput and empty is not None and not args.all:
5482         raise RuntimeError(
5483             fr'Bailing out, file {mmz_fn} does not end with \endinput; '
5484             fr'this could mean that the compilation did not finish properly. '
5485             fr'You can only clean with --all.'
5486         )

```

It is not an error if the file doesn't exist. Otherwise, cleaning from scripts would be cumbersome.

```

5487     except FileNotFoundError:
5488         pass
5489
5490     tbdeleted = []
5491     def populate_tbdeleted(folder, basename_prefix):
5492         re_aux = re.compile(
5493             re.escape(basename_prefix) +
5494             '[0-9A-F]{32}(?:-[0-9A-F]{32})?'
5495             '(?:-[0-9+)?(?:\.memo|(?:-[0-9+)?\.pdf|\.log)$')
5496         try:
5497             for f in folder.iterdir():
5498                 if re_aux.match(f.name) and (args.all or f not in keep):
5499                     tbdeleted.append(f)
5500         except FileNotFoundError:
5501             pass
5502
5503     for prefix in prefixes:

```

```

    "prefix" is interpreted both as a directory (if it exists) and a basename prefix.
5504     if prefix.is_dir():
5505         populate_tbdeleted(prefix, '')
5506     populate_tbdeleted(prefix.parent, prefix.name)
5507
5508 allowed_dirs = [pathlib.Path().absolute()] # todo: output directory
5509 deletion_not_allowed = [f for f in tbdeleted if not f.is_relative_to(*allowed_dirs)]
5510 if deletion_not_allowed:
5511     raise RuntimeError("Bailing out, "
5512         "I was asked to delete these files outside the current directory:\n" +
5513         "\n".join(str(f) for f in deletion_not_allowed))
5514
5515 _cwd_absolute = pathlib.Path().absolute()
5516 def relativize(path):
5517     try:
5518         return path.relative_to(_cwd_absolute)
5519     except ValueError:
5520         return path
5521
5522 if tbdeleted:
5523     tbdeleted.sort()
5524     if not args.yes:
5525         print('I will delete the following files:')
5526         for f in tbdeleted:
5527             print(relativize(f))
5528         print("Proceed (y/n)? ")
5529         a = input()
5530     if args.yes or a == 'y' or a == 'yes':
5531         for f in tbdeleted:
5532             if not args.quiet:
5533                 print("Deleting", relativize(f))
5534             try:
5535                 f.unlink()
5536             except FileNotFoundError:
5537                 print(f"Cannot delete {f}")
5538     else:
5539         print("Bailing out.")
5540 elif not args.quiet:
5541     print('Nothing to do, the directory seems clean.')

```

# Index

Numbers written in red refer to the code line where the corresponding entry is defined; numbers in blue refer to the code lines where the entry is used.

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