The **mathstyle** package

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Feedback: `https://github.com/wspr/breqn/issues`

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User's guide

This package exists for two reasons:

- The primitive operations for creating a super- or subscript in TeX work almost as if `^` and `_` are macros taking an argument. However, that is not quite the case, and some things that you'd expect to work don't (e.g., `^\cong`) whereas others which you'd think shouldn't work actually do (such as `^\mathsf{s}`). We do everyone a favor if it behaves consistently, i.e., if the superscript and subscript operations act as if they are macros taking exactly one argument.

- Because the TeX math typesetting engine uses infix notation for fractions, one has to use `\mathchoice` or `\mathpalette` whenever trying to do anything requiring boxing or measuring math. This creates problems for loading fonts on demand as the font loading mechanism has to load fonts for all styles without even knowing if the font is going to be used. Getting the timing of `\mathchoice` right can be tricky as well. Since LaTeX does not promote the primitive infix notation, this package keeps track of a current mathstyle parameter.

1 Some usage tips

If you want to use this package with `amsmath`, it is important `mathstyle` is loaded *after* `amsmath`.

The current mathstyle is stored in the variable `\mathstyle`. The command `\currentmathstyle` can be used to switch to the mode currently active. Below is shown how the macro `\mathrlap` from `mathtools` is implemented without knowing about the current mathstyle using `\mathpalette`.

```
\providecommand*\mathrlap[1][]{%
  \ifx\@empty#1\@empty
```

```
    \expandafter \mathpalette \expandafter \@mathrlap
  \else
    \expandafter \@mathrlap \expandafter #1%
  \fi}
\providecommand*\@mathrlap #1#2{{}\rlap{$\m@th#1{#2}$}}
```

The same definition using `\currentmathstyle` from this package.

```
\providecommand*\mathrlap[2][]{%
  #1 {}\rlap{$\m@th \currentmathstyle {#2}$}}
```

1.1   Package options

This package has one set of options affecting the _ and ^ characters:

- `\usepackage[mathactivechars]{mathstyle}`

  This is the default behaviour. Here, _ and ^ are made into harmless characters in text mode and behave as expected (for entering sub/superscript) when inside math mode. Certain code that assumes the catcodes of these characters may get confused about this; see below for a possible fix.

- `\usepackage[activechars]{mathstyle}`

  With this option, _ and ^ are made into active characters for entering sub/superscript mode in all cases—therefore, in text mode they will produce a regular error ('Missing $ inserted') indicating they are being used out of place.

- `\usepackage[noactivechars]{mathstyle}`

  This is the option most like to solve any compatibility problems. Here, _ and ^ retain their regular catcodes at all times and behave in their default fashion. **However**, certain other features of this package (such as `\currentmathstyle` inside a subscript) will then fail to work, so only use this option as a last resort.

Implementation

```
1 ⟨∗package⟩
2 \NeedsTeXFormat{LaTeX2e}
3 \RequirePackage{expl3}
4 \ProvidesExplPackage{mathstyle}{2020/09/24}{0.98k}{Tracking mathstyle implicitly}
5 \ExplSyntaxOff
```

\@saveprimitive   A straight copy from breqn, see implementation details there. Of course, with a recent pdfTeX (v1.40+), one can just use `\primitive` to get the original. We will implement that some day.

```
 6 \providecommand\@saveprimitive[2]{%
 7  \begingroup
 8  \edef\@tempa{\string#1}\edef\@tempb{\meaning#1}%
 9  \ifx\@tempa\@tempb \global\let#2#1%
10  \else
11    \edef\@tempb{\meaning#2}%
12    \ifx\@tempa\@tempb
13    \else \@saveprimitive@a#1#2%
14    \fi
15  \fi
16  \endgroup
17 }
18 \providecommand\@saveprimitive@a[2]{%
19  \begingroup
20  \def\@tempb##1#1##2{\edef\@tempb{##2}\@car{}}%
21  \@tempb\nullfont{select font nullfont}%
22    \topmark{\string\topmark:}%
23    \firstmark{\string\firstmark:}%
24    \botmark{\string\botmark:}%
25    \splitfirstmark{\string\splitfirstmark:}%
26    \splitbotmark{\string\splitbotmark:}%
27    #1{\string#1}%
28    \@nil % for the \@car
29  \edef\@tempa{\expandafter\strip@prefix\meaning\@tempb}%
30  \edef\@tempb{\meaning#1}%
31  \ifx\@tempa\@tempb \global\let#2#1%
32  \else
33    \PackageError{mathstyle}%
34      {Unable to properly define \string#2; primitive
35      \noexpand#1no longer primitive}\@eha
36    \fi
37  \fi
38  \endgroup
39 }
```

\everydisplay We need to keep track of whether we're in inline or display maths, and the only way to do that is to add a switch inside \everydisplay. We act sensibly and preserve any of the previous contents of that token register before adding our own code here. As we'll see in a second, LuaTeX provides a native mechanism for this so we don't need any action in that case. (Various other parts of the code also need to have different paths for LuaTeX use.)

```
40 \begingroup\expandafter\expandafter\expandafter\endgroup
41 \expandafter\ifx\csname directlua\endcsname\relax
42   \everydisplay=\expandafter{\the\everydisplay\chardef\mathstyle\z@}
43 \fi
```

\mathstyle A counter for the math style: 0–display, 2–text, 4–script, 6–scriptscript. The logic
\mathstyledenom is that display maths will explicitly set \mathstyle to zero (see above), so by default it is set to the 'text' maths style. With LuaTeX there is a primitive to do

the same so it just has to be enabled. Note that in all cases we use LuaTeX-like numbering for the states.

```
44 \begingroup\expandafter\expandafter\expandafter\endgroup
45 \expandafter\ifx\csname directlua\endcsname\relax
46   \chardef\mathstyle=2\relax
47   \chardef\mathstyledenom=0\relax
48 \else
49   \directlua{tex.enableprimitives("", {"mathstyle"})}
50 \fi
```

Save the four style changing primitives, `\mathchoice` and the fraction commands.

```
51 \@saveprimitive\displaystyle\@@displaystyle
52 \@saveprimitive\textstyle\@@textstyle
53 \@saveprimitive\scriptstyle\@@scriptstyle
54 \@saveprimitive\scriptscriptstyle\@@scriptscriptstyle
55 \@saveprimitive\mathchoice\@@mathchoice
56 \@saveprimitive\over\@@over
57 \@saveprimitive\atop\@@atop
58 \@saveprimitive\above\@@above
59 \@saveprimitive\overwithdelims\@@overwithdelims
60 \@saveprimitive\atopwithdelims\@@atopwithdelims
61 \@saveprimitive\abovewithdelims\@@abovewithdelims
```

Then we redeclare the four style changing primitives: set the value of `\mathstyle` if LuaTeX is not in use.

```
62 \begingroup\expandafter\expandafter\expandafter\endgroup
63 \expandafter\ifx\csname directlua\endcsname\relax
64   \DeclareRobustCommand{\displaystyle}{%
65     \@@displaystyle \chardef\mathstyle0\relax}
66   \DeclareRobustCommand{\textstyle}{%
67     \@@textstyle \chardef\mathstyle2\relax}
68   \DeclareRobustCommand{\scriptstyle}{%
69     \@@scriptstyle \chardef\mathstyle4\relax}
70   \DeclareRobustCommand{\scriptscriptstyle}{%
71     \@@scriptscriptstyle \chardef\mathstyle6\relax}
72 \fi
```

First we get the primitive operations. These should have been control sequences in TeX just like operations for begin math, end math, begin display, end display.

```
73 \begingroup \catcode`\^=7\relax \catcode`\_=8\relax % just in case
74 \lowercase{\endgroup
75 \let\@@superscript=^ \let\@@subscript=_
76 }%
77 \begingroup \catcode`\^=12\relax \catcode`\_=12\relax % just in case
78 \lowercase{\endgroup
79 \let\@@superscript@other=^ \let\@@subscript@other=_
80 }%
```

If we enter a sub- or superscript the `\mathstyle` must be adjusted. Since all is happening in a group, we do not have to worry about resetting. We can't tell the

difference between cramped and non-cramped styles unless LuaTeX is in use, in which case this command is a no-op.

```
81 \begingroup\expandafter\expandafter\expandafter\endgroup
82 \expandafter\ifx\csname directlua\endcsname\relax
83   \def\subsupstyle{%
84     \ifnum\mathstyle<4\relax
85       \chardef\mathstyle\numexpr4+\mathstyledenom\relax
86     \else
87       \chardef\mathstyle\numexpr6+\mathstyledenom\relax
88     \fi
89   }
90 \else
91   \def\subsupstyle{}
92 \fi
```

Provide commands with meaningful names for the two primitives, cf. `\mathrel`.

```
93 \let\mathsup=\@@superscript
94 \let\mathsub=\@@subscript
```

`\sb` and `\sp` are then defined as macros.

```
95 \def\sb#1{\mathsub{\protect\subsupstyle#1}}%
96 \def\sp#1{\mathsup{\protect\subsupstyle#1}}%
```

`\mathchoice`   `\mathchoice` is now just a switch. Note that this redefinition does not allow the arbitrary ⟨*filler*⟩ of the TeX primitive. Very rarely used anyway.

```
 97 \def\mathchoice{%
 98   \relax\ifcase\numexpr\mathstyle\relax
 99     \expandafter\@firstoffour % Display
100   \or
101     \expandafter\@firstoffour % Cramped display
102   \or
103     \expandafter\@secondoffour % Text
104   \or
105     \expandafter\@secondoffour % Cramped text
106   \or
107     \expandafter\@thirdoffour % Script
108   \or
109     \expandafter\@thirdoffour % Cramped script
110   \else
111     \expandafter\@fourthoffour % (Cramped) Scriptscript
112   \fi
113 }
```

Helper macros.

```
114 \providecommand\@firstoffour[4]{#1}
115 \providecommand\@secondoffour[4]{#2}
116 \providecommand\@thirdoffour[4]{#3}
117 \providecommand\@fourthoffour[4]{#4}
```

`\genfrac`   The amsmath definition:

```
\DeclareRobustCommand{\genfrac}[4]{%
  \def\@tempa{#1#2}%
  \edef\@tempb{\@nx\@genfrac\@mathstyle{#4}%
    \csname @@\ifx @#3@over\else above\fi
    \ifx\@tempa\@empty \else withdelims\fi\endcsname}
  \@tempb{#1#2#3}}
```

with arguments:

- left-delim

- right-delim

- line thickness (default if empty)

- mathstyle override

- numerator

- denominator

The fractions. Note that this uses the same names as in amsmath. Much the same except here they call `\fracstyle`.

```
118 \DeclareRobustCommand\genfrac[6]{%
119   {%
120     % emulate old amsmath syntax:
121     \if 0#4\relax\displaystyle\else
122     \if 1#4\relax\textstyle\else
123     \if 2#4\relax\scriptstyle\else
124     \if 3#4\relax\scriptscriptstyle\else
125       #4%
126     \fi\fi\fi\fi
127     \fracstyle
128     {\begingroup #5\endgroup
129       \csname @@\ifx\maxdimen#3\maxdimen over\else above\fi
130         \if @#1@\else withdelims\fi\endcsname #1 #2 #3\relax
131       \ifnum\mathstyledenom=0\relax
132         \chardef\mathstyledenom=1\relax
133         \edef\mathstyle@tempa{\number\mathstyle}%
134         \chardef\mathstyle=\numexpr\mathstyle@tempa+1\relax
135       \fi
136       #6%
137       \chardef\mathstyledenom=0\relax}%
138   }%
139 }
140 \begingroup\expandafter\expandafter\expandafter\endgroup
141 \expandafter\ifx\csname directlua\endcsname\relax\else
142 \DeclareRobustCommand\genfrac[6]{%
143   {%
144     % emulate old amsmath syntax:
```

```
145     \if 0#4\relax\displaystyle\else
146     \if 1#4\relax\textstyle\else
147     \if 2#4\relax\scriptstyle\else
148     \if 3#4\relax\scriptscriptstyle\else
149        #4%
150     \fi\fi\fi\fi
151     \fracstyle
152     {\begingroup #5\endgroup
153       \csname @@\ifx\maxdimen#3\maxdimen over\else above\fi
154         \if @#1@\else withdelims\fi\endcsname #1 #2 #3\relax
155       #6%
156     }%
157   }%
158 }
159 \fi

160 \renewcommand{\frac}{\genfrac{}{}{}{}}
161 \providecommand{\dfrac}{}
162 \providecommand{\tfrac}{}
163 \renewcommand{\dfrac}{\genfrac{}{}{}\displaystyle}
164 \renewcommand{\tfrac}{\genfrac{}{}{}\displaystyle}
165 \providecommand{\binom}{}
166 \providecommand{\tbinom}{}
167 \providecommand{\dbinom}{}
168 \renewcommand{\binom}{\genfrac(){0pt}{}}
169 \renewcommand{\dbinom}{\genfrac(){0pt}\displaystyle}
170 \renewcommand{\tbinom}{\genfrac(){0pt}\textstyle}
```

The \fracstyle command is a switch to go one level down but no further than three.

```
171 \begingroup\expandafter\expandafter\expandafter\endgroup
172 \expandafter\ifx\csname directlua\endcsname\relax
173   \def\fracstyle{%
174     \ifcase\numexpr\mathstyle\relax
175             \chardef\mathstyle=0\relax % 0
176     \or     \chardef\mathstyle=1\relax % 1
177     \or     \chardef\mathstyle=2\relax % 2
178     \or     \chardef\mathstyle=3\relax % 3
179     \else \chardef\mathstyle=3\relax % 4 or more
180     \fi
181   }
182 \else
183   \def\fracstyle{}
184 \fi
```

The \currentmathstyle checks the value of \mathstyle and switches to it so it is in essence the opposite of \displaystyle and friends.

```
185 \def\currentmathstyle{%
186   \ifcase\numexpr\mathstyle\relax
187     \@@displaystyle
188   \or
```

```
189     \@@displaystyle
190   \or
191     \@@textstyle
192   \or
193     \@@textstyle
194   \or
195     \@@scriptstyle
196   \or
197     \@@scriptstyle
198   \else
199     \@@scriptscriptstyle
200   \fi}
```

Finally, we declare the package options.

```
201 \DeclareOption{mathactivechars}{%
202 %   \catcode'\^=12\relax
203 %   \catcode'\_=12\relax
204 \AtBeginDocument{\catcode'\^=12\relax \catcode'\_=12\relax}%
205 }
206 \DeclareOption{activechars}{%
207 %   \catcode'\^=13\relax
208 %   \catcode'\_=13\relax
209 \AtBeginDocument{\catcode'\^=13\relax \catcode'\_=13\relax}%
210 }
211 \DeclareOption{noactivechars}{%
212 %   \catcode'\^=7\relax
213 %   \catcode'\_=8\relax
214 \AtBeginDocument{\catcode'\^=7\relax \catcode'\_=8\relax}%
215 }
216 \ExecuteOptions{mathactivechars}
217 \ProcessOptions\relax
```

WSPR: Set up the active behaviours: (this is set even in the `noactivechars` case but they are never activated. no worries?)

```
218 \ifnum\catcode'\^=13\relax
219   \let^=\sp \let_=\sb
220 \else
221   \mathcode'\^="8000\relax
222   \mathcode'\_="8000\relax
223   \begingroup
224     \catcode'\^=\active
225     \catcode'\_=\active
226     \global\let^=\sp
227     \global\let_=\sb
228   \endgroup
229 \fi
230 ⟨/package⟩
```