The scalerel Package

Routines for constrained scaling and stretching of objects,
relative to a reference object or in absolute terms

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1 Commands and Description

The scalerel package is used to scale and vertically stretch objects, either relative to other objects, or in absolute terms. Its commands may be invoked in either math mode or text mode (if there is no math in the objects to manipulate); however, the objects it manipulates will, by default, be processed in math mode. Nonetheless, one may process the objects in text mode (assuming they do not contain math-specific characters or commands) by specifying arguments as `{$object$}`, instead of the usual `{object}`.

There are four basic commands with the scalerel package, two of which have star variants:

```
\scalerel[*][max_width]{object}{reference}
\stretchrel[*][min_aspect]{object}{reference}
\scaleto[max_width]{object}{height}
\stretchto[min_aspect]{object}{height}
```

In all cases, `object` is the object to be scaled or vertically stretched. It can be as simple as a symbol, like a summation sign ($\sum$), or it can be an object of complex description. Likewise, in cases of *relative* scaling and stretching, `reference` is the reference object in relation to which the manipulated `object` is scaled or vertically stretched. The `reference` may likewise be of complex description (such as a mathematical expression). When an `object` is scaled or stretched *relative* to a `reference` object, it is also vertically shifted, if necessary, so that its vertical extent conforms to that of the `reference` object.

In cases of scaling or stretching *to* a specified size, `height` will the final vertical height of `object` following a scale or stretch manipulation. Since scaling or stretching to an absolute size provides no `reference` object, the baseline of manipulated `object` remains unchanged.

In cases of scaling (relative or absolute), the constraint `max_width` is optionally

specified as the maximum width allowable for the manipulated object. If the manipulated width would otherwise exceed this limit, the `object` width is scaled back to this limit. If the `object` width is scaled back, its aspect ratio will change with respect to its original shape.

By definition, vertical stretching will change the aspect ratio of an object. In the case of stretching (relative or absolute), the constraint `min_aspect` is the minimum aspect ratio allowed by the stretch. Its value is given in %, such that a parameter value of `100` indicates 100% or an aspect ratio of 1. If the stretch would otherwise cause the manipulated `object`'s aspect ratio to fall below this value, the width of the manipulated `object` is increased to meet this minimum threshold. The value of `min_aspect` must be an integer.

Because *relative* scaling or stretching is done *relative* to a reference object, the `\scalerel` and `\stretchrel` commands will, by default, print out the manipulated `object` followed immediately by the `reference` object. Because this may not always be desired, the star (*) version of these commands suppresses the output of the `reference` object, so that only the `object` that was manipulated is output.

2 Examples

Now for a few examples. Let us define

```
\def\preblob{\displaystyle\sum_{i=0}^3}
\def\blob{\displaystyle\frac{\displaystyle\frac{x^3}{z+r^3}}%
          {\displaystyle\frac{y}{x^2}}%
}
```

Here are the raw definitions of `$\preblob\blob$`, unscaled:

$$\sum_{i=0}^{3} \frac{\dfrac{x^3}{z+r^3}}{\dfrac{y}{x^2}}$$

2.1 The `\scalerel` Command

Now we employ `$\scalerel{\preblob}{\blob}$`

$$\sum_{i=0}^{3} \frac{x^3}{\frac{z+r^3}{\frac{y}{x^2}}}$$

If we wish constrain the width of the summation to 3ex, we employ
`$\scalerel[3ex]{\preblob}{\blob}$`

$$\sum_{i=0}^{3} \frac{x^3}{\frac{z+r^3}{\frac{y}{x^2}}}$$

Of course, if the manipulated object contains text symbols, a width constraint will change their aspect ratio, which may not be desirable.

Now let's say you wanted to introduce notation to bound mathematical expressions by triangles. After defining `\blob` as before, you could use
`$\scalerel[3ex]{\triangleleft}{\blob}`
`\scalerel*[3ex]{\triangleright}{\blob}$`

$$\left\langle \frac{x^3}{\frac{z+r^3}{\frac{y}{x^2}}} \right\rangle$$

Here, the second call to `\scalerel` was with the star (`*`) option, indicating that `\blob` should not be printed out following the right-hand delimiter. A less-tall expression would appear in those same delimiters as

$\triangleleft Q \triangleright$

Because the width limit had not been reached, no horizontal compression of the object was required.

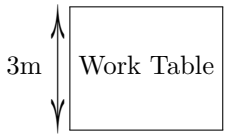
2.2 The `\stretchrel` Command

In its most simple application `\stretchrel` can be used in the fashion of a `\left\{` in math mode. While there is no reason to replace that more efficient usage supplied by LaTeX, it is nonetheless instructional to see a comparison of `$\left\{\blob\right.$` and `$\stretchrel[400]{\{}{\blob}$`, to see how the aspect-ratio limiting option can be employed to avoid an overly stretched manipulation:

$$\left\{\frac{\frac{x^3}{z+r^3}}{\frac{y}{x^2}}\right. \qquad \left\{\frac{\frac{x^3}{z+r^3}}{\frac{y}{x^2}}\right.$$

The expression on the right uses a standard { character, which has been vertically stretched, but limited to an aspect ratio of 4. To use symbols for which the `\left` nomenclature will not work, `\stretchrel` provides a viable alternative, as shown in this stick-figure example:

```
3m $\stretchrel[500]{\updownarrow\,}
{\fbox{\rule[-1.8em]{0ex}{4em}Work Table}}$
```

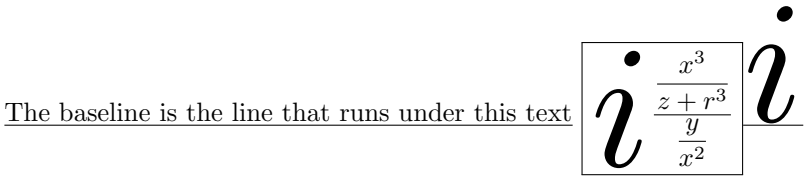


or in this use, `$\stretchrel[225]{\int}{\blob} dx$`, of the stretched integral sign (aspect limited to 2.25):

$$\int\frac{\frac{x^3}{z+r^3}}{\frac{y}{x^2}}dx$$

2.3 Baseline Shifts of *Relative* Scales and Stretches

It was mentioned that when `\scalerel` and `\stretchrel` are employed, the manipulated object gets vertically shifted to match the extent of the reference object. To see how this works, we provide the following example, that employs some inline math. and scaling.



The first case of the large letter "i" was generated with `\scalerel`, and so the baseline of the "i", normally not a descending letter, was dropped to conform to the descended reference equation. All of this was set in an `\fbox` to show the extent of the objects. For comparison, an "i" of the samesize was then placed using a `\scaleto` command, which does not change the baseline of the original object.

2.4 The \scaleto and \stretchto Commands

The \scaleto and \stretchto commands are comparable to the \scalerel and \stretchrel commands, except they do not accept a reference object as their second mandatory argument. Rather, they take an absolute height (specified with units). These commands use the same optional arguments as \scalerel and \stretchrel to constrain the width and/or the aspect ratio, respectively, of the manipulated object.

As was mentioned in the prior section, a difference between these and the *relative* commands is that an object's baseline is not altered with the use of \scaleto and \stretchto. Because there is no reference object employed with these commands, there is no need for starred (*) versions of these commands, which would otherwise suppress the printing of the reference object.

Examples follow the established pattern established in prior sections. First, we scale the equation blob used as an example in this documentation to a vertical extent of 80pt, preserving the original aspect ratio,

```
$\scaleto{\blob}{80pt}$
```

$$\cfrac{\cfrac{x^3}{z+r^3}}{\cfrac{y}{x^2}}$$

Then, we stretch the Greek letter, capital phi, to 60pt, but constrain the aspect ratio to no less than 1.75.

```
$\stretchto[175]{\Phi}{60pt}$
```

Φ

3 Future Development

It would be relatively straightforward to extend this approach to horizontal scaling problems. However, it is not exactly clear to the author what format is best suited for user needs. If he gets feedback in that regard, it will inform him how best to proceed.

4 Code Listing

```
\ProvidesPackage{scalerel}[2013/02/27]

\usepackage{calc}
\usepackage{tikz}
\global\newlength\thesrwidth
\global\newlength\thesrheight
\global\newlength\srblobheight
\global\newlength\srblobdepth
\global\newlength\mnxsrwidth
\newsavebox{\prebox}

\newcommand\scalerel{\@ifstar{\scalerelplain}{\scalerelplus}}

\newcommand\scalerelplain[3][99in]{%
  \sbox{\prebox}{$#2$}%
  \setbox0\hbox{$#3$}%
  \setlength\srblobheight{\ht0+\dp0}%
  \setlength\srblobdepth{\dp0}%
  \setbox0\hbox{$#2$}%
  \setlength\thesrwidth{\wd0*\ratio{\srblobheight}{\ht0+\dp0}}%
  \setlength\thesrheight{\ht0*\ratio{\srblobheight}{\ht0+\dp0}}%
  \setlength\mnxsrwidth{#1}%
  \ifdim\thesrwidth>\mnxsrwidth\setlength\thesrwidth{\mnxsrwidth}\fi%
  \raisebox{-\srblobdepth+\dp0*\ratio{\srblobheight}{\ht0+\dp0}}%
           {\resizebox{\thesrwidth}{\thesrheight}{\usebox{\prebox}}}%
}
\newcommand\scalerelplus[3][99in]{\scalerelplain[#1]{#2}{#3}#3}

\newcommand\stretchrel{\@ifstar{\stretchrelplain}{\stretchrelplus}}

\newcommand\stretchrelplain[3][10000]{%
  \sbox{\prebox}{$#2$}%
  \setbox0\hbox{$#3$}%
  \setlength\srblobheight{\ht0+\dp0}%
  \setlength\srblobdepth{\dp0}%
  \setbox0\hbox{$#2$}%
  \setlength\thesrwidth{\wd0}%
  \setlength\thesrheight{\ht0*\ratio{\srblobheight}{\ht0+\dp0}}%
  \setlength\mnxsrwidth{\thesrheight*100/#1}
  \ifdim\thesrwidth<\mnxsrwidth\setlength\thesrwidth{\mnxsrwidth}\fi%
  \raisebox{-\srblobdepth+\dp0*\ratio{\srblobheight}{\ht0+\dp0}}%
           {\resizebox{\thesrwidth}{\thesrheight}{\usebox{\prebox}}}%
}
```

```
\newcommand\stretchrelplus[3][10000]{\stretchrelplain[#1]{#2}{#3}#3}

\newcommand\scaleto[3][99in]{%
  \sbox{\prebox}{$#2$}%
  \setlength\srblobheight{#3}%
  \setlength\srblobdepth{0pt}%
  \setbox0\hbox{$#2$}%
  \setlength\thesrwidth{\wd0*\ratio{\srblobheight}{\ht0+\dp0}}%
  \setlength\thesrheight{\ht0*\ratio{\srblobheight}{\ht0+\dp0}}%
  \setlength\mnxsrwidth{#1}%
  \ifdim\thesrwidth>\mnxsrwidth\setlength\thesrwidth{\mnxsrwidth}\fi%
  \setlength\srblobdepth{\dp0*\ratio{\srblobheight}{\ht0+\dp0}}%
  \raisebox{-\srblobdepth+\dp0*\ratio{\srblobheight}{\ht0+\dp0}}%
           {\resizebox{\thesrwidth}{\thesrheight}{\usebox{\prebox}}}%
}

\newcommand\stretchto[3][10000]{%
  \sbox{\prebox}{$#2$}%
  \setlength\srblobheight{#3}%
  \setlength\srblobdepth{0pt}%
  \setbox0\hbox{$#2$}%
  \setlength\thesrwidth{\wd0}%
  \setlength\thesrheight{\ht0*\ratio{\srblobheight}{\ht0+\dp0}}%
  \setlength\mnxsrwidth{\thesrheight*100/#1}
  \ifdim\thesrwidth<\mnxsrwidth\setlength\thesrwidth{\mnxsrwidth}\fi%
  \setlength\srblobdepth{\dp0*\ratio{\srblobheight}{\ht0+\dp0}}%
  \raisebox{-\srblobdepth+\dp0*\ratio{\srblobheight}{\ht0+\dp0}}%
           {\resizebox{\thesrwidth}{\thesrheight}{\usebox{\prebox}}}%
}

\endinput
```