

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 addition, there are four added commands that have been implemented as composites of the four basic commands, they are

```
\scaleleftright[max_width]{left-obj.}{reference}{right-obj.}  
\stretchleftright[min_aspect]{left-obj.}{reference}{right-obj.}  
\hstretch{scale}{object}  
\vstretch{scale}{object}
```

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 be 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.

The `\scaleleftright` and `\stretchleftright` commands are intended to provide the functional capability of the `\left` and `\right` commands in math mode, for delimiting symbols not otherwise supported by those commands.

The `\hstretch` and `\vstretch` commands merely take the second argument and either horizontally or vertically stretch it by a scale factor given by the first argument. The scale is not given in percent, like some aforementioned commands. Remember also, that these commands are, by default processed in math mode.

2 Usage 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` and `\blob`, unscaled:

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

2.1 The `\scalere1` Command

Now we employ `\scalere1{\preblob}{\blob}`

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

If we wish constrain the width of the summation to 3ex, we employ `\scalere1[3ex]{\preblob}{\blob}`

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

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

```

\scalere1[3ex]{\triangleleft}{\blob}
\scalere1*[3ex]{\triangleright}{\blob}

```

$$\triangleleft \frac{\frac{x^3}{z+r^3}}{\frac{y}{x^2}} \triangleright$$

Here, the second call to `\scalere1` 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. Note: see the `\scaleleftright` and `\stretchleftright` commands for a more direct way to employ these sort of transformations.

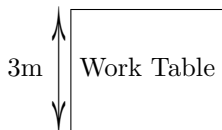
2.2 The `\stretchrel` Command

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 L^AT_EX, 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:

$$\left\{ \begin{array}{c} x^3 \\ z + r^3 \\ y \\ x^2 \end{array} \right. \quad \left\{ \begin{array}{c} x^3 \\ z + r^3 \\ y \\ x^2 \end{array} \right.$$

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):

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

2.3 Baseline Shifts of *Relative* Scales and Stretches

It was mentioned that when `\scalereel` 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 baseline is the line that runs under this text

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,

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

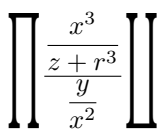
$$\frac{x^3}{\frac{z+r^3}{\frac{y}{x^2}}}$$

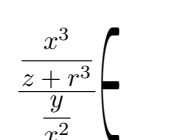
Then, we stretch the Greek letter, capital phi, to 60pt, but constrain the aspect ratio to no less than 1.75.

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

2.5 The `\scaleleftright` and `\stretchleftright` Commands

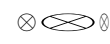
These commands are composites of several `\scalereel` and `\stretchreel` commands, intended to provide the functionality of the `\left ... \right` syntax of `mathmode`, for symbols for which the `\left ... \right` syntax does not work. It uses the same optional arguments as `\scalereel` and `\stretchreel` in order to limit the width or aspect ratio of the respective manipulated objects. If one of the symbols on the left or right end of the enclosed reference block is to be blank, these commands support the use of the period argument `{.}` as a blank placeholder, in a fashion analogous to the `\left ... \right` syntax of `mathmode`.


`\scaleleftright[3ex]{\prod}{\blob}{\coprod}` 

`\stretchleftright[450]{.}{\blob}{\in}` 

2.6 The `\hstretch` and `\vstretch` Commands

These commands simply perform horizontal or vertical stretching, respectively. They use a scale factor, rather than an absolute length. If the stretch factor is greater than 1, the stretched length is larger than the original. If less than one, it is compressed with respect to the original.

`\otimes\hstretch{3}{\otimes}\hstretch{0.5}{\otimes}` 

`\otimes\vstretch{3}{\otimes}\vstretch{0.5}{\otimes}` 

3 Real World Application

3.1 White Curly Brackets

Ref: <http://tex.stackexchange.com/questions/100966/defining-scalable-white-curlly-brackets-and-and>

A user defined two new symbols made by combining the font glyphs of a brace and a vertical strut, calling them `\llbrace` and `\rrbrace`, to look as follows around an argument (in this case x):



But they found that when represented in reduced size fonts, the symbol glyphs of the brace and the strut separated (note: `\tiny` font has been scaled up to match prior figure's height):



This happens because font designers don't merely scale their fonts when shrunk down in size, but they do things (like thickening up lines and changing aspect ratios) in an attempt to retain legibility. In this case, the font's auto-adjustment at smaller scale caused this composite representation to change in unacceptable ways.

The `scalereel` solution was to use the image from the normal-size representation and to shrink it down as needed. So, in this case, a normal-sized copy of the braces were stored in boxes called `\lXbrace` and `\rXbrace`, respectively. Then the following terms were defined:

```
\def\lxbrace{\scalereel*\usebox{\lXbrace}}{\llbrace}}
\def\rxbrace{\scalereel*\usebox{\rXbrace}}{\rrbrace}}
```

Now, in lieu of using `\llbrace` directly, the use of `\lxbrace` would take a copy of the normal-sized `\lXbrace` and scale it down to the vertical height of the malformed tiny `\llbrace`, and substitute for it. Here, we show the result at both normal size and tiny size:

$$\left\{ x \right\} \{ x \}$$

Note that the brace is the properly formed scale of the normal-sized brace in both cases, even as the x adjusts to the fontsize reduction.

If one wanted the default braces narrower (to match the look of the comparable symbols in the literature), one could use `\hstretch` in the definitions to achieve that quickly as

```
\def\lxbrace{%
  \hstretch{0.6}{\scalerel*{\usebox{\lXbrace}}{\llbrace}}}
\def\rxbrace{%
  \hstretch{0.6}{\scalerel*{\usebox{\rXbrace}}{\rrbrace}}}
```

to give the following

$$\left\{ x \right\} \{ x \}$$

Likewise, the `\left` and `\right` features of equation mode cannot be used with the white braces,

$$\left[\left[\left\{ \left[(a) \cdot bc^{2^3} \right]^4 \right\}^5 \right] \right]$$

but `\scalerel` can fix that, too:

$$\left[\left[\left\{ \left[(a) \cdot bc^{2^3} \right]^4 \right\}^5 \right] \right]$$

with

```
\(\scalerel[1.5ex]{\lxbrace}{\core}%
  \scalerel*[1.5ex]{\rxbrace}{\core}\)
```

where `\core` is the core inner equation to which the white braces need to be scaled. In this case, the scaled white braces were width-limited to 1.5ex.

3.2 Extra-Wide Oversymbols

Refs: <http://tex.stackexchange.com/questions/86036/use-overarc-to-represent-an-arc/101539#101539>, <http://tex.stackexchange.com/questions/100574/really-wide-hat-symbol/101136#101136>

There are many oversymbols defined to stand over a single-letter variable. There are a smaller number of extra-wide oversymbols to extend over small groups of symbols. Occasionally, however, a need arises for an oversymbol to stretch over a larger group of symbols.

With these definitions,

```
\newcommand\reallywidehat[1]{%
\begin{array}{c}%
\stretchto{%
\scalet{%
\scalerel*[\widthof{#1}]{\bigwedge}%
{\rule[-\textheight/2]{1ex}{\textheight}}}% WIDTH-LIMITED
%
% BIG WEDGE
}{1.25\textheight}% THIS STRETCHES THE WEDGE A LITTLE EXTRA
% WIDE
}{0.9ex}\% THIS SQUEEZES THE WEDGE TO 0.9ex HEIGHT
#1\% THIS STACKS THE WEDGE ATOP THE ARGUMENT
\rule{0ex}{.01ex}%
\end{array}%
}
```

```
\newcommand\reallywideparen[1]{%
\begin{array}{c}%
\stretchto{%
\scalet{%
\scalerel*[\widthof{#1}]{\frown}%
{\rule[-\textheight/2]{1ex}{\textheight}}}% WIDTH-LIMITED
%
% BIG WEDGE
}{1.25\textheight}% THIS STRETCHES THE WEDGE A LITTLE EXTRA
% WIDE
}{0.6ex}\% THIS SQUEEZES THE WEDGE TO 0.6ex HEIGHT
#1\% THIS STACKS THE WEDGE ATOP THE ARGUMENT
\rule{0ex}{.01ex}%
\end{array}%
}
```

arbitrarily wide oversymbols may be constructed:

$$\widehat{POQ} + \widehat{QOR} + \widehat{ROP} = 2\pi r$$

$$\widehat{zbcdefghijklm}$$

4 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.

5 Code Listing

```
\ProvidesPackage{scalerel}
[2013/03/20 v1.3
  Routines for constrained scaling and stretching of objects,
  relative to a reference object or in absolute terms]
%% Copyright 2013 Steven B. Segletes
%
% This work may be distributed and/or modified under the
% conditions of the LaTeX Project Public License, either version 1.3
% of this license or (at your option) any later version.
% The latest version of this license is in
%   http://www.latex-project.org/lppl.txt
% and version 1.3c or later is part of all distributions of LaTeX
% version 2005/12/01 or later.
%
% This work has the LPPL maintenance status ‘maintained’.
%
% The Current Maintainer of this work is Steven B. Segletes.

% V1.01 Correct typos in documentation
% V1.1  Corrected usepackage dependencies; Significant doc rewrite.
% V1.2  Added \scaleleftright and \stretchleftright; revised docs.
% V1.3  Corrected missing % in stretch routines, added \hstretch and
%       \vstretch commands; fixed version number in .sty file
\usepackage{calc}
\usepackage{graphicx}
```

```

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

\newcommand\scalerelel{\@ifstar{\scalerelelplain}{\scalerelelplus}}

\newcommand\scalerelelplain[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\scalerelelplus[3][99in]{\scalerelelplain[#1]{#2}{#3}#3}

\newcommand\stretchrelel{\@ifstar{\stretchrelelplain}{\stretchrelelplus}}

\newcommand\stretchrelelplain[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\stretchrelelplus[3][10000]{\stretchrelelplain[#1]{#2}{#3}#3}

\newcommand\scaletolel[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}}}%
}

\def\bl@nk{\rule{-.01ex}{1ex}}

\newcommand\scaleleftright[4][99in]{%
\if.#2\def\leftarg{\bl@nk}\else\def\leftarg{#2}\fi%
\if.#4\def\rightarg{\bl@nk}\else\def\rightarg{#4}\fi%
\scalerel{#1}{\leftarg}{#3}\scalerel*{#1}{\rightarg}{#3}%
}

\newcommand\stretchleftright[4][10000]{%
\if.#2\def\leftarg{\bl@nk}\else\def\leftarg{#2}\fi%
\if.#4\def\rightarg{\bl@nk}\else\def\rightarg{#4}\fi%
\stretchrel{#1}{\leftarg}{#3}\stretchrel*{#1}{\rightarg}{#3}%
}

\newcommand\hstretch[2]{\stretchrel*{\scalebox{#1}{${#2$}}}{#2}}

\newcommand\vstretch[2]{\stretchrel*{#2}{\scalebox{#1}{${#2$}}}}

\endinput

```