The package cascade*

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Abstract

The LaTeX package cascade provides a command \Cascade to do constructions to present mathematical demonstrations with successive braces for the deductions.

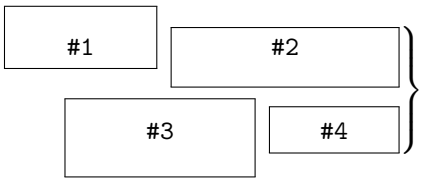
1 Presentation

The package cascade gives a command \Cascade which allows constructions like the following where the size of the right brace is computed on only a part of the LaTeX elements composed on the left.

$$\left.\begin{array}{r}\det(A) = \begin{vmatrix}3 & 4\\ -1 & 7\end{vmatrix} \neq 0 \text{ and, therefore, } A \text{ is inversible}\\ \text{yet } AX = Y\end{array}\right\} \text{hence, } X = A^{-1}Y$$

```
\Cascade{$\det(A) = \begin{vmatrix}3&4\\ -1&7\end{vmatrix}\neq 0$ and, therefore, $A$ is inversible}%
        {}%
        {yet $AX=Y$}
hence, $X = A^{-1}Y$
```

The command \Cascade takes its four arguments as follow :



The commands \Cascade can be nested as in the following example :

$$\left.\begin{array}{l}\left.\begin{array}{l}(BH) \perp (AC)\\ (OC) \perp (AC)\end{array}\right\} \text{hence } (BH) \parallel (OC)\\ \left.\begin{array}{l}(CH) \perp (AB)\\ (OB) \perp (AB)\end{array}\right\} \text{hence } (CH) \parallel (OB)\end{array}\right\} \text{hence } (OBHC) \text{ is a parallelogram}$$

*This document corresponds to the version 1.01 of cascade, at the date of 2018/07/12.

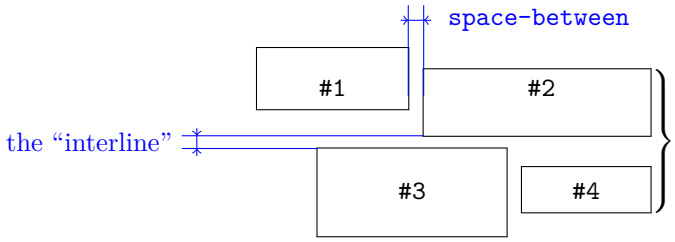
For the lisibility of such constructions, a simplified version of `\Cascade` is available, named `\ShortCascade`.
The code `\ShortCascade{X}{Y}` is merely a shortcut for the code `\Cascade{}{X}{}{Y}`.

The preceding example can be coded with two commands `\ShortCascade` and an encompassing command `\Cascade` :

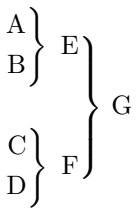
```
\Cascade{\ShortCascade{$(BH) \perp (AC)$}
                      {$(OC) \perp (AC)$}}
        {hence\enskip $(BH) \parallel (OC)$}
        {\ShortCascade{$(CH) \perp (AB)$}
                      {$(OB) \perp (AB)$}}
        {hence\enskip $(CH) \parallel (OB)$}
hence $(OBHC)$ is a parallelogram
```

2 The options

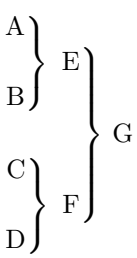
- The option `space-between` is a TeX dimension described on the following figure. Its default value is 0.5 em. It applies to the current command `\Cascade` but also to the possible nested commands.
- The option `interline` can be used to *increase* the "interline" showed in the following picture. The default value of `interline` is 0 pt and applies only to the current command `\Cascade`.
- The option `interline-all` changes the default value of `interline` used by the current command `Cascade` and all the possible nested commands `\Cascade`.




```
\Cascade[interline=4mm]{\ShortCascade{A}{B}}{E}{\ShortCascade{C}{D}}{F} G
```




```
\Cascade[interline-all=4mm]{\ShortCascade{A}{B}}{E}{\ShortCascade{C}{D}}{F} G
```



The options can also be given at the document level with the command `\CascadeOptions`. In this case, the scope of the declarations is the current TeX group (these declarations are "semi-global").

3 Technical remark

The package `\Cascade` is designed to give by default results similar to the those given by the environments of amsmath — and mathtools — especially `{aligned}`.

```
\[\left.\begin{aligned}
& A = \sqrt{a^2+b^2} \\
& B = \frac{ax+b}{cx+d}
\end{aligned}\right\}\]
```

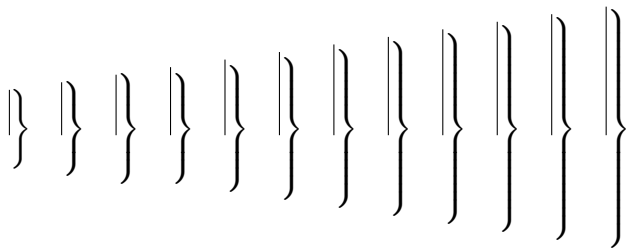
$$\left.\begin{aligned} A &= \sqrt{a^2+b^2} \\ B &= \frac{ax+b}{cx+d} \end{aligned}\right\}$$

```
\ShortCascade{$\displaystyle A = \sqrt{a^2+b^2}$}
             {$B = \dfrac{ax+b}{cx+d}$}
```

$$\left.\begin{aligned} A &= \sqrt{a^2+b^2} \\ B &= \frac{ax+b}{cx+d} \end{aligned}\right\}$$

The package cascade constructs the braces with the classical pair `\left-\right` of TeX. However, the extensible delimiters, in TeX, cannot take all sizes. We give, in the following example, the braces obtained when surrounding vertical rules from 6 mm to 17 mm (the code is in `expl3`).

```
\int_step_inline:nnnn 6 1 {17} { $\left.\hbox{\vrule height #1 mm}\right\}$\quad }
```



4 Implementation

```
\RequirePackage{l3keys2e}
\ProvidesExplPackage
  {cascade}
  {\myfiledate}
  {\myfileversion}
  {Easy presentation of demonstrations in cascades}


\RequirePackage{xparse}
```

\spread@equation

We will use the command `\spread@equation` of amsmath to increase the interline in the commands `\Cascade`. When used, this command becomes no-op (in the current TeX group).
Nevertheless, we want the extension cascade available without amsmath. That's why we give a definition of `\spread@equation` (this definition will be loaded only if amsmath — or mathtools — has not been loaded yet).

```
\cs_if_free:NT \spread@equation
    {\cs_set_protected:Npn \spread@equation
                {\openup\jot
                 \cs_set_protected:Npn \spread@equation {}}}
```

Don't put `\cs_set_eq:NN \spread@equation \prog_do_nothing:` in the last line because this would raise errors with nested environments.

The dimension `\l_@@_interline_dim` will be the value of the vertical space added between the two boxes connected by the brace.

```
\dim_new:N \l_@@_interline_dim
```

The dimension `\l_@@_interline_all_dim` is the default value of `\l_@@_interline_dim`. This default value can be modified with the option `interline-all`. Therefore, when modified in the options of a command `\Cascade`, this value will affect all the possible nested commands.

```
\dim_new:N \l_@@_interline_all_dim
```

The dimension `\l_@@_space_between_dim` is the horizontal space inserted between the two elements of the same row of the construction.

```
\dim_new:N \l_@@_space_between_dim
\dim_set:Nn \l_@@_space_between_dim {0.5 em}
```

The set of keys `cascade/command` will be used for the commands `\Cascade`.

```
\keys_define:nn {cascade/command}
  {
```

The option `interline` is the vertical space added between the two items connected by a brace.

```
    interline          .dim_set:N        = \l_@@_interline_dim,
    interline          .value_required:n = true ,
```

The option `interline-all` will change the value of `interline` for all the commands `\Cascade`, even the nested commands.

```
    interline-all      .code:n           = { \dim_set:Nn \l_@@_interline_all_dim {#1}
                                             \dim_set:Nn \l_@@_interline_dim {#1} },
    interline-all      .value_required:n = true,
```

The option `space-between` is the horizontal space inserted between the two elements of the same row of the construction.

```
    space-between      .dim_set:N        = \l_@@_space_between_dim,
    space-between      .value_required:n = true}
```

The set of keys `cascade/global` will be used for the command `\CascadeOptions` (which fixes the options at a "global" level).

```
\keys_define:nn {cascade/global}
  {interline-all      .dim_set:N        = \l_@@_interline_all_dim,
   interline-all      .value_required:n = true,
   space-between      .dim_set:N        = \l_@@_space_between_dim,
   space-between      .value_required:n = true}
```

`\CascadeOptions` The command `\CascadeOptions` is the command to set the options of the cascade at the document level (these options are set in a local way in the sense of the TeX groups).

```
\NewDocumentCommand \CascadeOptions {m}
    {\keys_set:nn {cascade/global} {#1}}
```

`\Cascade` The command `\Cascade` is the main command of this package.

```
\NewDocumentCommand \Cascade {O{} mmmm}
   { \if_mode_math:
        \msg_error:nn {cascade} {Cascade~in~math~mode}
     \fi:
     \mode_leave_vertical:
     \group_begin:
     \spread@equation
     \dim_set_eq:NN \l_@@_interline_dim \l_@@_interline_all_dim
     \keys_set:nn {cascade/command} {#1}
     \box_clear_new:N \l_@@_box_one
     \box_clear_new:N \l_@@_box_two
     \box_clear_new:N \l_@@_box_three
     \box_clear_new:N \l_@@_box_four
     \hbox_set:Nn \l_@@_box_one {#2}
     \hbox_set:Nn \l_@@_box_two {#3}
     \hbox_set:Nn \l_@@_box_three {#4}
     \hbox_set:Nn \l_@@_box_four {#5}
```

The dimension `\l_@@_top_dim` is the space that we will have to add before the main construction to make up for the "`\smash[t]`" of the box `#1`.

```
     \dim_zero_new:N \l_@@_top_dim
     \dim_set:Nn \l_@@_top_dim
           {\dim_max:nn \c_zero_dim
                        {\box_ht:N \l_@@_box_one - \box_ht:N \l_@@_box_two}}
```

The dimension `\l_@@_bottom_dim` is the space that we will have to add after the main construction to make up for the "`\smash[b]`" of the box `#3`.

```
     \dim_zero_new:N \l_@@_bottom_dim
     \dim_set:Nn \l_@@_bottom_dim
           {\dim_max:nn \c_zero_dim
```

```
                        {\box_dp:N \l_@@_box_three - \box_dp:N \l_@@_box_four}}
```

We do the "`\smash[t]`" of box `#1` and the "`\smash[b]`" of box `#3`.

```
    \box_set_ht:Nn \l_@@_box_one \c_zero_dim
    \box_set_dp:Nn \l_@@_box_three \c_zero_dim
```

We can now construct the box.

```
    \vbox:n
     {\skip_vertical:N \l_@@_top_dim
      \vbox_top:n
       {\hbox:n
         {$\left.
             \vcenter {\halign{\hfil##\cr
                               \hbox:n{\tl_if_empty:nF {#2}
                                         {\box_use_drop:N \l_@@_box_one
                                          \skip_horizontal:n \l_@@_space_between_dim}
                                       \box_use_drop:N \l_@@_box_two \strut} \cr
                               \noalign{\skip_vertical:n \l_@@_interline_dim}
                               \hbox:n{\tl_if_empty:nF {#4}
                                         {\box_use_drop:N \l_@@_box_three
                                          \skip_horizontal:n \l_@@_space_between_dim}
                                       \box_use_drop:N \l_@@_box_four \strut} \cr
                             }
                       }
           \right\}$
         }
        \skip_vertical:N \l_@@_bottom_dim
       }
     }
    \group_end:
}

\msg_new:nnn {cascade}
             {Cascade~in~math~mode}
             {The~commands~\token_to_str:N \Cascade\
              and~\token_to_str:N \ShortCascade\
              should~be~used~in~text~mode~only.~However,~you~can~
              go~on~for~this~time.}
```

`\ShortCascade` The command `\ShortCascade` is a version simplified of `\Cascade` with only two arguments.

```
\NewDocumentCommand \ShortCascade {O{}mm}
    {\Cascade[#1]{}{#2}{}{#3}}
```