

# The package `cascade`\*

F. Pantigny  
fpantigny@wanadoo.fr

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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.

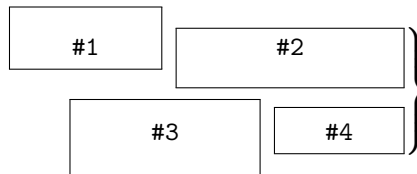
## 1 Presentation

The package `cascade` provides 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.

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

```
\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 :

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

---

\*This document corresponds to the version 1.1 of `cascade`, at the date of 2020/07/05.

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 option t

With the option `t` in the encompassing command `\Cascade`, a whole strucutre of nested commands `\Cascade` is aligned on the top line.

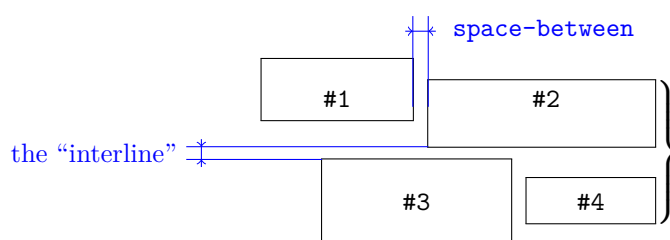
When the key `t` is used, if we wish to add some text after the structure, we have to put that text between angle brackets in order to have that text aligned with the last brace.

```
\begin{enumerate}
\item \Cascade[t]{\ShortCascade{$(BH) \perp (AC)$}{$(OC) \perp (AC)$}}
      {hence\enskip $(BH) \parallel (OC)$}
      {\Cascade{}{$(CH) \perp (AB)$}{$(OB) \perp (AB)$}}
      {hence\enskip $(CH) \parallel (OB)$}
      <hence $(OBHC)$ is a parallelogram>
\end{enumerate}
```

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

## 3 Other options

- The option `space-between` is a TeX dimension described on the following figure. Its initial 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 initial 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
```

$$\left. \begin{array}{c} A \\ B \end{array} \right\} E \left. \begin{array}{c} C \\ D \end{array} \right\} F \left. \begin{array}{c} E \\ F \end{array} \right\} G$$

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

$$\left. \begin{array}{c} A \\ B \end{array} \right\} E \left. \begin{array}{c} C \\ D \end{array} \right\} F \left. \begin{array}{c} E \\ F \end{array} \right\} G$$

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”).

## 4 Technical remark

The package `\Cascade` is designed to provide 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\} \right]
```

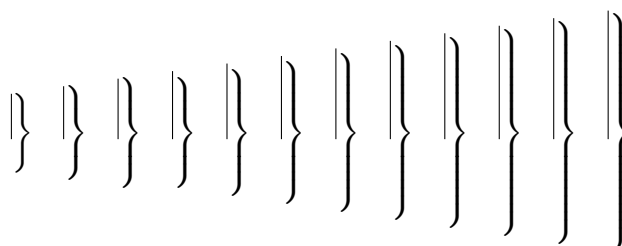
$$\left. \begin{array}{l} A = \sqrt{a^2+b^2} \\ B = \frac{ax+b}{cx+d} \end{array} \right\}$$

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

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

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 }
```



## 5 Implementation

```

1 \RequirePackage{l3keys2e}
2 \ProvidesExplPackage
3   {cascade}
4   {\myfiledate}
5   {\myfileversion}
6   {Easy presentation of demonstrations in cascades}

7 \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).

```

8 \cs_if_free:NT \spread@equation
9   {
10     \cs_set_protected:Npn \spread@equation
11       {
12         \openup \jot
13         \cs_set_protected:Npn \spread@equation { }
14       }
15   }

```

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.

```

16 \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.

```

17 \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.

```

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

```

```

20 \bool_new:N \l_@@_t_bool
21 \bool_new:N \l_@@_main_command_bool
22 \bool_new:N \l_@@_nested_command_bool
23 \bool_new:N \l_@@_first_argument_bool

```

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

```

24 \keys_define:nn { cascade / command }
25 {

```

The key `t` means that the command `\Cascade` will be aligned upwards.

```

26 t .code:n =
27 \bool_if:NTF \l_@@_t_bool
28 { \msg_error:nn { cascade } { t~option~already~set } }
29 { \bool_set_true:N \l_@@_t_bool } ,
30 t .value_forbidden:n = true ,

```

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

```

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

```

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

```

33 interline-all .code:n =
34 {
35 \dim_set:Nn \l_@@_interline_all_dim { #1 }
36 \dim_set:Nn \l_@@_interline_dim { #1 }
37 } ,
38 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.

```

39 space-between .dim_set:N = \l_@@_space_between_dim ,
40 space-between .value_required:n = true
41 }

```

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

```

42 \keys_define:nn { cascade / global }
43 {
44 interline-all .dim_set:N = \l_@@_interline_all_dim ,
45 interline-all .value_required:n = true ,
46 space-between .dim_set:N = \l_@@_space_between_dim ,
47 space-between .value_required:n = true
48 }

```

**\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).

```

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

```

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

```

51 \NewDocumentCommand \Cascade { O { } m m m m D < > { } }
52 {
53 \if_mode_math:
54 \msg_error:nn { cascade } { Cascade~in~math~mode }
55 \fi:
56 \mode_leave_vertical:

```

The dimension `\g_@@_yoffset_dim` will be used by the option `t`.

```

57 \bool_if:NF \l_@@_nested_command_bool

```

```

58     {
59       \dim_gzero_new:N \g_@@_yoffset_dim
60       \bool_set_true:N \l_@@_first_argument_bool
61     }
62     \group_begin:
63
64     \spread@equation
65     \dim_set_eq:NN \l_@@_interline_dim \l_@@_interline_all_dim
66     \keys_set:nn { cascade / command } { #1 }
67     \box_clear_new:N \l_@@_box_one
68     \box_clear_new:N \l_@@_box_two
69     \box_clear_new:N \l_@@_box_three
70     \box_clear_new:N \l_@@_box_four
71     \hbox_set:Nn \l_@@_box_one
72     {
73       \bool_set_true:N \l_@@_first_argument_bool
74       \bool_set_true:N \l_@@_nested_command_bool
75       #2
76     }
77     \hbox_set:Nn \l_@@_box_two { #3 }
78     \hbox_set:Nn \l_@@_box_three
79     {
80       \bool_set_false:N \l_@@_first_argument_bool
81       \bool_set_true:N \l_@@_nested_command_bool
82       #4
83     }
84     \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.

```

85     \dim_zero_new:N \l_@@_top_dim
86     \dim_set:Nn \l_@@_top_dim
87     {
88       \dim_max:nn
89         \c_zero_dim
90         { \box_ht:N \l_@@_box_one - \box_ht:N \l_@@_box_two }
91     }

```

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.

```

92     \dim_zero_new:N \l_@@_bottom_dim
93     \dim_set:Nn \l_@@_bottom_dim
94     {
95       \dim_max:nn
96         \c_zero_dim
97         { \box_dp:N \l_@@_box_three - \box_dp:N \l_@@_box_four }
98     }

```

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

```

99     \box_set_ht:Nn \l_@@_box_one \c_zero_dim
100    \box_set_dp:Nn \l_@@_box_three \c_zero_dim

```

We can now construct the box.

```

101    \vbox_set:Nn \l_tmpa_box

```

```

102     {
103       \skip_vertical:N \l_@@_top_dim
104       \vbox_top:n
105       {
106         \@@_the_vcenter:nn { #2 } { #4 }
We update \g_@@_yoffset_dim.
107         \bool_if:NT \l_@@_first_argument_bool
108         {
109           \dim_set:Nn \l_tmpa_dim
110             { \box_ht:N \l_tmpb_box + \box_dp:N \l_tmpb_box }
111           \l_tmpa_dim = 0.5\l_tmpa_dim
112           \dim_add:Nn \l_tmpa_dim { \the \fontdimen 22 \textfont2 }
113           \dim_sub:Nn \l_tmpa_dim
114             { \dim_max:nn { \box_ht:N \l_@@_box_two } { \box_ht:N \strutbox } }
115           \dim_gadd:Nn \g_@@_yoffset_dim \l_tmpa_dim
116         }
117       \hbox:n
118       {
119         \c_math_toggle_token
120         \left .
121         \box_use_drop:N \l_tmpb_box
122         \right \}
123         \c_math_toggle_token
124         \bool_if:NT \l_@@_t_bool
125         {
126           \bool_if:NF \l_@@_nested_command_bool
127           {
128             \tl_if_empty:nF { #6 }
129             {
130               \skip_horizontal:n \l_@@_space_between_dim
131               #6
132             }
133           }
134         }
135       }
136       \skip_vertical:N \l_@@_bottom_dim
137     }
138   }
139   \bool_if:NTF \l_@@_nested_command_bool
140   { \box_use_drop:N \l_tmpa_box }
141   {

```

We are in the main command `\Cascade` and, if the option `t` is in force, we have now to take into account that key.

```

142     \bool_if:NTF \l_@@_t_bool
143     { \box_move_down:nn \g_@@_yoffset_dim { \box_use:N \l_tmpa_box } }
144     { \box_use_drop:N \l_tmpa_box }
145   }
146   \group_end:
147 }

```

The following macro is only for the lisibility of the code.

```

148 \cs_new_protected:Npn \@@_the_vcenter:nn #1 #2

```

```

149 {
150   \hbox_set:Nn \l_tmpb_box
151   {
152     \c_math_toggle_token
153     \vcenter
154     {
155       \halign
156       {
157         \hfil ## \cr
158         \hbox:n
159         {
160           \tl_if_empty:nF { #1 }
161           {
162             \box_use_drop:N \l_@@_box_one
163             \skip_horizontal:n \l_@@_space_between_dim
164           }
165           \box_use:N \l_@@_box_two
166           \strut
167         }
168         \cr
169         \noalign { \skip_vertical:n \l_@@_interline_dim }
170         \hbox:n
171         {
172           \tl_if_empty:nF { #2 }
173           {
174             \box_use_drop:N \l_@@_box_three
175             \skip_horizontal:n \l_@@_space_between_dim
176           }
177           \box_use_drop:N \l_@@_box_four
178           \strut
179         }
180         \cr
181       }
182     }
183     \c_math_toggle_token
184   }
185 }

186 \msg_new:nnn
187 { cascade }
188 { Cascade~in~math~mode }
189 {
190   The~commands~\token_to_str:N \Cascade\
191   and~\token_to_str:N \ShortCascade\
192   should~be~used~in~text~mode~only.~However,~you~can~
193   go~on~for~this~time.
194 }

195 \msg_new:nnn
196 { cascade }
197 { t~option~already~set }
198 {
199   You~can't~use~the~key~'t'~here~because~it~has~been~set~
200   in~an~encompassing~command.~If~you~go~on,~this~key~will~be~

```



```

201     ignored.
202 }

```

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

```

203 \NewDocumentCommand \ShortCascade { 0 { } m m }
204 { \Cascade [ #1 ] { } { #2 } { } { #3 } }

```

## 6 History

### Changes between versions 1.0 and 1.1

New option `t`.

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