

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. The package `cascade` provides also a command `\Edacsac` which creates similar structures but with braces going backwards.

1 The command `\Cascade`

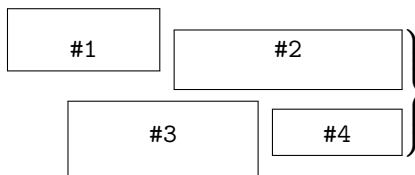
The package `cascade` provides a command `\Cascade` which allows constructions like the following where the size of the right brace is computed on only a part of the LaTeX elements composed on the left.

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

$\text{yet } AX = Y$

```
\Cascade{\det(A) = \begin{vmatrix}3&4\\ -1&7\end{vmatrix}\neq 0$}
  {and, therefore, $A$ is invertible}
  {}
  {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 :

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

*This document corresponds to the version 1.2 of `cascade`, at the date of 2021/08/23.

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.

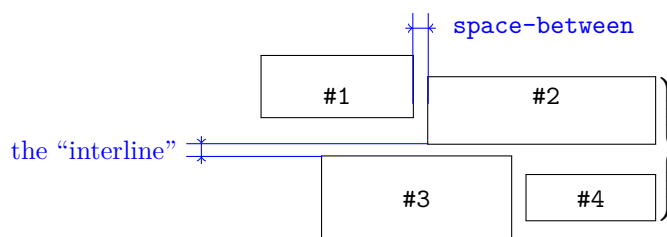
When the key `t` is used, if we wish to add some text after the structure, we have to put that text between angle brackets in order to have that text aligned with the last brace.

```
\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}
```

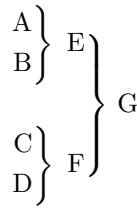
$$\begin{array}{l}
 1. \left. \begin{array}{l} (BH) \perp (AC) \\ (OC) \perp (AC) \end{array} \right\} \text{hence } (BH) \parallel (OC) \\
 \left. \begin{array}{l} (CH) \perp (AB) \\ (OB) \perp (AB) \end{array} \right\} \text{hence } (CH) \parallel (OB)
 \end{array} \left. \vphantom{\begin{array}{l}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

3 Other options

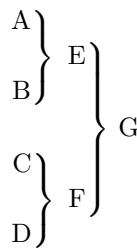
- The option `space-between` is a TeX dimension described on the following figure. Its initial value is 0.5 em. It applies to the current command `\Cascade` but also to the possible nested commands.
- The option `interline` can be used to *increase* the “interline” showed in the following picture. The 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`



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

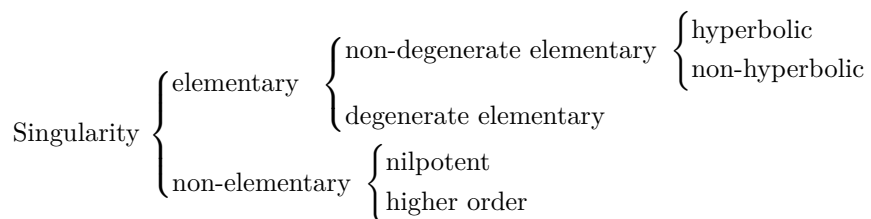


The options can also be given at the document level with the command `\CascadeOptions`. In this case, the scope of the declarations is the current TeX group (these declarations are “semi-global”).

4 The command `\Edacsac`

The command `\Edacsac` (*cascade* written in reverse) is similar to the command `\Cascade` but with braces going backwards. The key `t` is not available in that command.

```
Singularity
\Edacsac
  {elementary}
  {
    \Edacsac
      {non-degenerate elementary}
      {\ShortEdacsac{hyperbolic}{non-hyperbolic}}
      {degenerate elementary}
      {}
    }
  {non-elementary}
  {\ShortEdacsac{Nilpotent}{Higher order}}
```



5 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\}

```

```

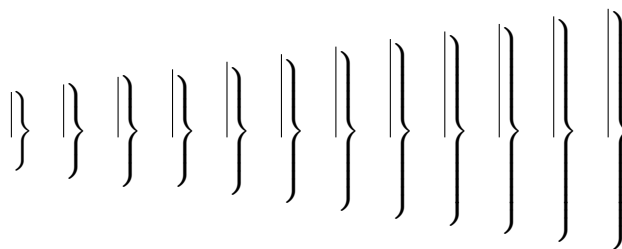
\ShortCascade{ ${ $B = \frac{ax+b}{cx+d}$ }}$ 
```

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 uses the L3 programming layer).

```

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

```



6 Implementation

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

`\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).

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

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.

```
15 \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.

```
16 \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.

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

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

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

```
23 \keys_define:nn { cascade / command }
24 {
```

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

```

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

```

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

```

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

```

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

```

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

```

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

```

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

```

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

48 \cs_new_protected:Npn \@@_initialisation:
49 {
50   \box_clear_new:N \l_@@_box_one
51   \box_clear_new:N \l_@@_box_two
52   \box_clear_new:N \l_@@_box_three
53   \box_clear_new:N \l_@@_box_four
54   \dim_zero_new:N \l_@@_top_dim
55   \dim_zero_new:N \l_@@_bottom_dim
56 }

```

`\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).

```

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

```

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

```

59 \NewDocumentCommand \Cascade { 0 { } m m m m D < > { } }
60 {
61   \if_mode_math:
62     \msg_error:nn { cascade } { math-mode }
63   \fi:
64   \mode_leave_vertical:

```

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

```

65   \bool_if:NF \l_@@_nested_command_bool
66   {
67     \dim_gzero_new:N \g_@@_yoffset_dim
68     \bool_set_true:N \l_@@_first_argument_bool
69   }
70   \group_begin:
71
72   \spread@equation
73   \dim_set_eq:NN \l_@@_interline_dim \l_@@_interline_all_dim
74   \keys_set:nn { cascade / command } { #1 }
75   \@@_initialisation:
76   \hbox_set:Nn \l_@@_box_one
77   {
78     \bool_set_true:N \l_@@_first_argument_bool
79     \bool_set_true:N \l_@@_nested_command_bool
80     #2
81   }
82   \hbox_set:Nn \l_@@_box_two { #3 }
83   \hbox_set:Nn \l_@@_box_three
84   {
85     \bool_set_false:N \l_@@_first_argument_bool
86     \bool_set_true:N \l_@@_nested_command_bool
87     #4
88   }
89   \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.

```

90   \dim_set:Nn \l_@@_top_dim
91   {
92     \dim_max:nn
93     \c_zero_dim
94     { \box_ht:N \l_@@_box_one - \box_ht:N \l_@@_box_two }
95   }

```

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.

```

96   \dim_set:Nn \l_@@_bottom_dim
97   {
98     \dim_max:nn
99     \c_zero_dim
100    { \box_dp:N \l_@@_box_three - \box_dp:N \l_@@_box_four }
101   }

```

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

```

102   \box_set_ht:Nn \l_@@_box_one \c_zero_dim
103   \box_set_dp:Nn \l_@@_box_three \c_zero_dim

```

We can now construct the box.

```

104   \vbox_set:Nn \l_tmpa_box
105   {
106     \skip_vertical:N \l_@@_top_dim
107     \vbox_top:n
108     {
109       \@@_the_vcenter:nn { #2 } { #4 }

```

We update `\g_@@_yoffset_dim`.

```

110     \bool_if:NT \l_@@_first_argument_bool
111     {

```

Here, you should use `\box_ht_plus_dp:N` when TeXLive 2021 will be available on Overleaf.

```

112         \dim_set:Nn \l_tmpa_dim
113         { \box_ht:N \l_tmpb_box + \box_dp:N \l_tmpb_box }
114         \l_tmpa_dim = 0.5\l_tmpa_dim
115         \dim_add:Nn \l_tmpa_dim { \the \fontdimen 22 \textfont2 }
116         \dim_sub:Nn \l_tmpa_dim
117         { \dim_max:nn { \box_ht:N \l_@@_box_two } { \box_ht:N \strutbox } }
118         \dim_gadd:Nn \g_@@_yoffset_dim \l_tmpa_dim
119     }
120   \hbox
121   {
122     \c_math_toggle_token
123     \left .
124     \box_use_drop:N \l_tmpb_box
125     \right \}
126     \c_math_toggle_token
127     \bool_if:NT \l_@@_t_bool
128     {
129       \bool_if:NF \l_@@_nested_command_bool
130       {
131         \tl_if_empty:nF { #6 }
132         {
133           \skip_horizontal:n \l_@@_space_between_dim
134           #6
135         }
136       }
137     }
138   }
139   \skip_vertical:N \l_@@_bottom_dim
140 }
141 }
142 \bool_if:NTF \l_@@_nested_command_bool
143 { \box_use_drop:N \l_tmpa_box }
144 {

```

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

```

145     \bool_if:NTF \l_@@_t_bool
146     { \box_move_down:nn \g_@@_yoffset_dim { \box_use:N \l_tmpa_box } }
147     { \box_use_drop:N \l_tmpa_box }
148   }
149 \group_end:
150 }

```


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

```

151 \cs_new_protected:Npn \@@_the_vcenter:nn #1 #2
152 {
153   \hbox_set:Nn \l_tmpb_box
154   {
155     \c_math_toggle_token
156     \vcenter
157     {
158       \halign
159       {
160         \hfil ## \cr
161         \hbox
162         {
163           \tl_if_empty:nF { #1 }
164           {
165             \box_use_drop:N \l_@@_box_one
166             \skip_horizontal:n \l_@@_space_between_dim
167           }
168           \box_use:N \l_@@_box_two
169           \strut
170         }
171         \cr
172         \noalign { \skip_vertical:n \l_@@_interline_dim }
173         \hbox
174         {
175           \tl_if_empty:nF { #2 }
176           {
177             \box_use_drop:N \l_@@_box_three
178             \skip_horizontal:n \l_@@_space_between_dim
179           }
180           \box_use_drop:N \l_@@_box_four
181           \strut
182         }
183         \cr
184       }
185     }
186     \c_math_toggle_token
187   }
188 }

```

The command `\Edacsac`. The code is simpler because we don't need the `\halign` and we don't have the key `t`.

```

189 \NewDocumentCommand \Edacsac { 0 { } m m m m }
190 {
191   \if_mode_math:
192     \msg_error:nn { cascade } { math-mode }
193   \fi:
194   \mode_leave_vertical:
195   \group_begin:
196   \spread@equation
197   \dim_set_eq:NN \l_@@_interline_dim \l_@@_interline_all_dim
198   \keys_set:nn { cascade / command } { #1 }
199   \@@_initialisation:

```

```

200 \hbox_set:Nn \l_@@_box_one { #2 }
201 \hbox_set:Nn \l_@@_box_two { #3 }
202 \hbox_set:Nn \l_@@_box_three { #4 }
203 \hbox_set:Nn \l_@@_box_four { #5 }
204 \dim_set:Nn \l_@@_top_dim
205 {
206   \dim_max:nn
207   \c_zero_dim
208   { \box_ht:N \l_@@_box_two - \box_ht:N \l_@@_box_one }
209 }
210 \dim_set:Nn \l_@@_bottom_dim
211 {
212   \dim_max:nn
213   \c_zero_dim
214   { \box_dp:N \l_@@_box_four - \box_dp:N \l_@@_box_three }
215 }
216 \box_set_ht:Nn \l_@@_box_two \c_zero_dim
217 \box_set_dp:Nn \l_@@_box_four \c_zero_dim
218 \vbox
219 {
220   \skip_vertical:N \l_@@_top_dim
221   \vtop
222   {
223     \hbox
224     {
225       \c_math_toggle_token
226       \left \{
227       \vcenter
228       {
229         \hbox
230         {
231           \tl_if_empty:nF { #2 }
232           {
233             \box_use_drop:N \l_@@_box_one
234             \skip_horizontal:n \l_@@_space_between_dim
235           }
236           \box_use_drop:N \l_@@_box_two
237           \strut
238         }
239         \skip_vertical:N \l_@@_interline_dim
240         \hbox
241         {
242           \tl_if_empty:nF { #4 }
243           {
244             \box_use_drop:N \l_@@_box_three
245             \skip_horizontal:n \l_@@_space_between_dim
246           }
247           \box_use_drop:N \l_@@_box_four
248           \strut
249         }
250       }
251       \right .
252       \c_math_toggle_token

```

```

253         }
254         \skip_vertical:N \l_@@_bottom_dim
255     }
256 }
257 \group_end:
258 }

259 \msg_new:nnn
260 { cascade }
261 { math-mode }
262 {
263     The~commands~of~the~extension~'cascade'~
264     should~be~used~in~text~mode~only.~However,~you~can~
265     go~on~for~this~time.
266 }

267 \msg_new:nnn
268 { cascade }
269 { t~option~already~set }
270 {
271     You~can't~use~the~key~'t'~here~because~it~has~been~set~
272     in~an~encompassing~command.~If~you~go~on,~this~key~will~be~
273     ignored.
274 }

```

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

```

275 \NewDocumentCommand \ShortCascade { 0 { } m m }
276 { \Cascade [ #1 ] { } { #2 } { } { #3 } }

```

\ShortEdacsac Idem for `\ShortEdacsac`

```

277 \NewDocumentCommand \ShortEdacsac { 0 { } m m }
278 { \Edacsac [ #1 ] { #2 } { } { #3 } { } }

```

7 History

Changes between versions 1.0 and 1.1

New option `t`.

Changes between versions 1.0 and 1.1

New commands `\Edacsac` and `\ShortEdacsac`.

Index

The italic numbers denote the pages where the corresponding entry is described, numbers underlined point to the definition, all others indicate the places where it is used.

Symbols

`@@` commands:
`\l_@@_bottom_dim` [92](#), [93](#), [136](#)¹¹

<code>\textfont</code>	112		
<code>\the</code>	112		
tl commands:		vbox commands:	
<code>\tl_if_empty:nTF</code>	128, 160, 172	<code>\vbox_set:Nn</code>	101
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