The package \texttt{cascade}* 

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Abstract

The LaTeX package \texttt{cascade} provides a command \texttt{\Cascade} to do constructions to present mathematical demonstrations with successive braces for the deductions. The package \texttt{cascade} provides also a command \texttt{\Edacsac} which creates similar structures but with braces going backwards.

1 The command \texttt{\Cascade}

The package \texttt{cascade} provides a command \texttt{\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.

\[
\det(A) = \begin{vmatrix} 3 & 4 \\ -1 & 7 \end{vmatrix} \neq 0 \text{ and, therefore, } A \text{ is invertible} \quad \begin{array}{c} \text{hence, } X = A^{-1}Y \\ \text{yet } AX = Y \end{array}
\]

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

The command \texttt{\Cascade} takes its four arguments as follow:

\begin{center}
\begin{tabular}{c}
#1 \\
#2 \\
#3 \\
#4
\end{tabular}
\end{center}

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

\[
\begin{align*}
(BH) \perp (AC) & \quad \text{hence } (BH) \parallel (OC) \\
(OC) \perp (AC) & \quad \text{hence } (OBHC) \text{ is a parallelogram} \\
(CH) \perp (AB) & \quad \text{hence } (CH) \parallel (OB) \\
(OB) \perp (AB)
\end{align*}
\]

\*This document corresponds to the version 1.2 of \texttt{cascade}, at the date of 2021/08/23.
For the lisibility of such constructions, a simplified version of \texttt{\textbackslash Cascade} is available, named \texttt{\textbackslash ShortCascade}.

The code \texttt{\textbackslash ShortCascade\{X\}\{Y\}} is merely a shortcut for the code \texttt{\textbackslash Cascade\{\}\{X\}\{\}\{Y\}}.

The preceding example can be coded with two commands \texttt{\textbackslash ShortCascade} and an encompassing command \texttt{\textbackslash Cascade}:

\begin{verbatim}
\texttt{\textbackslash Cascade\{\texttt{\textbackslash ShortCascade}\{$(BH) \perp (AC)$}\}{$(OC) \perp (AC)$}\}}
{\texttt{\textbackslash hence\enskip $(BH) \parallel (OC)$}}
{\texttt{\textbackslash \texttt{\textbackslash ShortCascade}\{$(CH) \perp (AB)$\}{$(OB) \perp (AB)$}\}}
{\texttt{\textbackslash hence\enskip $(CH) \parallel (OB)$}}
hence $(OBHC)$ is a parallelogram
\end{verbatim}

2 The option \texttt{t}

With the option \texttt{t} in the encompassing command \texttt{\textbackslash Cascade}, a whole structure of nested commands \texttt{\textbackslash Cascade} is aligned on the top line.

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

1. $(BH) \perp (AC)$ \hence $(BH) \parallel (OC)$
   $(OC) \perp (AC)$
   $(CH) \perp (AB)$ \hence $(CH) \parallel (OB)$
   $(OB) \perp (AB)$
\hence $(OBHC)$ is a parallelogram

3 Other options

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

![Diagram showing the "interline" and "space-between" options]
The options can also be given at the document level with the command \texttt{\CascadeOptions}. In this case, the scope of the declarations is the current TeX group (these declarations are "semi-global").

4 The command \texttt{\Edacsac}

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

Singularity
\texttt{\Edacsac}
{elementary}
{non-degenerate elementary}
{{\texttt{\ShortEdacsac}{non-degenerate elementary}}{\hyperbolic}{non-hyperbolic}}
{degenerate elementary}
{}
{non-elementary}
{{\texttt{\ShortEdacsac}{nilpotent}}{Higher order}}

Singularity
{elementary
{non-degenerate elementary
{hyperbolic
{non-hyperbolic}
{degenerate elementary

{non-elementary
{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\}.

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

\[
\text{A} = \sqrt{a^2+b^2} \\
\text{B} = \frac{ax+b}{cx+d}
\]

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).

\[
\int_{\text{step inline:nnnn} 6 1 \{17\}} \quad \left.\hbox{\vrule height #1 mm}\right\}
\]

\[
\text{A} = \sqrt{a^2+b^2} \\
\text{B} = \frac{ax+b}{cx+d}
\]
6 Implementation

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

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 }
\bool_new:N \l_@@_t_bool
\bool_new:N \l_@@_main_command_bool
\bool_new:N \l_@@_nested_command_bool
\bool_new:N \l_@@_first_argument_bool

The set of keys cascade/command will be used by the command \Cascade.
\keys_define:nn { cascade / command }
{
The key \texttt{t} means that the command \texttt{\Cascade} will be aligned upwards.

\begin{verbatim}
  \bool_if:NTF \l_@@_t_bool
  { \msg_error:nn { cascade } { t-option-already-set } }
  { \bool_set_true:N \l_@@_t_bool },
  \t .value_forbidden:n = true ,
\end{verbatim}

The option \texttt{interline} is the vertical space added between the two items connected by a brace.

\begin{verbatim}
interline .dim_set:N = \l_@@_interline_dim,
interline .value_required:n = true ,
\end{verbatim}

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

\begin{verbatim}
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 ,
\end{verbatim}

The option \texttt{space-between} is the horizontal space inserted between the two elements of the same row of the construction.

\begin{verbatim}
space-between .dim_set:N = \l_@@_space_between_dim ,
space-between .value_required:n = true
\end{verbatim}

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

\begin{verbatim}
\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
  }
\end{verbatim}

\begin{verbatim}
\cs_new_protected:Npn \@@_initialisation:
  { \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 \dim_zero_new:N \l_@@_top_dim \dim_zero_new:N \l_@@_bottom_dim }
\end{verbatim}

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

\begin{verbatim}
\NewDocumentCommand \CascadeOptions { m }
  { \keys_set:nn { cascade / global } { #1 } }
\end{verbatim}

\texttt{\Cascade} The command \texttt{\Cascade} is the main command of this package.
The dimension $\dim_g_@@_yoffset_dim$ will be used by the option t.

```latex
\bool_if:NF \l_@@_nested_command_bool {
  \dim_gzero_new:N \g_@@_yoffset_dim
  \bool_set_true:N \l_@@_first_argument_bool
}
```

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

```latex
\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 \texttt{\smash[b]} of the box #3.

```latex
\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 \texttt{\smash[t]} of box #1 and the \texttt{\smash[b]} of box #3.

```latex
\box_set_h:Nn \l_@@_box_one \c_zero_dim
\box_set_dp:Nn \l_@@_box_three \c_zero_dim
```
We can now construct the box. We update \g@_yoffset_dim.

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

We are in the main command \Cascade and, if the option t is in force, we have now to take into account that key.
The following macro is only for the lisibility of the code.

\cs_new_protected:Npn \@@_the_vcenter:nn #1 #2
{
\hbox_set:Nn \l_tmpb_box
\c_math_toggle_token
\vcenter
{
\halign
{
\hfil ## \cr
\hbox
{
\tl_if_empty:nF { #1 }
\box_use_drop:N \l_@@_box_one
\skip_horizontal:n \l_@@_space_between_dim
\}
\box_use:N \l_@@_box_two
\strut
\cr
\noalign { \skip_vertical:n \l_@@_interline_dim }
\hbox
{
\tl_if_empty:nF { #2 }
\}
\box_use_drop:N \l_@@_box_three
\skip_horizontal:n \l_@@_space_between_dim
\}
\box_use_drop:N \l_@@_box_four
\strut
\cr
\c_math_toggle_token
}
}

The command \Edacsac. The code is simpler because we don’t need the \halign and we don’t have the key t.
\NewDocumentCommand \Edacsac { O { } m m m m }
{
\if_mode_math:
\msg_error:nn { cascade } { 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 }
\@@_initialisation:
\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 }
\dim_set:Nn \l_@@_top_dim
\dim_max:nn \c_zero_dim
\dim_set:Nn \l_@@_bottom_dim
\dim_max:nn \c_zero_dim
\box_set_ht:Nn \l_@@_box_two \c_zero_dim
\box_set_dp:Nn \l_@@_box_four \c_zero_dim
\vbox
\skip_vertical:N \l_@@_top_dim
\vtop
\hbox
\c_math_toggle_token
\left \{
\vcenter
\hbox
\tl_if_empty:nF { #2 }
\hbox
\tl_if_empty:nF { #4 }
\hbox
\right .
\c_math_toggle_token
\vcenter
\hbox
The commands of the extension ‘cascade’ should be used in text mode only. However, you can go on for this time.

The command \ShortCascade is a simplified version of \Cascade with only two arguments.\NewDocumentCommand \ShortCascade { O { } m m } \Cascade [ #1 ] { } { #2 } { } { #3 } 

Idem for \ShortEdacsac
\NewDocumentCommand \ShortEdacsac { O { } m m } \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
\textfont \the \tl commands: \tl_if_empty:nTF \ 128, 160, 172 \ \vbox commands: \vbox_set:Nn \ 101 \ \vbox_top:n \ 104 \ \token commands: \token_to_str:N \ 190, 191 \ \vcenter \ 153

Contents

1 The command \Cascade 1
2 The option t 2
3 Other options 2
4 The command \Edacsac 3
5 Technical remark 4
6 Implementation 5
7 History 11

Index 11