The package *cascade*

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**Abstract**

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

1 The command \texttt{\textbackslash Cascade}

The package *cascade* provides a command \texttt{\textbackslash 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.

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

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

\[
\texttt{\textbackslash Cascade}\{#1\quad #2\quad #3\quad #4\}
\]

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

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

*This document corresponds to the version 1.2a of *cascade*, at the date of 2023/02/08.*
For the legibility 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 ShortCascade}\{$(CH) \perp (AB)$}\{$(OB) \perp (AB)$}\}\{\texttt{\textbackslash enskip $($(BH) \parallel (OC)$)}\}
\texttt{\textbackslash ShortCascade}\{$(CH) \perp (AB)$}\{$(OB) \perp (AB)$}\\{\texttt{\textbackslash enskip $($(BC) \parallel (OB)$)}\}
\end{verbatim}

hence $(OBHC)$ is a parallelogram

2 The option 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{enumerate}
\item \texttt{\textbackslash Cascade[\texttt{t}]}\{\texttt{\textbackslash ShortCascade}\{$(BH) \perp (AC)$}\{$(OC) \perp (AC)$}\}\{\texttt{\textbackslash ShortCascade}\{$(CH) \perp (AB)$}\{$(OB) \perp (AB)$}\}\{\texttt{\textbackslash enskip $($(BH) \parallel (OC)$)}\}
\texttt{\textbackslash ShortCascade}\{$(CH) \perp (AB)$}\{$(OB) \perp (AB)$}\\{\texttt{\textbackslash enskip $($(BC) \parallel (OB)$)}\}
<\texttt{\textbackslash hence $($(OBHC)$ is a parallelogram\texttt{)}}\}
\end{enumerate}

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}.

\begin{itemize}
\item 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.
\item 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}.
\item 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}.
\end{itemize}
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 \texttt{t} is not available in that command.

\begin{verbatim}
\texttt{Singularity} \Edacsac
{\texttt{elementary}}
  {
    \\Edacsac
    {non-degenerate elementary}
    {\\ShortEdacsac{hyperbolic}{non-hyperbolic}}
    {degenerate elementary}
    {}
  }
{non-elementary}
  {\\ShortEdacsac{Nilpotent}{Higher order}}
\end{verbatim}

3
5 Technical remark

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

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

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

The package \texttt{cascade} constructs the braces with the classical pair \texttt{\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).

\hspace{1em} 
\begin{verbatim}
\int_step_inline:nnnn 6 1 {17} { \left.\hbox{\vrule height #1 mm}\right\}$\quad }
\end{verbatim}

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{\textbackslash Cascade} will be aligned upwards.

\begin{verbatim}
t .code:n = \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{\textbackslash 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{\textbackslash 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{\textbackslash CascadeOptions} The command \texttt{\textbackslash 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{\textbackslash Cascade} The command \texttt{\textbackslash Cascade} is the main command of this package.
\NewDocumentCommand \Cascade { O { } m m m m D < > { } } 
{ 
  \if_mode_math: 
    \msg_error:nn { cascade } { math~mode } 
  \fi: 
  \mode_leave_vertical: 

The dimension \texttt{g@@yoffset_dim} will be used by the option \texttt{t}.
\bool_if:NF \l_@@nested_command_bool 
{ 
  \dim_gzero_new:N \g@@yoffset_dim 
  \bool_set_true:N \l_@@first_argument_bool 
} 
\group_begin: 
\spread@equation 
\dim_set_eq:NN \l_@@interline_dim \l_@@interline_all_dim 
\keys_set:nn { cascade / command } { #1 } 
\tl_if_empty:nF { #6 } 
{ 
  \bool_if:NF \l_@@t_bool 
    \msg_error:nn { cascade } { angular~argument~without~t } 
} 
\@@initialisation: 
\hbox_set:Nn \l_@@box_one 
{ 
  \bool_set_true:N \l_@@first_argument_bool 
  \bool_set_true:N \l_@@nested_command_bool 
  \l_@@interline_dim 
} 
\hbox_set:Nn \l_@@box_two { \l_@@interline_dim } 
\hbox_set:Nn \l_@@box_three 
{ 
  \bool_set_false:N \l_@@first_argument_bool 
  \bool_set_true:N \l_@@nested_command_bool 
  \l_@@interline_dim 
} 
\hbox_set:Nn \l_@@box_four { \l_@@interline_dim } 

The dimension \texttt{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.
\dim_set:Nn \l_@@top_dim 
{ 
  \dim_max:nn 
  \c_zero_dim 
  \l_@@interline_dim 
} 

The dimension \texttt{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.
\dim_set:Nn \l_@@bottom_dim 
{ 
  \dim_max:nn 
  \c_zero_dim 
  \l_@@interline_dim 
}
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_set:Nn \l_tmpa_box
{\skip_vertical:N \l_@@_top_dim
\vbox_top:n
{\@@_the_vcenter:nn { #2 } { #4 }
\hbox
{\c_math_toggle_token
\left . \box_use_drop:N \l_tmpb_box \right \}
\c_math_toggle_token
\bool_if:NT \l_@@_t_bool
{\skip_horizontal:n \l_@@_space_between_dim
\box_use:N \l_tmpa_box
}\bool_if:NF \l_@@_nested_command_bool
{\tl_if_empty:nF { #6 }
\skip_vertical:N \l_@@_bottom_dim
}else{
\box_use_drop:N \l_tmpa_box
\bool_if:NTF \l_@@_nested_command_bool
{\box_use:N \l_tmpa_box }\box_use:N \l_tmpa_box }

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 legibility of the code.

```
\cs_new_protected:Npn \@@_the_vcenter:nn #1 #2
\begin{lrbox}{\l_tmpb_box}
\c_math_toggle_token
\vcenter
\begin{halign}
\hfil ## \cr
\hbox
\tl_if_empty:nF { #1 }
\box_use_drop:N \l_@@_box_one
\skip_horizontal:n \l_@@_space_between_dim
\end{halign}
\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
\end{halign}
\box_use_drop:N \l_@@_box_four
\strut
\cr
\end{halign}
\c_math_toggle_token
\end{lrbox}
```

The command \texttt{\Edacsac}. The code is simpler because we don’t need the \texttt{\halign} and we don’t have the key \texttt{t}.

```
\NewDocumentCommand \Edacsac { O { } m m m m }
\begin{lrbox}{\l_tmpb_box}
\begin{lrbox}{\l_tmpb_box}
\c_math_toggle_token
\end{lrbox}
```

9
\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
{ \box_ht:N \l_@@_box_two - \box_ht:N \l_@@_box_one }
}
\ dim_set:Nn \l_@@_bottom_dim
{ \dim_max:nn \c_zero_dim
{ \box_dp:N \l_@@_box_four - \box_dp:N \l_@@_box_three }
}
\ hbox_set_ht:Nn \l_@@_box_two \c_zero_dim
\ hbox_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 }
{ \box_use_drop:N \l_@@_box_one
\ skip_horizontal:n \l_@@_space_between_dim
}
\ box_use_drop:N \l_@@_box_two
\ strut
}
\ skip_vertical:N \l_@@_interline_dim
\ hbox
{ \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
\endverbatim
The command \ShortCascade is a simplified version of \Cascade with only two arguments.

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

\ShortEdacsac \NewDocumentCommand \ShortEdacsac { O { } m m } { \Edacsac [ #1 ] { #2 } { } { #3 } { } }

7 History

Changes between versions 1.1 and 1.2

New commands \Edacsac and \ShortEdacsac.
Changes between versions 1.0 and 1.1

New option t.

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