

# The **ebproof** package

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## Contents

		<b>3.2 Additional statements</b> . . . . .	<b>3</b>
<b>1 Introduction</b>	<b>1</b>	<b>4 Options</b>	<b>4</b>
		4.1 General shape . . . . .	4
<b>2 Environments</b>	<b>1</b>	4.2 Spacing . . . . .	5
		4.3 Shape of inference lines . . . . .	5
<b>3 Statements</b>	<b>2</b>	4.4 Format of conclusions . . . . .	7
3.1 Basic statements . . . . .	2	4.5 Format of labels . . . . .	7

## 1 Introduction

The **ebproof** package provides commands to typeset proof trees, in the style of sequent calculus and related systems:

$\frac{\Gamma, A \vdash B}{\Gamma \vdash A \rightarrow B} \text{ abs} \quad \frac{\Gamma \vdash A}{\Gamma \vdash B} \text{ app}$	<pre>\begin{prooftree}   \Hypo{ \Gamma, A &amp;\vdash B }   \Infer1[abs]{ \Gamma &amp;\vdash A \to B }   \Hypo{ \Gamma &amp;\vdash A }   \Infer2[app]{ \Gamma &amp;\vdash B } \end{prooftree}</pre>
--	---

The structure is very much inspired by the **bussproofs** package, in particular for the postfix notation. I actually wrote **ebproof** because there were some limitations in **bussproofs** that I did not know how to lift, and also because I did not like some choices in that package (and also because it was fun to write).

## 2 Environments

The package provides the **prooftree** environment, in a standard and starred variants.

`\begin{prooftree}[\langle options \rangle] \langle statements \rangle \end{prooftree}`

Typeset the proof tree described by the  $\langle statements \rangle$ , as described in section 3. The  $\langle options \rangle$  provide default formatting options for the proof tree. This environment can be used either in math mode or in text mode. It produces a proof tree at the current position in the text flow.

`\begin{prooftree*}[\langle options \rangle] \langle statements \rangle \end{prooftree*}`

Typeset the proof centered on a line of its own; it is essentially equivalent to wrapping the `prooftree` environment inside a `center` environment.

The starred version is used in situations when a single proof will be displayed. The non-starred version is useful in order to integrate the proof into some larger structure, like two parts of a formula:

$$\frac{\frac{\vdash A \quad \vdash B}{\vdash B, C} \quad \vdash A}{\vdash A \wedge B, C} \rightsquigarrow \frac{\frac{\vdash A \quad \vdash B}{\vdash A \wedge B}}{\vdash A \wedge B, C}$$

```

\[\begin{prooftree}
  \Hypo{\vdash A}
  \Hypo{\vdash B} \Infer1{\vdash B, C}
  \Infer2{\vdash A \wedge B, C}
\end{prooftree}
\quad \rightsquigarrow \quad
\begin{prooftree}
  \Hypo{\vdash A} \Hypo{\vdash B}
  \Infer2{\vdash A \wedge B}
  \Infer1{\vdash A \wedge B, C}
\end{prooftree}
\]
```

### 3 Statements

Statements describes proofs in postfix notation: when typesetting a proof tree whose last rule has, say, two premisses, you will first write statements for the subtree of the first premiss, then statements for the subtree of the second premiss, then a statement like `\Infer2{<conclusion>}` to build an inference with these two subtrees as premisses and the given text as conclusion.

Hence statements operate on a stack of proof trees. At the beginning of a `prooftree` environment, the stack is empty. At the end, it must contain exactly one tree, which is the one that will be printed.

#### 3.1 Basic statements

The basic statements for building proofs are the following, where `<options>` stands for arbitrary options as described in section 4.

`\Hypo[<options>]{<text>}`

Push a new proof tree consisting only in one conclusion line, with no premiss and no line above, in other words a tree with only a leaf (`\Hypo` stands for *hypothesis*).

`\Infer[<options>]{<arity>}[<label>]{<text>}`

Build an inference step by taking some proof trees from the top of the stack, assembling them with a rule joining their conclusions and putting a new conclusion below. The `<arity>` is the number of sub-proofs, it may be any number including 0 (in this case there will be a line above the conclusion but no sub-proof). If `<label>` is present, it is used as the label on the right of the inference line; it is equivalent to using the `right label` option.

The `<text>` in these statements is the contents of the conclusion at the root of the tree that the statements create. It is typeset in math mode by default but any kind of formatting can be used instead, using the `template` option. The `<label>` text is formatted in horizontal text mode by default.

Each proof tree has a vertical axis, used for alignment of successive steps. The position of the axis is deduced from the text of the conclusion at the root of the tree: if `<text>` contains the

alignment character `&` then the axis is set at that position, otherwise the axis is set at the center of the conclusion text. The `\Infer` statement makes sure that the axis of the premiss is at the same position as the axis of the conclusion. If there are several premisses, it places the axis at the center between the left of the leftmost conclusion and the right of the rightmost conclusion:

$$\begin{array}{c}
 \frac{\frac{\frac{\vdash A, B, C}{A \vdash B, C}}{A, B \vdash C} \quad D \vdash E}{A, B, D \vdash C, E} \\
 \frac{A, B \vdash C, D, E}{A \vdash B, C, D, E}
 \end{array}
 \quad
 \begin{array}{l}
 \begin{array}{l}
 \backslash\text{begin}\{\text{prooftree}\} \\
 \backslash\text{Hypo}\{ \&\vdash A, B, C \} \\
 \backslash\text{Infer1}\{ A \&\vdash B, C \} \\
 \backslash\text{Infer1}\{ A, B \&\vdash C \} \\
 \backslash\text{Hypo}\{ D \&\vdash E \} \\
 \backslash\text{Infer2}\{ A, B, D \&\vdash C, E \} \\
 \backslash\text{Infer1}\{ A, B \&\vdash C, D, E \} \\
 \backslash\text{Infer1}\{ A \&\vdash B, C, D, E \} \\
 \backslash\text{end}\{\text{prooftree}\}
 \end{array}
 \end{array}$$

### 3.2 Additional statements

The following additional statements may be used to affect the format of the last proof tree on the stack:

`\Ellipsis{⟨label⟩}{⟨text⟩}`

Typeset vertical dots, with a label on the right, and a new conclusion. No inference lines are inserted.

$$\begin{array}{c}
 \Gamma \vdash A \\
 \vdots \text{ foo} \\
 \Gamma \vdash A, B
 \end{array}
 \quad
 \begin{array}{l}
 \begin{array}{l}
 \backslash\text{begin}\{\text{prooftree}\} \\
 \backslash\text{Hypo}\{ \Gamma \&\vdash A \} \\
 \backslash\text{Ellipsis}\{\text{foo}\}\{ \Gamma \&\vdash A, B \} \\
 \backslash\text{end}\{\text{prooftree}\}
 \end{array}
 \end{array}$$

`\Alter{⟨code⟩}`

Modify the proof with arbitrary commands, assuming that these commands do not affect the size. The `⟨code⟩` is executed in an `\hbox` and is followed by the insertion of the actual box with the current sub-proof. It is mostly useful with `\color` commands:

$$\begin{array}{c}
 \frac{\frac{\Gamma, A \vdash B}{\Gamma \vdash A \rightarrow B} \text{ abs}}{\Gamma \vdash B} \text{ app} \quad \Gamma \vdash A
 \end{array}
 \quad
 \begin{array}{l}
 \begin{array}{l}
 \backslash\text{begin}\{\text{prooftree}\} \\
 \backslash\text{Hypo}\{ \Gamma, A \&\vdash B \} \\
 \backslash\text{Infer1}[\text{abs}]\{ \Gamma \&\vdash A \rightarrow B \} \\
 \backslash\text{Alter}\{\textcolor{red}\} \\
 \backslash\text{Hypo}\{ \Gamma \&\vdash A \} \\
 \backslash\text{Infer2}[\text{app}]\{ \Gamma \&\vdash B \} \\
 \backslash\text{end}\{\text{prooftree}\}
 \end{array}
 \end{array}$$

`\Delims{⟨left⟩}{⟨right⟩}`

Put left and right delimiters around the whole sub-proof, without changing the alignment (the spacing is affected by the delimiters, however). The `⟨left⟩` text must contain an opening occurrence of `\left` and the `⟨right⟩` text must contain a matching occurrence of `\right`. For instance, `\Delims{\left(}{\right)}` will put the sub-proof between parentheses.

$$\frac{A_1 \vee \dots \vee A_n \quad \left( \begin{array}{c} [A_i] \\ \vdots \\ B \end{array} \right)_{1 \leq i \leq n}}{B}$$

```

\begin{prooftree}
  \Hypo{ A_1 \vee \cdots \vee A_n }
  \Hypo{ [A_i] }
  \Ellipsis{}{ B }
  \Delims{ \left( }{ \right) }_{1 \leq i \leq n}
  \Infer2{ B }
\end{prooftree}

```

## 4 Options

The formatting of trees, conclusion texts and inference rules is affected by options, specified using the key-value system of PGF/TikZ, provided by the `pgfkeys` package. All options are in the `/ebproof/` path in the key tree of `pgfkeys`. They can be set locally for a proof tree or for a single statement using optional arguments in the associated commands.

`\ebproofset{<options>}`

Set some options. The options will apply in the current scope; using this in preamble will effectively set options globally. Specific options may also be specified for each proof tree and for each statement in a proof tree, using optional arguments.

### 4.1 General shape

The options in this section only make sense at the global level and at the proof level. Changing the proof style inside a `proof` environment has undefined behaviour.

`proof style=<name>`

Set the general shape for representing proofs. The following styles are provided:

**upwards**

This is the default style. Proof trees grow upwards, with conclusions below and premisses above.

**downwards**

Proof trees grow downwards, with conclusions above and premisses below.

$$\frac{\frac{\Gamma \vdash B}{\Gamma \vdash A \rightarrow B} \text{ abs} \quad \Gamma \vdash A}{\Gamma, A \vdash B} \text{ app}$$

```

\begin{prooftree}[proof style=downwards]
  \Hypo{ \Gamma, A \vdash B }
  \Infer1[abs]{ \Gamma \vdash A \vdash B }
  \Hypo{ \Gamma \vdash A }
  \Infer2[app]{ \Gamma \vdash B }
\end{prooftree}

```

In the optional argument of `prooftree` environments, proof styles can be specified directly, without prefixing the name by “`proof style=`”. For instance, the first line of the example above could be written `\begin{prooftree}[downwards]` equivalently.

`center=<boolean>`

If set to **true**, the tree produced by the `prooftree` environment will be vertically centered around the text line. If set to **false**, the base line of the tree will be the base line of the conclusion. The default value is **true**.

$\frac{}{A \vdash A} \quad \frac{\Gamma, A \vdash B}{\Gamma \vdash A \rightarrow B}$	$\frac{}{A \vdash A} \quad \frac{\Gamma, A \vdash B}{\Gamma \vdash A \rightarrow B}$	<pre> \begin{prooftree}[center=false]   \Infer0{ A \vdash A } \end{prooftree} \quad \begin{prooftree}[center=false]   \Hypo{ \Gamma, A \vdash B }   \Infer1{ \Gamma \vdash A \rightarrow B } \end{prooftree} </pre>
--	--	---

## 4.2 Spacing

**separation**= $\langle dimension \rangle$

The horizontal separation between sub-proofs in an inference. The default value is 1.5em.

$\frac{\frac{A \ B}{C} \quad \frac{D \ E \ F}{G}}{K} \quad H$	<pre> \begin{prooftree}[separation=0.5em]   \Hypo{ A } \Hypo{ B } \Infer2{ C }   \Hypo{ D } \Hypo{ E } \Hypo{ F } \Infer3{ G }   \Hypo{ H } \Infer[separation=3em]3{ K } \end{prooftree} </pre>
---	---

**rule margin**= $\langle dimension \rangle$

The spacing above and below inference lines. The default value is 0.7ex.

$\frac{\Gamma, A \vdash B}{\Gamma \vdash A \rightarrow B} \text{ abs} \quad \Gamma \vdash A$ $\frac{\Gamma \vdash A \rightarrow B \quad \Gamma \vdash A}{\Gamma \vdash B} \text{ app}$	<pre> \begin{prooftree}[rule margin=2ex]   \Hypo{ \Gamma, A \vdash B }   \Infer1[abs]{ \Gamma \vdash A \rightarrow B }   \Hypo{ \Gamma \vdash A }   \Infer2[app]{ \Gamma \vdash B } \end{prooftree} </pre>
--	--

## 4.3 Shape of inference lines

**rule style**= $\langle name \rangle$

Set the shape of inference lines. The following values are provided:

**simple**

A simple horizontal rule is drawn. This is the default style.

**no rule**

No inference line is drawn. A single space of the length of **rule margin** is inserted.

**double**

A double line is drawn.

**dashed**

A single dashed line is drawn.

The precise rendering is influenced by parameters specified below. Arbitrary new shapes can be defined using the **rule code** option described afterwards.

In the optional argument of the `\Infer` statement, rule styles can be specified directly, without prefixing the style name by “`rule style=`”. For instance, `\Infer[dashed]` is equivalent to `\Infer[rule style=dashed]`.

$  \begin{array}{c}  \frac{\Gamma \vdash A \rightarrow B \quad \frac{\Delta \vdash A \quad B \vdash B}{\Delta, !A \multimap B \vdash B}}{\Gamma \vdash !A \multimap B} \\  \hline  \Gamma, \Delta \vdash B \\  \hline  \Gamma \cup \Delta \vdash B  \end{array}  $	<pre> \begin{prooftree}   \Hypo{ \Gamma &amp; \vdash A \multimap B }   \Infer[no rule]1{ \Gamma &amp; \vdash {!A} \multimap B }   \Hypo{ \Delta &amp; \vdash A }   \Infer[rule thickness=2pt]1{ \Delta &amp; \vdash {!A} }   \Infer0{ B \vdash B }   \Infer[dashed]2{ \Delta, {!A} \multimap B \vdash B }   \Infer2{ \Gamma, \Delta &amp; \vdash B }   \Infer[double]1{ \Gamma \cup \Delta &amp; \vdash B } \end{prooftree} </pre>
--	--

**rule thickness**= $\langle dimension \rangle$

The thickness of inference lines. It is 0.4pt by default.

**rule separation**= $\langle dimension \rangle$

The distance between the two lines in the **double** rule style. It is 2pt by default.

**rule dash length**= $\langle dimension \rangle$

The length of dashes in the **dashed** rule style. It is 0.2em by default.

**rule dash space**= $\langle dimension \rangle$

The space between dashes in the **dashed** rule style. It is 0.3em by default.

**rule code**= $\langle code \rangle$

This option is used to define an arbitrary shape for rules. The  $\langle code \rangle$  is used to render the rule, it is executed in vertical mode in a `\vbox` whose `\hsize` is set to the width of the rule. Margins above and below are inserted automatically (they can be removed by setting `rule margin` to 0pt).

$  \begin{array}{c}  \Gamma \vdash A \\  \hline  \Gamma \vdash A, \dots, A \quad \Delta, A, \dots, A \vdash \Theta \\  \hline  \Gamma, \Delta \vdash \Theta  \end{array}  $	<pre> \begin{prooftree}[rule code={\hbox{\tikz   \draw[decorate,decoration={snake,amplitude=.3ex}]     (0,0) -- (\hsize,0);}}]   \Hypo{ \Gamma &amp; \vdash A }   \Infer1{ \Gamma &amp; \vdash A, \ldots, A }   \Hypo{ \Delta, A, \ldots, A \vdash \Theta }   \Infer2{ \Gamma, \Delta &amp; \vdash \Theta } \end{prooftree} </pre>
---	--

Note that this example requires the `tikz` package, with the `decorations.pathmorphing` library for the **snake** decoration.

The option **rule code** is particularly useful in a “**styles**” in the sense of **pgfkeys** as it allows to define new rule styles. The allowed values for **rule style** are actually defined this way. The above example could be turned into a new rule style **zigzag** with the following command:

$\frac{\Gamma \vdash A}{\Gamma \vdash A, \dots, A \quad \Delta, A, \dots, A \vdash \Theta}$ <hr style="border: none; border-top: 1px wavy black; margin: 5px 0;"/> $\Gamma, \Delta \vdash \Theta$	<pre> \ebproofset{   rule style/zigzag/.style={rule code={\hbox{\tikz     \draw[decorate,decoration={snake,amplitude=.3ex}]     (0,0) -- (\hsize,0);}}} \begin{prooftree}   \Hypo{ \Gamma &amp;\vdash A }   \Infer1{ \Gamma &amp;\vdash A, \ldots, A }   \Hypo{ \Delta, A, \ldots, A \vdash \Theta }   \Infer[zigzag]2{ \Gamma, \Delta \vdash \Theta } \end{prooftree} </pre>
---	---

#### 4.4 Format of conclusions

```

template=<macro>
left template=<macro>
right template=<macro>

```

Defines how conclusions are formatted. The macros are arbitrary TeX code, composed in horizontal mode, with the macro argument #1 standing for the actual text passed to the `\Hypo` and `\Infer` statements. The `template` value is used for conclusions with no alignment mark. The `left template` and `right template` values are used on the left and right side of the alignment mark when it is present. The default value for `template` is simply `$#1$`, so that conclusions are set in math mode. The default values for `left template` and `right template` are similar, with spacing assuming that a relation symbol is put near the alignment mark, so that `\Infer1{A &\vdash B}` is spaced correctly.

$\frac{\begin{array}{cc} & (\text{bar}) \\ (\text{foo}) & (\text{baz}) \end{array}}{(\text{quux})}$	<pre> \begin{prooftree}[template=(\textbf{\#1})]   \Hypo{ foo }   \Hypo{ bar }   \Infer1{ baz }   \Infer2{ quux } \end{prooftree} </pre>
---	--

#### 4.5 Format of labels

```

left label=<text>
right label=<text>

```

The text to use as the labels of the rules, on the left and on the right of the inference line. Using the second optional argument in `\Infer` is equivalent to setting the `right label` option with the value of that argument.

```

left label template=<macro>
right label template=<macro>

```

These macros are used to typeset the text of labels on the left and right of inference lines. The default values are #1 so that labels are set in plain text mode.

```

label separation=<dimension>

```

The spacing between an inference lines and its labels. The default value is 0.5em.