

Proof-at-the-end, or how to move proofs in appendix in LaTeX

Léo Colisson

Contents

1	Introduction	1
2	Demo	2
3	Quickstart	2
3.1	Install	2
3.2	Use in your project	3
4	Use cases	4
4.1	Configuration and how to use and create styles	4
4.2	Usual styles	6
4.3	Categories, or how to move proofs in different sections	6
4.4	Comments	7
4.5	Restate a theorem	7
4.6	Translate the links	8
4.7	Write a sketch of proof in the main text	8
5	List of options	9
6	Contributions	11

1 Introduction

This package aims to provide a way to easily move proofs in the appendix. You can:

- Move proofs in different places/sections by giving different “categories” to the theorems
- Create links from theorem to proof, and from proof to theorem
- Restate the theorem in appendix (or before)

- Keep the proof in the main body like normal theorems by just adding with just one keyword
- Duplicate the proof in appendix and in the current section, practical to use synctex during the proof writing
- Add comments that would appear only in the appendix (or in both body and appendix)
- Move both the theorem and the proof completely in appendix
- Easily change the defaults, and create your own styles/environments
- Include sketch of proof in the main text, and full proof in appendix
- Change the text of the link, for example to translate into another language
- Have a nice environment-based commands in order to mimic the usual theorem/proof structure.

NB: This project is hosted on github at <https://github.com/leo-colisson/proof-at-the-end>. Feel free to contribute, report bugs, or read/copy-paste the documentation/examples from there.

Disclaimer: This package is still in beta and not considered as stable.

This package is licensed under LPPL v1.3, and the last version of this package on CTAN is 2019/05/21.

2 Demo

If you just want to see an example of what you can do, you can directly open the file `demo.pdf` (also available online at <https://github.com/leo-colisson/proof-at-the-end/raw/master/demo.pdf>) to see what is possible, or generate it with

```
git clone https://github.com/leo-colisson/proof-at-the-end.git
pdflatex demo.tex && pdflatex demo.tex
```

3 Quickstart

3.1 Install

If your CTAN distribution is recent enough, you have nothing to do. Otherwise if it's not yet in your CTAN distribution, first download the `proof-at-the-end.sty` file and insert it in the root of your project with the following commands on unix (you can also clone this repository if you prefer, or just manually download or copy/paste the files on Windows). It also requires a recent version of xparse, so for simplicity we included the sty file of xparse in this repository as well:

```
cd <your project>
repopratend="https://raw.githubusercontent.com/leo-colisson/proof-at-the-end"
```

```
wget ${repopratend}/master/proof-at-the-end.sty
wget ${repopratend}/master/xparse.sty
```

If you have an old distribution of LaTeX (before 2018 basically, which is the case of Overleaf), you may also need a more recent expl3. It is also very easy to install, just download the zip file <http://mirrors.ctan.org/install/macros/latex/contrib/l3kernel.tds.zip>, unzip, and copy the content of the directory `tex/latex/l3kernel/` into your project. On linux it's a matter of two commands in your project:

```
wget http://mirrors.ctan.org/install/macros/latex/contrib/l3kernel.tds.zip
unzip -d . -j l3kernel.tds.zip 'tex/latex/l3kernel/*'
rm l3kernel.tds.zip
```

If you don't want to pollute your main project with all these files, you may be interested to put them in a subfolder and update the environment variable `TEXINPUTS` or, if you use `latexmk` or overleaf, you can write instead a `latexmkrc` file as explained here.

That's all!

3.2 Use in your project

Now, you can load the library in your project by simply using:

```
\usepackage{proof-at-the-end}
```

Then, you can configure your theorem/lemma/... environments as usual, by using any counter you like...:

```
\usepackage{amssymb, amsthm, amsmath}
% Theorems
\newtheorem{thm}{Theorem}[section]
\newtheorem*{thm*}{Theorem}
\providecommand*\thmautorefname{Theorem}
% Lemmas
\newtheorem{lemma}[thm]{Lemma}
\newtheorem*{lemma*}{Lemma}
\providecommand*\lemmaautorefname{Lemma}
```

And inside your document, you can use the following syntax to create a new theorem:

```
\begin{theoremEnd}[OPTIONS]{THEOREM ENVIRONMENT}[OPTIONAL TITLE]
    YOUR THEOREM, with eventually labels like \label{thm:OPTIONAL LABEL}
\end{theoremEnd}
\begin{proofEnd} %% Optional environment
    YOUR (OPTIONAL) PROOF
\end{proofEnd}
```

For example:

```
\begin{theoremEnd}{thm}[Yes I can have a title]
  \label{thm:ilikelabels}
  Creating a new theorem is easy
\end{theoremEnd}
\begin{proofEnd}
  You want a proof? Here is it!
\end{proofEnd}
```

And put in the place where you would like to display the theorem the following code:

```
\printProofs
```

If you would like to display a lemma instead, just change {thm} into {lemma}, or into any other theorem environment you defined! You can now compile safely your document ;)

NB: if you want to make sure all the references are linked correctly, make sure to compile twice the document!

Isn't it simple ?

4 Use cases

4.1 Configuration and how to use and create styles

You can very easily configure this package, and choose how each theorem/proof must be displayed by providing a value in OPTIONS. For example, if you would like to keep the proof of a theorem in the main text like any normal theorem, use the `normal` option:

```
\begin{theoremEnd}[normal]{thm}[A title]
  You can easily turn a theorem back into a normal theorem!
\end{theoremEnd}
\begin{proofEnd}
  And keep the proof with you!
\end{proofEnd}
```

The options are in fact a set of keys/values, thanks to `pgfkeys`. So you can combine them with comma separated list like that (order matters, as the right-most values may overwrite configuration set by left-most values):

```
\begin{theoremEnd}[proof at the end,
  no link to proof,
  text proof={Difficult proof}]
]{thm}[A title]
```

```

    Each theorem can have a custom configuration!
\end{theoremEnd}
\begin{proofEnd}
    Quite practical, isn't it?
\end{proofEnd}

```

You can easily create your own styles like that:

```
\pgfkeys{/prAtEnd/my great style/.style={
    proot at the end,
    no link to proof,
    text proof={Difficult proof},
}
}
```

You can also change the default configuration when you load the package by nesting the configuration into a `conf` key:

```
\usepackage[conf={normal, one big link}]{proof-at-the-end}
```

Note however that for now it is *not* possible to use macros directly inside the options when you load the package, so if you need to use more complicated configuration, you can overwrite the `global custom defaults` style for global configuration, and the `local custom defaults` style for local configuration (useful for example if you want to define a category for a single section):

```
\pgfkeys{/prAtEnd/global custom defaults/.style={
    one big link={Go to proof on page~\pageref*{proof:prAtEnd\pratendcountercurrent}}
}
}
```

and for local configuration:

```
\pgfkeys{/prAtEnd/local custom defaults/.style={
    category=greattheorem
}
}
```

Finally, it can be practical to define custom environments to avoid typing always `theoremEnd`:

```
\NewDocumentEnvironment{thmE}{0{}0{}+b}{%
\begin{theoremEnd}[normal,#2]{thm}[\#1]%
#3%
\end{theoremEnd}%
}{}%
% Do not forget the second parameter or you might get Missing \begin{document} error
\NewDocumentEnvironment{proofE}{0{}+b}{%
\begin{proofEnd}[\#1]%
#2%
}
```

```
\end{proofEnd}%
}{}
```

That you could use like that:

```
\begin{thmE}[Title]
  Here is a normal theorem with the proof in the main text.
\end{thmE}
\begin{proofE}
  The (optional) proof
\end{proofE}

\begin{thmE}[Title][end]
  Here is a theorem whose proof goes to the end.
\end{thmE}
\begin{proofE}
  The proof
\end{proofE}

\begin{thmE}[Title][all end]
  Here is a theorem that goes with the proof at the end.
\end{thmE}
\begin{proofE}
  The proof
\end{proofE}
```

Note also that it is also possible to give options to the `proofEnd` environment, but it is usually useless, as it will automatically pick the parameters from the last `theoremEnd` environment. However, if for some reasons you want to change the options of the proof only, you can do it, but do it as your own risks ;)

4.2 Usual styles

We predefined some pretty common styles/options. The full list is at the end of this document, but here is a list of the most practical ones:

- `normal`: turn the theorem into a “normal” theorem, with the proof in the main text and nothing in appendix
- `category=yourowncategory`: change the category of the theorem (see next sub-section)
- `end`: put the proof in appendix
- `all end`: put both the theorem and the proof in appendix
- `debug`: make sure the proof is written in the main text as well. Practical when you write the proof to be able to use syntex (if you use syntex with the proof in appendix, your will be unfortunately moved to a temporary file that this library is using... so **make sure you don't modify the files**

named like `prattheenddefaultcategory.tex` or all your changes will be lost at the next compilation!).

- `one big link`: if you prefer to have a single big link instead of two links (one for the proof, one for the page)
- `one big link translated=Your translation`: to change/translate the text of the link easily
- `text link section`: put a link looking like “See proof in section XX.”
- `text link section full proof`: put a link looking like “See full proof in section XX.”
- `text proof translated=Your translation`: to change/translate the text of the proof at the end easily
- `global custom defaults`: empty style that you can modify to change the configuration (globally)
- `local custom defaults`: empty style that you can modify to change the configuration (locally). Practical to set a category for a single section.

4.3 Categories, or how to move proofs in different sections

Let’s imagine that you have some proofs that are easy to do, and some proofs that are long but interesting. You may want to put the easy proofs in a different place than the long proofs. It is super easy to do, you just need to give a category name to the option `category` like here:

```
\begin{theoremEnd}[category=mylongproofs]{thm}[A title]
  You can easily change the place of the proofs
\end{theoremEnd}
\begin{proofEnd}
  Just use a different category name!
\end{proofEnd}
```

and give this category name to `\printProofs` in the section where you would like to display the proofs:

```
\printProofs[mylongproofs]
```

4.4 Comments

You can also move some text in the appendix by using:

```
\textEnd{Your text that should go in appendix}
```

You can also give it a category as explained above, or configure it to be displayed in both the main text and at the end of the file with:

```
\textEnd[both]{I am a comment that is written in both the main text
and the appendix}
```

You can also use the environment notation like that:

```
\begin{textAtEnd}[options]
  You can also use the environment syntax.
\end{textAtEnd}
```

4.5 Restate a theorem

It is easy to restate a theorem in the appendix, to have both the theorem in the main text and in the appendix: just use the option `restate`:

```
\begin{theoremEnd}[end, restate]{thm}[A title]
  This theorem will be displayed both in main text and appendix.
\end{theoremEnd}
\begin{proofEnd}
  Just use restate option.
\end{proofEnd}
```

You can also use the option `restate command=yourcustomcommand` in order to create a macro `\yourcustomcommand` that will restate the theorem wherever you want (but after the definition).

If you want to (re)state a theorem *before* its definition (say in the introduction), there is also a special environment `theoremEndRestateBefore` that requires a (unique) custom name that you need to provide also later on in place of the real theorem with the option `restated before`:

```
\section{Introduction}
\begin{theoremEndRestateBefore}{thm}[Title]{anamethatisusedtorestate}
  It is possible to state the theorem before
  in the introduction, and restate it later
\end{theoremEndRestateBefore}

\section{Real definition}
\begin{theoremEnd}[restated before]{thm}
  anamethatisusedtorestate
\end{theoremEnd}
\begin{proofEnd}
  Proof of the theorem, put in place of the theorem the unique name
\end{proofEnd}
```

4.6 Translate the links

The more powerful way to change the text of the links is to redefine `text link` and `text proof` (see section List of options for more details). However we defined also some easy way to redefine the text using one big link translated

and `text` `proof` `translated`. For example, to create your `french` style you can do:

```
\pgfkeys{/prAtEnd/french/.style={  
    one big link translated={Voir preuve page},  
    text proof translated={Preuve du}  
}  
}
```

4.7 Write a sketch of proof in the main text

You can include a sketch of proof in the main text by simply adding a proof in between `theoremEnd` and `proofEnd`. An alias option `see full proof` can also be used to change the link into “See full proof on page X.”:

```
\begin{theoremEnd}[see full proof]{thm}  
    I can also write a sketch of proof, and put the full proof in appendix.  
\end{theoremEnd}  
\begin{proof}  
    Hint: look at the alias options.  
\end{proof}  
\begin{proofEnd}  
    You just use ``see full proof'' as an option  
\end{proofEnd}
```

5 List of options

Here is the list of fundamental options supported. Most options have a `no` version, with `no` written before. Note that you may prefer to use directly the alias/styles (see next paragraph) as the options listed here are quite fundamental and atomic.

- `category`: category of the proof (if you want to put proofs at several places), can be anything
- `proof here/no proof here`: put (or not) the proof in the main text
- `proof end/no proof end`: display the proof in appendix
- `restate/no restate`: restate the theorem in appendix
- `link to proof/no link to proof`: Display a link to the proof in the main text
- `opt all end/no opt all end`: put the theorem and proof only in appendix. You may prefer the alias `all end`, that also makes sure that the proof is indeed displayed in appendix.

- **text link**: text of the link to the proof, defaults to
`{See \hyperref [proof:prAtEnd\pratendcountercurrent]{proof}
on page~\pageref{proof:prAtEnd\pratendcountercurrent}.}`
- **text proof**: text displayed in place of “Proof” in the appendix. Defaults to
`{Proof of \string\autoref{thm:prAtEnd\pratendcountercurrent}}`
- **restate command**: name of a unique macro (without backslash) that will be defined as an alias to restate the theorem wherever you want
- **restated before**: if the theorems has been stated before (with `\theoremProofEndRestateBefore`), then we just need to put the restate command in place of the theorem, and enable this option
- **both/no both**: only for `\textInAppendix`, specifies that the text must be present in both the main text and the appendix.

Here are all the alias/styles (you can create your own as well), they are practical to quickly define a behaviours, but are made of the basic options listed above:

- **normal**: like a ‘normal’ theorem, without any proof in the appendix, and with a proof displayed in the main text. Shortcut for `proof here, no all end, no proof end, no link to proof, no restate, no both`.
- **end**: theorems whose proof need to go in the appendix. Shortcut for `proof at the end, link to proof`.
- **all end**: makes sure both the theorem and the proof are in appendix. Alias of `end`, opt `all end`.
- **proof at the end**: theorems whose proof need to go in the appendix contrary to `end` it does not make sure that there is a link to the proof. Shortcut for `no proof here, no all end, proof end, no both`.
- **debug**: make sure the proof is written in the main text as well (alias of `proof here, no opt all end`), it is quite practical to use when you write a proof to be able to use syntex features to move between the pdf and the file.
- **no link to theorem**: Remove the link from the proof to the theorem, alias of `text proof=\{\proofname\}`
- **stared (or no number)**: when you use the stared version of a theorem you don’t have any number, so `autoref` fails to write a nice link to the theorem. This option changes the text of “Proof”, by keeping the link but writing only `Proof`. Equivalent to `text proof=\{\string\mbox{\string\hyperref [thm:prAtEnd\pratendcountercurrent]{\proofname}}\}`
- **see full proof**: useful when you want to write in the main text only a sketch of proof, this alias writes a link `See full proof on page X..` Equivalent to `text link={See \hyperref [proof:prAtEnd\pratendcountercurrent]{full proof} on page~\pageref{proof:prAtEnd\pratendcountercurrent}.}`
- **one big link**: instead of two links, one for page, one for proof, put just one link around everything. It can also accept an optional argument which will be the text of the link, like `one`

- `big link`=Go to the proof. The default value is `See proof on page~\pageref*{proof:prAtEnd\pratendcountercurrent}.`.
- `one big link translated`: This is like `one big link`, but automatically add the page at the end (and a big link around). Practical to quickly define a translation like `one big link translated=Voir preuve page`. See also `text proof translated`.
 - `text link section`: Put a link to the proof looking like “See proof in section X”. Defaults to `text link={See \hyperref [proof:prAtEnd\pratendcountercurrent]{proof} in \autoref{proofsection:prAtEnd\pratendcountercurrent}.}`
 - `text link section full proof`: Put a link to the proof looking like “See full proof in section X”. Defaults to `text link={See \hyperref [proof:prAtEnd\pratendcountercurrent]{full proof} in \autoref{proofsection:prAtEnd\pratendcountercurrent}.}`
 - `default text link`: default text for the link to the proof, equivalent of `text link={See \hyperref [proof:prAtEnd\pratendcountercurrent]{proof} on page~\pageref{proof:prAtEnd\pratendcountercurrent}.}`
 - `default text proof`: default text for the proof in appendix, equivalent of `text proof={Proof of \string\autoref{thm:prAtEnd\pratendcountercurrent}}`
 - `text proof translated`: like `default text proof`, but takes one argument and use it instead of `Proof of`. Example: `text proof translated={Preuve du}`
 - `bare defaults`: default style that is loaded before anything else that configure by default a link to the proof, put the proof in appendix, use the category `defaultcategory`. It is an alias of `end, link to proof, no restate,category=defaultcategory, default text link,default text proof,restate command=pratenddummymacro`.
 - `configuration options`: style that contains the options used to load the package. It is called right after `bare defaults`. Note that you cannot insert macro in the options, overwrite `global custom defaults` instead
 - `global custom defaults`: empty style that you can overwrite to change the global defaults
 - `local custom defaults`: empty style that you can overwrite to change the “local” defaults, like category
 - `all defaults`: all the defaults, equivalent of `bare defaults, configuration options, global custom defaults, local custom defaults`

6 Contributions

Feel free to contribute, report bugs, and send pull requests on the github repository <https://github.com/leo-colisson/proof-at-the-end> !

NB: the documentation is generated from the Markdown file `README.md` thanks to pandoc. These commands may help you:

```
%% Compile the demo
make demo
%% Clean the project
make clean
%% Generate the documentation
make doc
%% Generate a package for CTAN
make package
```