The apxproof package

Pierre Senellart
pierre@senellart.com
http://github.com/PierreSenellart/apxproof

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Abstract

This package makes it easier to write articles where proofs and other material are deferred to the appendix. The appendix material is written in the LaTeX code along with the main text which it naturally complements, and it is automatically deferred. The package can automatically send proofs to the appendix, can repeat in the appendix the theorem environments stated in the main text, can section the appendix automatically based on the sectioning of the main text, and supports a separate bibliography for the appendix material.

1 Usage

The apxproof package is intended to simplify the writing of articles where some of the content needs to be deferred to an appendix. This is in particular useful for the submission of scientific articles to conferences or journals that limit the number of pages in the main text but allow an extra appendix, where proofs of theorems and other material can be added.

1.1 Basics

To use apxproof, first load it in the header of your document:

```
\usepackage{apxproof}
```

On its own, this does not do anything and should not change the appearance of your document. To add an appendix with some material from your document, use the `toappendix` environment:

`toappendix`

```
\begin{toappendix}
  ...
\end{toappendix}
```

The content will appear at the end of your document, in an automatically generated section that refers to the current section in the main text.

Example 1. *Throughout this documentation, all examples produce content deferred to the appendix, at the very end of this document.*

```
\begin{toappendix}
This content is in the appendix.
\end{toappendix}
```

When the content to put in appendix is an entire section, make sure that `\section` is the very first command that appears within the `toappendix` environment. It will disable the automatic production of a section heading.

1.2 Repeated Theorems and Proofs

In some scientific papers that include proofs, it is common to defer proofs to the appendix. This can easily be achieved using the `appendixproof` environment:

`appendixproof`

```
\begin{appendixproof}
  ...
\end{appendixproof}
```

This behaves like the `toappendix` environment, except that a proof environment is generated.

Example 2. *We now send a proof to the appendix:*

```
\begin{appendixproof}
This proof is in the appendix.
\end{appendixproof}
```

When deferring proofs to the appendix, an annoying problem is that the statement of the theorem remains in the main text; it is hard to read a proof that is far away from the statement it proves. apxproof solves this issue by allowing statements of theorems to be *repeated*: once in the main text, and once in the appendix before the proof of the statement. To use this feature, you can define a new *repeated theorem* environment using the `\newtheoremrep` command:

`\newtheoremrep`

`\newtheoremrep{`⟨*name*⟩`}[`⟨*counter*⟩`]{`⟨*title*⟩`}[`⟨*countersec*⟩`]`

Usage is exactly the same as that of AMS LaTeX's `\newtheorem` macro:

- ⟨*name*⟩ (e.g., `theorem`) is the name of an environment that is created for this kind of theorem;
- ⟨*counter*⟩ (e.g., `definition`) is an optional counter describing from which kind of environment should the numbering of these environments be inherited;
- ⟨*title*⟩ (e.g., `Theorem`) is the title that will be used to display this theorem environment;

- ⟨*countersec*⟩ (e.g., `section`) is an optional counter of a sectioning command indicating that counters for this theorem should be prefixed by this counter (and reset at each occurrence of the sectioning command).

⟨*counter*⟩ and ⟨*countersec*⟩ should not be used together. What differs from `\newtheorem` is that, when the following is written:

```
\newtheoremrep{foobar}{Foobar}
```

then *two* environments are defined: the `foobar` environment, which behaves as if `\newtheorem` had been used, and the `foobarrep` environment, which results in the statement of this environment being repeated in the appendix.

One interesting feature of apxproof is that in most situations, there is no need to
`proof` use the `appendixproof` environment. Indeed, the `proof` environment is redefined by apxproof to automatically put the proof either in the main text (if it follows a regular theorem) or in the appendix (if it follows a repeated theorem).

Example 3. *Assume we have first defined a repeated theorem environment* `foobar` *as above. We can now use this theorem environment, first for a regular theorem in the main text, then for a theorem repeated in the main text and in the appendix:*

```
\begin{foobar}
This foobar is a regular one, in the main text.
\end{foobar}
\begin{proof}
This is the proof of the regular foobar.
\end{proof}
```

We obtain:

Foobar 1. *This foobar is a regular one, in the main text.*

Proof. This is the proof of the regular foobar. □

Now, if we use a repeated theorem:

```
\begin{foobarrep}
This foobar is repeated in the appendix.
\end{foobarrep}
\begin{proof}
This is the proof of the repeated foobar.
\end{proof}
```

We now obtain:

Foobar 2. *This foobar is repeated in the appendix.*

Note that, since `hyperref` *is loaded, there are hyperlinks created between the statements of the theorems in the main text and in the appendix.*

When the proof is deferred to the appendix, it is common practice to add a proof sketch in the main text. apxproof defines a simple `proofsketch` environment for this purpose:

`proofsketch`

```
\begin{proofsketch}
  ...
\end{proofsketch}
```

The proof sketch is typeset similarly to a proof, but is always in the main text. Similarly, an `inlineproof` environment is provided so as to be able to have both a proof in the appendix (using the regular `proof` environment, or alternatively the `appendixproof` environment) and a different proof in the main text (using the `inlineproof` environment).

`inlineproof`

Example 4. *Here are simple examples of proof sketches and inline proofs:*

```
\begin{proofsketch}
This is a proof sketch.
\end{proofsketch}
```

Proof sketch. This is a proof sketch. □

```
\begin{inlineproof}
This is an inline proof.
\end{inlineproof}
```

Proof. This is an inline proof. □

1.3 Bibliography

By default, apxproof automatically adds a bibliography in the appendix with only the references cited in the appendix material. This allows for a clean separation of references used solely in the main text, and those used in the appendix.

Example 5. *Assume we have citations both in the main text and in the appendix.*

```
This is a citation in the main text~\cite{lamport86}.
\begin{toappendix}
This is a citation in the appendix~\cite{proofsAreHard}.
\end{toappendix}
```

This is a citation in the main text [1].

The bibliography in the appendix can use a different style and heading than the bibliography in the main text (and, by default, it does). See Section 1.5 for how to configure the appearance of that bibliography.

option `bibliography`

In order to use a single appendix for the main text and the bibliography, one can specify the value `common` to the `bibliography` option when loading the package. (By default this option is set to `separate`.)

1.4 Mode

option `appendix`

An optional ⟨*mode*⟩ can be specified when loading the package:

```
\usepackage[appendix=⟨mode⟩]{apxproof}
```

⟨*mode*⟩ can take one of the following three values:

`append` This is the default. Appendix material gathered by apxproof is appended to the main text.

`inline` In this mode, apxproof simply inline the content along with the main text.

`strip` This mode functions similarly to `append` except that the appendix is not appended at the end of the document. All appendix material is therefore removed.

1.5 Customization

apxproof provides a few macros that can be redefined (using `\renewcommand`) to customize the appearance of the appendix:

`\appendixsectionformat` **`\appendixsectionformat{`**⟨***number***⟩**`}{`**⟨***title***⟩**`}`** is a macro that indicates how to format the section titles in the Appendix, given the number and title of the section in the main text. By default, they appear as "Proofs for Section ⟨*number*⟩ (⟨*title*⟩)".

`\appendixrefname` **`\appendixrefname`** contains the heading that is displayed before the bibliography. By default, this is "References for the Appendix".

`\appendixbibliographystyle` **`\appendixbibliographystyle`** contains the `.bst` bibliography style that is used in the bibliography in appendix. By default, this is `alpha`.

`\appendixbibliographyprelim` **`\appendixbibliographyprelim`** contains arbitrary code that is executed just before the production of the bibliography in appendix, which can be used to configure the way it is displayed.

`\appendixprelim` **`\appendixprelim`** contains arbitrary code that is executed just before the production of the appendix, which can be used to configure the way it is displayed. By default, this command contains `\clearpage\onecolumn` (the appendix is typeset on a new page in single-column mode) but redefining this option allows changing this behavior.

option `repeqn`

Another customization capability concerns *numbered equations* that are present within repeated theorems. An optional `repeqn` option can be specified when loading the package, which controls whether equation numbers should be as in the same text (by setting this option to `same`, the default) or independently numbered (by setting this option to `independent`). In the latter case, whenever a referenceable counter is set with `\label{`⟨*counter*⟩`}`, `\ref{`⟨*counter*⟩`}` references the counter in the main text, while `\ref{`⟨*counter*⟩`-apx}` references the counter in the appendix (except in `inline` mode, where both have the same effect).

1.6 Advanced Features

We now describe a few advanced macros and environments, whose usage is limited to special cases:

`nestedproof` **`nestedproof`** is an environment that can be used within a `proof` environment deferred in the appendix; this is required because, for technical reasons, no `proof` environment can be nested within a deferred `proof` environment.

`\noproofinappendix` **`\noproofinappendix`** can be used inside repeated theorems that are not followed by a `proof` or `appendixproof` theorem; the point is to ensure that a further `proof` environment cannot be mistakenly understood as a proof of the repeated theorem. It should not be needed in most situations as apxproof tries figuring out when a proof follows a repeated theorem automatically, but may occasionally be needed in complex scenarios.

`\nosectionappendix` **`\nosectionappendix`** is to be used inside a section that *does* contain appendix material, but for which a section in the appendix should not be created. This should be rarely needed. When this command is present, appendix material is appended to the end of the previously created section.

2 Supported Document Classes

Because apxproof modifies sectioning commands, bibliographies, and proofs, it may not work straight away with arbitrary document classes. It has currently been tested with and is supported for the following document classes:

- LaTeX standard document classes (e.g., `article.cls`)
- KOMA-Script (e.g., `scrartcl.cls`, `scrbook.cls`)
- ACM SIG Proceedings (e.g., `sig-alternate.cls`, `acmart.cls`)
- Springer's Lecture Notes in Computer Science (e.g., `llncs.cls`)
- Schloß Dagstuhl's Leibniz International Proceedings in Informatics (e.g., `lipics.cls`, `lipcs-v2016.cls`)

Other classes may work out of the box. Adding support for specific classes is possible and can be requested from the author of this package.

3 Known Issues and Limitations

We report here some issues we are currently aware of:

- When using hyperref, the appendix in the bibliography is not hyperlinked. This is to avoid possible issues with multiply defined bibliography entries.

- `appendixproof`, `proof`, `toappendix` environments cannot be nested. This is a limitation of the fancyvrb package that apxproof relies on. Note the existence of the `nestedproof` environment for nested proofs.
- apxproof is incompatible with a separate use of the fancyvrb package. This is because apxproof redefines some internal mechanisms of fancyvrb.
- apxproof poorly interacts with SyncTEX: identifying which source line has produced which box does not work for appendix content managed by apxproof or repeated theorems. No obvious fix is known, though this issue will be investigated in the long term.

Issues not listed here should be reported to the author.

4 License

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5 Contact

- https://github.com/PierreSenellart/apxproof
- Pierre Senellart <pierre@senellart.com>

Bug reports and feature requests should preferably be submitted through the *Issues* feature of GitHub.

6 Acknowledgments

Thanks to Antoine Amarilli for feedback and proofreading. Thanks to K. D. Bauer for the implementation of the forward-linking mechanism, and for various bugfixes.

7 Implementation

We now describe the entire code of the package, in a literate programming fashion. Throughout the package, we use the `axp@` prefix to identify local macros and environment names, which are not meant to be used by the final user.

7.1 Dependencies

We first load a few package dependencies:

- bibunits to add a second bibliography for the appendix material.

```
\RequirePackage{bibunits}
```

- environ to easily define the repeated theorem environments.

```
\RequirePackage{environ}
```

- etoolbox to define simple toggles.

```
\RequirePackage{etoolbox}
```

- fancyvrb for the bulk of the work of exporting appendix material in an auxiliary file.

```
\RequirePackage{fancyvrb}
```

- ifthen for easier comparison of character strings.

```
\RequirePackage{ifthen}
```

- kvoptions to manage options passed to the package.

```
\RequirePackage{kvoptions}
```

- amsthm for its `\newteorem` macro. Some document classes (e.g., lipics) preload amsthm: this is fine, `\RequirePackage{amsthm}` will simply have no effect. On the other hand, some other document classes (e.g., llncs or sig-alternate) define a `proof` environment that conflicts with amsthm, so we have to undefine this environment before loading amsthm. In that case, we reestablish the existing proof environments, in case they had been customized (e.g., sig-alternate)

```
\@ifpackageloaded{amsthm}{
  }{
    \let\apx@oldamsthmproof\proof
    \let\apx@oldamsthmendproof\endproof
    \let\proof\undefined
    \let\endproof\undefined
  }
\RequirePackage{amsthm}
\ifdefined\apx@oldamsthmproof
  \let\proof\apx@oldamsthmproof
  \let\endproof\apx@oldamsthmendproof
\fi
```

7.2 Option Processing

Many names throughout the package use an arobase (`@`) to avoid name conflict with user-defined names. To simplify the compilation of the documentation, we simply make it a regular character in all the rest.

```
\makeatletter
```

We setup the processing of options using keyval facilities.

```
\SetupKeyvalOptions{
  family=axp,
  prefix=axp@
}
```

We declare the following options:

- `appendix`, with a default value of `append` (other possible values: `strip`, `inline`);
- `bibliography`, with a default value of `separate` (other possible value: `common`);
- `repeqn`, with a default value of `same` (other possible value: `independent`).

`\axp@appendix`

```
\DeclareStringOption[append]{appendix}
```

`\axp@bibliography`

```
\DeclareStringOption[separate]{bibliography}
```

`\axp@repeqn`

```
\DeclareStringOption[same]{repeqn}

\ProcessLocalKeyvalOptions*
```

We check that the value of the options are valid, and add a message to the compilation log.

```
\ifthenelse{\equal{\axp@appendix}{append}}{
  \message{apxproof: Appendix material appended to the document}
}{\ifthenelse{\equal{\axp@appendix}{strip}}{
  \message{apxproof: Appendix material stripped}
}{\ifthenelse{\equal{\axp@appendix}{inline}}{
  \message{apxproof: Appendix material inlined within the document}
}{
  \errmessage{Error: unsupported option appendix=\axp@appendix\ for
  package apxproof}
}}}
\ifthenelse{\equal{\axp@bibliography}{separate}}{
  \message{apxproof: Separate bibliography for appendix material}
}{\ifthenelse{\equal{\axp@bibliography}{common}}{
  \message{apxproof: Common bibliography for appendix and main text}
}{
```

```
  \errmessage{Error: unsupported option bibliography=\axp@bibliography\ for
  package apxproof}
}}
\ifthenelse{\equal{\axp@repeqn}{same}}{
  \message{apxproof: Repeated equations keep the same numbering}
}{\ifthenelse{\equal{\axp@repeqn}{independent}}{
  \message{apxproof: Repeated equations are independently numbered}
}{
  \errmessage{Error: unsupported option repeqn=\axp@repeqn\ for
  package apxproof}
}}
```

7.3 Macros Common to All Compilation Modes

`\axp@newtheorem` `\@axp@newtheorem` `\@@axp@newtheorem`

We introduce an intermediate `\axp@newtheorem` command to define a new theorem, differently depending on whether there is a section counter or not. This will be useful, in particular to allow changing this definition depending on the document class. This command uses two intermediary commands, `\@axp@newtheorem` and `\@@axp@newtheorem`, for the non-starred and starred versions.

`\newtheoremrep` `\axp@newtheoremreptmp`

We define the high-level `\newtheoremrep` to have the same syntax as amsthm's `\newtheorem`. For this purpose, we need a little trick to deal with the second and fourth optional arguments, which is what `\@oparg` and `\axp@newtheoremreptmp` are used for. `\axp@newtheoremrep` is defined differently depending on the compilation mode.

```
\newcommand\newtheoremrep[1]{%
  \@oparg{\axp@newtheoremreptmp{#1}}[]%
}
\def\axp@newtheoremreptmp#1[#2]#3{%
  \@oparg{\axp@newtheoremrep{#1}[#2]{#3}}[]%
}
```

`proofsketch`

Simple `proofsketch` environment.

```
\newenvironment{proofsketch}{\begin{axp@oldproof}[Proof sketch]}{\end{axp@oldproof}}
```

`\thmhead`

We redefine AMS-LaTeX's `\thmhead` to use a format where the repeated version of a theorem, using a theorem note, can look exactly like the original version of the theorem and its theorem counter.

```
\AtBeginDocument{%
  \def\thmhead#1#2#3{%
    \thmname{#1}\thmnumber{\@ifnotempty{#1}{ }\@upn{#2}}%
    \thmnote{ #3}}%
}
```

`\appendixrefname` `\appendixbibliographystyle` `\appendixbibliographyprelim` `\appendixprelim` `\appendixsectionformat`

We provide sensible defaults for these four user-customizable macros. Even though they are only useful in append mode, we define them for all modes so that a `\renewcommand` works in all cases.

```
\newcommand{\appendixrefname}{References for the Appendix}
```

```
\newcommand{\appendixbibliographystyle}{alpha}
\newcommand{\appendixbibliographyprelim}{}
\newcommand{\appendixprelim}{\clearpage\onecolumn}
\newcommand{\appendixsectionformat}[2]{Proofs for Section~#1\ (#2)}
```

`axp@oldproof` We save the definition of the existing `proof` environment.

```
\let\axp@oldproof\proof
\let\endaxp@oldproof\endproof
```

We define a utility macro that will be used to properly set the `\label` command (and its amsmath counterpart, `\label@in@display`) for equations within repeated theorems, depending on the compilation mode.

`\axp@redefinelabels`

```
\newcommand{\axp@redefinelabels}{%
  \providecommand\label@in@display{}
  \ifthenelse{\equal{\axp@appendix}{inline}}{
    \let\axp@oldlabel\label
    \let\axp@oldlabel@in@display\label@in@display
    \renewcommand\label[1]{%
      \axp@oldlabel{##1}%
      \axp@oldlabel{##1-apx}%
    }%
    \renewcommand\label@in@display[1]{%
      \axp@oldlabel@in@display{##1}%
      \axp@oldlabel{##1-apx}%
    }%
  }{%
    \let\axp@oldlabel\label
    \let\axp@oldlabel@in@display\label@in@display
    \renewcommand\label[1]{\axp@oldlabel{##1-apx}}%
    \renewcommand\label@in@display[1]{\axp@oldlabel@in@display{##1-apx}}%
  }%
}
```

7.3.1 Class-Specific Behavior

Finally, some class-specific behavior common to all compilation modes

llncs and other Springer document classes

```
 \ifdefined\spnewtheorem
```

`\@axp@newtheorem` `\@@axp@newtheorem` It is necessary to use `\spnewtheorem` instead of `\newtheorem` in Springer document classes to obtain standard formatting.

```
\def\@axp@newtheorem#1#2#3#4{%
  \ifx\relax#4\relax
    \ifx\relax#2\relax
      \spnewtheorem{#1}{#3}{\bfseries}{\itshape}%
    \else
```

```
      \spnewtheorem{#1}[#2]{#3}{\bfseries}{\itshape}%
    \fi
  \else
    \spnewtheorem{#1}{#3}[#4]{\bfseries}{\itshape}%
  \fi
}
\def\@@axp@newtheorem#1#2{%
  \spnewtheorem*{#1}{#2}{\upshape\bfseries}{\itshape}%
}
```

We have to redefine the macro `\@thmcountersep` for proper sectioned counters.

```
\def\@thmcountersep{.}
```

We remove the parentheses added by default for theorem notes, which are not compatible with the use of theorem notes by apxproof.

```
\def\@Opargbegintheorem#1#2#3#4{#4\trivlist
      \item[\hskip\labelsep{#3#1}]{#3 #2\@thmcounterend\ }}
\def\@spopargbegintheorem#1#2#3#4#5{\trivlist
      \item[\hskip\labelsep{#4#1\ #2}]{#4 #3\@thmcounterend\ }#5}
  \fi
```

7.4 Inline Compilation Mode

```
\ifthenelse{\equal{\axp@appendix}{inline}}{
```

`\axp@newtheoremrep` In inline mode, `\axp@newtheoremrep` undefines the existing theorem environment if it has already been defined (e.g., by the document class), invokes `\newtheorem` and creates a repeated theorem environment that behaves exactly as the regular theorem environment, while calling `\axp@redefinelabels` to make sure that `-axp` variants of equation counters are defined.

```
  \def\axp@newtheoremrep#1[#2]#3[#4]{%
    \expandafter\let\csname #1\endcsname\undefined
    \expandafter\let\csname c@#1\endcsname\undefined
    \axp@newtheorem{#1}{#2}{#3}{#4}%
    \NewEnviron{#1rep}[1][]{%
      \begin{#1}[##1]\axp@redefinelabels\BODY\end{#1}%
    }
  }
```

`inlineproof` `nestedproof` `appendixproof` In inline mode, these environments behave like the regular `proof` environment.

```
  \let\inlineproof\proof
  \let\endinlineproof\endproof
  \let\nestedproof\proof
  \let\endnestedproof\endproof
  \let\appendixproof\proof
  \let\endappendixproof\endproof
```

`toappendix` `\noproofinappendix` `\nosectionappendix` In inline mode, this environment and these macros are no-ops.

```
  \newenvironment{toappendix}{}{}
```

```
\let\noproofinappendix\relax
\let\nosectionappendix\relax
}
```

7.5 Append or Strip Compilation Modes

```
{
```

We now deal with the case where apxproof really does something useful: either append the appendix material to the document, or strip it entirely.

7.5.1 Auxiliary File for the Appendix

`\axp@proofsfile` We open a new auxiliary file, with extension `.axp`, where the appendix material will be dumped.

```
\AtBeginDocument{
  \newwrite\axp@proofsfile
  \immediate\openout\axp@proofsfile=\jobname.axp
}
```

`proof` `\section` At the beginning of this file, we make `@` a regular character (since it will be used in several places for internal names) and reestablish the original definition of the `proof` environment and the `\section` macro.

```
\AtBeginDocument{
  \immediate\write\axp@proofsfile{%
    \noexpand\makeatletter
    \noexpand\let\noexpand\proof\noexpand\axp@oldproof
    \noexpand\let\noexpand\endproof\noexpand\endaxp@oldproof
    \noexpand\let\noexpand\section\noexpand\axp@oldsection
  }
}
```

`\FVB@VerbatimOut` `\FVE@VerbatimOut` We modify the internal behavior of the fancyvrb package to write to the `\axp@proofsfile`, without closing it and re-opening it on every write.

```
\def\FVB@VerbatimOut{%
  \@bsphack
  \begingroup
    \FV@UseKeyValues
    \FV@DefineWhiteSpace
    \def\FV@Space{\space}%
    \FV@DefineTabOut
    \def\FV@ProcessLine{\immediate\write\axp@proofsfile}%
    \let\FV@FontScanPrep\relax
    \let\@noligs\relax
    \FV@Scan}
\def\FVE@VerbatimOut{\endgroup\@esphack}
```

`toappendix` The entire content of this environment is put in appendix, starting a new appendix section beforehand if needed.

```
\newenvironment{toappendix}
  {\axp@writesection\VerbatimOut}
  {\endVerbatimOut}
```

7.5.2 Definition of New Theorems

`axp@seenreptheorem` Used to indicate whether a repeated theorem was just typeset, without its proof.

```
\newtoggle{axp@seenreptheorem}
```

`axp@rpcounter` Sequentially incremented for every repeated theorem, used to create labels.

```
\newcounter{axp@rpcounter}
```

`axp@equation` Used to save the value of the `equation` counter, when `repeqn` is set to `same`.

`axp@equationx`

```
\newcounter{axp@equation}
\newcounter{axp@equationx}
```

`axp@newtheoremrep` When called with first argument `foobar`, we first undefine the existing `foobar` environment (and its counter) if it has already been defined (e.g., by the document class), then invoke `\newtheorem` for the regular version of the theorem `foobar` (patching the `\begin{foobar}` so as not to expect a proof in the appendix) and `\newtheorem*` for an internal version `axp@foobarrp` that will be used in the appendix to restate the existing theorem.

```
\def\axp@newtheoremrep#1[#2]#3[#4]{%
  \expandafter\let\csname #1\endcsname\undefined
  \expandafter\let\csname c@#1\endcsname\undefined
  \axp@newtheorem{#1}{#2}{#3}{#4}%
  \expandafter\pretocmd\csname #1\endcsname{\noproofinappendix}{}{}%
  \axp@newtheorem*{axp@#1rp}{#3}%
  \axp@forward@setup{#1}{#2}{#3}{#4}%
```

We then define a `foobarrep` environment that increments the `axp@rpcounter` and typeset the regular `foobar` theorem with a label derived from the counter. We distinguish the case when the theorem argument has a note and when it does not. We save the equation counter before typesetting the theorem environment, to reset it to the same value in the repeated environment when `repeqn` is set to `same`.

```
  \NewEnviron{#1rep}[1][]{%
    \ifthenelse{\equal{\axp@repeqn}{same}}{%
      \setcounter{axp@equation}{\value{equation}}%
    }{}%
    \addtocounter{axp@rpcounter}{1}%
    \ifx\relax##1\relax
      \axp@with@forward{#1}{\begin{#1}}\label{axp@r\roman{axp@rpcounter}}\BODY\end{#1}%
    \else
      \axp@with@forward{#1}{\begin{#1}[##1]}\label{axp@r\roman{axp@rpcounter}}\BODY\end{#1}%
    \fi
```

We set the `axp@seenreptheorem` toggle to indicate that we are looking for the proof of the theorem, then store in a macro the content of the theorem's body.

```
    \global\toggletrue{axp@seenreptheorem}%
```

```
      \global\expandafter\let\csname rplet\roman{axp@rpcounter}%
                                \endcsname
      \BODY
```

Possibly after starting a new appendix section if needed, we typeset a repeated version of the theorem using the `axp@foobarrp` environment and a reference to the previously defined label. We use `\axp@redefinelabels` in this environment to avoid multiply defined labels.

```
      \axp@writesection%
      \ifthenelse{\equal{\axp@repeqn}{same}}{%
        \immediate\write\axp@proofsfile{%
          \noexpand\setcounter{axp@equationx}{\value{equation}}%
          \noexpand\setcounter{equation}{\theaxp@equation}%
        }%
      }{}%
      \immediate\write\axp@proofsfile{%
        \noexpand\begin{axp@#1rp}
          [\noexpand\ref{axp@r\roman{axp@rpcounter}}%
           \@ifnotempty{##1}{ \unexpanded{##1}}]%
          \noexpand\axp@forward@target{axp@fw@r\roman{axp@rpcounter}}{}%
          \noexpand\axp@redefinelabels
          \expandafter\noexpand\csname rplet\roman{axp@rpcounter}%
                                  \endcsname
        \noexpand\end{axp@#1rp}
      }%
      \ifthenelse{\equal{\axp@repeqn}{same}}{%
        \immediate\write\axp@proofsfile{%
          \noexpand\setcounter{equation}{\value{axp@equationx}}%
        }%
      }{}%
    }%
  }
```

7.5.3 Forward-Linking Mechanism

When hyperref is loaded, `foobarrep` environments in the main text have their number link to their repetition in the appendix.

`\axp@with@forward` In order to make the number of the `foobarrep` theorem a link to its repeated version, we temporarily redefine the `\thefoobar` command, or, if we inherited the counter from a `bazbar` environment, the `\thebazbar` command. This seems to be the only robust way, to make the number a `\hyperlink`, without adding extensive dependence on internals of `amsthm`, the builtin `\newtheorem` and possibly document-class specific definitions.

In order to allow users to redefine `\thefoobar` without breaking this feature, we redefine `\thefoobar` only for the duration of the `\begin{foobar}` form, resetting it to the old value as soon as possible.

Redefining `\thefoobar` has the side effect of changing `\newlabel` entries in the `.aux` file, so we need to to be able to disable addition of the hyperlink, which is

why we use an intermediate `\axp@forward@link{`⟨*target*⟩`}{`⟨*text*⟩`}` macro, We also redefine `\theHfoobar` which is used by `hyperref` but not defined if `hyperref` was loaded after `\newtheoremrep` was used. and `\protect` it to output it verbatim into the `.aux` file.

These hyperlinks are of course disabled in the `strip` compilation mode.

```
\newcommand{\axp@with@forward}[2]{%
  \ifthenelse{\equal{\axp@appendix}{strip}}{#2}{
    \global\booltrue{axp@forward}%
    \ifcsundef{axp@old@the\csname axp@cn@#1\endcsname}{%
      \csletcs{axp@old@the\csname axp@cn@#1\endcsname}{the\csname axp@cn@#1\endcsname}%
      \csletcs{theH\csname axp@cn@#1\endcsname}{the\csname axp@cn@#1\endcsname}%
      \csdef{the\csname axp@cn@#1\endcsname}{%
        \protect\axp@forward@link{axp@fw@r\roman{axp@rpcounter}}%
          {\csname axp@old@the\csname axp@cn@#1\endcsname\endcsname}%
      }%
    }{}%
    #2%
    \ifcsdef{axp@old@the\csname axp@cn@#1\endcsname}{%
      \csletcs{the\csname axp@cn@#1\endcsname}{axp@old@the\csname axp@cn@#1\endcsname}%
    }{}%
    \global\boolfalse{axp@forward}
  }}%
```

`\axp@forward@link` `axp@forward` Dummy macro, for handling the unwanted change of the `\newlabel` entry in the `.aux` file caused by changing the definition of `\thefoobar`.

```
\newbool{axp@forward}
\newcommand{\axp@forward@link}[2]{%
  \ifbool{axp@forward}{%
    \ifcsdef{hyperlink}{%
      \hyperlink{#1}{#2}%
    }{%
      #2%
    }%
  }{%
    #2%
  }%
}%
```

`\axp@forward@target` Provides the needed `\hypertarget`. Intended to be written to the `.axp` file.

```
\newcommand{\axp@forward@target}[2]{%
  \ifcsname hypertarget\endcsname
    \hypertarget{#1}{#2}%
  \else
    #2%
  \fi
}
```

`\axp@forward@setup` In order to support counter inheritance with the first optional argument of `\newtheoremrep`, we need access to the name of the counter. For compliance

with the behavior of `\@axp@newtheorem`, the first optional argument (`#2`) is ignored if the second optional argument (`#4`) is given.

```
\newcommand{\axp@forward@setup}[4]{%
  \csedef{axp@cn@#1}{\ifblank{#4}{\ifblank{#2}{#1}{#2}}{#1}}%
}
```

7.5.4 Proof Environments

`\noproofinappendix` Utility macro that toggles `axp@seenreptheorem` to false.

```
\newcommand\noproofinappendix{%
  \global\togglefalse{axp@seenreptheorem}%
}
```

`appendixproof` We dump the content of this in appendix, within an original `proof` environment, possibly after creating a new appendix section.

```
\newenvironment{appendixproof}
  {%
    \axp@writesection
    \immediate\write\axp@proofsfile{%
      \noexpand\begin{axp@oldproof}%
    }%
    \VerbatimOut
  }
  {%
    \endVerbatimOut
    \immediate\write\axp@proofsfile{%
      \noexpand\end{axp@oldproof}%
    }%
    \noproofinappendix
  }
```

`proof` This environment either puts the proof in appendix, if we are after a repeated theorem without its proof, or inlines it otherwise.

```
\renewenvironment{proof}
  {%
    \iftoggle{axp@seenreptheorem}{%
      \appendixproof
    }{%
      \axp@oldproof
    }%
  }
  {%
    \iftoggle{axp@seenreptheorem}{%
      \endappendixproof
    }{%
      \endaxp@oldproof
    }%
  }
```

inlineproof
nestedproof

These two environments are synonyms for the original `proof` environment.

```
\let\inlineproof\axp@oldproof
\let\endinlineproof\endaxp@oldproof
\let\nestedproof\axp@oldproof
\let\endnestedproof\endaxp@oldproof
```

7.5.5 Section Management

axp@seccounter

Sequentially incremented for every section, used to create labels.

```
\newcounter{axp@seccounter}
```

\axp@sectitle

Saves the title of the last encountered section.

```
\def\axp@sectitle{}
```

\axp@section
\axp@@ssection
\axp@@section

This command behaves similarly to `\axp@oldsection`, except that it first tests whether a `\section` follows, and if so, does not produce anything. This is useful to avoid producing empty sections in the appendix. As usual, we have to process starred and unstarred version separately.

```
\def\axp@section{\@ifstar\axp@@ssection\axp@@section}
\def\axp@@ssection#1{%
  \@ifnextchar\section{}{\axp@oldsection*{#1}}%
}
\def\axp@@section#1{%
  \@ifnextchar\section{}{\axp@oldsection{#1}}%
}
```

\axp@oldsection
\section
\@section
\@@section

We redefine the `\section` command to create a label based on `axp@seccounter` and to store its title in `\axp@sectitle`. In order to support starred and unstarred versions, as well as the optional short-title argument, the intermediate macros `\@section` and `\@@section` are needed.

```
\let\axp@oldsection\section
\def\section{\@ifstar\@section\@@section}
\newcommand{\@section}[2][\relax]{\axp@@@section{*}{#1}{#2}}%
\newcommand{\@@section}[2][\relax]{\axp@@@section{}{#1}{#2}}%
\newcommand{\axp@@@section}[3]{%
  \global\def\axp@sectitle{#3}%
  \ifx\relax#2\relax
    \axp@oldsection#1{#3}%
  \else
    \axp@oldsection#1[{#2}]{#3}%
  \fi
  \addtocounter{axp@seccounter}{1}%
  \label{axp@s\roman{axp@seccounter}}%
}
```

\nosectionappendix

We remove the current section title, to indicate no section should be created in the appendix.

```
\newcommand{\nosectionappendix}{
```

```
    \global\def\axp@sectitle{}%
  }
```

`\axp@writesection` If `\axp@sectitle` is not empty, we create a new section in the appendix, referring to the main text section.

Here, we wrap `\ref{axp@si}` into `\axp@protectref@i`, in order to protect the label name from wrongly being converted to uppercase, e.g., in fancyhdr with `\pagestyle{fancy}`.

This macro is defined both in the `.aux` file (in order to ensure availability when typesetting the `\tableofcontents`), and immediately before typesetting the appendix section (to ensure availability in the `\section` command).

```
  \newcommand\axp@writesection{%
    \ifx\axp@sectitle\@empty
    \else
      \edef\axp@tmp{%
        \noexpand\global\noexpand\def
        \expandonce{\csname axp@protectref@\roman{axp@seccounter}\endcsname}{%
          \noexpand\ref{axp@s\roman{axp@seccounter}}%
        }%
      }%
      \immediate\write\@auxout{\expandonce\axp@tmp}
      \immediate\write\axp@proofsfile{%
        \expandonce\axp@tmp^^J%
        \noexpand\axp@section{%
          \noexpand\appendixsectionformat{%
            \protect
            \expandonce{\csname axp@protectref@\roman{axp@seccounter}\endcsname}%
          }{\expandonce\axp@sectitle}%
        }%
      }%
      \nosectionappendix
    \fi
  }
```

Finally, in a somewhat ad hoc manner, we disable the whole section management for `\tableofcontents`, which may be typeset using a section heading, but for which automatic section management does not make sense.

`\axp@oldtableofcontents` `\tableofcontents`

```
  \let\axp@oldtableofcontents\tableofcontents
  \def\tableofcontents{{\let\section\axp@oldsection\axp@oldtableofcontents}}
```

7.5.6 Append Compilation Mode

```
  \ifthenelse{\equal{\axp@appendix}{append}}{
```

`\axp@oldbibliography` `\bibliography` Thanks to bibunits's `\defaultbibliography` macro, we set the appendix bibliography source to be the same as that of the main text.

```
    \let\axp@oldbibliography\bibliography
```

```
    \renewcommand\bibliography[1]{%
      \defaultbibliography{#1}%
      \axp@oldbibliography{#1}%
    }
```

After the end of the main text, we add the appendix (after the command `\appendixprelim` is issued) within a `bibunit` environment so as to typeset a separate bibliography for the appendix (unless the `bibliography` option is set to `common`). There is an extra test to ensure an empty bibliography environment is not produced. The name of the bibliography is changed to `\appendixrefname`; in most document classes, it is called `\refname` but it is occasionally (`scrartcl`, `scrreprt`) called `\bibname`.

```
    \AtEndDocument{
      \appendixprelim
      \appendix
      \ifthenelse{\equal{\axp@bibliography}{separate}}{
      \begin{bibunit}[\appendixbibliographystyle]
      }{}
        \immediate\closeout\axp@proofsfile
        \input{\jobname.axp}
      \ifthenelse{\equal{\axp@bibliography}{separate}}{
        \ifdefined\refname
          \renewcommand{\refname}{\appendixrefname}
        \else\ifdefined\bibname
          \renewcommand{\bibname}{\appendixrefname}
        \fi\fi
        \let\axp@oldthebibliography\thebibliography
        \renewcommand\thebibliography[1]{%
          \ifx\relax#1\relax\else\axp@oldthebibliography{#1}\fi}
        \appendixbibliographyprelim
        \putbib
      \end{bibunit}
      }{}
    }
}{}
```

7.5.7 Class-Specific Behavior

We conclude with some class-specific behavior.

ACM Document Classes (old versions, till 2017)

```
\ifdefined\@acmtitlebox
```

We first redefine the `proofsketch` environment, which is used differently in the base class.

```
\renewenvironment{proofsketch}{\begin{axp@oldproof}[sketch]}{\end{axp@oldproof}}
```

We adjust the styling of theorems for the needs of apxproof.

```
\newtheoremstyle{mystyle}
```

```
    {6pt}
    {6pt}
    {\itshape}
    {10pt}
    {\scshape}
    {.}
    {.5em}
    {}
  \theoremstyle{mystyle}
```

\thebibliography
\refname
\appendixrefname

The section title of the bibliography is in uppercase in these document classes. In addition, the \thebibliography macro hard-codes twice the section title, so we un-hardcode it so that it can be modified in the appendix.

```
    \patchcmd{\thebibliography}{References}{\protect\refname}{}{}
    \patchcmd{\thebibliography}{References}{\protect\refname}{}{}
    \newcommand{\refname}{REFERENCES}
    \renewcommand{\appendixrefname}{REFERENCES FOR THE APPENDIX}

  \fi
```

ACM Document Classes (new version) Again, we adjust the styling of theorems for the needs of apxproof.

```
  \@ifclassloaded{acmart}{

  \newtheoremstyle{mystyle}
    {.5\baselineskip\@plus.2\baselineskip
      \@minus.2\baselineskip}
    {.5\baselineskip\@plus.2\baselineskip
      \@minus.2\baselineskip}
    {\@acmplainbodyfont}
    {\@acmplainindent}
    {\@acmplainheadfont}
    {.}
    {.5em}
    {\thmname{#1}\thmnumber{ #2}\thmnote{ {\@acmplainheadfont #3}}}
  \theoremstyle{mystyle}

  }{}
```

lipcs

```
   \ifdefined\lipics@opterrshort
```

\appendixbibliographyprelim

The default bibliography in the lipics document class formatting is not compatible with the alpha bibliography style. We fix this here.

```
    \renewcommand{\appendixbibliographyprelim}{%
      \global\let\@oldbiblabel\@biblabel
      \def\@biblabel{\hspace*{-2em}\small\@oldbiblabel}%
    }

  \fi
```

llncs

```
\@ifclassloaded{llncs}{
```

proofsketch We redefine the `proofsketch` environment, which is used differently in the base class.

```
  \renewenvironment{proofsketch}{\begin{axp@oldproof}[sketch]}{\end{axp@oldproof}}

}{}
%     \end{macrocode}
%    \begin{macrocode}
}
```

Change History

v1.0.0

General: Initial released version . . 1

v1.0.1

General: Prevent empty bibliography environment; fix typos 1

v1.0.2

`\thmhead`: Fix display of repeated theorem counter in some document classes 10

`axp@newtheoremrep`: Fix missing space between repeated theorem counter and theorem note 15

v1.0.3

`\appendixbibliographyprelim`: Support for lipics-v2016 21

General: Note on entire sections in appendix 2

`proofsketch`: Ignore spaces after beginning of Proof sketch . . . 10

v1.0.4

`\appendixprelim`: Configurable appendix style 10

`\axp@bibliography`: `bibliography` option 9

General: More faithful theorem style for ACM templates 20

More robust coherent styling of proof sketches 20

Re-establish custom proof environments 8

Show options commented on in margin and index 1

v1.0.5

General: Ability to specify a sectioning counter in newtheoremrep 2

Fix compilation of proofsketch environment in inline mode . . . 4

v1.0.6

`\axp@newtheorem`: Introduce intermediary command for theorem macro 10

`\axp@writesection`: Fix extraneous space after section number in appendix titles . . . 19

General: Better support of Springer document classes 11

Deal with document classes where the bibliography is called `\bibname` 20

Support of new ACM document class (`acmart.cls`) 21

`axp@newtheoremrep`: Better handling of note-free theorems in document classes that treat theorems differently when they have an empty note 14

Fix incorrect use of `\noexpand` in optional argument of macro environment 15

v1.1.0

`\appendixsectionformat`: Fix missing space in default

\appendixsectionformat . . . 10
\axp@proofsfile: Initialization deferred to \AtBeginDocument for compatibility with \dumped precompiled preambles (K. D. Bauer) 13
\axp@redefinelabels: Fix \label not being disabled in amsmath environments, where \label@in@display is used instead (K. D. Bauer) 11
\axp@repeqn: repeqn option 9
\axp@writesection: Make \axp@tmp wrapper more robust. Resolves issues from use of section title in fancyhdr, and in \tableofcontents (K. D. Bauer). 19
\section: Fix handling of fragile macros within section headings. See #22. 18
Rewrote definition of \section to enable optional argument. See #23. (K. D. Bauer) 18
\tableofcontents: Disable section management for table of contents 19
General: Added forward-link mechanism (K. D. Bauer) . . . 15

Index

Numbers written in italic refer to the page where the corresponding entry is described; numbers underlined refer to the code line of the definition; numbers in roman refer to the code lines where the entry is used.

Symbols

\@@axp@newtheorem 54, 94
\@@section 295
\@Opargbegintheorem 109
\@acmplainbodyfont 388
\@acmplainheadfont 390, 393
\@acmplainindent 389
\@acmtitlebox 365
\@auxout 321
\@axp@newtheorem 54, 94
\@biblabel 398, 399
\@bsphack 147
\@esphack 157
\@ifclassloaded 382, 402
\@ifnextchar 290, 293
\@ifpackageloaded 7
\@ifstar 288, 296
\@minus 385, 387
\@noligs 155
\@oldbiblabel 398, 399
\@oparg 55, 58
\@plus 384, 386
\@section 295
\@spopargbegintheorem 111
\@thmcounterend 110, 112
\@thmcountersep 108
\@upn 63

\␣ 35, 43, 51, 70, 110, 112

A

\appendix 344
appendix (option) *5*
\appendixbibliographyprelim *5*, 66, 359, 397
\appendixbibliographystyle *5*, 66, 346
\appendixprelim *5*, 66, 343
\appendixproof 127, 270
appendixproof (environment) *2*, 123, 252
\appendixrefname . *5*, 66, 352, 354, 377
\appendixsectionformat . . . *5*, 66, 325
\apx@oldamsthmendproof 10, 17
\apx@oldamsthmproof 9, 15, 16
\AtBeginDocument 61, 134, 138
\AtEndDocument 342
\axp@@@section 297, 298, 299
\axp@@section 288
\axp@@ssection 288
\axp@appendix 24, 28, 30, 32, 35, 75, 114, 211, 336

\axp@bibliography 25, 38, 40, 43, 345, 350
\axp@equation 163
\axp@equationx 163
\axp@forward 227
\axp@forward@link 217, 227
\axp@forward@setup 171, 246
\axp@forward@target 197, 239
\axp@newtheorem 54, 118, 168, 170
\axp@newtheoremrep . . 58, 115, 165, 165
\axp@newtheoremreptmp 54
\axp@oldbibliography 337
\axp@oldlabel . . . 76, 79, 80, 84, 87, 89
\axp@oldlabel@in@display 77, 83, 88, 90
\axp@oldproof . . 71, 141, 272, 282, 284
axp@oldproof (environment) 71
\axp@oldsection 143, 290, 293, 295, 335
\axp@oldtableofcontents 334
\axp@oldthebibliography . . . 356, 358
\axp@proofsfile 134, 139, 153, 188, 193, 204, 255, 262, 322, 348
\axp@redefinelabels 73, 120, 198
\axp@repeqn 26, 46, 48, 51, 173, 187, 203
\axp@rpcounter 162
\axp@seccounter 286
\axp@section 288, 324
\axp@sectitle . 287, 300, 310, 313, 328
\axp@seenreptheorem 161
\axp@tmp 315, 321, 323
\axp@with@forward 178, 180, 210
\axp@writesection . . 159, 186, 254, 312

B

\baselineskip 384, 385, 386, 387
\bfseries 97, 99, 102, 106
\bibliography 337
bibliography (option) *4*
\bibname 353, 354
\BODY 120, 178, 180, 185
\boolfalse 225
\booltrue 212

C

\clearpage 69
\closeout 348
\csdef 216
\csedef 247
\csletcs 214, 215, 223

D

\DeclareStringOption 24, 25, 26
\defaultbibliography 339

E

\endappendixproof 128, 277
\endaxp@oldproof 72, 142, 279, 283, 285
\endinlineproof 124, 283
\endnestedproof 126, 285
\endproof 10, 12, 17, 72, 124, 126, 128, 142
\endVerbatimOut 160, 261
environments:
appendixproof *2*, 123, 252
axp@oldproof 71
inlineproof *4*, 123, 282
nestedproof *6*, 123, 282
proof *3*, 138, 267
proofsketch *4*, 60
toappendix *1*, 129, 158
\errmessage 35, 43, 51
\expandonce . . . 317, 321, 323, 327, 328

F

\FV@DefineTabOut 152
\FV@DefineWhiteSpace 150
\FV@FontScanPrep 154
\FV@ProcessLine 153
\FV@Scan 156
\FV@Space 151
\FV@UseKeyValues 149
\FVB@VerbatimOut 146
\FVE@VerbatimOut 146

H

\hskip 110, 112
\hspace 399
\hyperlink 231
\hypertarget 241

I

\ifblank 247
\ifbool 229
\ifcsdef 222, 230
\ifcsname 240
\ifcsundef 213
\inlineproof 123, 282
inlineproof (environment) . *4*, 123, 282
\input 349
\item 110, 112
\itshape 97, 99, 102, 106, 370

L

\label 76, 78, 87, 89, 178, 180, 307

\label@in@display . . . 74, 77, 82, 88, 90
\labelsep 110, 112
\lipics@opterrshort 396

M

\message 29, 31, 33, 39, 41, 47, 49

N

\nestedproof 125, 284
nestedproof (environment) . *6*, 123, 282
\newbool 227
\newtheoremrep *2*, 54
\newtheoremstyle 367, 383
\noproofinappendix *6*, 129, 169, 249, 265
\nosectionappendix . . . *6*, 129, 309, 331

O

\onecolumn 69
\openout 136
options:
  appendix *5*
  bibliography *4*
  repeqn *5*

P

\pretocmd 169
\ProcessLocalKeyvalOptions 27
\proof . 9, 11, 16, 71, 123, 125, 127, 141
proof (environment) *3*, 138, 267
\proofsketch 403
proofsketch (environment) *4*, 60
\providecommand 74
\putbib 360

R

\ref 195, 318
\refname 351, 352, 377
repeqn (option) *5*

S

\scshape 372
\section 138, 290, 293, 295, 335
\setcounter 174, 189, 190, 205
\SetupKeyvalOptions 20
\small 399
\spnewtheorem 93, 97, 99, 102, 106

T

\tableofcontents 334
\theaxp@equation 190
\thebibliography 356, 357, 377
\theoremstyle 376, 394
\thmhead 61
\thmname 63, 393
\thmnote 64, 393
\thmnumber 63, 393
toappendix (environment) . . *1*, 129, 158
\togglefalse 250
\toggletrue 182
\trivlist 109, 111

U

\unexpanded 196
\upshape 106

V

\value 174, 189, 205
\VerbatimOut 159, 258

W

\write 139, 153,
188, 193, 204, 255, 262, 321, 322

References

[1] Leslie Lamport. *LaTeX: A Document Preparation System*. Addison–Wesley Pub. Co., Reading, MA, 1986.

A Proofs for Section 1 (Usage)

This content is in the appendix.

Proof. This proof is in the appendix. □

Foobar 2. *This foobar is repeated in the appendix.*

Proof. This is the proof of the repeated foobar. □

This is a citation in the appendix [Unk16].

References for the Appendix

[Unk16] Unknown. Proofs are hard, 2016.