

# PREPARING ARTICLES FOR COMPUTATIONAL COMPLEXITY

*User's manual*

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**Abstract.** This text describes the  $\text{\LaTeX}2_{\epsilon}$  document class `cc`, which is recommended for typesetting articles accepted for computational complexity.

**Keywords.**  $\text{\LaTeX}2_{\epsilon}$  document class, computational complexity.

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## 1. Submission

Submission of a manuscript implies

- that the work described has not been published before except possibly in conference proceedings; if the latter is the case, it must be clearly acknowledged in the submission and a clearly marked copy of the proceedings version should be sent as well (possibly by separate mail);
- that it is not under consideration for publication elsewhere;
- that its eventual publication has been approved by all coauthors;

- that, if and when the manuscript is accepted for publication, the authors agree to automatically transfer the copyright to the publisher; and
- that the manuscript will not be published elsewhere in any language without the consent of the copyright holder.

Manuscripts must be in English. Authors should send a PostScript™ file plus a short cover email, giving the contact author's name and address, either to the Editor-in-Chief or to one of the Editors. Submissions can also be sent by ordinary mail to the Editor-in-Chief.

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Information about computational complexity can be found at the journal's homepage <http://www-math.upb.de/~aggathen/cc/>. There you also find a pointer to the publisher's page for computational complexity: <http://www.linkspringer.com/?genre=article&issn=1016-3328>, which contains the current editorial board, information about subscription and prices, and more.

The following instructions only apply to final versions of *accepted* manuscripts for computational complexity. For a submission, you may follow these instructions or use your own setup and submit your article as a PostScript™ file or a typeset manuscript.

computational complexity expects authors of articles accepted for publication to submit camera-ready copy as a L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> source file. If that cannot be provided, computational complexity will typeset the article. The editorial decision to accept or reject a manuscript is independent of the technology (computer or typewriter) used to prepare it.

## 2. Submission of the final version

Camera-ready copy can be produced with L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> using the document class `cc` which is described below. All necessary files can be obtained in the WWW, see <http://www-math.upb.de/~aggathen/cc/> for the necessary files and installation instructions. The older L<sup>A</sup>T<sub>E</sub>X style file `cc.sty` should not be used anymore. There is no corresponding plainT<sub>E</sub>X style file.

**2.1. Combining several files into one.** When your article is typed, it might be distributed over several files. But the  $\text{\LaTeX} 2_{\epsilon}$  source file that you submit must consist of exactly *one* file. You may, however, use the  $\text{\LaTeX} 2_{\epsilon}$  environments `filecontents` and `filecontents*` to incorporate the contents of other  $\text{\LaTeX}$  or ASCII(!) files, respectively, into the main  $\text{\LaTeX} 2_{\epsilon}$  source file. These two environments can only be used *before* the `\documentclass` command. For example, PostScript<sup>TM</sup> files can be handled this way. (Note: it seems to be a feature that there must be a line break just after the environment's argument, in particular, a comment can only start on the following line.)

```
\begin{filecontents}{section1.tex}
  \section{First section}
  ... \cite{Euclidean} wrote ...
\end{filecontents}
\begin{filecontents*}{picture.ps}
%!PS-Adobe-2.0 EPSF-2.0
...
\end{filecontents*}
\begin{filecontents*}{myrefs.bib}
@book{Euclidean,
author = {Euclidean},
title = {Elements},
year = {about 300 BC},
}
\end{filecontents*}
\begin{filecontents}{main.bbl}
\begin{thebibliography}{1}

\bibitem[{Euclidean(about 300 BC)}]{Euclidean}
\textsc{Euclidean} (about 300 BC).
\newblock \emph{Elements}.

\end{thebibliography}
\end{filecontents}

\documentclass{cc}
\usepackage{graphics}
% ...
\begin{document}
\includegraphics{picture.ps}
\input{section1}
\bibliography{journals,myrefs}
\end{document}
```

**2.2. Testing your final file.** Once your source file is prepared like this, send it via email to `cctest@upb.de`. It will then automatically be processed in

a defined setup: `latex`, `bibtex`, `latex`, `latex`, `dvips` are executed unless an error occurs. (Of course, `latex` calls  $\text{\LaTeX} 2_{\epsilon}$ .) The log files and the resulting PostScript<sup>TM</sup> file will be sent back to you. (This usually takes only a couple of minutes.) Verify whether everything is ok. If so, submit your  $\text{\LaTeX}$  file as the final version to `cc@upb.de`. Mail sent to `cctest@upb.de` is not read by anyone; only the software described above is automatically executed.

### 3. Using the document class `cc`

The freeware document class `cc` is intended for writing articles for **computational complexity**. But you may, of course, also use this class for your other work. For this purpose, several features of this class can be turned on or off. (Using `noccpublish` turns off the special requirements for **computational complexity**. Furthermore, this document class can also be used as a package if desired. Try `\usepackage{cc-cls}`. Thus you can, for example, combine it with the  $\text{\LaTeX} 2_{\epsilon}$  document class `book`.)

Before giving any description we would like to stress a major difference from standard  $\text{\LaTeX} 2_{\epsilon}$ : References and citations are, by default, more informative. We recommend this style. See below for details. (The new features can be turned off by options to `\documentclass`, see p. 15: `noprefixes`, and `cccite` or `nonatbib`, respectively.)

After the optional *secondary file contents*, the standard structure of a **computational complexity** article starts with `\documentclass{cc}` and continues with optional personal declarations, information concerning author, title and content, and finally the article text including acknowledgments and references. The overall structure of a typical  $\text{\LaTeX} 2_{\epsilon}$  file is shown in Table 3.1. On **computational complexity**'s homepage you can also find a template file `cctemplate.tex` reflecting this.

Most *personal macros and packages* can be freely used. If your file is processed successfully when sent to `cctest@upb.de`, then your macros and the packages you used should be ok.

The *contact email address* is the email address of the contact author. It is required for **computational complexity** to facilitate communication between the publisher and the authors. The author received a message acknowledging receipt of the manuscript, with the *received date*. The *title* should be broken into balanced lines by `\\` if necessary. The *author list* contains the names and addresses of the authors separated by `\and`, each address consisting of a line with full author name and some address lines separated by `\\`. There should be no font or size changing commands. If an address line is very long and not

<i>&lt;secondary file contents&gt;</i>	<code>\author{</code>
<code>\documentclass{cc}</code>	<code>First A. Author\\</code>
<i>&lt;personal macros and packages&gt;</i>	<code>Department of Mathematics\\</code>
	<code>University of Somewhere\\</code>
	<code>Somewhere, USA 99999\\</code>
<code>%\ccpublish{}{}{}{}</code>	<code>\email{faa@ford.somewhere.edu}\\</code>
<code>\contact{&lt;contact email address&gt;}</code>	<code>\homepage</code>
<code>\received{&lt;received date&gt;}</code>	<code>{http://www.somewhere.edu/~faa/}</code>
<code>\title{&lt;title&gt;}</code>	<code>\currentaddress</code>
<code>\author{&lt;author list&gt;}</code>	<code>Somewhere Sunny\\</code>
	<code>SAMOA\\</code>
<code>\begin{abstract}</code>	<code>\email{faa@sunny.samoa.gov}</code>
<i>&lt;abstract&gt;</i>	<code>\and</code>
<code>\end{abstract}</code>	<code>Second B. Author\\</code>
	<code>Faculty of Computer Science\\</code>
<code>\begin{keywords}</code>	<code>Anyplace College\\</code>
<i>&lt;keywords&gt;</i>	<code>Anyplace, CANADA Z9Z 1X1\\</code>
<code>\end{keywords}</code>	<code>\email{author@pearson.anyplace.edu}</code>
	<code>\otheraddress</code>
<code>\begin{subject}</code>	<code>Private address of</code>
<i>&lt;subject classification&gt;</i>	<code>\textsc{Second B. Author}:\\</code>
<code>\end{subject}</code>	<code>Green Road\\</code>
	<code>Notown, MOON\\</code>
<code>\begin{document}</code>	<code>\and</code>
	<code>Third C. van~Author\\</code>
<i>&lt;article text&gt;</i>	<code>Electrical Engineering Division \\</code>
	<code>Institute of Nowhere\\</code>
<code>\begin{acknowledge}</code>	<code>Nowhere, ANTARCTICA\\</code>
<i>&lt;acknowledgments&gt;</i>	<code>\email{tcauthor@penguin.nowhere.ant}</code>
<code>\end{acknowledge}</code>	<code>}</code>
<code>\bibliography{&lt;bibliography files&gt;}</code>	
<code>\end{document}</code>	

Table 3.1: Typical structure of the L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> source and an example of an `\author` declaration

nicely broken, `\newline` forces a break. Note the use of the tilde (~) in the name of the last author. It guarantees that `van~Author` is considered as her last name. Email and home page can be given as last line(s) of an address using the commands `\email{<email-address>}` and `\homepage{<www-address>}`. To give a different current address, use `\currentaddress` to separate the lines of the latter from the standard address. It produces a new address block en-

titled `Current address of \textsc{<present author name>}`:`\`. The command `\otheraddress` can be used to specify another address block for the present author without such a heading. An `<abstract>`, `<keywords>` and a `<subject classification>` are required for articles in **computational complexity**. The `<abstract>` should summarize, in less than 150 words, the context, content and conclusions of the paper. It should not contain any references or citations. (If you insist on them, you must use `\Abstract{<abstract>}` instead of the `abstract` environment.) List four to six `<keywords>` characterizing the article. A `<subject classification>` should be given according to the Mathematical Subject Classification 2000 (MSC 2000), which can be found in the Internet, see **computational complexity**'s homepage <http://www-math.upb.de/~aggathen/cc/>.

The `<article text>` can be structured by `\section`, `\subsection`, and `\subsubsection`. Use `\` to split long headings. A table of contents should normally *not* be used. You can use diverse theorem and proof environments described below. Finally your text might end with `<acknowledgments>` including funding information, references to previous versions, and thanks for help.

**3.1. Theorems and proofs.** Typing theorems is much easier than finding or proving them. We give some examples.

```
\begin{theorem}\label{thm1}          THEOREM 3.1. This is a very simple theo-
  This is a very simple theorem.      rem.
\end{theorem}
```

This environment supports an optional argument. Often it is used to supply source information:

```
\begin{theorem}[\cite{knu84}]        THEOREM 3.2 (Knuth 1984). This is a the-
  \label{thm2}                       orem by somebody else.
  This is a theorem
  by somebody else.
\end{theorem}
```

In rare occasions, you might prefer an unnumbered theorem:

```
\begin{theorem*}                     THEOREM. This theorem is so important
  This theorem is so important        that it has no number.
  that it has no number.
\end{theorem*}
```

Of course, we are not restricted to theorems:

```

\begin{lemma}
  \label{lemma}
  We can also have lemmas.
  \begin{enumerate}
    \item\label{lemma:1}
      It has two claims.
    \item\label{lemma:2}
      And it shows how lists
      are used, formatted
      and referenced.
    \end{enumerate}
  \end{lemma}

```

LEMMA 3.3. *We can also have lemmas.*

(i) *It has two claims.*

(ii) *And it shows how lists are used, formatted and referenced.*

You can replace `theorem` by `lemma` to obtain lemmas instead of theorems in the above examples. Further, you can use the theorem-like environments listed in Table 3.2. Each of these environments has a starred form which produces

environment	title	environment	title
<code>answer</code>	Answer	<code>note</code>	Note
<code>assumption</code>	Assumption	<code>observation</code>	Observation
<code>claim</code>	Claim	<code>openquestion</code>	Open Question
<code>conjecture</code>	Conjecture	<code>problem</code>	Problem
<code>convention</code>	Convention	<code>proposition</code>	Proposition
<code>corollary</code>	Corollary	<code>question</code>	Question
<code>definition</code>	Definition	<code>remark</code>	Remark
<code>example</code>	Example	<code>result</code>	Result
<code>exercise</code>	Exercise	<code>theorem</code>	Theorem
<code>fact</code>	Fact	<code>thesis</code>	Thesis
<code>hypothesis</code>	Hypothesis	<code>warning</code>	Warning
<code>lemma</code>	Lemma	<code>namedtheorem</code>	<i>⟨user specified⟩</i>
<code>notation</code>	Notation		

Table 3.2: Defined theorem-like environments

no number. Moreover, you can give examples, and continue them.

```

\begin{example}
  \label{myfirst}
  Or you give an example.
\end{example}
\begin{contexample}{myfirst}
  Sometimes it is nice
  to continue an example.
\end{contexample}

```

EXAMPLE 3.4. Or you give an example.  $\diamond$

EXAMPLE 3.4 CONTINUED. Sometimes it is nice to continue an example.  $\diamond$

Note that an example is always terminated by a lozenge ( $\diamond$ ). You can redefine

`\eoesymbol` if you prefer another (or no) symbol. The other theorem-like environments can be continued in this way:

```
\begin{continued}{lemma}          LEMMA 3.3 CONTINUED. This continues  
  This continues the lemma.       the lemma.  
\end{continued}
```

All this is not enough? Ok, we also support a theorem-like environment with a name that you can choose yourself.

```
\begin{namedtheorem}{Fundamental  FUNDAMENTAL THEOREM 3.5. This is a  
theorem}                        simple named theorem with a number.  □  
  \label{FunThm}  
  This is a simple named  
  theorem with a number.\qed      FUNDAMENTAL LEMMA. This is a simple  
\end{namedtheorem}              named theorem without number.  
\begin{namedtheorem*}{Fundamental  
lemma}  
  \label{FunLemma}  
  This is a simple named  
  theorem without number.  
\end{namedtheorem*}
```

Note that the references to the labels are “Fundamental theorem 3.5” and “Fundamental lemma”, respectively.

Typing proofs is even easier:

```
\begin{proof}                     PROOF.  This is a very simple proof.  □  
  This is a very simple proof.  
\end{proof}
```

The default `qed` symbol is an open square ( $\square$ ). Sometimes, not a proof but only an outline of a proof or a sketch is given. This can be done as follows:

```
\begin{namedproof}               OUTLINE OF PROOF (following THIRD).  
  {Outline of proof}             This is a named proof. Its title claims that  
  [following \textsc{Third}]      this is only an outline.  □  
  This is a named proof.  
  Its title claims that this  
  is only an outline.  
\end{namedproof}
```

Typesetting of proofs should only be done with these proof environments. There is one further problem. Sometimes a proof (or an example) terminates with a list, an equation, or some other similar environment. Then the end of proof mark often seems to be placed incorrectly. If so, place `\qed` at the end of this environment. Usually this fixes this problem. (If not, maybe you can spend a few extra words at the end of your proof?)

Typing equations can be done as usual. But note that `amsmath` provides a lot of additional equation-like environments, see *AMS* (1996) or Chapter 8 in Goossens *et al.* (1995).



**3.2. Labels and references.** Labels and references, as we use them, have been known since the time  $\text{\LaTeX}$  was born. But note that references using the document class `cc` are more informative than usual. For example, `\ref{myfirst}` now produces: Example 3.4. In the standard setup, you would have obtained: 3.4. If you use the document class option `noprefixes`, `\ref` behaves as usual. We recommend to adopt the new style. You can access the bare (unprefixed) form with `\bare\ref{myfirst}` unless you issue the document class option `nobare`. (The latter might be necessary to save space.)

We have seen two theorems:`\`  
`\ref{thm1}` and `\bare\ref{thm2}`.      We have seen two theorems:  
Theorem 3.1 and 3.2.

Further, list items in theorem-like environments produce either only the item number or the theorem reference plus the item number, depending on whether the reference occurs near the theorem or not. (Near means, after this theorem (or lemma, ...) and before the next theorem or equation.) For example, `\ref{lemma:1}` here produces Lemma 3.3(i). You can force the short form: `\short\ref{lemma:1}` yields (i), or the whole form: `\whole\ref{lemma:1}` yields Lemma 3.3(i). If you issue the document class option `notheoremitemprefixes`, subitems are referenced as in standard  $\text{\LaTeX} 2_{\epsilon}$ : you always obtain the short form.

**3.3. Bibliography and citations.** The most comfortable citation scheme comes with the `natbib` package. By default this is loaded. Let's begin with an example:

Don `\citeauthor{knu84}`'s design  
of `\TeX{}`, as described in The  
`\TeX{}`book `\citep{knu84}`,  
enabled the typesetting of texts  
containing complicated formulas.  
In `\citet{knu86b,knu86c,%`  
`knu86d,knu86e}` the  
underlying programs and fonts  
are collected. On this basis,  
`\LaTeX{}` and `\LaTeXe{}` were  
developed, see `\citet{goomit95,%`  
`lam94,kopdal99}`.  
(Graphics can be included in many  
ways, see `\citealp*{goomit96g}`.)

Don Knuth's design of  $\text{\TeX}$ , as described  
in The  $\text{\TeX}$ book (Knuth 1984), enabled the  
typesetting of texts containing complicated  
formulas. In Knuth (1986a,b,c,d) the un-  
derlying programs and fonts are collected.  
On this basis,  $\text{\LaTeX}$  and  $\text{\LaTeX} 2_{\epsilon}$  were de-  
veloped, see Goossens *et al.* (1995); Kopka  
& Daly (1999); Lamport (1994). (Graphics  
can be included in many ways, see Goossens,  
Mittelbach & Rahtz 1996.)

The command `\citet` (equivalent to `\cite`) is used for textual citations and the command `\citep` for parenthetical citations. Multiple citations are simply listed in one command. The alternative commands `\citealt` and `\citealp`

produce the same output but without parentheses. This avoids nested parentheses in text which is already inside parentheses. Note that the years are in parentheses in the running text, but without parentheses if the reference itself is in parentheses. Several papers in the same year are distinguished as “Knuth (1986d), Knuth (1986c)”. Further examples:

<code>\citet{knu84}</code>	$\Rightarrow$ Knuth (1984)
<code>\citet{knu84,knu86b,knu86c,knu86d,knu86e}</code>	$\Rightarrow$ Knuth (1984, 1986a,b,c,d)
<code>\citep{knu84}</code>	$\Rightarrow$ (Knuth 1984)
<code>\citealt{knu84}</code>	$\Rightarrow$ Knuth 1984
<code>\citealp{knu84}</code>	$\Rightarrow$ Knuth 1984
<code>\citeauthor{knu84}</code>	$\Rightarrow$ Knuth
<code>\citeyear{knu84}</code>	$\Rightarrow$ 1984
<code>\citet{goomit95}</code>	$\Rightarrow$ Goossens <i>et al.</i> (1995)
<code>\citet*{goomit95}</code>	$\Rightarrow$ Goossens, Mittelbach & Samarin (1995)
<code>\citeauthor*{goomit95}</code>	$\Rightarrow$ Goossens, Mittelbach & Samarin

If the first author’s name contains a *von* part, such as “della Robbia”, then `\citet{dRob98}` produces “della Robbia (1998)”, even at the beginning of a sentence. One can force the first letter to be in upper case with the command `\Citet` instead. Other upper case commands also exist. More features are documented with the `natbib` package, see Daly (1999).

Bibliography is best produced using `BIBTEX`. See Kopka & Daly (1999), Lamport (1994), Goossens *et al.* (1995) or Patashnik (1988) for information about using `BIBTEX`. Then `\bibliography{<bibliography files>}` produces the bibliography. (The `\bibliographystyle` is automatically issued by the class, so you need not do this.) In this case, the `BIBTEX` file(s) and the `.bbl` file should be embedded in the `LATEX 2ε` source file using the `filecontents` environment (see above).

The `BIBTEX` file `journals.bib`, available on computational complexity’s homepage <http://www-math.upb.de/~aggathen/cc/>, contains macros for a number of journals and conference proceedings. If in your document you have `\bibliography{journals,myrefs}`, then an entry `journal = FOCS99`, in your file `myrefs.bib` will produce: ‘Proceedings of the 40th Annual IEEE Symposium on Foundations of Computer Science, New York City NY’ when `BIBTEX` is run. (Note that `journals` must precede your own bibliography file!) Since this will be updated only sporadically, the latest conference proceedings may be missing here.

**3.3.1. ... without natbib.** If the package `natbib` is not installed on your system for some obscure reason, you can issue the option `cccite` to switch to

the old `computational complexity` style of referring to the bibliography. This still works but is not recommended any more.

Don `\citeauthor{knu84}`'s design of `\TeX{}`, as described in The `\TeX{}`book `\parencite{knu84}`, enabled the typesetting of texts containing complicated formulas. In `\citemul{knu86b,knu86c,%knu86d,knu86e}` the underlying programs and fonts are collected. On this basis, `\LaTeX{}` and `\LaTeXe{}` were developed, see `\cite{goomit95}`, `\cite{lam94}`, `\cite{kopdal99}`. (Graphics can be included in many ways, see `\shortcite{goomit96g}`.)

Don Knuth's design of `\TeX`, as described in The `\TeX`book (Knuth 1984), enabled the typesetting of texts containing complicated formulas. In Knuth (1986a,b,c,d) the underlying programs and fonts are collected. On this basis, `\LaTeX` and `\LaTeXε` were developed, see Goossens *et al.* (1995), Lamport (1994), Kopka & Daly (1999). (Graphics can be included in many ways, see (Goossens *et al.* 1996).)

Using numbered references are used if the references give no additional information. (As most hand-made references do.) This is not recommended:

Don Knuth's design of `\TeX{}`, as described in The `\TeX{}`book `\cite{knu84}`, enabled the typesetting of texts containing complicated formulas. In `\cite{knu86b,knu86c,%knu86d,knu86e}` the underlying programs and fonts are collected. On this basis, `\LaTeX{}` and `\LaTeXe{}` were developed, see `\cite{goomit95,%lam94,kopdal99}`. (Graphics can be included in many ways, see `\cite{goomit96g}`.)

Don Knuth's design of `\TeX`, as described in The `\TeX`book [5], enabled the typesetting of texts containing complicated formulas. In [6–9] the underlying programs and fonts are collected. On this basis, `\LaTeX` and `\LaTeXε` were developed, see [4, 10, 11]. (Graphics can be included in many ways, see [3].)

Note that only `\cite` makes sense here! Although this is acceptable, the first style is preferred since it is more informative.

**3.4. Mathematical typesetting à la `amsmath`.** We recommend to use the features provided by `amsmath`, `amsmath`, and `amssymb`. By default the class already loads these packages. For example, the `gather` environment allows you to combine several equations into one, `gather*` produces no numbers. The `align` or `align*` environments are similar to `eqnarray` but you only need one ampersand `&`. Other than `eqnarray`, `align` and all other `amsmath` environments take care of the position of the number: there will be no overlap between

number and formula! The `multline` or `multline*` environment allows you to type very long equations, the first line is flushed left, the last line is flushed right and all others are centered. The `alignat` or `alignat*` environment allows you to put two or more equations on a line, aligned with those on the other lines.

See *AMS* (1996) or Chapter 8 in the *L<sup>A</sup>T<sub>E</sub>X* companion (Goossens *et al.*, 1995) for a complete description. But note that `amsthm` is not compatible with the `cc` class and must not be used. (The same holds for its derivative `apthm`.)

### 3.5. Reminders.

- The following items tend to be overlooked:

- email address of contact author,
- key words,
- subject classification,
- received date.

Please make sure you have filled them appropriately.

- Manuscripts are in *(American) English*. Authors are encouraged to have their contribution checked for *grammar*, and to use a spelling checker. We emphasize that *American spelling* should be used.
- Use `\hyphenation{<hyphenation exceptions>}` or `\-` if words are not correctly hyphenated.
- *Abbreviations* should be spelled out in full when first used. (With *L<sup>A</sup>T<sub>E</sub>X*, try the package `acronym`.)
- Non-negative *integers* up to twelve should usually be spelled out.
- *Funding information* and help from friends and referees go into the acknowledgments section.
- *Appendices* should not be used.
- Read your `.log` file carefully. There should be no `Overfull \hbox`, and certainly no visible one (more than `1pt`). If necessary, reword the text. (Sometimes `\begin{sloppypar} ... \end{sloppypar}` or local use of `\sloppy`, `\tolerance=<number>`, `\emergencystretch=<dimension>` help, see Goossens *et al.* (1995).)

- *Blank (redundant) spaces* should be minimized by careful arrangement of tables and figures.
- *Avoid starting* a sentence with a symbol.
- It is best to *avoid footnotes*.
- *Figures and tables* are to be inserted in the text nearest their first reference. They should be arranged so as not to cause an excessive amount of blank space on the remainder of the page.
- Goossens *et al.* (1996) describe various ways to include *pictures* in  $\text{\LaTeX} 2_{\epsilon}$ . They also mention how to scale pictures up or down, which can be used for fine tuning and to avoid redundant white space. (Try to stick to `\includegraphics{⟨PostScript file⟩}` and `\input{⟨gnuplot  $\text{\LaTeX}$  file⟩}`.)  
Alternatively, original India ink drawings are possible. Please send one set of originals which must be clear and clean. Ensure that the figures (including letterings and numbers) are large enough to be clearly seen after reduction to 86%.
- Recall that  $\text{\LaTeX}$  has tools to build *lists*, the environments `itemize` and `enumerate` are the most frequent. Please, use them!  
Note that a list in a theorem is numbered differently than outside.
- *Font selection* in  $\text{\LaTeX} 2_{\epsilon}$ 's new font selection scheme (nfss) should be done using the commands

`\emph{...}, \texttt{...}, \textbf{...},`  
`\textsf{...}, \textsc{...}, \textrm{...},`

and so on. Usually, you should only use the first one. In any case, try to use them as rarely as possible! In math mode there are similar commands. Note that `\mathbb{⟨letter(s)⟩}` produces blackboard bold letters and `\mathcal{⟨letter(s)⟩}` produces calligraphic letters. For mathematical operators you should not use font selection but `\operatorname{⟨name⟩}`.

- Normally, you should not at all be concerned about *line or page breaks*. Also, *vertical space* should be correctly adjusted by the document class. Use the corresponding commands only if no other solution is possible. If you need to use `\` in plain text, you probably did something wrong.

**3.6. Commands for the journal editor and publishers.** The journal editor and publishers will insert the publishing data. The declaration

`\ccpublish{\year}{\volume}{\number}{\first page}`

will be inserted next to author and title information. Further, the commands `\electronic` and `\printed` switches the ISSN to the electronic or printed version, respectively.

**3.7. Disclaimer.** The macros are not guaranteed to be free of errors, and any bugs, inconsistencies, and suggestions for further improvement or other comments should be reported to `cc@upb.de`.

## 4. Quick upgrade: from bare L<sup>A</sup>T<sub>E</sub>X to cc

Replace your `\documentclass{...}` command with the line

`\documentclass[nonatbib,noprefixes]{cc}`

and adjust author, title, keywords and subject classification according to Table 3.1 (page 5). (In particular, all this information must appear before the `\begin{document}`.) The title may be too long for the running head. You need to supply `\titlehead{\short title}` then.

If there are any `\newtheorem` commands then turn them off and use the cc theorem environments described in Section 3.1. (Note that there is an environment `namedtheorem` for theorem-like environments with unforeseen names. You can also use this in a `\newenvironment` definition if necessary.) If there are definitions for proofs or qed signs then turn them off, too; the cc class provides these things.

Optional: For better readability you are asked to switch to the new citation scheme. To do so: add your `.bib`-file, throw away your handwritten environment `thebibliography` and the command `\bibliographystyle` if present, and replace it with `\bibliography{\name of your .bib-file}`. Then run `latex` twice and adjust the text at the citation points.

## 5. Make your document portable

In order to make your cc source file portable to persons who did not yet install the cc class, include the file `cc-cls-inline.tex`. This file can be found on the journal's homepage <http://www-math.upb.de/~aggathen/cc/>. Please do not forget to remove the following changes prior to sending your file to computational complexity, it will have no effect there. You have two options:

1. Simply include the entire file `cc-cls-inline.tex` in your file just before the `\documentclass` command. This has the drawback that your personal texts starts only after many lines irrelevant to you.
2. Insert your file in the following framework:

```
\newif\ifcc\IfFileExists{cc.cls}{\cctrue}{\ccfalse}\ifcc

%% Include your document here
%% (formatted as described in this documentation or
%%  sketched by the template file cctemplate.tex).

\else

%% Include cc-cls-inline.tex here.

\typeout{Please call latex again.}
\makeatletter\expandafter\@@end
\fi
```

This has the advantage that the cc stuff is at the end. The drawback is that you need to call L<sup>A</sup>T<sub>E</sub>X once more.

## 6. Commands

`\documentclass[<options>]{cc}`

Possible *<options>* are:

- any option from the article document class. (a4paper, a4paper, b5paper, letterpaper, legalpaper, executivepaper, landscape, 10pt, 11pt, 12pt, one-side, twoside, draft, final, titlepage, notitlepage, onecolumn, twocolumn, leqno, fleqn, openbib, though not all of them might produce nice results.) Note that all the *\*paper* options invoke the option `nocctextarea`, you need to add `cctextarea` after the *\*paper* option to get the same text area as in computational complexity then.
- any option from the  $\mathcal{A}\mathcal{M}\mathcal{S}$  packages (if they are not disabled by `noams`). (intllimits, nointlimits, sumlimits, nosumlimits, namelimits, nonamelimits, leqno, reqno, centertags, tbtags, cmex10, fleqn.)

- `localnumbering`, `longarticle` (default): theorem and equation numbering is local to each section, e.g. Theorem 3.4.
- `globalnumbering`, `shortarticle`: theorem and equation numbering is global, e.g. Theorem 17.
- `ccpublish` (default): requirements as for publication in computational complexity.
- `noccpublish`: `\contact`, `abstract`, `keywords` and `subject` are optional now.

Further, the following *options* are available. They are mainly intended to deactivate certain standard features of the class, in cases where these cause trouble.

- `ams` (default): use the  $\mathcal{AMS}$  packages `amsmath`, `amsfonts`, `amssymb`.
- `noams`: do not use the  $\mathcal{AMS}$  packages.
- `cclayout`, `nocclayout` turn the computational complexity layout on or off.
- `cctextarea`, `nocctextarea` turn the computational complexity text area on or off. They are only effective with `cclayout`.
- `noothermargins`, `classicalmargins`, `printmargins`, `balancedmargins`: Choose margin mode. `noothermargins` leaves the margins alone, `classicalmargins` leaves the outer margin but fits the inner one to paper and text widths, `printmargins` puts 5mm to the outer edge, `balancedmargins` makes both margins equal.
- `autotitle` (default): at `\begin{document}` the title is generated, and at `\end{document}` the receipt information and affiliations are generated.
- `noautotitle`: `\maketitle` and `\makeendtitle` must be explicitly written.
- `ccsectioning` (default): use centered section headings and in-line subsection and subsubsection headings.
- `noccsectioning`: use section, subsection, subsubsection, paragraph, subparagraph headings as with the `article` document class.
- `natbib` (default): use the citation scheme provided by the `natbib` package by Patrick W. Daly, the options `sort&compress` (default), `sort` and `nosort` decide whether multiple citations are sorted or not (compression only affects numerical citations).



- `cccite`: use the (old) author-year citation scheme of computational complexity.
- `nocccite`, `nonatbib`: do neither use the `natbib` nor the computational complexity citation scheme.
- `onecolumnbibliography` (default), `twocolumnbibliography`: With these options you can choose one or two columns for the bibliography.
- `cctheorems` (default): theorem like environments are defined as described.
- `nocctheorems`: theorem like environments are *not* defined at all.
- `prefixes` (default): references to theorems, equations, and so on, come with prefixes, e.g. `\ref{lemma}` produces ‘Lemma 3.3’ rather than only ‘3.3’,
- `noprefixes`: references behave as in standard  $\text{\LaTeX} 2_{\epsilon}$ ,
- `bare` (default): `\label` produces two labels instead of one, a long form for `\ref` and a short form for `\bare\ref`,
- `nobare`: `\label` works as usual, `\bare\ref` is equivalent to `\ref` (but gives a warning),
- `theoremitemprefixes` (default): references to subtopics of a theorem (or lemma ...) consist of the theorem reference and the item reference, for example, `\ref{lemma:2}` produces ‘Lemma 3.3(ii)’. In fact, between Lemma 3.3 and the following theorem or equation (Example 3.4 in our case) you would have obtained ‘(ii)’. This short form can be forced by `\short\ref{lemma:2}`. You can also force the whole form by `\whole\ref{lemma:2}`.
- `notheoremitemprefixes`: with this option you always get the short form.
- `separateequationcounting`: Do not count equations together with theorems, lemmas, ...
- `noseparateequationcounting` (default): Count equations together with theorems, lemmas, ...
- `ccalgorithms` (default): Load the algorithms stuff.
- `nocalgorithms`: Do not load the algorithms stuff.

And finally there are some options for font, input and multilingual support.

- `OT1` (default): use the font encoding scheme OT1 (this is standard with  $\text{\LaTeX}$ ).

- **T1**: use the new font encoding scheme T1 (256 characters per font instead of 128).
- **nolatin1** (default): do not use the input encoding scheme latin1 (this is standard with L<sup>A</sup>T<sub>E</sub>X).
- **latin1**: use the input encoding scheme latin1 (so Umlaute, äöü, and so on can be typed in literally).
- **nobabel** (default): do not use **babel** for multilingual support.
- **babel** (default): load **babel** for multilingual support (at an appropriate place, i.e. before **inputenc**), required languages must be included as options to the **\documentclass**.
- **multilingual**: this is an abbreviation for **T1**, **latin1** and **babel**.
- **nomultilingual**: this is an abbreviation for **OT1**, **nolatin1** and **nobabel**.

**\contact**{*<contact email address>*}

Preamble command to specify the email address of the contact author. This is required for publications in **computational complexity**.

**\received**{*<received date>*}

Preamble command to declare the received date of the manuscript. Use the format 8 August 2008.

**\author**{*<author list>*}

Preamble command to specify the authors and their addresses. Different authors are separated by **\and**. If you are not writing for **computational complexity** footnotes can be produced by **\thanks**{*<text>*}. If an author has a different current address, use **\currentaddress**. For an other type of other address, use **\otheraddress** followed by a line like **Guest address of \textsc{<author name>}**. Use the macros **\email**{*<email-address>*} and **\homepage**{*<www-address>*} to specify the email address and home page, respectively. The combination of these things can be seen best in the example in Table 3.1.

Note that from this declaration also the list of authors in the title and the short list of authors for the running head is derived. Usually, the automatism should work well. If not (maybe the authors' names are very long), you can use **\authorhead**{*<last name list>*} to specify the author list for the running head. Similarly, you can use **\authorlist**{*<name list>*} if the the automatic extraction of the author names for the title does not work as expected.

`\title{title}`

Preamble command to specify the title. If the title is not broken nicely, you can use `\\` to improve line breaking. Long titles do not fit into the running head. In this case please specify a shorter version using `\titlehead{short title}`.

`\subtitle{subtitle}`

`\version{version}`

These preamble command allows to insert, e.g., ‘Preliminary version’ under the title.

`\date{date}`

Preamble command, default is `\today`. This date is *not* used when the article is published in *computational complexity*.

`\begin{abstract} text \end{abstract}`

Preamble environment to specify the abstract. If the abstract contains any `\ref` or `\cite` this does not work. Try to avoid it. If you cannot avoid it use `\Abstract{text}`.

`\begin{keywords} list of keywords \end{keywords}`

Preamble environment to specify keywords.

`\begin{subject} subject classification \end{subject}`

Preamble environment to specify the subject classification.

`\begin{acknowledge} acknowledgments \end{acknowledge}`

Environment for acknowledgments. Funding information can also be included here.

`\bibliography{list of bibliography files}`

Command to produce the bibliography from the *list of bibliography files* using `BIBTEX`.

`\begin{theorem}[citation] theorem text \end{theorem}`

```
\begin{theorem*}[\langle citation \rangle] \langle theorem text \rangle \end{theorem*}
```

Environment for theorems. There are similar environments, for example, `lemma`, `definition`, `example`. Compare Table 3.2 for a complete list. Each of them has a starred version that is not numbered.

```
\begin{continued}{\langle label-key \rangle} \langle theorem text \rangle \end{continued}
```

```
\begin{contexample}{\langle label-key \rangle} \langle example text \rangle \end{contexample}
```

Environment to continue theorems-like environments. Note that examples need a different environment since they use an end of example mark.

```
\begin{namedtheorem}{\langle heading \rangle}[\langle citation \rangle]
\langle theorem text \rangle
\end{namedtheorem}
```

```
\begin{namedtheorem*}{\langle heading \rangle}[\langle citation \rangle]
\langle theorem text \rangle
\end{namedtheorem*}
```

This also is an environment for theorems. Other than `theorem`, the  $\langle heading \rangle$ , e.g. ‘Theorem’, is specified explicitly. Thus a ‘Fundamental Theorem’ can be easily typed.

```
\begin{proof}[\langle citation \rangle] \langle proof text \rangle \end{proof}
```

This is the standard environment to type proofs. The default qed symbol is an open square ( $\square$ ), but you can redefine `\qedsymbol`. You can use `\qed` to force the qed symbol at an earlier place. This is usually necessary whenever a proof terminates with a math environment or a list.

```
\begin{namedproof}[\langle end of proof mark \rangle]{\langle heading \rangle}[\langle citation \rangle]
\langle proof text \rangle
\end{namedproof}
```

Environment to type proof-like things which differ in  $\langle heading \rangle$  and optionally also in the  $\langle end of proof mark \rangle$ . Note that the latter is typeset in math mode.

```
\begin{enumerate}* \langle items \rangle \end{enumerate}
```

This is simply a variant of the traditional `enumerate` environment, it continues a previously terminated list. This allows you to make intermediate remarks and then continue your numbered list.

---

```
\label{<key>}, \ref{<key>}, \bare\ref{<key>}, \short\ref{<key>},
\whole\ref{<key>}
```

These macros are used for referencing. `\label` defines a label, `\ref` produces a reference to the label with the corresponding `<key>`. In the standard setup, a theorem will be referenced as ‘Theorem 3.4’ or the like. Unless the document class option `nobare` was given, `\bare\ref` produces a short label, e.g. ‘3.4’.

The other two modifications are important for references to list items in theorem-like environments. Usually, the reference would be the whole reference which is forced by `\whole\ref`, for example, `\whole\ref{lemma:1}` is Lemma 3.3(i). But near the theorem, that is until the next theorem or equation, a shortened form is used which is forced by `\short\ref`, for example, `\short\ref{lemma:1}` is (i). This feature can be turned off by the document class option `notheoremitemprefixes`.

```
\begin{thebibliography}{}
\bbitem[<label>]{<key>} <bibliographic information>
\end{thebibliography}
```

This environment is used to typeset the references. For each reference there is a `\bbitem`. Usually, this is automatically produced by `BIBTEX`.

```
\citet* [<prefix>] [<postfix>] {<key>},
\citep* [<prefix>] [<postfix>] {<key>},
\citealt* [<prefix>] [<postfix>] {<key>},
\citealp* [<prefix>] [<postfix>] {<key>},
\citeauthor* [<prefix>] [<postfix>] {<key>},
\citeyear [<prefix>] [<postfix>] {<key>}
```

These macros are defined by the package `natbib`. With the option `cccite` they lose most of their functionality. With the options `nocccite` or `nonatbib` they are not defined.

All of these can have a comma separated list of `<key>`s. The star indicates that the full list of authors should be used if possible. The `<prefix>` precedes, the `<postfix>` follows the citation. If only one optional argument is present, it is considered to be the `<postfix>`. The `<postfix>` may be empty to allow the specification of a `<prefix>` only. There are several examples in Section 3.3.

<code>\citet{goomit95}\</code>	Goossens <i>et al.</i> (1995)
<code>\citeauthor{kopdal99}\</code>	Kopka & Daly
<code>\citeyear{knu84}\</code>	1984
<code>\cite{knu84,knu86b,knu86c}\</code>	Knuth (1984, 1986c,d)
<code>\citealt{lam94}\</code>	Lamport 1994
<code>\citep{goomit96g}\</code>	(Goossens <i>et al.</i> , 1996)
<code>This\nocite{pat88}</code> produces no text but a bibliography entry.	This produces no text but a bibliography entry.

`\cite{⟨key⟩}`, `\citeauthor{⟨key⟩}`, `\citeyear{⟨key⟩}`, `\citemul{⟨key⟩}`,  
`\shortcite{⟨key⟩}`, `\parencite{⟨key⟩}`, `\nocite{⟨key⟩}`

These obsolete macros are used for citations when the option `cccite` is used.

`\setlength{\headrulewidth}{⟨width⟩}`

If a head rule is desired, use this in the preamble. The default value for `⟨width⟩` is `.4pt`. Note that this has only an effect with the document class option `noccpublish`.

`\maketitle`

This command produces the title if not done yet. You never need this command unless you use the document class option `noautotitle`.

`\makeendtitle`

This command produces receipt information and affiliations if not done yet. You do not need this command unless you use the document class option `noautotitle`.

`\ccpublish{⟨year⟩}{⟨volume⟩}{⟨number⟩}{⟨first page⟩}`

Preamble command to define `⟨year⟩`, `⟨volume⟩`, `⟨number⟩`, and `⟨first page⟩` of the final publication *by the editor*. Not intended for use by anybody else. Note that this forces the document class options `autotitle` and `ccpublish`.

`\electronic`, `\printed`

Commands *for the editor*. Switches the ISSN to the electronic or to the printed version.

```

\begin{algorithm}[rs][Repeated
  squaring]
\item An element
   $x \in \mathbb{Z}_m$  and
  an exponent  $e \in \{2, \dots, \varphi(m)\}$ .
\item  $x^e \in \mathbb{Z}_m$ .
  \begin{block}
  \item
    Compute the binary
    representation  $(e_n, \dots, e_0)$  of  $e$ .
  \item
    \algolabel{B}
     $z \leftarrow x$ .
  \item
    \algolabel{D}
    \begin{forblock}
       $i = n-1, \dots, 0$ 
      \algolabel{C}
      \item  $z \leftarrow z^2$ .
      \begin{ifblock}
         $e_i = 1$ 
        \item  $z \leftarrow z * x$ .
      \end{ifblock}
    \end{forblock}
  \item
    \algolabel{G}
    \RETURN  $z$ .
  \end{block}
\end{algorithm}


---


B: \stepref{rs}{B}
C: \ref{rs-C}, \whole\ref{rs-C}
D: \short\ref{rs-D},
  \whole\ref{rs-D}

```

ALGORITHM 7.1. Repeated squaring.

Input: An element  $x \in \mathbb{Z}_m$  and an exponent  $e \in \{2, \dots, \varphi(m)\}$ .

Output:  $x^e \in \mathbb{Z}_m$ .

1. Compute the binary representation  $(e_n, \dots, e_0)$  of  $e$ .
2.  $z \leftarrow x$ .
3. For  $i = n - 1, \dots, 0$  do 4–6
4.  $z \leftarrow z^2$ .
5. If  $e_i = 1$  then
6.  $z \leftarrow z * x$ .
7. Return  $z$ .

---

B: Step 2 in Algorithm 7.1  
C: 3–6, Algorithm 7.1 step 3–6  
D: 3, Algorithm 7.1 step 3

Table 7.1: An example algorithm

## 7. Commands for algorithms

The commands and environments related to algorithms can also be used independently, try `\usepackage{ccalgo}` to activate them. For a longer example, see Table 7.1.

```
\begin{algorithm}{\langle masterkey \rangle}[\langle citation \rangle]
  \item \langle input \rangle
  \item \langle output \rangle
  \begin{block}
    \langle body \rangle
  \end{block}
\end{algorithm}
```

This is a specialization of the following environment `namedalgorithm`. You may define such specializations using `\newalgorithm`.

```
\newalgorithm{\langle environment name \rangle}[\langle list of required items \rangle]{\langle heading \rangle}.
```

You can use this to specialize the following environment `namedalgorithm`.

```
\begin{namedalgorithm}{\langle heading \rangle}[\langle list of required items \rangle]
  {\langle masterkey \rangle}[\langle citation \rangle]
  \item \langle first required item \rangle
  ...
  \item \langle last required item \rangle
  \begin{block}
    \langle body \rangle
  \end{block}
\end{namedalgorithm}
```

Typesetting algorithms is an art by itself. We hope that this environment is flexible enough to reflect also your taste. The environment `namedalgorithm` takes four arguments, two of them are optional. The *`\langle list of required items \rangle`* is a comma separated list of titles for required items. It defaults to: `Input,Output`. Thus the first required item is entitled `Input` and the second and last required item is entitled `Output`. An interactive protocol might have many more required items, for example, `Common input,Prover's input,Verifier's input,Output`. The *`\langle heading \rangle`* could be `Algorithm` or `Extended Euclidean Algorithm`, it will be referenced together with the number (if any). The *`\langle masterkey \rangle`* is used to set a label; this is obligatory since labels to steps or ranges of steps in the algorithm are created using this. Finally *`\langle citation \rangle`* usually is either a phrase describing the algorithm, or a reference.

The *`\langle body \rangle`* is a sequence of steps and blocks.

`\item[\langle label \rangle]` starts a new step of the algorithm, either numbered or labelled *`\langle label \rangle`*. As usual, a `\label` command after the item refers to the step,



but it is wiser to use `\algotlabel{⟨subkey⟩}` instead which is equivalent to `\label{⟨masterkey⟩-⟨subkey⟩}`. (Note that also items with given `⟨label⟩` can have an `\algotlabel` or a `\label!`!) A reference must then be written `\stepref{⟨masterkey⟩}{⟨subkey⟩}` or `\ref{⟨masterkey⟩-⟨subkey⟩}`. If the standard width of the item labels is not enough, use

```
\settowidth{\steplabelwidth}{\makeoptalgotlabel{⟨widest label⟩}}
```

before the first step in the algorithm to adjust this. (If you have a problem because your algorithm is longer than 99 steps then you should better use `\settowidth{\steplabelwidth}{\makealgotlabel{999}}`.)

`\begin{block} ⟨body⟩ \end{block}` produces an indented block. An `\algotlabel{⟨subkey⟩}` before the `⟨body⟩` generates a reference to the *range* of steps inside the block. Actually, the environment `block` is combined from environments `indentation` and `range`. `\begin{indentation} ⟨body⟩ \end{indentation}` just produces some indented lines, while `\begin{range} \algotlabel{⟨subkey⟩} ⟨body⟩ \end{range}` allows to reference a range of steps.

More advanced facilities might help you:

- `\begin{ifblock}{⟨condition⟩} ⟨body⟩ \end{ifblock}`
- `\begin{elifblock}{⟨condition⟩} ⟨body⟩ \end{elifblock}`
- `\begin{elseblock} ⟨body⟩ \end{elseblock}`
- `\begin{forblock}{⟨loop control⟩} ⟨body⟩ \end{forblock}`
- `\begin{whileblock}{⟨condition⟩} ⟨body⟩ \end{whileblock}`
- `\begin{untilblock}{⟨condition⟩} ⟨body⟩ \end{untilblock}`
- `\begin{blockwhile}{⟨condition⟩} ⟨body⟩ \end{blockwhile}`
- `\begin{blockuntil}{⟨condition⟩} ⟨body⟩ \end{blockuntil}`

For example, the first of these is almost equivalent to:

```
\item
  \IF ⟨condition⟩ \THEN
\begin{block}
  ⟨body⟩
\end{block}
```

The actual implementation also takes care of a label to the entire range of steps. If you put a label in an `ifblock`, you reference the range containing the `if` step and the `then` block. If you need a reference for the `if` step itself, or you use  $\langle label \rangle$  for all steps, then put `\item[\langle label \rangle]\algolabel{\langle subkey \rangle}` before the `ifblock`.

Typesetting keywords is done as follows: `\keyword{\langle name \rangle}` produces a keyword. `\FOR`, `\DO`, `\WHILE`, `\REPEAT`, `\UNTIL`, `\IF`, `\THEN`, `\ELSE`, `\RETURN` are predefined keywords. Further, `\COMMENT{\langle comment \rangle}` can be used to type comments.

## 8. Interaction with other packages

**hyperref** This package must be loaded after `cc-cl`s. Otherwise, references will not work as expected with `hyperref`.

## 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.

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