LaTeX for beginners
An introduction to TeX and LaTeX

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Support documents at https://www.edpif.org/documents/latex/beginners/

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Contents

Summary

What are they?

TeX is a system for producing high quality digital typesetting, especially mathematical typesetting.

- The first and still alive format for using TeX is the so called plain-TeX.
- LaTeX is a high level format that use TeX, but things much more easy.

The name TeX comes from Greek $\tau\varepsilon\chi\nu o\nu$: the X is a χ, to be pronounced like in "technology" or like in the Scottish "Loch"

Main interest of LaTeX

- TeX produces high quality typography.
- For mathematics, it is almost the only way !
- You are a scientist researcher, so — by default — you will like it.
- It is the *de facto* standard of scientific publishing.

$$e = 2 + \cfrac{1}{1 + \cfrac{1}{2 + \cfrac{1}{1 + \cfrac{1}{1 + \cfrac{1}{4 + \cfrac{1}{1 + \cfrac{1}{1 + \cdots}}}}}}}$$

- Many features, such as hyperlinking, labeling & referring, table of contents, citations, glossaries, indices etc.
- It is free and highly portable.
- Better (and easier ?) typesetting than word processors, such as Microsoft Word®, OpenOffice Writer®.

Why do you need LaTeX?

Typeset by Microsoft Word®

This is some text that intends to show you the difference between a Word processor and TeX when it comes to high quality typography. There is a man called Dr○ John,○who○likes○the○Binomial theorem, which says that for any positive integer n:

$$(x + a)^n = \sum_{k=0}^{n} \binom{n}{k} x^k \, a^{n-k}$$

Typeset by LaTeX

This is some text that intends to show you the difference between a Word processor and TeX when it comes to high quality typography. There is a man called Dr. John, who likes the Binomial theorem, which says that for any positive integer n:

$$(x + a)^n = \sum_{k=0}^{n} \binom{n}{k} x^k a^{n-k}$$

Why do they need LaTeX?

Sie haben Fragen, Wünsche oder Anregungen zum Buch?
Gerne sind wir für Sie da:

Anmerkungen zum Inhalt des Buches: maike.luebbers@vierfarben.de
Bestellungen und Reklamationen: service@vierfarben.de
Rezensions- und Schulungsexemplare: julia.bruch@vierfarben.de

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An diesem Buch haben viele mitgewirkt, insbesondere:

Lektorat Maike Lübbers
Korrektorat Petra Bromand, Düsseldorf
Herstellung Iris Warkus
Einbandgestaltung Marc Thoben, Köln
Coverentwurf Daniel Kratzke
Layout Vera Brauner
Satz Markus Miller, München
Druck Himmer AG, Augsburg

Gesetzt wurde dieses Buch aus der Linotype Syntax (10,25 pt/14,25 pt) in Adobe InDesign CS5.
Und gedruckt wurde es auf mattgestrichenem Bilderdruckpapier (115 g/m²).
Hergestellt in Deutschland.

Gesetzt wurde dieses Buch aus der Linotype Syntax (10,25 pt/14,25 pt) in Adobe InDesign CS5.
Und gedruckt wurde es auf mattgestrichenem Bilderdruckpapier (115 g/m²).
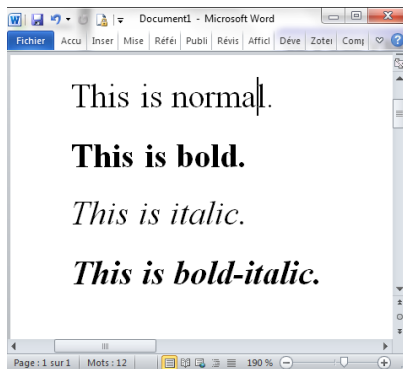Hergestellt in Deutschland.

This book was typeset from Linotype Syntax (10.25 pt/14.25 pt) in Adobe InDesign CS5.
And was printed on matte-coated illustration paper (115 g/m2).
Made in Germany.

Will I switch to LATEX?

An instructive diagram :
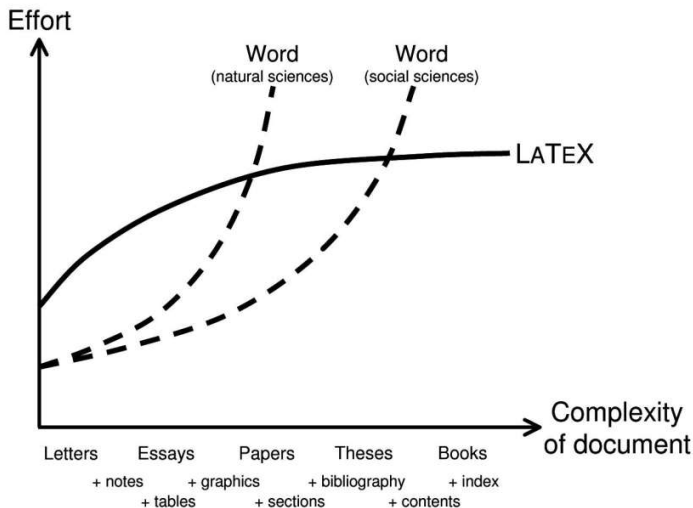
User interface


```
1  This is normal.
2
3  {\bfseries This is bold.}
4
5  {\itshape This is italics.}
6
7  {\itshape\bfseries This is bold-italics.}
8
```

⇓

This is normal.

This is bold.

This is italics.

This is bold-italics.

WYSIWYG vs WYSIWYM paradigm

For the user essential difference is the approach of the work-flow :

*-Office: WYSIWYG

You see something looking to what you will obtain on printing:

What You See Is What You Get

You define the document layout and text formating interactively. And can be distracted by these visual details, to the detriment of the content. Often, the result is inconsistent.

LaTeX: WYSIWYM

You have to compile from time to time to see the formatted result:

What You See Is What You Mean

You can concentrate on the text that you are writing, without care to the format which is well separated, and will be excellently handled by LaTeX.

Summary

What is T_EX ?

T_EX:

- Is a computer program aimed at *typesetting* text and much more,
- Intend to conform to the fundamental rules of *typography*,
- Was developed by Donald E. KNUTH between 1968 and 1982, with the aim to exploit the new (at that time) arising digital printers, in the hope to reverse the deterioration of typographical quality that he experimented for his books and articles.

Fig. 1: Donald KNUTH

- Evolved along the time, the version released in 1982 was labeled 3.0, and the current version is 3.141592653

What is T_EX?

- T_EX evolves slowly, is very stable and run on many kinds of platforms, and is reputed to be (almost) bug free.
- It is a full programming language, with a great facility to create simple macro, and the possibility to implement complex structure (wizards only :-))
- Being mostly aimed at handling text, it is very good at handling line breaking and an page breaking

- KNUTH being a mathematician, T_EX features impressive ability to typeset maths.
- It has, out of the box, quite poor graphics capabilities, but many efficient solutions are now available, both in the T_EX family or in the wide world of other programs companies or nonprofit organizations.

What is LaTeX ?

- LaTeX is a large set of TeX macros which provides a high-level language and enables the author to typeset complex documents with the typographic quality of TeX with a document layout provided by LaTeX documents classes.

- When providing the content, the author inserts "LaTeX commands" describing the logical structure of the text, which will be used to structure and format the output.

- It was first developed by Leslie LAMPORT in 1982/86 and was at this time the version 2.09, the current one is LaTeX 2_ε released in 1994...

- One of the principal interest is its amazing ability to handle cross-references in the document, bibliographies and indexes (with companion programs), and it also adds several graphics capabilities.
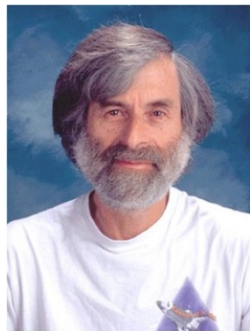

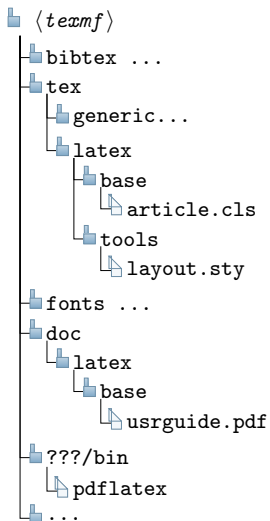**Fig. 2:** Leslie LAMPORT

Some milestones for LaTeX 2_ε

LaTeX 2_ε (2_ε = largest number < 3) was created for the following reasons:

1988 Since 1982, due to the success of LaTeX but the small number of "styles", a big mess of *incompatible* variants appeared to handle math articles, posters, presentations, newsletters etc.

1989 The new font selection scheme (PS)NFSS ebables the handling fonts other than CM, and namely the Postscript fonts (Adobe Type 1), and fixes awful problems.

1990 Cork encoding : KNUTH's CM font only provided ASCII text. In 1990, a TUG conference defined a new encoding (named T1) which encompasses 256 characters, thus providing true glyphs for the accented characters of occidental European languages. This finally resulted in the "Latin Modern" font.

1994 The maintainers of LaTeX decided to create a new version (LaTeX 2_ε) containing all the capabilities of the variants as classes or packages, deeply based on PSNFSS, and compatible with various font encodings for different languages.

Which "friends" beside LaTeX?

- The TeX engine is `pdftex`. Modern siblings: `xetex` & `luatex`.
- Calling `tex` or `latex` actually launch the `pdftex` motor. By default, `pdftex` produces PDF output, more convenient than the old fashion `DVI`, but journals don't accept yet submission in PDF-wise LaTeX. `pdflatex` is simply a wrapper for `pdftex` with `latex` format.
- The "companion programs" include notably `bibtex` and `biber` for the bibliography, `makeidx` for the index, `dvips`, `dvipdfm` to convert DVI, **ht** to produce `html` etc. More that 400 programs...
- A special mention about METAFONT, also written by D. KNUTH at the same time as TeX, and used to create new fonts, including the "Computer Modern", and METAPOST based on METAFONT for production of vectorial graphics.
- There also also the font files ($\sim 10\,000$ files for me), and all the package files ($\sim 50\,000$ files)

The "TeX Directory Structure" (TDS)

```
📁 ⟨texmf⟩
├─📁 bibtex ...
├─📁 tex
│  ├─📁 generic...
│  └─📁 latex
│     ├─📁 base
│     │  └─📄 article.cls
│     └─📁 tools
│        └─📄 layout.sty
├─📁 fonts ...
├─📁 doc
│  └─📁 latex
│     └─📁 base
│        └─📄 usrguide.pdf
├─📁 ???/bin
│  └─📄 pdflatex
└─📁 ...
```

Some contributors to $\mathrm{\LaTeX}\,2_\varepsilon$ or to $\mathrm{\LaTeX}3$ project

Frank Mittelbach[*]

Johannes Braams[*]

Michel Goossens

Sebastian Rahtz[†]

Hàn Thế Thành
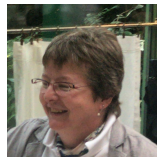
Ulrike Fischer[*]

Enrico Gregorio[*]

Heiko Oberdiek

David Carlisle[*]

Summary

General work-flow for LaTeX

- The LaTeX input file (the code) is a lightweight pure ASCII, Latin1 or (better) UTF-8 text file that can be edited in any text editor. For example a 125 pages long course I wrote a few years ago is less than 500 Kb, while the PDF is close to 10 Mb.
- This files contains the text of the content, sometime the pictures and the needed commands or macros.
- In order to see the result, on has to "compile" the `.tex` file by using a TeX compiler, often referred to as the "motor".
- The output is a `.dvi` or a `.ps` or a `.pdf` file that can be viewed or printed with the suited program.
- At each run, the compiler writes to the `.aux` file the information needed for the table of contents, cross-references, bibliography etc. This file is read and updated at further compile steps.
- Elements that require further processing (like bibliography) are handled by companion programs before the final compilation(s).

The minimal LaTeX file

The minimal file contains only tree lines :

```
1 \documentclass[<someoptions>]{<classname>}
2 \begin{document}
3 Text body...
4 \end{document}
```

- Commands start with a "backslash" `\`.
- Command arguments are enclosed in **curly** braces `{` and `}`, or in **square** braces `[...]` for *optional* arguments.
- `<classname>` is the type of document. Standard classes provided by base LaTeX are `article`, `report` and `book`, intended to produce "papers". There is also a `letter` class, less used, and this presentation is produced with the `beamer` class.
- `<someoptions>` is an optional list of options like `a4paper`,`11pt`. Other options: `landscape`, `twoside`, `twocolumn`, `draft`, `french`...

Getting started with the minimal LaTeX preamble

- The lines between the `\documentclass` and the `\begin{document}` form the so called "preamble" and are used to define further options, commands an settings.
- Most options will be imported by the mean of *packages*. For example you will always uses the following packages :
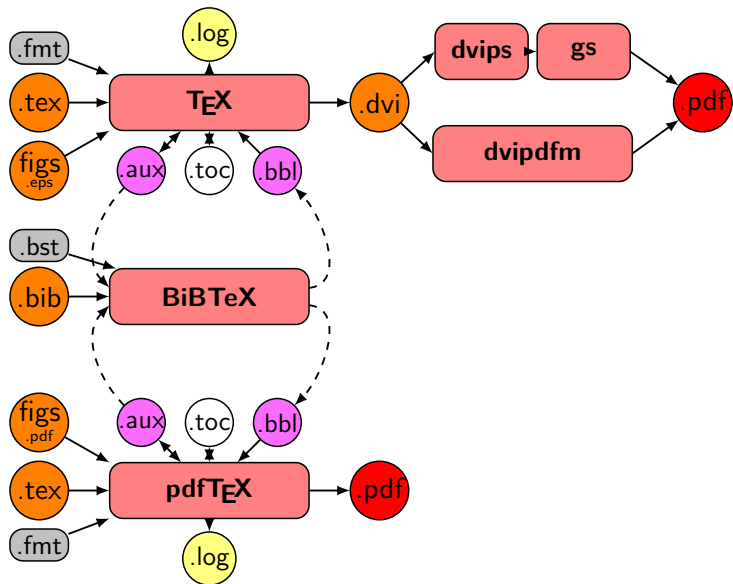
```
1 \documentclass[a4paper,11pt]{article}
2 \usepackage[utf8]{inputenc}
3 \usepackage[french]{babel}
4 \usepackage[margin=28mm]{geometry}
5 \usepackage[T1]{fontenc}
6 \usepackage{lmodern}
7 \begin{document}
8 some text...
9 \end{document}
```

the meaning of which will be explained soon.

The compilation chain

Summary

What is needed to run LATEX?

MOST COMPUTERS JUST SLEEP !

In order to run LATEX you need several kind of tools...

A TeX distribution

Distribution refers to the huge set of "TeX and friends" files needed to compile, choose the fonts, define the layout, various kinds of formating, produce bibliography, etc.

- On MS-Windows (7 to 10) the best choice is the `MiKTeX` distribution, to freely download from `https://miktex.org/download` Take care to choose the $\times 86$ or $\times 64$ according to your computer. Install only the `basic-miktex` bundle, the other package will be downloaded latter, either manually or on the fly.
- On Mac OS-X, the simplest choice is to use the `TEXLive` distribution. Actually, it will install automatically when you will install `MacTeX` including both `TEXLive` and `TeXShop` `http://pages.uoregon.edu/koch/texshop`.
- On Unix/Linux, you will also use `TEXLive`, to download preferably from your package management utility.

These files are stored together in a so called « TDS-compliant » folder, generally named `texmf` (or `MiKTeX` for Window computers).

An editor I/II

Any text editor, but you **need** a TeX oriented IDE featuaring :

- Support of UTF-8.
- Syntax highlighting.
- A spell-checker at least for English, French, and more ...
- A contextual help hot-key (or `texdoc <package>` in the console).
- A button and/or hot-key to start the compilation.
- Compatibility with Synctex, for direct and inverse search.
- Parsing of the output console with the listing of errors and hyperlink jump to source.
- The possibility to edit the compilation command line.

If you prefer the WYSIWIG paradigm, look at: Scientific WorkPlace or BaKoMa TeX ($ Win only) or at the free and multippatform LyX or TeXmacs.

An editor II/II

Recommended choices

- Free multi-platform editor, and the best choices in this range are:
  - The `TeXWorks` editor/IDE (simple but efficient) included in `MiKTeX` and in `TEXLive`, can work "out of the box".
  - `TeXmaker` `http://www.xm1math.net/texmaker` or `TeXstudio` `https://www.texstudio.org/`, with palettes of symbols, project management, better autocompletion, and a lot of tools.
- On MAC OS-X, one will likely use the free and excellent `TeXShop`, which is clearly the "champion in every category" for any platform.
- On Window, one has several alternative to the former, like the brilliant `WinEdt` (shareware) `http://www.winedt.com`
- On Unix/Linux, the uncontested leader was for a long time `Kile` `https://kile.sourceforge.io/` but it was perhaps superseded by `TeXmaker`, and other people stick to `emacs`/`AUCTeX` `https://www.gnu.org/software/auctex` or `VIM`

Other Tools

- Programs to handle, create and edit postscript and PDF :
  (* means functionality already included in MiKTeX/TeXLive)
  - Ghostscript* (AGPL) https://www.ghostscript.com/download
  - Ghostview http://pages.cs.wisc.edu/~ghost
  - pstoedit http://www.pstoedit.net
  - esptopdf* https://ctan.org/pkg/epspdf
    or https://ctan.org/pkg/epspdf-setup
  - pdftk free https://www.pdflabs.com
    or pdfsam https://pdfsam.org
  - jpeg2ps, sam2p https://pdfsam.org/fr, etc.
- Vectorial drawing programs like
  - inkscape https://inkscape.org
  - Xfig or winFIG https://projet-plume.org/fiche/xfig-winfig
  - TpX http://tpx.sourceforge.net

Summary

About characters

- TEX defines 16 categories of input characters (catcodes 0 to 15)

- Valid characters are the 95 ASCII characters, on 7 bits (catcodes 11/12).

- Reserved characters are : (@ is used only for internal macros in `.sty`/`.cls`)

```
1  \  is used to introduce the commands (catcode 0)
2  {  and } are used to define groups (catcodes 1 & 2)
3  $ switch math mode on and off (catcode 3)
4  &  is used for alignment structures (catcode 4)
5  # is used for macro argument names (catcode 6)
6  ^  and _ for supers/subscript (in math) (catcodes 7 & 8)
7  ~ is an unbreakable space (catcode 13=active char)
8  % is used to start a comment (catcode 14)
```

- 8 bits chars via `inputenc` package, with option `latin`1, `latin`9 & others.

- Unicode chars with `utf`8 option. New translations possible via
  `\DeclareUnicodeCharacter{<hexcode>}{<command>}`, or with
  `newunicodechar` package, `\newunicodechar{<char>}{<command>}`, e.g.
  `\newunicodechar{†}{$\dag$}`.

Summary

Sizes

Sizes

`{\tiny tiny}`	tiny
`{\scriptsize scriptsize}`	scriptsize
`{\footnotesize footnotesize}`	footnotesize
`{\small small}`	small
`{\normalsize normalsize}`	normalsize
`{\large large}`	large
`{\Large Large}`	Large
`{\LARGE LARGE}`	Large
`{\huge huge}`	huge
`{\Huge Huge}`	Huge

- Arbitrary sizes: package `anyfontsize`;
- Use of relative sizes: package `relsize`;
- Larger or smaller base document fonts: package `extsize`.

Styles

Styles

`\textrm{Roman}`	`{\rmfamily Roman}`	Roman
`\textit{Italics}`	`{\itshape Italics}`	*Italics*
`\textmd{Medium}`	`{\mdseries Medium}`	Medium
`\textbf{Boldface}`	`{\bfseries Boldface}`	**Boldface**
`\textsl{Slanted}`	`{\slshape Slanted}`	*Slanted*
`\textsf{Sans serif}`	`{\sffamily Sans serif}`	Sans serif
`\textsc{Small caps}`	`{\scshape Small caps}`	SMALL CAPS
`\texttt{Typewriter}`	`{\ttfamily Typewriter}`	Typewriter

- `\emph{<some text>}` → *some text* must bee preferred to `\textit` : it toggles between `\textit` and `\textrm` and corrects the spacing.
- Styles modifications can be locally inverted with the commands:
  - `\textnormal` or `\normalfont` : return to main document font;
  - `\textup` or `\upshape` The opposite of slanted.
- Styles and size can also be used as `\begin{small}`...`\end{small}` or `\begin{slshape}`...`\end{slshape}`.

Summary

Sectioning commands

Commands : `\chapter[]{}`, `\section[]{}`, `\subsection{}`, `\subsubsection{}`, `\paragraph{}`, `\subparagraph{}`

Article:(No \chaptercommand)

---

1   Section

A section...

1.1   Subsection

A subsection...

1.1.1   Subsubsection

A subsubsection...

Paragraph   A paragraph...

Subparagraph   A subparagraph...

2   Another section

Report/Book:

Chapter 1

My firstchapter

1.1   Section

A section...

1.1.1   First subsection

A subsection...

1.1.1.1   Subsubsection

A subsubsection...

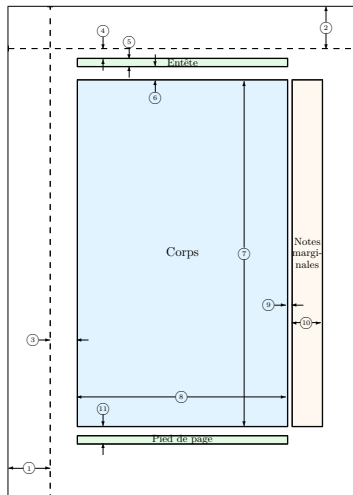**Paragraph**   A paragraph...

Subparagraph   A subparagraph...

1.1.2   New subsection

Page layout for the standard `article` class

Default setting for `article` class with `11pt` and `french` options.
To adjust it, exclusively use the `geometry` package.

1	un pouce + \hoffset
2	un pouce + \voffset
3	\oddsidemargin = 16.167 mm
4	\topmargin = 6.326 mm
5	\headheight = 4.218 mm
6	\headsep = 8.786 mm
7	\textheight = 209.118 mm
8	\textwidth = 126.525 mm
9	\marginparsep = 3.515 mm
10	\marginparwidth = 17.573 mm
11	\footskip = 10.544 mm

Non affichés :
\marginparpush = 1.757 mm
\hoffset = 0 mm
\voffset = 0 mm
\paperwidth = 209.821 mm
\paperheight = 296.983 mm

Produced by the (customized) \layout command defined by the `layout` package.

Headers and footers

They are defined by the command \pagestyle{<style>} in the preamble.

A local change scan be defined with \thispagestyle{<style>}.

These style are :

- empty : headers and footers are ... empty!
- plain : empty header, page number centered in footer, default for article.
- headings : empty footer, and titles & page numbers in header, chapter on left pages & section on right pages, default for book.
- myheadings : similar to headings, but the headings are manually defined by the commands \markright{...} and \markboth{...}{...}, instead of automatically used by \chapter or \section in headings case.
- fancy : when customized with the fancyhdr package.

Environments

Structure delimited by `\begin{<envname>}` ... `\end{<envname>}`
like the main environment `document`.

verse

> *Voici venir les temps où vibrant sur sa tige*
> *Chaque fleur s'évapore ainsi qu'un encensoir ;*
> *Les sons et les parfums tournent dans l'air du soir ;*
> *Valse mélancolique et langoureux vertige !*

abstract

Résumé

Dans une Note récente, nous avons montré qu'un observateur, pour décrire le mouvement d'un mobile de vitesse $\beta < 1$, doit lui associer une onde sinusoïdale non matérielle se propageant dans la même direction ; la fréquence de cette onde est égale à l'énergie totale, par rapport à l'observateur, divisée par la constante h de Planck.

Below : `minipage`, `figure`, `tabular`, `displaymath`, `itemize` etc.

Summary

Handling of (cross-)references and citations

A great advantage of LaTeX is the elementary handling of references.

- In most cases the target of a cross-reference is marked with `\label{thelabel}`, where `thelabel` is a valid *alphanumeric* string[1], that is not printed (use package `showkeys` to see them).
- This holds for all sectioning titles, tables and figures, lists and their `\item`s, equations, `\footnote`s, etc
- For the callback, one use the command `\ref{thelabel}`.
- Nevertheless, there are specialized versions like `\pageref{thelabel}`, `\eqref{thelabel}` (package `amsmath`), `\titleref{thelabel}` (package `titleref`), or `\nameref{thelabel}` (package `hyperref`, with many variations.)...
- Command `\eqref` formats the number and adds the parenthesis.

Examples

```
1  ............
2  \begin{document}
3  \section{First section}\label{s:one}
4  This simple text contains a
5  reference to the
6  nextpage (\pageref{s:another}),
7  which contains
8  the equation (\ref{e:nice_eq})
9  in the \S~\ref{s:another}.
10 \clearpage
11 \section{Second section}
12 \label{s:another}
13 Here is a nice equation :
14 \begin{equation}\label{e:nice_eq}
15 E=mc^2
16 \end{equation}
17 that is referenced in section
18 named ``\titleref{s:one}''.
```

1 A section

This simple text contains a reference to the nextpage (2), which contains the equation (1) in the § 2

1

2 Second section

Here is a nice equation :

$$E = mc^2 \qquad (1)$$

that is referenced in section named "A section".

2

Hyperreferences

The package `hyperref` takes advantage of the hypertext potentiality of PDF format to add hyperlinks to the references (and citations).

- For this purpose `hyperref` modifies most semantic commands (sectioning, labels etc) into commands that add a suitable hypertarget.
- At the same time, all the `\ref` and siblings are turned into hyperlinks, allowing to jump from the `\ref` to the `\label`.
- For the callback, one use the command `\ref{<thelabel>}`.

Example with hyperref

```
 1  ............
 2  \usepackage[colorlinks]{hyperref}
 3  \begin{document}
 4  \section{First section}\label{s:one}
 5  This simple text contains a
 6  reference to the
 7  nextpage (\pageref{s:another}),
 8  which contains
 9  the equation (\ref{e:nice_eq})
10  in the \S~\ref{s:another}.
11  \clearpage
12  \section{Second section}
13  \label{s:another}
14  Here is a nice equation :
15  \begin{equation}\label{e:nice_eq}
16  E=mc^2
17  \end{equation}
18  that is referenced in section
19  named ``\titleref{s:one}''.
```

1 A section

This simple text contains a reference to the nextpage (2), which contains the equation (1) in the § 2

1

2 Second section

Here is a nice equation :

$$E = mc^2 \qquad (1)$$

that is referenced in section named "A section".

2

Other uses of hyperref

- hyperref also turns the \tableofcontents into a list of hyperlinks
- It can produce bookmarks (in French : « signets ») facilitating the navigation.
- It turns the \cite{...} commands, and similar (see below) into hyperlinks pointing to the relative bibliographic references.
- In some conditions, "back links" can be created.
- Custom hyperlinks can be produced anywhere with the commands : \url{someurl} or \href{someurl}{a text}.
- Can set PDF specific parameters, like metadata with pdfinfo option.
- Many option can be added after loading with \hypersetup, e.g.:
  ```
  \hypersetup{pdfdisplaydoctitle=true,
  bookmarksopen=true,bookmarksnumbered=true, pdfpagemode=UseOutlines,
  breaklinks=true, linktocpage=true, colorlinks=true, menucolor=blue,
  citecolor=tial, urlcolor=pink}
  ```
- With package pdfx, it can be used to create PDF/A ou PDF/X files