LaTeX 101

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`http://sje30.github.io/post/latex2016/`

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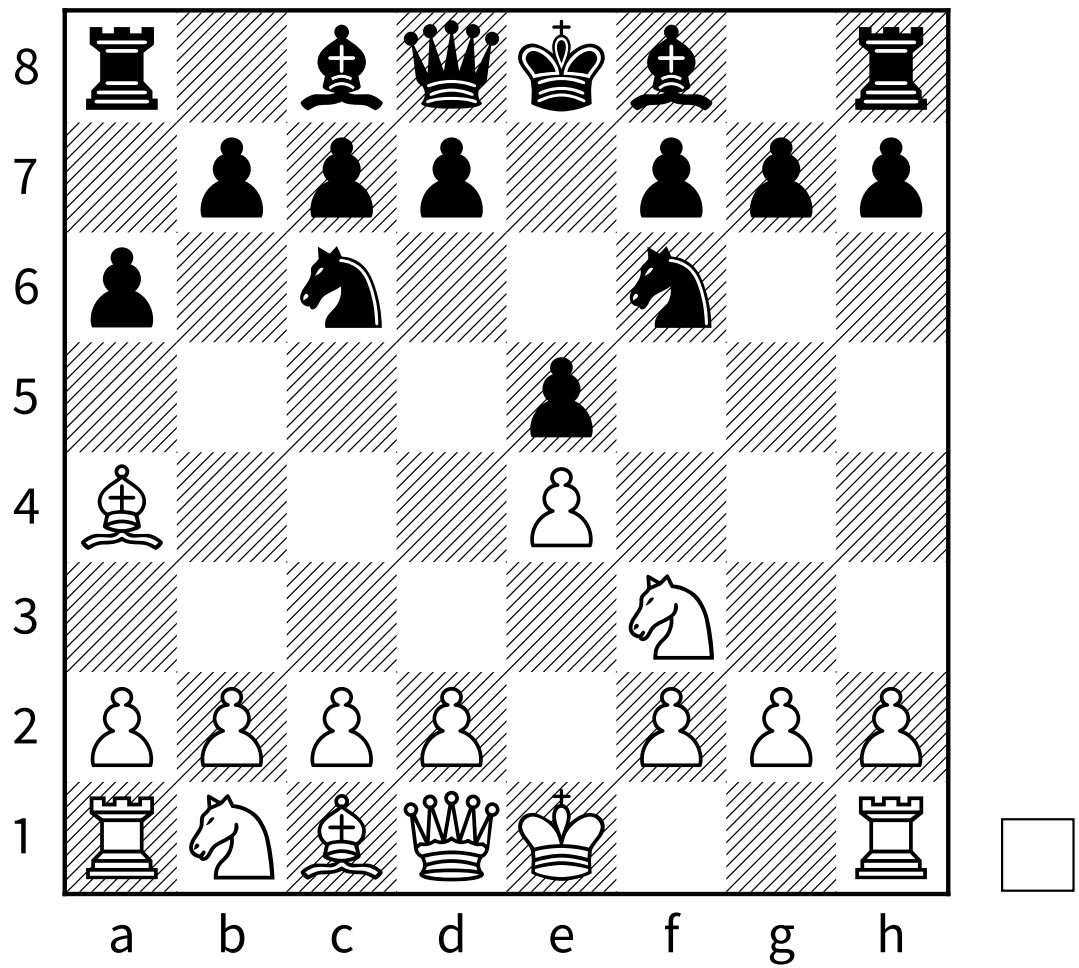
What is LaTeX?

- Typesetting, not WYSIWYG.
- Given a source file (file.tex) you **compile** your document (file.pdf).
- Heavily used by mathematicians/scientists/publishers for formatting papers/books.
- Logical markup of your document (like HTML) rather than specifying exactly how you want it look.
- Use Word (or program of your choice) if you want to.
- These slides are written in LaTeX using the “beamer” package.
- You can typeset music, wiring diagrams, chess …

```
\newchessgame % from the xskak package
\mainline{1. e4 e5 2. Nf3 Nc6 3. Bb5 a6 4. Ba4 Nf6}
\chessboard
```

1 e4 e5 2 ♘f3 ♘c6 3 ♗b5 a6 4 ♗a4 ♘f6



“Hello world” example

```
1 \documentclass{article}
2 \begin{document}
3   Hello  world.   Welcome to \LaTeX.
4 \end{document}
```

Hello world. Welcome to LaTeX.

Another example (Taken from `showexpl-test.tex`)

```
\documentclass[a4paper,twoside]{article}
\begin{document}
\begin{equation}
   \sigma(t)=\frac {1}{\ sqrt{2\pi }}
   \int^t_0 e^{-x^2/2} dx
\end{equation}
\end{document}
```

$$\sigma(t) = \frac{1}{\sqrt{2\pi}} \int_0^t e^{-x^2/2} dx \qquad (1)$$

Getting started

- LaTeX is free to download.
- Can use it from the command line.
- Lots of editors/GUIs available.
- I suggest trying *texstudio* or *texmaker*. They both handle all the compilation steps for you and provides easy way of forward/inverse searching (Ctrl + left mouse button).
- `http://www.lyx.org` = latex engine + WYSIWYG interface.

Welcome to the 21st century

1. Many LaTeX guides describe how you can create .dvi files and .ps (postscript) files.
2. Ignore that; we typically create .pdf files now, via 'pdflatex'.
3. Create your figures in .pdf or .eps wherever you can, else png/jpg.
4. Matlab users: .eps files have tight bounding boxes, whereas pdf files do not. However, pdflatex will silently convert `sin.eps` to `sin-eps-converted-to.pdf` for you:

```
\fbox{\includegraphics[width=6cm]{sin.eps}}
```

Online tools (good for collaboration)

- `www.overleaf.com`
- `???`

LaTeX syntax - commands

- LaTeX commands start with backslash and are case-sensitive:

```
1        The \large cat \LARGE sat on \Huge the \normalsize mat
```

The cat **sat on** **the** mat

- Commands can take compulsory { ... } and optional [...] arguments.

```
1        A \rule{10mm}{3mm} B \rule[-1mm]{10mm}{3mm}
```

A  B 

- You can sometimes drop { and }:

```
1        e.g. if superscript is one character: compare $x^3$ with
2        $x^{19}$ and with $x^19$.
```

e.g. if superscript is one character: compare x^3 with x^{19} and with x^19.

Special characters

Some characters are commands. To type these characters, you normally escape them:

```
I got a 30\% *discount*, *saving me a few* \$\$\$ \ldots
```

I got a 30% discount, saving me a few $$$ …

The most common characters that need escaping are:

```
\ $ ^ _ % # & ~ { }
```

Space

```
1 Multiple     spaces     between words are treated  as
2 one space.
3
4 Blank  lines  denote
5 paragraph separators.
6
7 Use a  non--breaking space, like  3~mm, to prevent  line  breaks.   Even
8 better  for  separating  numbers from units,  try  a  small  non--breaking
9 space,  e.g.  3\,mm.
```

Multiple spaces between words are treated as one space.
Blank lines denote paragraph separators.
Use a non-breaking space, like 3 mm, to prevent line breaks. Even better for separating numbers from units, try a small non-breaking space, e.g. 3 mm.

Environments

An environment is a block of latex code to provide some functionality. They can be nested.

```
1  \textbf{Top TV programmes}:
2  \begin{enumerate}
3  \item Homeland
4  \item The West Wing
5     \begin{itemize}
6     \item Series 1
7     \item (Not series 3)
8     \end{itemize}
9  \item 24
10 \end{enumerate}
```

Top TV programmes:

1. Homeland
2. The West Wing
    - Series 1
    - (Not series 3)
3. 24

Typesetting math

1. LaTeX normally is in text mode. You must switch to math mode using $ to get into and out of math.

```
1 This equation $x^2 + y^2 = z^2$ is in-line; compare with:
2 \begin{eqnarray}
3   I_1 &= \int_0^{2 \pi} \sin (x^2) dx \nonumber \\
4   \text{but}\, I_2 &= \int_0^{2 \pi} \cos (x^2) dx \label{key}
5 \end{eqnarray}
6 The dx in Equation 2 needs fixing later \ldots
```

This equation $x^2 + y^2 = z^2$ is in-line; compare with:

$$\begin{aligned} I_1 &= \int_0^{2\pi} \sin(x^2)dx \\ \text{but } I_2 &= \int_0^{2\pi} \cos(x^2)dx \end{aligned} \tag{2}$$

The dx in Equation 2 needs fixing later ...

amsmath – AMS mathematical facilities for LaTeX

`http://mirrors.ctan.org/macros/latex/required/amslatex/math/amsldoc.pdf`
Lots of good examples for formatting maths. See the examples in:
`http://mirrors.ctan.org/macros/latex/required/amslatex/math/testmath.pdf`

This is an example of a package that has been contributed to LaTeX. These packages are available on Comprehensive TeX Archive Network (CTAN). Most of them are downloaded for you when installed LaTeX.

Universe of mathematics symbols and operators

`http://mirror.ox.ac.uk/sites/ctan.org/info/symbols/comprehensive/symbols-a4.pdf`

contains ∼6000 symbols and LaTeX commands to generate them. e.g. see Table 97 for inequalities:

TABLE 97: MnSymbol Inequalities

⩾	\eqslantgtr	⪌	\gtreqqless	≲	\lesssim	⋛̸	\ngtreqless
⩽	\eqslantless	≷	\gtrless	≪	\ll	⋛̸	\ngtreqlessslant
≥	\geq	≩	\gtrneqqless	⋘	\lll	⪌̸	\ngtreqqless
≧	\geqclosed	≳	\gtrsim	⪉	\lnapprox	≯	\ngtrless
⩾	\geqdot	≤	\leq	≨	\lneqq	≰	\nleq
≧	\geqq	⊴	\leqclosed	⋦	\lnsim	⋬	\nleqclosed
⩾	\geqslant	⩽	\leqdot	⪈	\neqslantgtr	⩽̸	\nleqdot
⪀	\geqslantdot	≦	\leqq	⩇	\neqslantless	⩽̸	\nleqq
≫	\gg	⩽	\leqslant	≱	\ngeq	≱	\nleqslant
⋙	\ggg	⪿	\leqslantdot	⋭	\ngeqclosed	⪾̸	\nleqslantdot
⪊	\gnapprox	<	\less	⩾̸	\ngeqdot	≮	\nless
≩	\gneqq	≲	\lessapprox	≱	\ngeqq	⋪	\nlessclosed
⋧	\gnsim	◁	\lessclosed	⪆̸	\ngeqslant	⩿̸	\nlessdot
>	\gtr	⩿	\lessdot	⪆̸	\ngeqslantdot	⪋̸	\nlesseqgtr
⪆	\gtrapprox	≶	\lesseqgtr	≫	\ngg	⪋̸	\nlesseqgtrslant
⧐	\gtrclosed	⪋	\lesseqgtrslant	⋙	\nggg	⪋̸	\nlesseqqgtr
⩿	\gtrdot	≦	\lesseqqgtr	≯	\ngtr	≸	\nlessgtr
⪌	\gtreqless	≶	\lessgtr	⋫	\ngtrclosed	≪̸	\nll
≩	\gtreqlessslant	≨	\lessneqqgtr	⩾̸	\ngtrdot	⋘̸	\nlll

MnSymbol additionally defines synonyms for some of the preceding symbols:

Finding maths operators the “modern” way

- Draw some equations and it will try to render it in latex or mathml: Wolfram: graph an equation, with latex output.
  `http://webdemo.myscript.com/#/demo/equation`
- `http://detexify.kirelabs.org/classify.html`

Defining your own commands

```
\newcommand{\betaIIKO}
{\ensuremath{\beta\mathit{2}^{-/-}}\xspace}
The \betaIIKO mouse is widely studied \ldots
the \betaIIKO command is easier for me
to type than the whole expansion.

\newcommand{\nnn}[1]{\ensuremath{#1^{#1^{#1}}}}
Or we can compare \nnn{3} with \nnn{16}.
```

The $\beta 2^{-/-}$ mouse is widely studied …the $\beta 2^{-/-}$ command is easier for me to type than the whole expansion.
Or we can compare 3^{3^3} with $16^{16^{16}}$.

Typesetting mathematics for science has many hints for getting things "just right", e.g. the differential operator, partial, total derivatives:
`http://www.tug.org/TUGboat/Articles/tb18-1/tb54becc.pdf`

Bibliography / citations

Entries like the following are stored in a bibliography file:

```
@article{ihaka1996,
  author =    {R. Ihaka and R. Gentleman},
  title =     {R: A Language for Data Analysis and Graphics},
  journal =   {Journal of Computational . . . Statistics},
  year =      1996,
  volume =    5,
  pages =     {299--314}
}
```

which you can then cite using e.g.

```
We used the R programming environment \cite{ihaka1996}
for our analysis.
```

To create:

```
We used the R programming environment (Ihaka and Gentleman,
1996) for our analysis.
```

and references at end. See `texintro/intro.tex` for more info.

Creating a bibliography

- Create it by hand. Slow, tedious, and error-prone.
- Grab them from Google scholar, e.g. `http://scholar.google.co.uk/scholar?q=ihaka+gentleman`. The cite link takes you to the formats for citing (you may need to configure google scholar).
- zotero/paperpile/mendeley all generate good bibtex entries.

Preamble

1. Everything before the `begin{document}` is the preamble.
2. Use it to set up document, load packages. My favourite packages:

```
\usepackage{graphicx}                   % Including graphics.
\usepackage{url}                        % active URLs.
\usepackage[a4paper,margin=2cm]{geometry}
\usepackage{mathpazo}                   % or mathptmx
\usepackage{amsmath}                    % AMS Maths goodies
```

Your choice of fonts

Choose a font that has good support for both math and text modes:

1. Do nothing. Stick with Donald Knuth's *Computer Modern*.
2. I prefer mathpazo (Palatino) or mathptmx (Times).
3. Explore the free guide `http://mirrors.ctan.org/info/Free_Math_Font_Survey/en/survey.html`

Floats: tables and figures

- Floats are objects (tables, figures) that move in your document; LaTeX will move them to somewhere it thinks sensible.
- If you don't like where it put a float, relax. You can give it hints, but normally it does a good job.
- This is the LaTeX philosophy in general – let it worry about layout so that you worry about content.
- You can then refer to figures/tables by labels.

Tables

```
\begin{table}
  \centering
  \begin{tabular }{| l | rr |}    \hline
    year  & min temp (C)  & max temp (C)\\  \hline
    1970  & −5 & 35\\
    1980  & −3 & 30\\
    1985  & −2 & 32\\  \hline
  \end{tabular}
  \caption{ Fictional   min/max temperatures.} \label{tab:simple}
\end{table}
```

year	min temp (C)	max temp (C)
1970	-5	35
1980	-3	30
1985	-2	32

Table: Fictional min/max temperatures.

Labels and references

1. For complex documents, rather than writing “Table 3”, it is better to give the Table a label using `\label{tab:simple}`, and then refer to that label, using e.g. `See Table~\ref{tab:simple}`.
2. You can also refer to figures, equations, sections in a similar way.
3. To refer to pages you can do:

```
1                    This  is  on page \pageref{labels }.
```

This is on page 24.

Figures

```
\begin{figure}
   \centering
   \fbox{\includegraphics[width=4cm]{sigmoid}}
   \caption{Example of a sigmoidal curve.}
   \label{fig:example}
\end{figure}
```

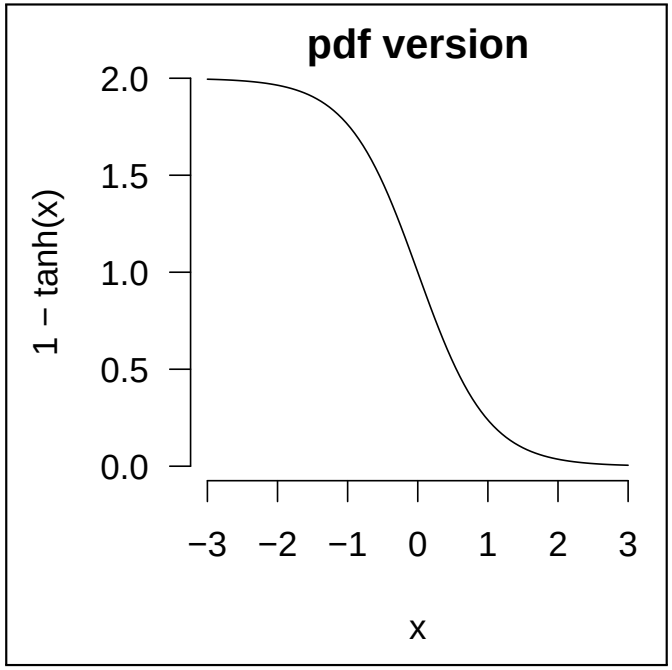


Figure: Example of a sigmoidal curve.

Advanced topics

mathml `http://docs.mathjax.org/en/latest/tex.html` latex in your web pages is converted to mathml, and then rendered.

lualatex Embedded programming language (LUA) within latex.

Reproducible research `https://github.com/sje30/waverepo/blob/master/paper/waverepo_paper.Rnw`
`http://www.gigasciencejournal.com/content/3/1/3`

markdown If latex looks too cumbersome/heavyweight, write in markdown, which can then be converted to .tex (.pdf) or .html or .doc by `http://johnmacfarlane.net/pandoc/`

unicode xelatex engine allows you to use unicode directly in source file, e.g. α rather than the command. See `https://github.com/sje30/latex101/blob/master/unicode-eg.tex`

Getting help

1. Work through Lamport's book slowly and surely.
2. Google what you need to. Often you can find good answers on `http://tex.stackexchange.com/`
3. Keep it simple for now! Focus on the content, not the form.
4. *The LaTeX companion* lists vast number of packages.

Further reading

A (not so) short introduction to LaTeX2e
`https://www.ctan.org/tex-archive/info/lshort/english/?lang=en`.
(about 133 pages).
Lamport (1994) LaTeX: a Document Preparation System : User's Guide and Reference Manual.
Kopka and Daly (2003) A Guide to LaTeX (Tools and Techniques for Computer Typesetting).
Mittelbach et al. (2004.) The LaTeX Companion.

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History of TEX and LATEX

TEX was originally a six-month project in 1978 started by Donald Knuth, which took ten years:
`http://www.ctan.org/ctan-portal/tex/`

Command line material (Advanced)

If you run from the command line, you need to follow instructions on how often to re-rerun LaTeX to resolve references.
latexmk, texi2pdf help with this problem.