

L^AT_EX 101

Stephen J. Eglen

Cambridge Computational Biology Institute
Department of Applied Mathematics and Theoretical Physics
University of Cambridge
<http://sje30.github.io/post/latex2016/>

October 2016

What is L^AT_EX?

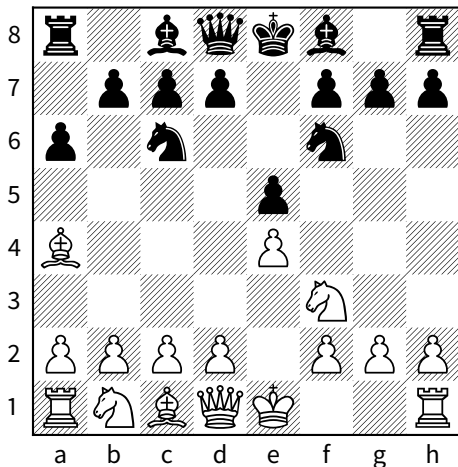
- Typesetting, not WYSIWYG.
- Given a source file (file.tex) you **compile** your document (file.pdf).
- Heavily used by mathematicians/scientists/publishers for formatting papers/books.
- Logical markup of your document (like HTML) rather than specifying exactly how you want it look.
- Use Word (or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

```

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

```

1 e4 e5 2 Nf3 Nc6 3 Bb5 a6 4 Ba4 Nf6



“Hello world” example

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

Hello world. Welcome to L^AT_EX.

Another example (Taken from showexpl-test.tex)

```
1 \documentclass[a4paper,twoside]{article}
2 \begin{document}
3 \begin{equation}
4   \sigma(t)=\frac{1}{\sqrt{2\pi}} \int_0^t e^{-x^2/2} dx
5 \end{equation}
6 \end{document}
```

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

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 L^AT_EX 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`
- `www.sharelatex.com`
- Which is better?
`http://tex.stackexchange.com/questions/179030/
comparison-sharelatex-vs-overleaf-formerly-writelatex`

L^AT_EX syntax - commands

- L^AT_EX 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:

1 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 $\text{\texttt{\backslash begin{eqnarray}}}$
 - 3 $\text{\texttt{\quad I_1 \&= \backslash int_0^{2 \pi} \sin (x^2) dx \backslash nonumber \}}$
 - 4 $\text{\texttt{\quad \text{but}\backslash, \quad I_2 \&= \backslash int_0^{2 \pi} \cos (x^2) dx \backslash label{key}}}$
 - 5 $\text{\texttt{\backslash end{eqnarray}}}$
 - 6 The dx in Equation 2 needs fixing later $\text{\texttt{\backslash ldots}}$

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 L^AT_EX

<http://mirrors.ctan.org/macros/latex/required/amslatex/math/amslldoc.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 L^AT_EX. These packages are available on Comprehensive TeX Archive Network (CTAN). Most of them are downloaded for you when installed L^AT_EX.

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

\gtrsim	<code>\eqslantgtr</code>	\gtrless	<code>\gtreqless</code>	\lessapprox	<code>\lesssim</code>	\ngtrless	<code>\ngtreqless</code>
\lessapprox	<code>\eqslantless</code>	\gtrless	<code>\gtrless</code>	\ll	<code>\ll</code>	\ngtrlessless	<code>\ngtreqlessless</code>
\gtrsim	<code>\geq</code>	\gtrless	<code>\gtrneqless</code>	\lll	<code>\lll</code>	\ngtrless	<code>\ngtreqless</code>
\geq	<code>\geqclosed</code>	\gtrsim	<code>\gtrsim</code>	\lnapprox	<code>\lnapprox</code>	\ngtrless	<code>\ngtrless</code>
\geq	<code>\geqdot</code>	\lessapprox	<code>\leq</code>	\lneqq	<code>\lneqq</code>	\nleq	<code>\nleq</code>
\geqq	<code>\geqq</code>	\geq	<code>\leqclosed</code>	\lnsim	<code>\lnsim</code>	\nleqclosed	<code>\nleqclosed</code>
\geqslant	<code>\geqslant</code>	\geq	<code>\leqdot</code>	\neqslantgtr	<code>\neqslantgtr</code>	\nleqdot	<code>\nleqdot</code>
\geqslantdot	<code>\geqslantdot</code>	\leqq	<code>\leqq</code>	\neqslantless	<code>\neqslantless</code>	\nleqq	<code>\nleqq</code>
\gg	<code>\gg</code>	\leqslant	<code>\leqslant</code>	\ngeq	<code>\ngeq</code>	\nleqslant	<code>\nleqslant</code>
\ggg	<code>\ggg</code>	\leqslantdot	<code>\leqslantdot</code>	\ngeqclosed	<code>\ngeqclosed</code>	\nleqslantdot	<code>\nleqslantdot</code>
\gnaapprox	<code>\gnaapprox</code>	\less	<code>\less</code>	\ngeqdot	<code>\ngeqdot</code>	\nless	<code>\nless</code>
\gneqq	<code>\gneqq</code>	\lessapprox	<code>\lessapprox</code>	\ngeqq	<code>\ngeqq</code>	\nlessclosed	<code>\nlessclosed</code>
\gnsim	<code>\gnsim</code>	\lessclosed	<code>\lessclosed</code>	\ngeqslant	<code>\ngeqslant</code>	\nlessdot	<code>\nlessdot</code>
\gtr	<code>\gtr</code>	\lessdot	<code>\lessdot</code>	\ngeqslantdot	<code>\ngeqslantdot</code>	\nlesseqgtr	<code>\nlesseqgtr</code>
\gtrapprox	<code>\gtrapprox</code>	\lesseqgtr	<code>\lesseqgtr</code>	\ngg	<code>\ngg</code>	\nlesseqgtrslant	<code>\nlesseqgtrslant</code>
\gtrclosed	<code>\gtrclosed</code>	\lesseqgtrslant	<code>\lesseqgtrslant</code>	\nggg	<code>\nggg</code>	\nlesseqqgtr	<code>\nlesseqqgtr</code>
\gtrdot	<code>\gtrdot</code>	\lesseqqgtr	<code>\lesseqqgtr</code>	\ngtr	<code>\ngtr</code>	\nlessgtr	<code>\nlessgtr</code>
\gtreqless	<code>\gtreqless</code>	\lessgtr	<code>\lessgtr</code>	\ngtrclosed	<code>\ngtrclosed</code>	\nll	<code>\nll</code>
\gtreqlessless	<code>\gtreqlessless</code>	\lessneqqgtr	<code>\lessneqqgtr</code>	\ngtrdot	<code>\ngtrdot</code>	\nlll	<code>\nlll</code>

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

```
1 \newcommand{\betallKO}  
2 {\ensuremath{\beta\mathit{2}^{--}}\xspace}  
3 The \betallKO mouse is widely studied \ldots  
4 the \betallKO command is easier for me  
5 to type than the whole expansion.  
6  
7 \newcommand{\nnn}[1]{\ensuremath{\#1^{\#1^{\#1}}}}  
8 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 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

```
1 \begin{table}
2   \centering
3   \begin{tabular}{|l|rr|} \hline
4     year & min temp (C) & max temp (C)\\ \hline
5     1970 & -5 & 35\\
6     1980 & -3 & 30\\
7     1985 & -2 & 32\\ \hline
8   \end{tabular}
9   \caption{Fictional min/max temperatures.} \label{tab:simple}
10 \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

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

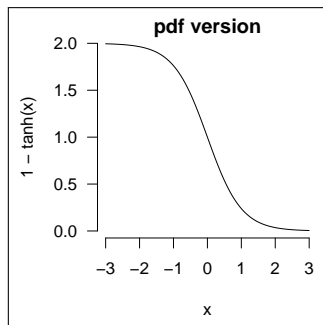


Figure: Example of a sigmoidal curve.

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/>

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 L^AT_EX 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>.
(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.

Acknowledgements Thanks to Robert Stojnic and Markus Kuhn, who wrote similar lectures and shared material.

History of T_EX and L^AT_EX

T_EX 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.