

# Advanced Use of L<sup>A</sup>T<sub>E</sub>X

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## Outline

Resources and documentation

Software

L<sup>A</sup>T<sub>E</sub>X to PDF

Graphics

Mathematics

## Resources and documentation: online

### T<sub>E</sub>X resources on the web

- ▶ **Everything**, including endless documentation, is at <http://www.tug.org/interest.html>

### Online guides (also included in most T<sub>E</sub>X distributions)

- ▶ The not so Short Introduction to LaTeX2e  
<http://www.ctan.org/tex-archive/info/lshort>
- ▶ User's Guide for the `amsmath` Package  
<http://www.tug.org/texlive/Contents/live/texmf-dist/doc/latex/amsmath/amslldoc.pdf>

## Resources and documentation: books

- ▶ See <http://www.tug.org/books/> for a comprehensive list

### We mention in particular

- ▶ *LaTeX: A Document Preparation System, 2nd Edition* by Leslie Lamport.  
An excellent introduction
- ▶ *Guide to LaTeX, 4th Edition* by Helmut Kopka and Patrick W. Daly.  
A more comprehensive reference
- ▶ *The LaTeX Companion, 2nd Edition* by Frank Mittelbach, Michel Goossens, Johannes Braams, David Carlisle, and Chris Rowley.  
A **heavy** introduction to some hundreds of useful packages: particularly good for its coverage of the  $\mathcal{A}\mathcal{M}\mathcal{S}$ -L<sup>A</sup>T<sub>E</sub>X mathematics packages (`amsmath`, etc).

## Requirements

You need:

- ▶ A recent T<sub>E</sub>X distribution
- ▶ A good L<sup>A</sup>T<sub>E</sub>X-aware editor
- ▶ A previewer with synchronisation

Possibilities:

- ▶ Editor-previewer packages
  - ▶ Windows: [TeXnicCenter](#), ...
  - ▶ Linux: [Kile](#), [TeXMaker](#), ...
  - ▶ Mac: [TeXShop](#), ...
- ▶ [Emacs](#) (with [AucTeX](#) and [RefTeX](#) plugins)  
+ (synchronising) previewer

## SyncTeX

- ▶ Permits [reverse search](#) from previewer to editor
- ▶ Included in T<sub>E</sub>X as of Version 3.1415926 (Summer 2008)
- ▶ Call with, e.g.  
`pdflatex -synctex=1 file.tex`  
or by placing  
`\synctex=1`  
in the document preamble
- ▶ Leaves output file [file.pdf](#) unchanged and writes auxiliary file [file.synctex.gz](#).
- ▶ Doesn't work very well with [Beamer](#)

## L<sup>A</sup>T<sub>E</sub>X to PDF — possible routes

- ▶ `file.tex`  $\xrightarrow{\text{pdflatex}}$  `file.pdf`
  - ▶ Graphics files for inclusion with `graphicx` package should be `.jpg`, `.png`, `.pdf`, or `.eps` (if `epstopdf` package loaded).
  
- ▶ `file.tex`  $\xrightarrow{\text{latex}}$  `file.dvi`  $\xrightarrow{\text{dvipdfm}}$  `file.pdf`
  - ▶ Graphics files should be `.eps`.
  
- ▶ `file.tex`  $\xrightarrow{\text{latex}}$  `file.dvi`  $\xrightarrow{\text{dvips -Ppdf}}$  `file.ps`  $\xrightarrow{?}$  `file.pdf`
  - ▶ Necessary only if using Postscript within L<sup>A</sup>T<sub>E</sub>X (e.g. `pstricks`)
  - ▶ `dvips` needs to be told to use **Postscript Type 1** scalable fonts.
  - ▶ Graphics files should be `.eps`.

## PDF font issues

- ▶ For good onscreen-readability of PDF files, embedded fonts should be **scalable**, e.g. Type-1 Postscript or TrueType — as opposed to the original **bit-mapped** fonts used by T<sub>E</sub>X.
- ▶ Not all fonts distributed with T<sub>E</sub>X/L<sup>A</sup>T<sub>E</sub>X include **scalable** versions.
- ▶ `pdflatex` and `latex` followed by `dvipdfm` automatically use **scalable** fonts where available.
- ▶ `dvips` needs to be configured to do so.

## The hyperref package

- ▶ Adds **document information** and **links** (both internal and external) to a PDF document

- ▶ Typical preamble:

```
\usepackage{hyperref}
\hypersetup{plainpages=false, colorlinks, urlcolor=blue,
pdftitle={Probability and Statistics},
pdfauthor={S Zachary},
pdfstartview={FitBH}
}
```

- ▶ **Internal links** made automatically (using `\label` and `\ref`)

- ▶ Make **external links** with, e.g.

```
\href{http://www.hw.ac.uk}{Heriot-Watt University}
```

This produces a link to **Heriot-Watt University**

## Graphics inclusion

- ▶ Via the `graphicx` package, i.e. place

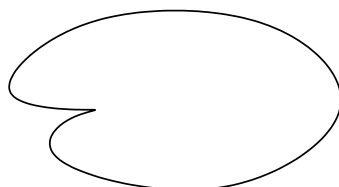
```
\usepackage{graphicx}
```

in the preamble.

- ▶ The figure `myfig.pdf` is then included in the appropriate place in the body of the document with

```
\begin{center}
\includegraphics{myfig}
\end{center}
```

(note that the extension may in general be omitted). This gives



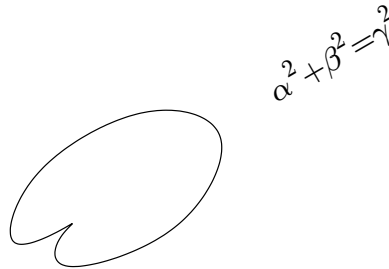
$$\alpha^2 + \beta^2 = \gamma^2$$

## Graphics inclusion

- ▶ The `includegraphics` command has many options to **scale**, **re-dimension**, **clip**, **rotate** the figure. For example

```
\begin{center}
  \includegraphics[scale=0.7,angle=30]{myfig}
\end{center}
```

gives



- ▶ The above code may be included within a `figure` environment for numbering, captioning and floating placement.

## Graphics inclusion – xfig

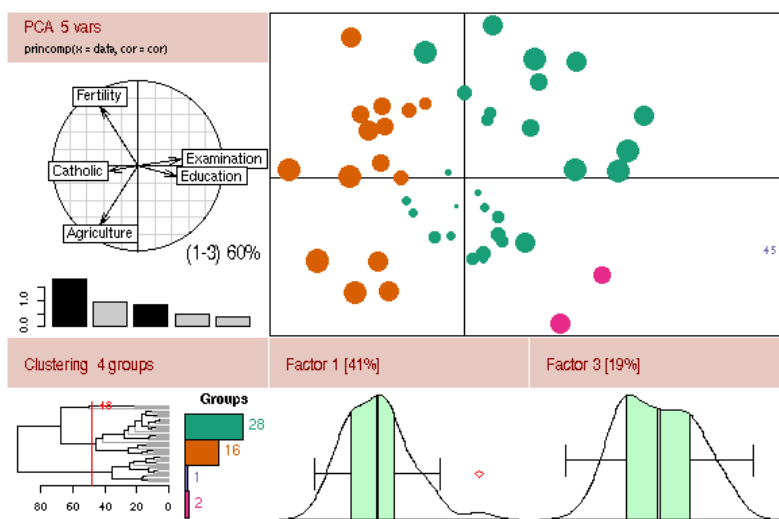
- ▶ **xfig** (primarily for Unix) is a useful, and very capable, program for drawing and annotating figures and diagrams.
- ▶ Home page: <http://www.xfig.org/>
- ▶ Can export figures as
  - ▶ **.tex** code for input into L<sup>A</sup>T<sub>E</sub>X
  - ▶ **.eps** or **.pdf** files for graphics inclusion in L<sup>A</sup>T<sub>E</sub>X.
- ▶ Useful to be able to use L<sup>A</sup>T<sub>E</sub>X code for annotation. This is quite complicated in the case of export to **.eps** or **.pdf** files (as **xfig** has no TeX engine).
- ▶ Details of how to do it, and also a workaround script (which directly converts **.fig** files to **.eps** and **.pdf** files) are at <http://www.ma.hw.ac.uk/~stan/computing/xfiglatexnotes.txt>

## Graphics inclusion – jfig

- ▶ **jfig** is a shareware clone of **xfig**.
- ▶ Home page: <http://tams-www.informatik.uni-hamburg.de/applets/jfig/>
- ▶ Written as a Java applet and hence multiplatform.
- ▶ Understands simple  $\text{\LaTeX}$  syntax, and so is easier to use for annotating figures for export to **.pdf**.

## Graphics inclusion – R

- ▶ **R** – programme for mathematical computation and statistical analysis
- ▶ Excellent plotting and other graphical capabilities
- ▶ Supports mathematical notation
- ▶ Can produce **.eps**, **.pdf**, and **.png** files
- ▶ Available free for all platforms
- ▶ Home page: <http://www.r-project.org>



## Packages to load

### Mandatory:

- ▶ `amsmath`: greatly enhanced capabilities for mathematical typesetting
- ▶ `amssymb`: additional fonts and symbols, e.g.  $\mathbb{R}$ ,  $\mathbb{Z}$ ,  $\mathfrak{F}$ ,  $\mathfrak{G}, \dots$
- ▶ `amsthm`: allows the creation of environments for typesetting lemmas, theorems, examples, remarks, etc, with flexible styles and numbering systems; also provides a proof environment

### Optional:

- ▶ `amscd`: commutative diagrams
- ▶ `eucal`: more readable calligraphic letters:  $\mathcal{A}, \mathcal{B}, \mathcal{C}, \mathcal{D}, \dots$

## `amsmath: align align*`

- ▶ `\begin{align}`  

$$x^2 + y^2 \quad \& = \quad z^2 \quad \backslash \text{nonumber} \quad \backslash \backslash$$

$$x^3 + y^3 \quad \& < \quad z^3$$
`\end{align}`

$$\begin{aligned} x^2 + y^2 &= z^2 \\ x^3 + y^3 &< z^3 \end{aligned} \tag{1}$$

- ▶ Better spacing than `eqnarray`
- ▶ Use `\nonumber` to suppress numbering of individual equations
- ▶ Replace `align` by `align*` to suppress all numbering
- ▶ Can be used for *n*-column alignment (using  $2n - 1$  “&”s).
- ▶ Variant `alignat` allows user-specification of horizontal spacing

amsmath: `multline` `multline*`

```

▶ \begin{multline}
  \lim_{x \to \infty} \frac{P(M > x)}{\overline{F^s}(x)} \leq
  \limsup_{x \to \infty} \frac{P(M > x, S_{\tau_1} > x - R + a - \epsilon)}{\overline{F^s}(x)}
  + \gamma
  \left( \frac{2 - \gamma}{(a - \epsilon)(1 - \gamma)^2} \right)
\end{multline}

```

$$\begin{aligned}
 \lim_{x \rightarrow \infty} \frac{P(M > x)}{\overline{F^s}(x)} &\leq \limsup_{x \rightarrow \infty} \frac{P(M > x, S_{\tau_1} > x - R + a - \epsilon)}{\overline{F^s}(x)} \\
 &\quad + \gamma \left( \frac{2 - \gamma}{(a - \epsilon)(1 - \gamma)^2} \right) \quad (2)
 \end{aligned}$$

## amsmath: further display environments for maths

- ▶ `equation` `equation*` single equation on single line
- ▶ `gather` `gather*` several equations without alignment
- ▶ `flalign` `flalign*` horizontally spread version of `align`
- ▶ `split` split a single equation with alignment

```

\begin{equation}
  \begin{split}
    (a + b)^3 &= (a + b)(a + b)^2 \\
    &= (a + b)(a^2 + 2ab + b^2) \\
    &= a^3 + 3a^2b + 3ab^2 + b^3
  \end{split}
\end{equation}

```

$$\begin{aligned}
 (a + b)^3 &= (a + b)(a + b)^2 \\
 &= (a + b)(a^2 + 2ab + b^2) \\
 &= a^3 + 3a^2b + 3ab^2 + b^3
 \end{aligned} \quad (3)$$

## amsmath: further display environments for maths

- ▶ the `cases` environment

```
\begin{equation*}
  I_A =
  \begin{cases}
    1 & \text{if } x \in A \\
    0 & \text{otherwise}
  \end{cases}
\end{equation*}
```

$$I_A = \begin{cases} 1 & \text{if } x \in A \\ 0 & \text{otherwise} \end{cases}$$

## amsmath: matrix environments

- ▶ `matrix`  $\begin{matrix} 0 & 1 \\ 1 & 0 \end{matrix}$
- ▶ `pmatrix`  $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$
- ▶ `bmatrix`  $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$
- ▶ `Bmatrix`  $\begin{Bmatrix} 0 & 1 \\ 1 & 0 \end{Bmatrix}$
- ▶ `vmatrix`  $\begin{vmatrix} 0 & 1 \\ 1 & 0 \end{vmatrix}$
- ▶ `Vmatrix`  $\begin{Vmatrix} 0 & 1 \\ 1 & 0 \end{Vmatrix}$

## amsmath: useful commands

► `\binom`  $\binom{n}{r}$

► `\substack` 
$$\sum_{\substack{1 \leq i \leq m \\ 1 \leq j \leq n}} a_{ij}$$

► `\xrightarrow`  $x \xrightarrow{f \circ g} y$

► `\boxed`  $\boxed{\alpha^2 + \beta^2 = \gamma^2}$

- many more commands to produce every conceivable mathematical notation and layout
- commands for fine control of equation numbering, size and placement of symbols, etc.