An introduction to LaTeX

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". . . intended for the creation of beautiful books – and especially for books that contain a lot of mathematics"

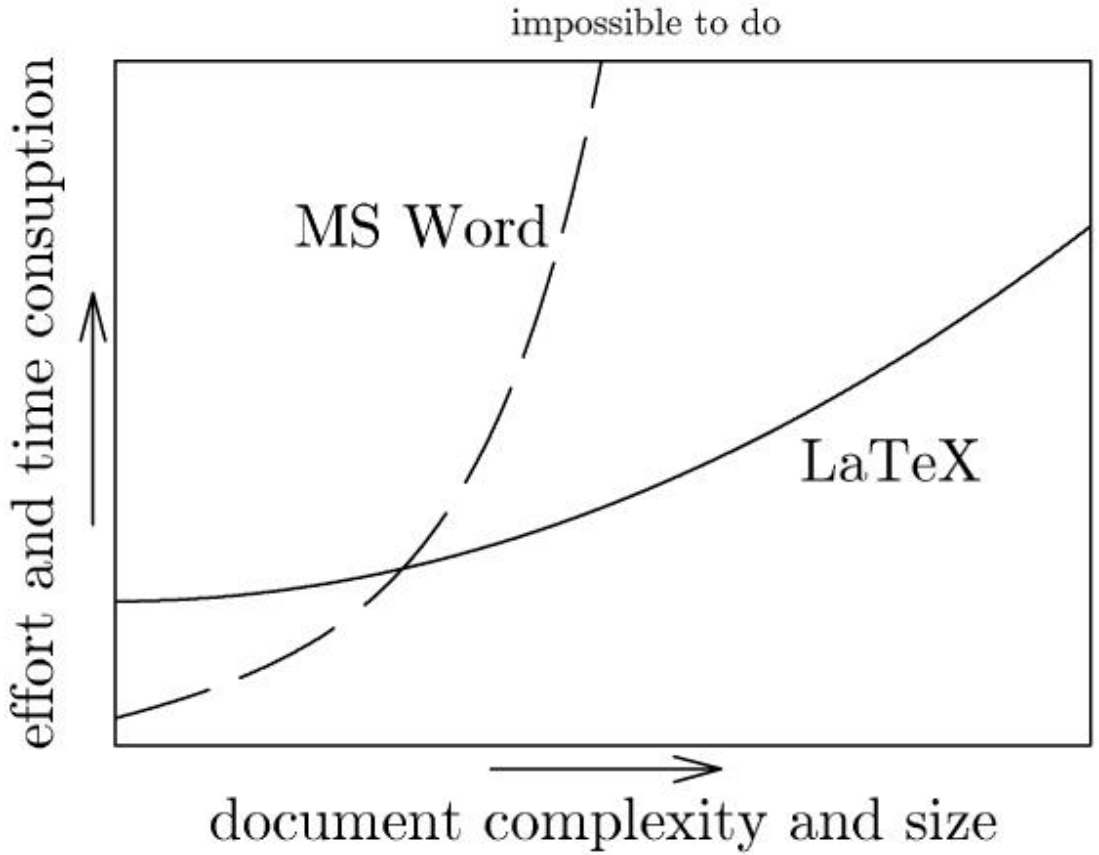
Donald E. Knuth on TeX (the original version of LaTeX).

- LaTeX (pronounced lay-tek) is a document preparation system for TeX
- Tex is a typesetting system designed by Donald Knuth and released in 1978
- LaTeX refers only to the language, not to the editor used to write LaTeX documents
- LaTeX documents are plain text files with the extension .tex
- Web site: `www.latex-project.org`
- LaTeX is free and widely used in academia

Why use LaTeX instead of MS Word?

UCL

According to some ...



- LaTeX produces good-looking mathematics
- LaTeX produces nice-looking documents
- It can easily be set up to update automatically references to sections, tables, figures
- BibTeX: automatic handling of references to papers/books
- **Main philosophy:** content is separate from layout. Write content without worrying (much) about appearance. One can change the appearance of the whole document easily

  ... and ...

- Using LaTeX pleases LaTeX-users. In some fields LaTeX is the norm

. . . but

- MS Word editor for formulas has improved in recent years
- MS Word: you see what your document looks like as you edit it
- Some journals/companies do not accept/use LaTeX
- For LaTeX you need to do a couple of steps to see the final document:
  - Either **.tex** $\rightarrow$ **.pdf**
  - or **.tex** $\rightarrow$ **.dvi** $\rightarrow$ **.pdf or .ps**
  - Then view **.pdf or .ps file**

LaTeX use in journals

- Nature:

  Our preferred format for text is Microsoft Word... If you have prepared your paper using TeX, please convert to PDF format and upload the PDF

- Journal of the American Statistical Association:

  Manuscripts submitted in LaTeX should use the "article" style and should not use any special macros. Authors should use BiBTeX to prepare references whenever possible. Please use natbib.sty, and either plain.bst or apalike.bst ...

- Journal of the Royal Statistical Society Series C:

  A complete LaTeX style file ... is available to download .. but it is not compulsory to use it

Getting LaTeX

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- You need to download MikTeX from www.miktex.org
- Choose your programme/editor
  - Free TeXstudio from http://texstudio.sourceforge.net
  - Free TeXworks from http://www.tug.org/texworks/
  - Free TeXMaker from https://www.xm1math.net/texmaker/
  - Almost free WinEdt from www.winedt.com
  - RStudio! and etc. ....
- These programmes include easy click-able routines for building pdf from a .tex file

Share the LaTeX knowledge

- Do not write a LaTeX file from scratch! Use an existing document/template and adapt
- **Annotated .tex file for these slides on Moodle**
- **Annotated .tex file for an MSc report also on Moodle**
- Use tips from other people or search the web when you encounter a problem

Next some explanation and tips for writing LaTeX...

Maths in the main text

- Distinguish math symbols in main text. Dollar signs denote math mode: `$x$` gives x (rather than x)
- Greek symbols: `$\alpha$` gives α, `$\Omega$` gives Ω etc.
- Mathematical operators:
  - `$1/x$` gives $1/x$
  - `$x^\alpha$` gives x^α
  - `$x^{-1}$` gives x^{-1}
  - `$\log x$` gives $\log x$
  - `$\frac{x}{y}$` gives $\frac{x}{y}$
  - `$\displaystyle\frac{x}{y}$` gives $\displaystyle\frac{x}{y}$

- You can define your own symbols/commands:

```
\newcommand{\e}{ {\rm e} }
```

Compare

```
f_X(x) = \lambda \e^{-\lambda x}, \quad x > 0.
```

$$f_X(x) = \lambda \mathrm{e}^{-\lambda x}, \quad x > 0.$$

with

```
f_X(x) = \lambda e^{-\lambda x}, \quad x > 0.
```

$$f_X(x) = \lambda e^{-\lambda x}, \quad x > 0.$$

Maths in displayed equations

```
\begin{equation}
  f_X(x) = \lambda \, \e^{-\lambda x}, \quad x > 0.
  \label{eqn:one} % label for equation
\end{equation}
This comment refers to equation (\ref{eqn:one}).
```

$$f_X(x) = \lambda \, \mathrm{e}^{-\lambda x}, \quad x > 0. \tag{1}$$

This comment refers to equation (1).

Multi-line displayed equations

```
\begin{eqnarray}
L(\lambda)
&=&\prod_{i=1}^n\lambda\e^{-\lambda x_i}\nonumber\\
&=&\lambda^n \exp\left\{-\lambda \sum_{i=1}^n x_i\right\}.
\label{eqn:two}
\end{eqnarray}
```

$$
\begin{aligned}
L(\lambda) &= \prod_{i=1}^{n} \lambda \mathrm{e}^{-\lambda x_i} \\
&= \lambda^n \exp\left\{-\lambda \sum_{i=1}^{n} x_i\right\}. \qquad (2)
\end{aligned}
$$

```
\begin{eqnarray*}    % eqnarray* for no equation numbers
P(M_n\leq z)
&=&P(X_1\leq z,X_2\leq z,\ldots,X_n\leq z)\\
&=&P(X_1 \leq z) \times \cdots \times P(X_n \leq z)\\
&=&{F(z)}^n.
\end{eqnarray*}
```

$$
\begin{aligned}
P(M_n \leqslant z) &= P(X_1 \leqslant z, X_2 \leqslant z, ..., X_n \leqslant z) \\
&= P(X_1 \leqslant z) \times \cdots \times P(X_n \leqslant z) \\
&= F(z)^n.
\end{aligned}
$$

Note: Mathematics should read just like sentences of text, with punctuation, i.e. commas, full stops etc.

Including a pdf file as a figure

```
\begin{figure}[h]
  \centering
  \includegraphics[width=7.5cm, angle=0]{file1.pdf}
  \includegraphics[width=7.5cm, angle=0]{file2.pdf}
  \caption{Put helpful caption in here ...}
  \label{fig:name}
\end{figure}

Figure \ref{fig:name} shows ...
```

Example of a table in LaTeX

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model	neg. log-lik	d.f.	ALRS	*p*-value
constant	22763.20			
linear	22742.59	2	34.23	0.0037
quadratic	22737.09	3	20.50	0.013
cubic	22737.02	4	2.09	0.72

Table 1: Summary of point process modelling in which the location parameter μ is modelled as a Legendre polynomial function of longitude and latitude and σ and ξ are constant. The tests compare the model with the model in the row above. Notation: neg. log-lik, negated maximised log-likelihood; d.f., degrees of freedom of the null chi-squared distribution; ALRS, adjusted likelihood ratio statistic.

A table

```
\begin{table}[h]
\centering
\begin{tabular}{lrcrl}\hline
model & neg. log-lik & df & ALRS  & $p$-value \\ \hline
constant & 22763.20     &    &       &           \\
linear   & 22742.59     & 2  & 34.23 & 0.0037    \\
quadratic  & 22737.09     & 3  & 20.50 & 0.013     \\
cubic & 22737.02     & 4  & 2.09  & 0.72      \\ \hline
\end{tabular}
\label{tab:simple}
\caption{Summary of point process modelling in which ...}
\end{table}

Table \ref{tab:simple} shows ...
```

Miscellaneous stuff

- Sections, graphs, tables, equations labelled using `\label{name}` and cited using `\ref{name}`
- Nested files? (to avoid having one big LaTeX file):

```
\begin{document}
\input{section1.tex}
\input{section2.tex}
etc.
\end{document}
```

- `\clearpage` forces LaTeX to put in all figures/tables before starting on new text. This can help to keep figures/tables close to where they are cited in the text
- `\hat{\theta}` gives $\hat{\theta}$
- `Y \sim N(0,\sigma^2)` gives $Y \sim N(0, \sigma^2)$

References

- LaTeX has BibTeX, an automatic way to produce citations in the text, using a consistent format, and a list of references
- Put details of books/papers etc. in a bibliography .bib file
- Often you can download the BibTeX entry from the web
  - from the publisher of an article or book
  - using reference managing software, such as Mendeley `https://www.mendeley.com/`
- Setup BibTeX when you first start writing
- Add citations as you go along: don't leave this until the end of your project

Giving a talk using beamer

- These slides have been produced using the LaTeX package **Beamer**
- For a user's guide: Google search for *Beamer User Guide for version 3.57*
- There is a lot on Beamer on-line. A nice example can be found at www.math.utah.edu/~smith/Beamer
- An alternative for making slides is using

```
\documentclass[landscape]{slides}
\begin{slide}
...
\end{slide}
```

Getting help

- There are many websites devoted to LaTeX
  `www.ctan.org/starter.html` is a good place to start
- Specifically for maths see also
  `www.math.uiuc.edu/~hildebr/tex/displays.html`
- There are also books:
  - Kopka and Daly (2003) *A Guide to LATEX: Tools and Technologies for Computer Typesetting*, Addison-Wesley
  - Lamport (1994) *LATEX: a Document Preparation System : User's Guide and Reference Manual*, Addison-Wesley
  - Mittelbach, Goossens, Braams, and Carlisle (2004) *The Latex Companion*, Addison-Wesley

- There are R packages, e.g.
  - Hmisc (cran.r-project.org/web/packages/Hmisc), and
  - xtable (cran.r-project.org/web/packages/xtable),

  that have functions for converting numerical results into LaTeX code for tables

- Automated on-line LaTeX table generator at www.tablesgenerator.com

- The R package mathpix (https://cran.r-project.org/web/packages/mathpix/index.html) can convert typed or handwritten maths to LaTeX code

Online LaTeX

- **Overleaf** is online system at `www.overleaf.com`
- Can be linked to GitHub (`www.github.com`) to facilitate synchronisation with a local machine
- OK for getting started, but long term: use your own editor, store your own files
  - To be independent of on-line access and problems at `www.overleaf.com`
  - To limit access to your *work in progress*

Markdown and Jupyter Notebooks

- **Markdown** is a simplified version of LaTeX
- For instance, to create an itemised list, just start sentences with an asterisk
- Markdown is also used by **Jupyter notebooks**, a way of integrating code and LaTeX-like comments ("Jupyter" stands for Julia/Python/R, the initial three languages targeted). It's a very good way to keep track of your code as you progress in your MSc project. See a few examples of it in some of your STAT0030 labs.
- A Markdown cheatsheet: https://stationinthemetro.com/apps-and-scripts/markdown-cheat-sheet
- Project Jupyter webpage: https://jupyter.org

Last-minute tips

- Don't forget spell-checking! Different editors offer different options. Old schoolers can use `aspell` for a plain tool
- Don't use spacing in names of files or directories
- Put your graph files where "LaTeX can find them". Either
  - same directory as the main .tex file
    ```
    \includegraphics[width=7cm, angle=0]{file1.pdf}
    ```
  - in a PLOTS directory
    ```
    \includegraphics[width=7cm, angle=0]{PLOTS/file1.pdf}
    ```
- Figures can be of extension .pdf and .eps. Depends on how you compile the .tex file. If you go directly from .tex to .pdf, then use .pdf figures

Finally

- I encourage you to use LaTeX for your project report
- The initial startup time/effort is worth it in the longer term

All the material from this workshop + template for an MSc project report are on Moodle