Latex

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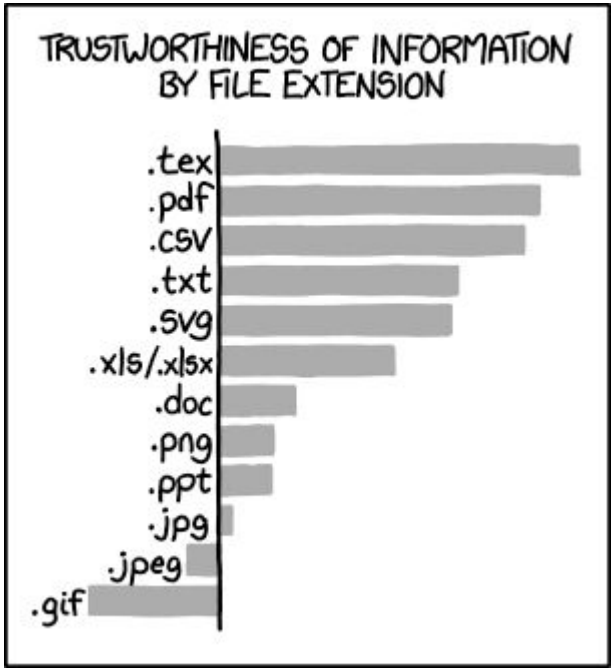
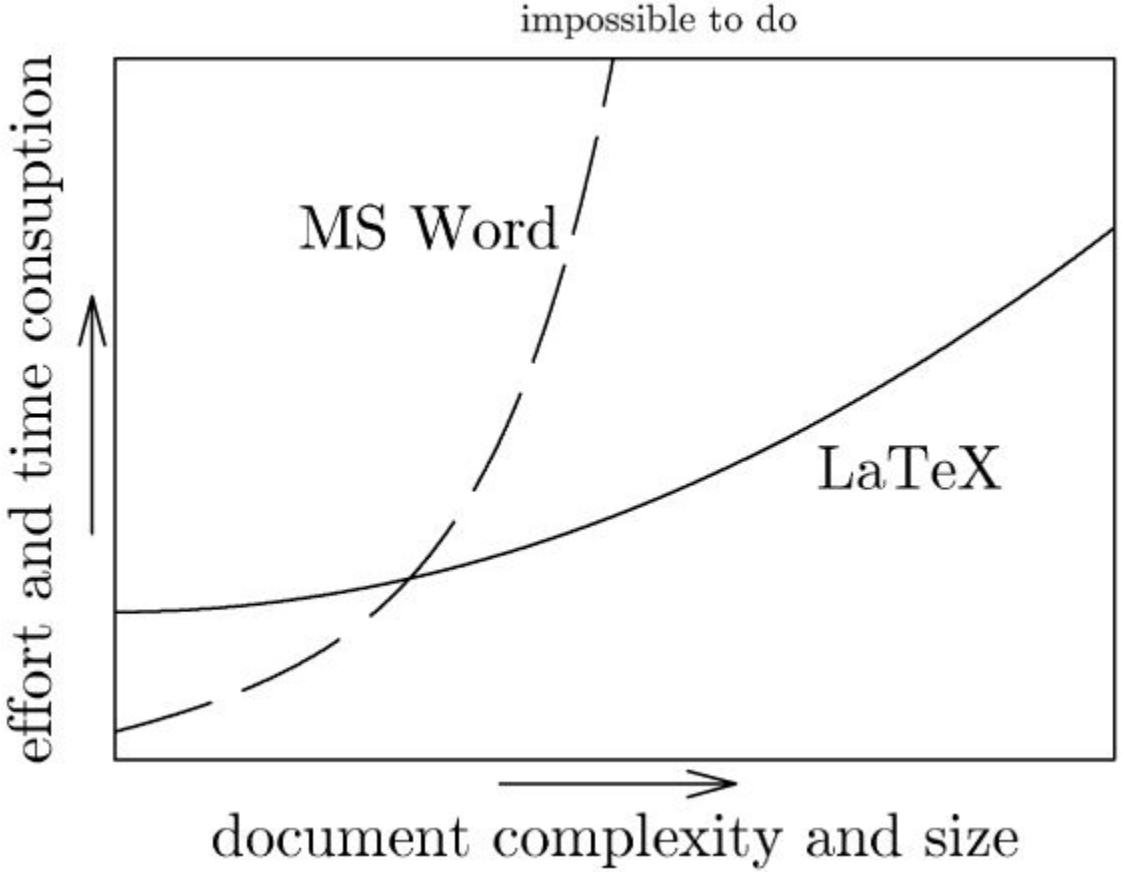


https://xkcd.com/1301/

Background

- Pronounced “lay-tech” or “lah-tech”
  - not lateks, as in gloves are made of latex
- LaTeX is a “Free” software system for document preparation
  - Provides high-quality typesetting
  - Authors can focus mostly on content/flow and not on aesthetics
  - Used to produce predominantly technical or scientific documents
    - Mathematical symbols, Equations, Footnotes, Tables, Figures, References, Table of contents, Bibliographies etc can be easily integrated



https://qph.cf2.quoracdn.net/main-qimg-7e3da016a0568d132ebea98a88654277

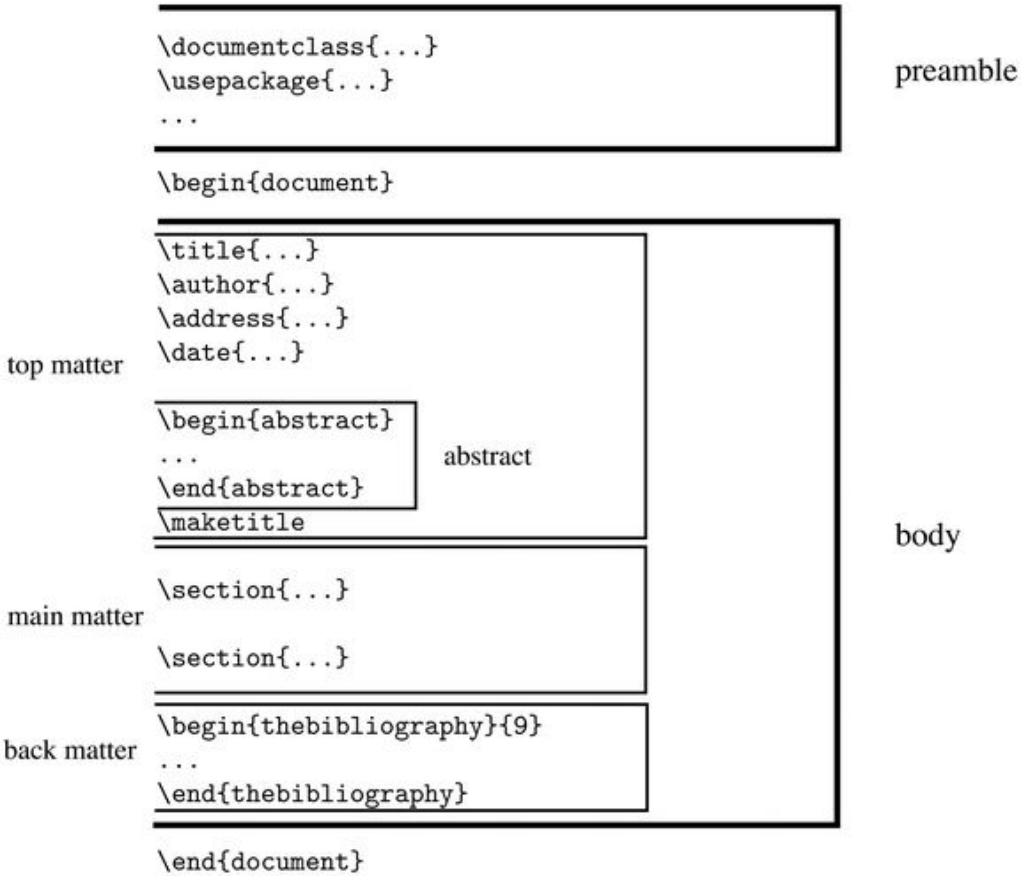
Files Used

- .tex: source document file (main file which you will edit)
- .cls: class file, loaded with \documentclass{...}
  - Mandatory, appears once in latex document, often very first command
  - Most common classes: article, report, letter, book, slides, beamer etc
  - E.g. article class provides commands for typesetting articles, such as \section, \tableofcontents, \author

- .sty: style or packages, loaded with \usepackage{...}
  - Packages are optional and many may be loaded
  - Often prior to the beginning of the document
  - Provide things on top of the class
  - E.g. graphicx package helps include images with graphical effects
- .bib: BibTeX Bibliographical Database file, a specially formatted text file that lists references

Format

https://media.springernature.com/lw685/springer-static/
_5_En_8_Fig1_HTML.gif



Simple Example

```
\documentclass[12pt, letterpaper]{article}

\title{My first LaTeX document}
\author{Hubert Farnsworth\thanks{Funded by the Overleaf team.}}
\date{August 2022}

\begin{document}
\maketitle
We have now added a title, author and date to our first \LaTeX{} document!
% This line here is a comment. It will not be typeset in the document.
\end{document}
```

Demo

- You can view, edit and compile latex in standalone applications like texstudio or cloud platforms like overleaf (https://www.overleaf.com/)
- We will use vscode to view and edit
  - Latex Workshop is an extension you can install for latex compilation if you want
- We will use pdflatex command to compile at a terminal
- See 01-simple.tex

Text Formatting

- Bold: bold text in LaTeX is typeset using the \textbf{...} command.
- Italics: italicised text is produced using the \textit{...} command.
- Underline: to underline text use the \underline{...} command.
- Example:
  - Some of the \textbf{greatest} discoveries in \underline{science} were made by \textbf{\textit{accident}}
- \emph{argument}: depends on the context
  - Inside normal text, the emphasized text is italicized
  - Reversed if used inside an italicized text

Demo

See 02-text.tex

Sections

- \section{section}: Creates a major section in the document
  - It is typically numbered automatically
- \subsection{subsection}: Defines a subsection within a section, allowing hierarchical organization
- \subsubsection{subsubsection}: Further divides subsections into smaller segments for detailed structuring

Lists

- Bullet List (itemize): Uses bullet points for each item
  - Suitable for unordered lists
- Numbered List (enumerate): Uses sequential numbers (1, 2, 3, …)
  - Suitable for ordered lists where order matters
- Description List (description): Uses a label for each item instead of a bullet or number
  - Useful for defining terms or explaining concepts.

See 03-section-lists.tex

Images, Captions, Labels, References

- LaTeX supports inserting images using the graphicx package
- The figure environment is used to position images with captions and labels
- Captions (\caption{}) provide descriptions for images and are automatically numbered within the figure environment
- Labels (\label{}) are used to uniquely identify figures for cross-referencing within the document
- Using \ref{} allows referring to figures by their assigned labels, ensuring automatic numbering updates

See 04-images.txt

Math

- Two writing modes for typesetting mathematics
- inline math mode: formulas inline i.e. part of a paragraph
  - Use dollar signs: $ E = mc^2 $
  - Alternative: \(E = mc^2 \)
- display math mode: write expressions not part of a text or paragraph
  - Typeset on separate lines
  - Use double dollar signs: $$ E = mc^2 $$ (not recommended in LaTeX documents)
  - Use square brackets: \[E = mc^2 \]
  - Use the equation environment for numbered equations
    - Can use \label{} and \ref{} for labelling and referencing

See 05-math.tex

See 06-complex-math.tex

Reference: https://www.cmor-faculty.rice.edu/~heinken/latex/symbols.pdf

Tables

- Tables in LaTeX are created using the tabular environment, often inside a table environment
- tabular Environment: Used to define the structure of the table
  - Specifies the number of columns and their alignment
  - l ⟶ Left-aligned (left)
  - c ⟶ Center-aligned (center)
  - r ⟶ Right-aligned (right)
  - | ⟶ Adds vertical lines between columns
  - E.g. \begin{tabular}{|c|c|}

- Adding Table Content: Each row is written on a new line, and columns are separated by &
  - E.g. A & B \\
    - \\ ends a row
- \hline is used to draw horizontal lines above or below rows
- \cline{i-j} – Partial Horizontal Line
  - Draws a partial horizontal line, spanning only from column i to column j

- table environment is used for floating tables
  - LaTeX automatically positions based on page layout
- Caption (\caption{...}) → Provides a title for the table
- Label (\label{...}) → Enables referencing the table

- Merging Columns (\multicolumn{columns}{alignment}{content})
  - Used to span multiple columns into one
- Merging Rows (\multirow{rows}{width}{content})
  - Used to span multiple rows into one
- Requires multirow package
- E.g. \multicolumn{2}{|c|}{Merged Header} \\

- tabular Environment: Used to create the actual table structure with rows and columns
- table Environment: A floating container used to wrap tabular
  - Allows adding captions, labels, and positioning (h, t, b, p for here, top, bottom, page)
  - Helps LaTeX handle table placement automatically for better document layout

See 07-tables.tex

References

- \bibitem (not recommended)
- \bibitem is a LaTeX command used in the bibliography environment to create references manually in a document
- Each \bibitem{label} creates a new reference with an identifier (label), which can be cited using \cite{label}
  - References are automatically numbered in the order they appear

%%%%%%%%%% Example %%%%%%%%%%%%%%%%%%%%%%%%%%%%
\begin{thebibliography}{100} % 100 is a random guess of the total number of %references
\bibitem{Boney96} Boney, L., Tewfik, A.H., and Hamdy, K.N., ``Digital Watermarks for Audio Signals," \emph{Proceedings of the Third IEEE International Conference on Multimedia}, pp. 473-480, June 1996.
\bibitem{MG} Goossens, M., Mittelbach, F., Samarin, \emph{A LaTeX Companion}, Addison-Wesley, Reading, MA, 1994.
\bibitem{HK} Kopka, H., Daly P.W., \emph{A Guide to LaTeX}, Addison-Wesley, Reading, MA, 1999.
\bibitem{Pan} Pan, D., ``A Tutorial on MPEG/Audio Compression," \emph{IEEE Multimedia}, Vol.2, pp.60-74, Summer 1998.
\end{thebibliography}

Reference: Digital watermarks for audio signals were introduced in 1996 \cite{Boney96}.

- Tough to accurately format each \bibitem based on the reference style you're asked to use
  - Should the year come immediately after the authors, or at the end of the entry?
  - Given names first, or last names first?
  - For different manuscripts or documents that use different reference styles you'll need to rewrite the \bibitem for each reference.

Bibtex

Maintain a bibliography database file (e.g. sample.bib) which contains format-independent information about our references

```
@book{texbook,
  author = {Donald E. Knuth},
  year = {1986},
  title = {The {\TeX} Book},
  publisher = {Addison-Wesley Professional}
}

@book{latex:companion,
  author = {Frank Mittelbach and Michel Gossens
            and Johannes Braams and David Carlisle
            and Chris Rowley},
  year = {2004},
  title = {The {\LaTeX} Companion},
  publisher = {Addison-Wesley Professional},
  edition = {2}
}
```

\bibliographystyle{plain} % We choose the "plain" reference style
\bibliography{sample} % Entries are in the sample.bib file

This is processed with the following sequence of commands, assuming our LATEX document is in a file named sample.tex (and that we are using pdflatex):

pdflatex sample
bibtex sample
pdflatex sample
pdflatex sample

Why 4 runs?

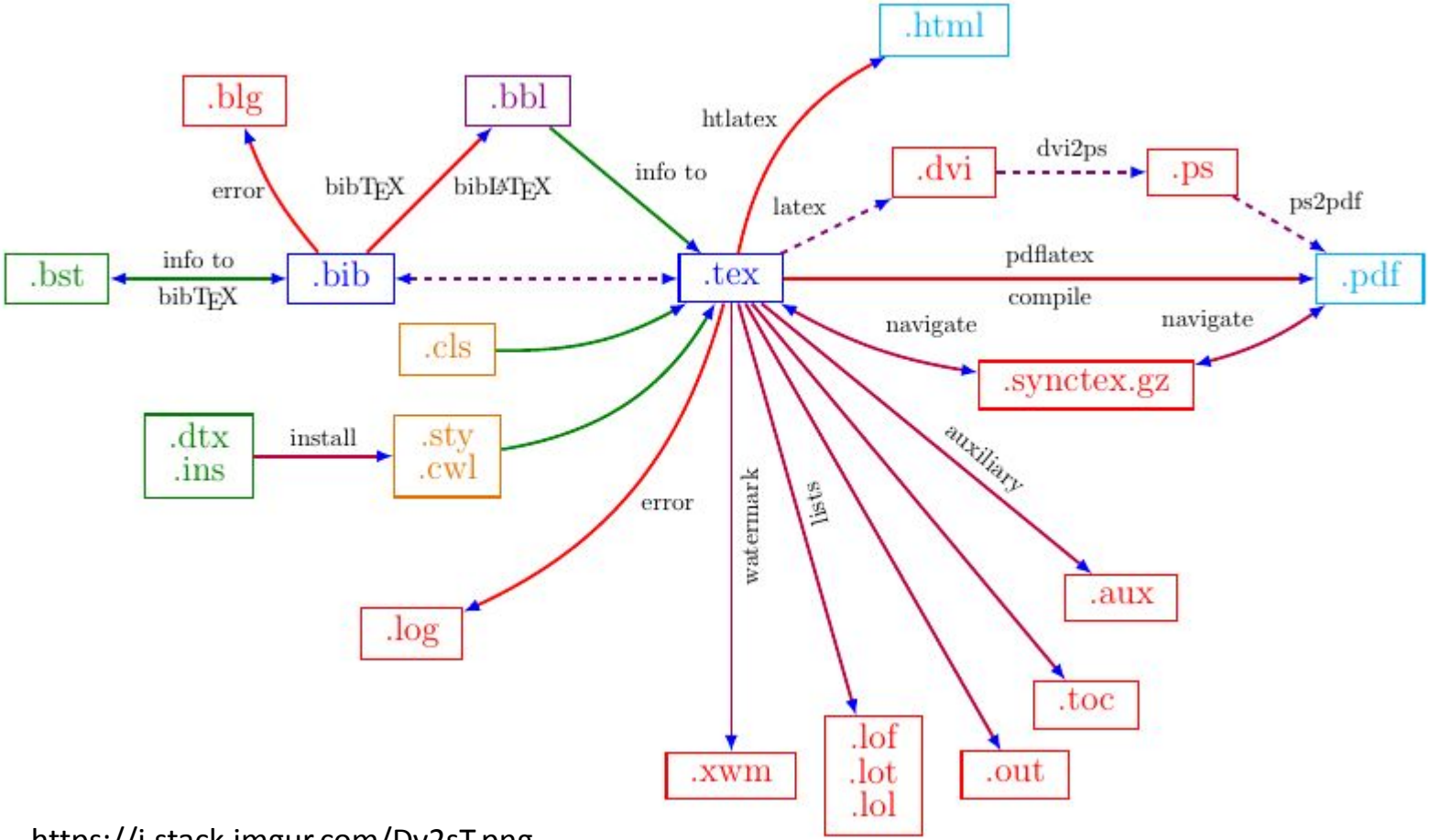
1. First pdflatex run: pdflatex sees \bibliographystyle{...} and a \bibliography{...}
   - Doesn't know what \cite{...} commands are about
   - In output PDF, all the \cite{...} commands are simply rendered as [?] and no reference list appears
   - pdflatex writes information about the bibliography style and .bib file, as well as all occurrences of \cite{...}, to the file sample.aux

2. Bibtex sample now looks at sample.aux

- Notes the .bib file indicated by \bibliography{...}
- Looks up all the entries with keys that match the \cite{...} commands used in the .tex file
- Uses the style specified with \bibliographystyle{...} to format the cited entries, and writes a formatted thebibliography list into the file sample.bbl
- no changes are made to the output PDF

3. pdflatex runs again: sees sample.bbl file
   - inserts the contents of sample.bbl i.e. the \begin{thebibliography}....\end{thebibliography} into the LATEX source, where \bibliography{...} is
   - reference list appears in the output PDF formatted according to the chosen \bibliographystyle{...}, but the in-text citations are still [?]

4. pdflatex run again: \cite{...} commands are replaced with the corresponding numerical labels in the output PDF!



https://i.stack.imgur.com/Dy2sT.png

See 08-references.tex

Also 09-sample.tex for a overall latex document

Common mistakes

- “end” doesn’t follow “begin”
- $ doesn’t follow $
- Using commands from packages not defined in the preamble
- Forgetting to escape i.e. “\”s.
- Forgetting bibliography{filename}
  - bibtex file is saved in the same location where the sample tex file is saved.
- Forgetting end{document}

References

- https://www.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes (brief)
- https://www.overleaf.com/learn/latex/Bibliography_management_with_bibtex
- https://www.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes (in-depth)
- https://www.andrew.cmu.edu/course/15-251/misc/LaTex%20Primer.pdf
- https://www.overleaf.com/learn/latex/Errors (errors)