A LaTeX Guide

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1 Introduction

What is LaTeX?   LaTeX is a macro language that lets you create PDFs out of code. It is made to handle formulas well. It streamlines cross-page references. Science book/article use LaTeX for publication in standard.

   Keep bookkeeping information after the `\documentclass{article}` command and before `\begin{document}`, a place known as the *preamble*.

   Materials between `\begin{document}` and `\end{document}`, a place known as the document *body*, show up in the PDF.

LaTeX Editors   You can install a LaTeX engine on your computer to compile LaTeX. There are various LaTeX Editors, including TeXLive, TeXmaker, vim, VSCode, etc. This tutorial recommends Overleaf, an awesome online LaTeXcompiler with collaboration features and a visual editor, which is very friendly to new LaTeX users.

2 Use LaTeX for Math

When writing math in LaTeX, the packages `amsfonts,amsmath,amssymb,amsthm` are really useful, provided by *American Mathematics Society* with many math symbols. The command `\usepackage{amsfonts,amsmath,amssymb,amsthm}` can use the packages in the file.

Commands   For math mode, LaTeX use `_`, `^` for subscript and superscript respectively. To type them in text, use `\_, \^` . Similarly, to type \$, %, & in text, use `\$, \%, \&` . For \, use `$\backslash$`

   For example,

```
The free fall equation is $y_t-y_0= gt^2/2$.
```

compiles as The free fall equation is $y_t - y_0 = gt^2/2.$

   Special symbols in math mode all begin with a backslash, and end when a space, number or another command appears.

   For example, `$\sin(\alpha+\beta)=\sin(\alpha)\cos(\beta)+\cos(\alpha)\sin(\beta)$` will be $\sin(\alpha + \beta) = \sin(\alpha)\cos(\beta) + \cos(\alpha)\sin(\beta)$

   There are a lot of math symbols, usually named exactly the same way you would expect.

Command	Symbol
`$\sum\prod\cap\cup\bigcap\bigcup$`	$\sum\prod\cap\cup\bigcap\bigcup$
`$\alpha \beta ... \omega$`	$\alpha\beta\gamma\delta\epsilon\varepsilon\zeta\eta\theta\vartheta\iota\kappa\lambda\mu\nu\xi o\pi\varpi\rho\varrho\sigma\varsigma\tau\upsilon\phi\varphi\chi\psi\omega$
`$\sum^{n}_{i=1} n$`	$\sum_{i=1}^{n} n$
`\LaTeX`	LaTeX
`$ < \leq \nleq > \geq \ngeq = \neq \approx$`	$<\leq\nleq>\geq\ngeq=\neq\approx$ $\forall\exists\forall$
`$\in \subset \subseteq \nsubseteq \notin \varnothing$`	$\in\subset\subseteq\nsubseteq\notin$ $\forall$ $\exists\varnothing$
`$\partial \nabla \int \iint \Im \Re$`	$\partial\ \nabla\ \int\ \iint\ \Im\ \Re$
`$10 \equiv 1 \pmod{3}$`	$10 \equiv 1 \pmod 3$
`$\rightarrow \Rightarrow \longrightarrow$`	$\rightarrow\Rightarrow\longrightarrow$
`$\mathbb{R}\mathbb{Q}\mathbb{Z}\mathbb{N}$`	$\mathbb{R}\mathbb{Q}\mathbb{Z}\mathbb{N}$
`$+ - \times \cdot \frac{a}{b}$`	$+-\times\cdot\frac{a}{b}$

Table 1: Some frequently-used symbols

   Some of them are not so intuitive, but you can use Detexify, Mathpix to recognize symbols, or through some LaTeX Math Symbol lists

- One LaTeX Math Symbols List
- Another LaTeX Math Symbols List

Inline Math   Inline math can be inserted by using the dollar symbol `$...$` and contents should be put between the dollar marks. For example, `$1+1+2$` will convert into $1 + 1 = 2$.

Displayed Math   When you want to separate the formulas from the text to make it a different line and centered, you can use `\[...\]` or `$$...$$`. `\[...\]` is more considered to be used when writing paper because sometimes `$$...$$` gets wrong without reasons (very old version command) while `\[...\]` always works.

For example,

```
Gauss proved that \[\sum_{k=0}^n k=\frac{n(n+1)}{2}.\]
```

compiles as

> Gauss proved that
> $$\sum_{k=0}^n k = \frac{n(n+1)}{2}.$$

Difference in Math Symbols in Inline and Displayed Math $\lim_{\delta x \to 0} f(x)$ and

$$\lim_{\delta x \to 0} f(x)$$

are different in the position of $\delta x \to 0$, to force inline math act the same as displayed ones, add `\displaystyle` at the front.

For example,

```
$\displaystyle\lim_{\delta x\to 0}f(x),
\displaystyle\sum^{n}_{i=1}a_i,
\displaystyle\prod^{n}_{i=1}a_j$
```

can compile as $\displaystyle\lim_{\delta x \to 0} f(x), \sum_{i=1}^n a_i, \prod_{i=1}^n a_j$, different from $\lim_{\delta x\to 0} f(x), \sum_{i=1}^n a_i, \prod_{i=1}^n a_j$. The display style fraction originally exists as `$\dfrac{}{}$`.

New Commands   It is very annoying to type $\displaystyle\sum_{i=1}^n a_i$ every time I am writing this in inline math, therefore we want to change the command.

The command can be changed by inserting `\newcommand{}[]{}` at the preamble.

Here are a few examples

```
\newcommand{\dsum}{\displaystyle\sum}
% type the new command in the first brace, equivalent original command in the second brace
\newcommand{\floor}[1]{\lfloor #1 \rfloor}
% $\floor{#1}=\lfloor #1 \rfloor$
\newcommand{\leg}[2]{\left(\dfrac{#1}{#2}\right)}
% $\leg{#1}{#2}=\left(\dfrac{#1}{#2}\right)$
```

> $$\sum_{i=1}^n a_i, \lfloor 0.5 \rfloor = 0, \left\lfloor \frac{16}{9} \right\rfloor \left(\frac{2}{3} \right)$$

Align   When writing papers, sometimes we write multiple formulas at one time or want to order them with numbers, then the `align, align*` environments should be useful.

To use the `align, align*` environments, the format is

```
\begin{align*} % (or align)
    \tan(\alpha + \beta) &= \dfrac{\sin(\alpha + \beta) }{\cos(\alpha + \beta)}\\
    \sin(\alpha + \beta) & = \sin \alpha \cos \beta + \cos \alpha \sin \beta \\
    \cos(\alpha + \beta) & = \cos \alpha \cos \beta - \sin \alpha \sin \beta
\end{align*}
```

`&` is used for align the "=" at the same position, `\\` is used to change the line.

In `align` environment,

$$\tan(\alpha + \beta) = \frac{\sin(\alpha + \beta)}{\cos(\alpha + \beta)} \tag{1}$$

$$\sin(\alpha + \beta) = \sin \alpha \cos \beta + \cos \alpha \sin \beta \tag{2}$$

$$\cos(\alpha + \beta) = \cos \alpha \cos \beta - \sin \alpha \sin \beta \tag{3}$$

formulas are centered and ordered.

In `align*` environment,

$$\tan(\alpha + \beta) = \frac{\sin(\alpha + \beta)}{\cos(\alpha + \beta)}$$

$$\sin(\alpha + \beta) = \sin \alpha \cos \beta + \cos \alpha \sin \beta$$

$$\cos(\alpha + \beta) = \cos \alpha \cos \beta - \sin \alpha \sin \beta$$

the displayed formulas are unordered and centered.

3 Tables

For tables, either use the `table` environment or `array` environment.

`table` environment is used when texts should be included, for example

```
\begin{table}[htbp!] % to make the table appears at the right position (for most time)
    \centering
    \begin{tabular}{|c|c|}\hline
        Alice  & Bob \\\hline
        10 pencils  & 12 pens\\\hline
    \end{tabular}
    \caption{Table Example}
    \label{tab:table example}
\end{table}
```

compiles as

Alice	Bob
10 pencils	12 pens

Table 2: Table Example

while tables that only consist symbols and numbers can use the `array` environment.
For example

```
    \begin{align*}
    \begin{array}{|c|c|}\hline
        a & b \\\hline
        1 & 2 \\\hline
    \end{array}
    \end{align*}
```

compiles as

a	b
1	2

The `[htbp!]` controls where the table or figure is placed. Tables (or figures) do not need to go where you put them in the text. LaTeX moves them around to prevent large areas of white space from appearing in your paper.

`{|c|c|}` controls the column specification and the vertical lines between the cells. If you want a vertical line between two columns, put a vertical line (`|`) in the column specification between the corresponding letters.

There are three possibilities of column specification:

`\hline` stands for horizontal line after a row. `\hline\hline` puts two horizontal lines before or after a row.

b Bottom	Place the table at the bottom of the current page.
h Here	Place the table at the spot where the table environment appears in the text (sometimes break)
t Top	Place the table at the top of the current page.
p Page	Place the table at the top of the next page.

c	centered column
l	left-justified column
r	right-justified column

```
\begin{table}[htbp!]
    \begin{tabular}{|l||c|c|} \hline\hline
    Ice Cream Store & Location & How to Get There \\ \hline
    Toscanini's & Central Square & Just walk! \\
    Herrell's & Harvard Square & Red Line \\
    J.P. Licks & Davis Square & Red Line \\
    Ben \& Jerry's & Newbury Street & Green Line \\ \hline\hline
\end{tabular}
\end{table}
```

compiles as

Ice Cream Store	Location	How to Get There
Toscanini's	Central Square	Just walk!
Herrell's	Harvard Square	Red Line
J.P. Licks	Davis Square	Red Line
Ben & Jerry's	Newbury Street	Green Line

If you are unfamiliar with commands, it is convenient to use the Table Generator. Also, Overleaf provides with the function to paste tables from other apps, for example, excel and word.

4 Figures

Figures are very similar to tables. After upload a figure called `image.png`, you can insert that figure by

```
\begin{figure}[htbp!]
    \centering
    \includegraphics[width=0.5\linewidth]{image.png}
    \caption{Example Figure}
    \label{fig:example_figure}
\end{figure}
```

which compiles as a figure with a width equal to half of the text line:

Figure 1: Example Figure

the width can also be changed to

```
    \includegraphics[width=7cm]{image.png}
    \includegraphics[width=6in]{image.png}
```

Figure 2: 7cm Example

Figure 3: 4in Example

In Overleaf, you can directly insert a figure by pasting it in the Code Editor.

If you want to place two figures in a line, the package `subfigure` should be used by adding `\usepackage{subfigure}` in the preamble.

For example

```
\begin{figure}[htbp!]
    \centering
    \subfigure[a figure]{\includegraphics[width=0.4\linewidth]{image.png}}
    \subfigure[another figure]{\includegraphics[width=0.4\linewidth]{image.png}}
    \caption{Subfigure Example}
\end{figure}
```

compiles as

(a) a figure   (b) another figure

Figure 4: Subfigure Example

5 Refer

In some previous examples, you might see `\label{fig:example_figure}`, etc. The `\label{}` are used for future reference to the figure/table/formula.

For example,

```
    A figure of minions is presented in Figure \ref{fig:example_figure}.

    I don't know what Table \ref{tab:table_example} means.
```

compiles as

> A figure of minions is presented in Figure 1.
> I don't know what Table 2 means.

To refer to webpage, `\usepackage{hyperref}` can be used and webpage can be inserted by `\href{webaddress}{Name}`.
For example, `\href{https://overleaf.com}{Overleaf}` creates a hyperref to Overleaf.

6 Citation

A paper includes a bunch of references. To cite papers using LaTeX, create another file with `.bib`.

To insert a paper into your reference database, we go to Google Scholar (or any other websites that provide a `bibtex`-format citation).

For example, here we want to cite the paper *What the fuck do I know?* byBlöndal, Sara Hjördís, we searched that on Google Scholar and click on cite.
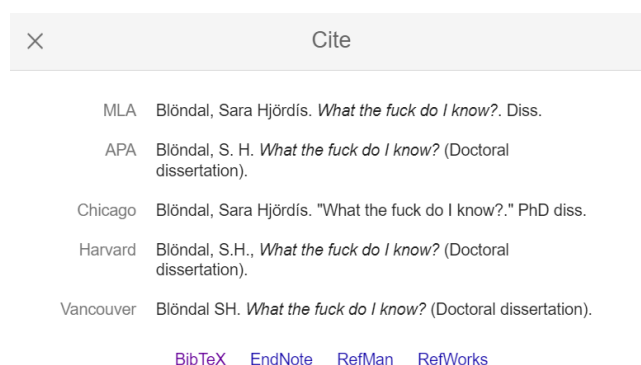
Click on BibTeX, copy and paste the BibTeX code to the `.bib` file:

```
@phdthesis{blondalfuck,
  title={What the fuck do I know?},
  author={Bl{\"o}ndal, Sara Hj{\"o}rd{\'\i}s}
}
```

To link the `.bib` file with the main LaTeX file, use

```
    \bibliographystyle{plainnat} % reference style.
    \bibliography{main}
```

and to cite the paper, use `\cite{}, \citep{}, \citet{}` according to different conditions.

`\citet{}`	the authors name(s) are to be read as part of the text
`\citep{}`	the entire citation id parenthetical.

For example, I write

```
    The paper established an idea that I don't fucking know anything :thumb\_up:

    \citep{blondalfuck}
```

which compiled as

> The paper established an idea that I don't fucking know anything :thumb_up: [Blöndal(2023)]

Besides, some informal citations use footnotes by `\footnote{}`.

7 Basic Dumb Knowledge

- `\section{}` creates a section

- `\subsection{}` creates a subsection

- `\subsubsection{}` creates a subsubsection

- `\paragraph{}` creates a paragraph (something smaller than subsubsubsection)

- `\par` separates paragraphs, while leaving with a blank line also works

- Ordered list by `\begin{itemize}\item ... \end{itemize}`

- Unordered list (bullets) by `\begin{enumerate}\item ... \end{enumerate}`

- Bold by `\textbf{}`, italic by `\textit{}`, underlined text by `\underline{}` ... Basically intuitive.

8 Remarks

1. $(\frac{4}{9})$ is ugly, to change the parentheses use `$\left(...\right)$`

2. `~` can provide a space in both math and text

3. Some useful packages: `\usepackage{siunitx}` for SI units, `\usepackage{mhchem}` for chemistry.

4. This guide is only for an introduction to how to use LaTeX to help people dealing with HiMCM paper writing, etc. A wide range of content isn't included and can always be found on the internet. TeX Stackexchange is always a good choice to look at.

5. In LaTeX, use `‘‘’’` for quotes instead of `""`, which doesn't work well.

References

[Blöndal(2023)] Sara Hjördís Blöndal. *What the fuck do I know?* PhD thesis, 2023.