Hacker Tools: LaTeX

Sun Yitao

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Slides at `https://tinyurl.com/ht-latex-2223`

adapted from Julius' 2020 LaTeX Workshop

Where are we?

NUS Hackers

https://nushackers.org

hackerschool

Friday **Hacks**

Hack & Roll

Hacker Tools

About Me

Hi! I'm Yitao. I'm currently a Y4 computer science student and I learned LaTeX through using it for homework and UROP reports.

Required Software

If you don't have these, you can follow along using Overleaf as well[1]

- A TEX distribution (instructions in our publicity channels)
- TeXstudio

[1] https://www.overleaf.com/

What is LaTeX?

- A markup language for document preparation[2]
- Uses plain text[3] in contrast to most WYSIWYG editors
- Started as a writing tool for mathematicians and computer scientists.
- Built on top of TeX by Leslie Lamport[4] in 1983

[2] Just like HTML (Hyper-Text Markup Language) is a markup language

[3] thus versionable using a VCS like `git`

[4] Winner of the Turing Award in 2013 for his work in distributed and concurrent systems

What is TEX?

- A typesetting system designed and mostly written by Donald Knuth[5] in 1978
- Because Knuth was disappointed with the typesetting of the 2nd edition of TAOCP.
- 2 Goals:
  - Allow anybody to produce high-quality books with minimal effort
  - Provide a system that would give exactly the same results on all computers, at any point in time

[5] Winner of the Turing Award in 1974 for analysis of algorithms and the design of programming languages

Trivia

Version number of TEX approaches π:

$3.0 \rightarrow 3.1 \rightarrow 3.14 \rightarrow 3.141 \rightarrow \ldots \rightarrow 3.141592653$ (current)

Version number of Metafont[6] approaches e:

$2.0 \rightarrow 2.7 \rightarrow 2.71 \rightarrow \ldots \rightarrow 2.71828182$ (current)

[6] Companion to TEX written by Knuth, used to describe fonts using geometrical equations

What can I use LaTeX for?

- Reports
- Books
- Presentation[7]
- And so much more!

[7] This presentation is written in LaTeX using Beamer!
https://github.com/indocomsoft/hackertools-slides/blob/master/latex/latex.tex

Basic LaTeX Syntax

- A LaTeX document consists of commands and environments[8]
- The command syntax:

```
\command[option1,option2,...]{arg1}{arg2}...
```

- The environment syntax:

```
\begin{environment}
  % Some children content
\end{environment}
```

- Comments are whatever comes after `%`

[8] HTML terms: tags = commands, tags with children = environments

Basic LaTeX Document

We will explain the commands and environment used here later on.

```
\documentclass{article}

\begin{document}
Hello world!
\end{document}
```

Spaces

- All whitespace characters are treated as space.
- Several consecutive spaces are treated as one space.
- Leading/trailing spaces are ignored.
- A single line break is treated as a space.
- Two or more line breaks define the end of a paragraph.

Let's try out spaces

```
\begin{document}
It does not matter whether you
enter one or several                spaces
after a word.

An empty line starts a new
paragraph.
\end{document}
```

Reserved Characters

Reserved characters have a special meaning and can't be used in plain text.

```
# $ % ^ & _ { } ~ \
```

Instead, use

```
\# \$ \% \^{} \& \_ \{ \} \~{} \textbackslash
```

Note the empty argument to caret and tilde, because otherwise they are used to create diacritics.

We use `\textbackslash` because `\\` is line breaking.

Other tricky characters

- < and > symbols usually do not get rendered correctly.
- Instead, use `\textless` and `\textgreater`
- In some circumstances, square brackets are reserved (for options)
- Thus, `\command [text]` fails, instead do `\command{} [text]`

Packages

- Just like other programming languages, LaTeX has packages as well
- LaTeX also has its own package manager, called **CTAN**
- Use the command `\usepackage {packagename}` to "import" and use a package.
- We will go through some useful packages in the upcoming subsections.

Where are we?

Back to Our Example

```
\documentclass{article}

\begin{document}
    Hello world!
\end{document}
```

Document Class

```
\documentclass{article}
```

- Use the **article** document class.
- Document class file defines the formatting standard to follow, which in this case is the generic article format.
- Other document classes, e.g. **acmart** for ACM[9] publications, **beamer** for presentations[10]

[9] Association for Computing Machinery
[10] Like this presentation!

Document Class options

- `10pt`, `11pt`, `12pt` – size of main font (default: 10pt)
- `a4paper`, `letterpaper`, ... - size of paper
- `landscape` – Landscape mode layout
- `titlepage`, `notitlepage` – whether a new page should be started after the document title

Find out more at `https://en.wikibooks.org/wiki/LaTeX/Document_Structure#Document_classes`

Where are we?

Document Environment

```
\begin{document}
```

- The beginning of the **document** environment.
- Tells LaTeX that the content of document starts here.
- Anything before this line is called **the preamble**

```
\end{document}
```

- The end of the **document** environment
- Tells LaTeX that the document is complete.
- Anything after this line is ignored.

Top Matter

Top Matter: information about the document itself

- Provide information using the `title`, `author`, `date`
- Typeset the title using `maketitle`

```
\documentclass{article}

\title{How to Basic: \LaTeX{}}
\author{Sun Yitao}
\date{11 October 2022}

\begin{document}
\maketitle
\end{document}
```

Sectioning Commands

```
\section{Some Section Title}
\subsection{Some Subsection Title}
\subsubsection{Some Subsubsection Title}
```

To get an unnumbered sections, add an asterisk to the end of the command name, e.g. `\section*{My section title}`

Typeset a table of contents using `\tableofcontents`

Note: unnumbered section will not be included in the TOC unless explicitly included:

```
\addcontentsline{toc}{subsection}{My section
↪  title}
```

Where are we?

Emphasising text

- Use the `\emph{text}` command
- Typically done by italicising the text.
- Note that the command is dynamic: emphasising a word in an already emphasised sentence will revert the word to upright font.

Font styles

```
\textnormal{document font family}
\emph{Emphasised text}
\texttt{teletype font family (monospaced)}
\textbf{bold fontface}
\textsc{Small Capitals}
\uppercase{uppercase}
```

Font size

Changes the size in scope

```
{\tiny test}
{\scriptsize test}
{\footnotesize test}
{\small test}
{\normalsize test}
{\large test}
{\Large test}
{\LARGE test}
{\huge test}
{\Huge test}
```

Where are we?

Non-breaking Space

Use tilde (~) to tell LaTeX not to change space into line break.

Line spacing

- For controlling line spacing, I usually use the `setspace` package.
- Import it in the preamble: `\usepackage{setspace}`
- Useful commands: `\singlespacing`, `\onehalfspacing`, `\doublespacing`
- Useful environments: `singlespace`, `onehalfspace`, `doublespace`, `spacing`

```
\begin{spacing}{2.5}
  This paragraph has \\ huge gaps \\ between
  ↪  lines.
\end{spacing}
```

Quote-marks

In LaTeX, quote-marks can go the wrong way if you're not careful!

```
To `quote' in LaTeX
To ``quote'' in LaTeX
```

Paragraph Alignment

Alignment	Environment	Command
Left justified	`flushleft`	`\raggedright`
Right justified	`flushright`	`\raggedleft`
Center	`center`	`\centering`

Paragraph Indentation

- By default, first paragraph after a heading is not indented, subsequent paragraphs are indented by `\parindent`
- This follows typical Anglo-American publishing convention.
- To set this length, in preamble:
```
\setlength{\parindent}{1cm} % Default 15pt
```
- You can use the `indentfirst` package to indent the beginning of every section
- To force indent a non-indented paragraph, use `\indent` at the beginning of the paragraph.
- To force non-indent an indented paragraph, use `\noindent`

Adding paragraph skips

- To make paragraphs boundary clear using zero indentation, vertical space between paragraphs is needed.
- Use the `parskip` package

Verbatim Environment

Introduce text that will not be interpreted by the compiler in a monospaced font

```
\begin{verbatim}
The verbatim environment
  simply reproduces every
 character you input,
including all  s p a c e s!
\end{verbatim}
```

Typesetting URLs

Use the **hyperref** package, with the `\url{https://stonks.trade}` command

If you want coloured hyperlink instead of box, set option **colorlinks** when using the **hyperref** package:

```
\usepackage[colorlinks]{hyperref}
```

Where are we?

Mathematics

Knuth's motivation to develop TEX among others was to allow simple construction of mathematical formulae that looks professional when printed.

Typesetting Mathematics is one of LATEX's greatest strengths

Getting started

I usually use the **mathtools** package to provide more powerful and flexible commands than plain LaTeX

```
\usepackage{mathtools}
```

Environments

LaTeX provides displayed equation environment (`displaymath`), where the formulae are on a line by themselves.

Short hand[11]: `\[e^{i \pi} + 1 = 5\]`

To get automatically numbered equations, use the `equation` environment:

```
\begin{equation}
e^{i \pi} + 1 = 0
\end{equation}
```

[11] DO NOT use `$$...$$`, it is an older TeX syntax that causes problems and is not officially supported by LaTeX

Inline vs Displayed Equations

However, if you want to get an inline formula, use the `math` environment or the shorthand[12]:

```
$e^{i \pi} + 1 = 0$
```

These work on some flavours of Markdown too, e.g. `https://hackmd.io`

[12] There also exists the LaTeX shorthand `\(...\)`

Maths Symbols

A pretty good list at
`https://en.wikibooks.org/wiki/LaTeX/Mathematics#List_of_mathematical_symbols`

You can also use detexify:
`http://detexify.kirelabs.org/`

Or even cooler: `https://mathpix.com/`

Powers and indices

Use the caret (^) to raise something, and underscore (_) to lower.

If more than one expression is raised or lowered, group them using curly braces

Exercise: typeset this

$k_{n+1} = n^2 + k_n^2 - k_{n-1}$

Fractions and Binomials

```
$\frac{x^2}{y^3}$
```

```
$\binom{n}{r}$
```

$\frac{x^2}{y^3}$

$\binom{n}{r}$

Roots

```
$\sqrt[n]{1 + x + x^2 + x^3 + \dots + x^n}$
```

$\sqrt[n]{1 + x + x^2 + x^3 + \dots + x^n}$

Sums and Integrals

Use the **\sum** and **\int** for sum and integral respectively, with the limits specified using caret and underscore.

Use **\limits** if you want the limits specified above and below the symbol in inline mode, or use displayed equation mode.

```
$\sum_{i=1}^{10} t_i$
```

$\sum_{i=1}^{10} t_i$

```
$\sum\limits_{i=1}^{10} t_i$
```

$$\sum\limits_{i=1}^{10} t_i$$

Use **\,** for a small space

```
$\int_0^\infty e^{-x}\,dx$
```

$\int_0^\infty e^{-x}\,dx$

```
$\int\limits_0^\infty e^{-x}\,dx$
```

$$\int\limits_0^\infty e^{-x}\,dx$$

Other big commands

Note that this also applies to other “big” commands like `$\prod$` ($\prod$), `$\bigcup$` ($\bigcup$), `$\bigcap$` ($\bigcap$), etc.

Brackets, braces, delimiters

```
$( a ), [ b ], \{ c \}, | d |, \| e \|,
 ↪  \langle f \rangle, \lfloor g \rfloor,
 ↪  \lceil h \rceil, \ulcorner i \urcorner$
```

$(a), [b], \{c\}, |d|, \|e\|, \langle f \rangle, \lfloor g \rfloor, \lceil h \rceil, \ulcorner i \urcorner$

Automatic sizing

```
$P\left(A=2\middle|\frac{A^2}{B}>4\right)$
```

```
$P(A=2|\frac{A^2}{B}>4)$
```

$$P\left(A=2\middle|\frac{A^2}{B}>4\right)$$

$$P(A=2|\frac{A^2}{B}>4)$$

Exercises

$$\binom{n}{r} = {}_nC_r = \frac{n!}{r!(n-r)!}, {}_nC_r \times r! = {}_nP_r$$

$$\lim_{n\to\infty} \left| \frac{a_{n+1}}{a_n} \right| = \rho$$

$$\frac{d^2y}{dx^2} + p(x)\frac{dy}{dx} + q(x)y = F(x)$$

$$\{x \mid x \in \mathbb{R}^+, -1 \leq x \leq 1\}$$

Where are we?

Adding images

Latex can not manage images by itself, so we need to use the graphicx package.

To use it, we include the following line in the preamble:

```
\usepackage{graphicx}
```

Adding images

Next, we need to specify the image directory relative to the main `.tex` file

```
\graphicspath{ {./images/} }
```

Lastly, we include the image file name without the file extension

```
\includegraphics[scale=1.2]{my_image}
```

Adding citations

`biblatex` is a modern option for processing bibliography information, provides an easier and more flexible interface and a better language localization than `bibtex` and `natbib`.

```
\usepackage{biblatex}
\addbibresource{sample.bib}
```

The bibliography file

A `.bib` file that looks like this:

```
@article{einstein,
    author = "Albert Einstein",
    title = "{Zur Elektrodynamik bewegter K{\"o}rper}. ({German})
    [{On} the electrodynamics of moving bodies]",
    journal = "Annalen der Physik",
    volume = "322",
    number = "10",
    pages = "891--921",
    year = "1905",
    DOI = "http://dx.doi.org/10.1002/andp.19053221004",
    keywords = "physics"
}

@book{dirac,
    title = {The Principles of Quantum Mechanics},
    author = {Paul Adrien Maurice Dirac},
    isbn = {9780198520115},
    series = {International series of monographs on physics},
    year = {1981},
    publisher = {Clarendon Press},
    keywords = {physics}
}
```

Adding citations

```
\begin{document}
  Let's cite! Einstein's journal paper
   ↪  \cite{einstein} and Dirac's book
   ↪  \cite{dirac} are physics-related
   ↪  items.

  \printbibliography %Prints bibliography

\end{document}
```

Adding citations

Let's cite! Einstein's journal paper [2] and Dirac's book [1] are physics-related items.

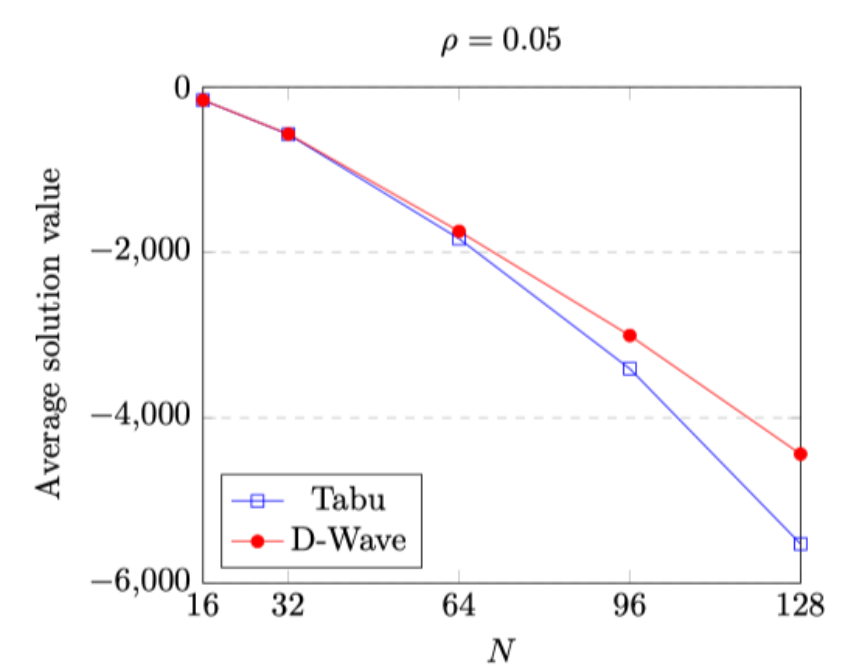
References

[1] Paul Adrien Maurice Dirac. *The Principles of Quantum Mechanics*. International series of monographs on physics. Clarendon Press, 1981. ISBN: 9780198520115.

[2] Albert Einstein. "Zur Elektrodynamik bewegter Körper. (German) [On the electrodynamics of moving bodies]". In: *Annalen der Physik* 322.10 (1905), pp. 891–921. DOI: http://dx.doi.org/10.1002/andp.19053221004.

Adding graphs

You can add you own graphs as an image, but the `pgfplots` package also provides decent plotting functionality.



Guide for `pgfplots`: `https://www.overleaf.com/learn/latex/Pgfplots_package`

Adding tables

LaTeX has built in functionality for tables as well.

N	Tabu	D-Wave (Total)	D-Wave (QPU)	CPLEX
16	0.016	0.328	0.0270	0.031
32	0.022	3.824	0.0271	0.039
64	0.321	52.320	0.0273	0.054
96	0.542	158.258	0.0275	0.063
128	0.501	318.624	0.0276	0.104

Guide for adding tables :
`https://www.overleaf.com/learn/latex/Tables`

Resources

Wikibooks provide some good resources:
`https://en.wikibooks.org/wiki/LaTeX`

So does overleaf: `https://www.overleaf.com/learn/latex/Main_Page`

Where are we?

Talk to us!

- Feedback form: `https://tinyurl.com/ht-latex-2223-feedback`
- Telegram: `https://t.me/nushackers` (@nushackers)