Introduction to LaTeX

Daniel Alexander

CISER, Cornell University

dra65@cornell.edu

Feb 18th 2019

Overview

Elements of Digital Publishing

The elements of publishing:

- **Layout design**
  - Font size
  - Spacing
  - Margins
  - Column width
  - Headings
  - ...
- **Typesetting**
  - Organizing content according to layout

TeX and LaTeX

TeX

Developer: Donald E. Knuth

- Year: 1978
- Current Version: 3.14159265
- Typesetting engine for digital printing
- Pronounced: "Tech"
- Renowned for stability

LaTeX

Developer: Leslie Lamport

- Year: 1980
- Current Version: LaTeX 2_ε
- Document Preparation System
- Pronounced: "Lay Tech"
- Uses TeX for typesetting
- Composed of TeX macros

Elements of Digital Publishing

The elements of publishing:

- **Layout design**
  - Font size
  - Spacing
  - Margins
  - Column width
  - Headings
  - ...
- **Typesetting**
  - Organizing content according to layout

- LaTeX
- TeX

LaTeX Vs WYSIWYG word processors

The gap between WYSIWYG word processors and LaTeX is closing down.

WYSIWYG word processors:

- Collaborative editing
- Spell check
- Compatibility
- Low Learning Curve

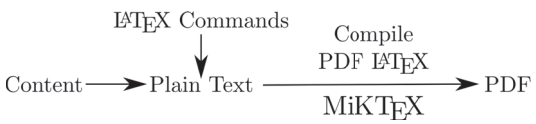
LaTeX:

- Consistent intradocument referencing
- Clean mathematical notation
- Separation of content and style
- Clean tables and illustration

Compiling

- Implementation of LaTeX, TeX opensource domain.
  - Windows users — MiKTeX
  - Linux users — Precompiled Binaries
  - Mac users — MacTeX, XeLaTeX
- Input to LaTeX — plain text file containing:
  - Content of the document
  - Instructions on typesetting

Typically the process of conversion from the plain text file into a pdf document happens through a program called 'pdflatex' using the underlying implementation.



Integrated Development Environment

Typically all packaged into an Integrated Development Environment (IDE).

- TeXnicCenter - `http://www.texniccenter.org/`
- TeXworks - `https://www.tug.org/texworks/`
- Winedit - `http://www.winedt.com/`
- TeXmaker - `http://www.xm1math.net/texmaker/`
- LEd - `http://www.latexeditor.org/`
- Kile - `http://kile.sourceforge.net/`

Online IDE

- Overleaf - `https://www.overleaf.com/`
- ShareLaTeX - `https://www.sharelatex.com/`

Note

Minimum requirement is only a plain text file with content, commands and a LaTeX installation to get an output.

Example 1: Washing Dishes to Wash Them

- Use the IDE in your computer/web.
- Open/Upload the TEX file and allied files in folder 'example1'.
- Set your compiler to pdflatex.
- Compile it to get your output.

Example 1: Washing Dishes to Wash Them

Example 1

```
\documentclass[a4paper,12pt]{article}
\title{Washing the dishes to wash the dishes}
\author{Thich Nhat Hanh}
\usepackage{graphicx}
\begin{document}
 \maketitle
\begin{center}
\includegraphics[scale=0.25]{washingdishes.jpg}
\end{center}
Thirty years ago ...........
and we are incapable of actually living one
minute of life.
\end{document}
```


Spaces, Breaks, and Special Char

Space, Line Breaks, Paragraph breaks,

"Whitespace" characters such as blank and tab are treated as a "space". A "\\" is a line break. An empty line between two text streams is a paragraph break.

It does not matter whether you enter one or several spaces after a word it is still treated
as a single space.
It does not matter whether you have one or more empty lines, it is still treated as a new paragraph.

```
1 It  does not matter whether you enter one or
2 several     spaces  after  a  word  it  is   still
3 treated\\ as a  single  space.
4
5
6 It  does not matter whether you have one or
7 more empty lines,  it  is   still   treated as a
8 new paragraph.
```

Special Characters

Reserved Characaters # $ % ^ & _ { } ~ \

$ % ^ & _ { } ~ \

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


Commands and Comments

LaTeX commands

\command[optional parameter]{parameter}

TEX and LATEX
Underline, *Italics* and **Bold**
February 20, 2019

```
1 \TeX{} and \LaTeX \newline
2 \underline{Underline}, \textit{ Italics } and \textbf{Bold}
3 \today \newline
```

Comments

The % sign is used to mark single line comments.

This is an example: Supercalifragilisticexpialidocious

```
1 This  is  an  % stupid
2 % Better:  instructive  <----
3 example: Supercal%
4                   ifragilisticexpialidocious
```

Example 2: Washing the Dishes to Wash Them

Open the TEX file in folder example2.
The second paragraph is a continuation of the same thought so replace the paragraph break with a line break.

```
. . . one hundred monks.
There was no soap . . .
```

```
1 \ldots one hundred monks.
2 \\
3 There was no soap \ldots
```

Notice the change in the indentation from paragraph breaks. Now convert the following text to boldface: "At first glance, that might seem a little silly . . . like a bottle slapped here and there on the waves."

```
At first glance, that might seem a little silly:. . . like a bottle slapped here and there on the waves.
```

```
1 \textbf{At first glance, that might seem a little
2 silly :\ldots like a bottle slapped here
3 and there on the waves.}
```

Convert the last paragraph to italics.

```
In fact we are completely incapable of realizing the miracle of life . . . and we are incapable of actually living one minute of life.
```

```
1 \textit{In fact we are completely incapable
2 of realizing the miracle of life
3 \ldots and we are incapable of
4 actually living one minute of life . }
```


Document Structure

\documentclass[⟨ Options ⟩]{Type of Document}

What class of document? article, report, book, beamer, memoir, letter, etc.
What options? 10pt, 12pt, a4paper, a3paper, landscape, portrait, twocolumn, etc.

Commands that affect the entire document. Declare new environemnts, commands, and add packages to provide additional features.

\usepackage[⟨ Options ⟩]{Package name}

Examples: \usepackage{graphicx}, \usepackage{titlepic}, \usepackage[hidelinks]{hyperref}, etc.

After all setup we start the body of the text with this command.

\begin{document}

Write content with logical demarkations such as \maketitle, \chapter{title}, \part{title}, \section{title}, \subsection{title},etc.
Use environments such as \begin{abstract} . . . \end{abstract}, \begin{equation} . . . \end{equation}, \begin{itemize} . . . \end{itemize}, \begin{enumerate} . . . \end{enumerate}, etc.

\end{document}

Marks the end of the content.

Example 3: A Guide To Walking Meditation

You are given a TEX document in the folder "example3" that has only the content. Let us add the structural component and compile it.

Structural Components

- Declare the nature of the document with options
- Identify the title and the author
- Start the document environment
- Make the title
- Identify Sections and other logical subdivisions.
- End the document environment

Structural Components

```
\documentclass[a4paper,12pt,twocolumn]{article}
\title{A Guide to Walking Meditation}
\author{Thich Nhat Hanh}
\begin{document}
\maketitle
\section{Your Steps Are Most Important}
.
.
.
\end{document}
```


Environments

\begin{ . . . } . . . \end { . . . }

These are logical structures within the document. It is established by a "begin" and an "end" statement.

Let us see some examples

Environments: Itemize

Itemize

```
\begin{itemize}
 \item
 \item
 \item
\end{itemize}
```

Funny ones from `www.dearblankpleaseblank.com`

- Dear Noah,
  We could have sworn you said the ark wasn't leaving till 5.
  Sincerely,
  Unicorns
- Dear Icebergs,
  Sorry to hear about the global warming. Enjoy the Karma...
  Sincerely,
  The Titanic.
- Dear Rubik's Cube,
  Done!
  Sincerely,
  Colorblind

```
1 Funny ones from \url{www.dearblankpleaseblank.com}
2 \begin{itemize}
3  \item Dear Noah, \\
4  We could have sworn you said
5  the ark wasn't leaving  till  5. \\
6  Sincerely , \\
7  Unicorns
8  \item Dear Icebergs,\\
9  Sorry to hear about the global
10 warming. Enjoy the Karma\ldots \\
11  Sincerely ,\\
12 The Titanic.
13 \item Dear Rubik's Cube,\\
14 Done!\\
15  Sincerely ,\\
16  Colorblind
17 \end{itemize}
```


Environments: Enumerate

Enumerate

```
\begin{enumerate}
 \item
 \item
 \item
\end{enumerate}
```

Funny ones from `www.dearblankpleaseblank.com`

1. Dear Noah,
   We could have sworn you said the ark wasn't leaving till 5.
   Sincerely,
   Unicorns
2. Dear Icebergs,
   Sorry to hear about the global warming. Enjoy the Karma...
   Sincerely,
   The Titanic.
3. Dear Rubik's Cube,
   Done!
   Sincerely,
   Colorblind

```
1 Funny ones from \url{www.dearblankpleaseblank.com}
2 \begin{enumerate}
3  \item Dear Noah, \\
4  We could have sworn you said
5  the ark wasn't leaving  till  5. \\
6  Sincerely , \\
7  Unicorns
8  \item Dear Icebergs,\\
9  Sorry to hear about the global
10 warming. Enjoy the Karma\ldots \\
11  Sincerely ,\\
12 The Titanic.
13 \item Dear Rubik's Cube,\\
14 Done!\\
15  Sincerely ,\\
16  Colorblind
17 \end{enumerate}
```


Environments: Figures

- Inserting figures needs an addon package – \usepackage{graphicx} added in the *preamble* before the \begin{document} environment.
- For inline figures i.e., ones that flows with text use the following command.

Inline Figures

```
\includegraphics[<Options>]{path to figure}
```

- For floating figures i.e., ones that float around with text adjusted accordingly use the following environment and the command

Floating Figures

```
\begin{figure}[location options]
    \includegraphics[<Options>]{path to figure }
    \caption{ text }
\end{figure}
```


Environments: Figures

- Figure Options
  - Options for figure placement
    - ! – ignore TEX algorithms
    - h – place the figure here
    - t – place the figure on the top of the page
    - b – place the figure at the bottom of the page
    - p – place graphics in a new page alltogether
  - Provide multiple options
  - Failure of location suggestion implies difficulty with layout and text
- includegraphics options
  - scale – scales a figure ex: scale=0.5
  - width – changes the width of the figure ex: width=5cm
  - height – changes the height of the figure ex: height=5cm

Example 4: Stir Frying Spinach

Open the given TEX document in folder "example4". In this document you are to incorporate a picture named "stirfryspinach.jpg" in the beginning of the document after the title.

Example 4

In the preamble insert

```
\usepackage{graphicx}
```

After the command \maketitle insert the following snippet

```
\begin{figure}[h]
 \includegraphics[scale=0.5]{stirfryspinach.jpg}
\end{figure}
```

You are to now *itemize* the contents of every section except the section titled "Procedure" which needs to be *enumerated*.

Inline and display math

- Inline $ math content $.

Represent a divided by b? It is $\frac{a}{b}$.
What is 2^4? It is 16.
What is $\sin(\phi + \theta)$? It is $\sin(\theta)\cos(\phi) + \sin(\phi)\cos(\theta)$.

```
1 Represent $a$ divided by $b$?
2 It is $\frac{a}{b}$.
3
4 What is $2^4$?
5 It is $16$.
6
7 What is $\sin(\phi+\theta)$?
8 It is $\sin(\theta)\cos(\phi)+
9 \sin(\phi)\cos(\theta)$.
```

- Displayed math content in a separate line.
  - \begin{equation} ... \end {equation}
  - \begin{equation*} ... \end {equation*}
- Packages needed
  - amsmath, amssymb, amsfont

$$\int_a^b x dx = \frac{b^2 - a^2}{2}$$

$$a\left(\frac{\partial \sigma^2 y}{\partial y}\right) = a\sigma^2 \quad (1)$$

```
1 \begin{equation*}
2  \int_{a}^{b} x dx
3  = \frac{b^2-a^2}{2}
4 \end{equation*}
5
6 \begin{equation}
7  a\left(\frac{\partial \sigma^2y}
8  {\partial y}\right)
9  = a\sigma^2
10 \end{equation}
```


Elements of Math Mode

- Greek letters
- Exponents, superscripts, and subscripts
- Nth root and surds
- Dots

$\alpha, \beta, \gamma, \phi, \theta$

$a^b, a_b, a_{d^e}^{b_c}$

$\sqrt[n]{ax^2 + bx + c}, \sqrt{gtx}, \sqrt{x}$

$\Psi = v_1 \cdot v_2 \cdot \ldots \quad \vdots, \quad \ddots$

```
1 \begin{equation*}
2 \alpha, \beta, \gamma, \phi, \theta
3 \end{equation*}
4 \begin{equation*}
5 a^b, a_b, a^{b_c}_{d^e}
6 \end{equation*}
7 \begin{equation*}
8 \sqrt[n]{ax^2+bx+c}, \sqrt{gtx}, \surd{x}
9 \end{equation*}
10 \begin{equation*}
11 \Psi=v_1 \cdot v_2 \cdot \ldots
12  \qquad \vdots, \qquad \ddots
13 \end{equation*}
```


Elements of Math Mode

- \underline, \overline, \overbrace, \underbrace
- Accents
- Standard functions
- Fractions

$\underline{a}, \overline{b}, \overbrace{a + b + c}^{q}, \underbrace{d + e + f}_{p}$

$\bar{a}, \widetilde{abc}, \hat{q}, \widehat{pqr}, \vec{a}, \overleftarrow{ghj}$

$\sin, \cos, \arcsin, \lg, \inf, \exp, \lim, \min$

$\frac{1}{2}, 1/2, \tfrac{1}{2}$

```
1 \begin{equation*}
2 \underline{a}, \overline{b},
3 \overbrace{a+b+c}^{q}, \underbrace{d+e+f}_{p}
4 \end{equation*}
5 \begin{equation*}
6 \tilde{abc}, \widetilde{abc}, \hat{q},
7 \widehat{pqr}, \overrightarrow{a},
8 \overleftarrow{ghj}
9 \end{equation*}
10 \begin{equation*}
11 \sin, \cos, \arcsin, \lg, \inf, \exp, \lim, \min
12 \end{equation*}
13 \begin{equation*}
14  \frac{1}{2}, 1/2, \tfrac{1}{2}
15 \end{equation*}
```

Elements of Math Mode

- Integral, Product, Sum
- Bracketing and other delimiters

$$\int_0^{\frac{\pi}{2}}, \prod_{i\in\mathcal{N}}, \sum_{i=1}^{N}$$

$$\left(1+\frac{a}{b}\right), \left[a^{\sin(x)}\right], ||v|| \qquad (\because a \neq b$$

```
1 \begin{equation*}
2 \int_0^{\frac{\pi}{2}},
3 \prod_{i\in \mathcal{N}},
4 \sum_{i=1}^{N}
5 \end{equation*}
6 \begin{equation*}
7  \left(1 + \frac{a}{b}\right),
8  \left[a^{\sin(x)}\right],
9  \left|\left| v \right|\right|
10  \qquad \left( \because a \neq b \right.
11 \end{equation*}
```

- Multiline Equations
  - \begin{align} ... \end{align}

$$\begin{aligned} a &= b + c && (2)\\ &= d + e + f + g + h + i \\ &+ m + n + o && (3)\\ &= p + q + r + s && (4) \end{aligned}$$

```
1 \begin{align}
2   a &= b + c \\
3   &= d + e + f +
4   g + h + i \nonumber\\
5   &+ m + n + o \\
6   &= p + q + r + s
7 \end{align}
```


Example 5: Quadratic Formula

In this example the math content has been written in text form and we are to convert them into TEX. Open the TEX file from the folder "example5". You are to correct the math content.

- Include the package amsmath in the preamble
- Put in $ $ for inline text.
- Replace "not equal to" with a symbol "\neq".
- Single line equations can be put in the equation environment.
- Multiline equations can be put in the align environment.
- Use \frac to represent fractions in the equation environment.
- Put in parantheses with \left(and \right).

Example 5: Quadratic Formula

```
\usepackage{amsmath}
...
For a first degree equation $ax+b=0$ with $a \neq 0$
the solution is $x=-b/a$.  We now look at solving $ax^2+bx+c=0$.
...
The equation $ax^2+bx+c=0$ with $a \neq 0$ has the solutions
...
\begin{equation}
x=\frac{-b \pm \sqrt{b^2-4ac}}{2a}
\end{equation}
...
We use the method of completing the square to rewrite $ax^2+bx+c$.
....
\begin{align}
ax^2+bx+c &= a \left( x^2 + \frac{b}{a} x \right)+c \\
&=a\left(x^2 + \frac{b}{a} x + \frac{b}{2a} \right)^2 -\frac{b}{2a}^2 +c\\
&=a\left(x + \frac{b}{2a}\right)^2 -  a\left(\frac{b}{2a}\right)^2+c \\
&=a\left(x+\frac{b}{2a}\right)^2 - \frac{\left(b^2-4ac\right)}{4a}.
\end{align}
Therefore $ax^2+bx+c=0$ can be rewritten as
```


Example 5: Quadratic Formula

```
\begin{equation}
a\left(x+\frac{b}{2a}\right)^2 - \frac{\left(b^2-4ac\right)}{4a}=0,
\end{equation}
....
\begin{equation}
\left(x+\frac{b}{2a}\right)^2= \frac{\left(b^2-4ac\right)}{4a^2}.
\end{equation}
...
\begin{equation}
x+\frac{b}{2a}= \pm \frac{\sqrt{b^2-4ac}}{2a}
\end{equation}
...
\begin{equation}
x=\frac{-b \pm \sqrt{b^2-4ac}}{2a}
\end{equation}
```

Intradocument Referencing

- To refer to content within a document we use the combination of \label {Key} and \ref {Key}.

In Eq. 5 the roots of a generic quadratic equation are represented.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad (5)$$

Oceanic breath:

1. Open your mouth.
2. Inhale and Exhale (sigh) deeply through it.
3. Close your mouth and repeat the same action.
4. Continue breathing like this for 20 cycles.

Step. 3 opens up your throat cavity and you breathe through it.

```
In Eq. \ref{eq:quad} the roots
of a generic quadratic equation
are represented.\label{sec:quad}
\begin{equation}
x=\frac{-b \pm
\sqrt{b^2-4ac}}{2a} \label{eq:quad}
\end{equation}
Oceanic breath:
\begin{enumerate}
\item Open your mouth.
\item Inhale and Exhale
(sigh) deeply through it.
\item Close your mouth
and repeat the same action.
\label{step:openthroat}
\item Continue breathing
like this for 20 cycles.
\end{enumerate}
Step. \ref{step:openthroat} opens up your
throat cavity and you
breathe through it.
```


Citing

There are many ways to cite documents in LaTeX. A simple way is to use "thebibliography" environment.

thebibliography

```
In text one can cite using command \cite{citekey}.

\begin{thebibliography}{size of widest label}
  \bibitem[label]{citekey} reference to be cited
\end{thebibliography}
```


Example 6: How to Tie an Overhand Knot

Open the given TeX document in folder "example6". You have to refer to figures and cite two bibliography items. The references are already entered in thebibliography environment.

- Enter labels in the figure environments using \label{ } command.
- Refer them in text using \ref{ } command.
- Wherever the references in the bibitems need to be cited use the command \cite{citekey} where citekey is mentioned in the corressponding bibitem.

```
  \caption{Tying the Overhand knot}
  \label{fig:overhand}
\end{figure}
There are a number of ways to tie
the Overhand Knot, but the essential
technique is shown in Fig. \ref{fig:overhand}.
```

```
  \caption{Stafford Knot}
  \label{fig:heraldry}
\end{figure}
In heraldry, the overhand knot
is known as a ``Stafford knot'',
due to use first as a heraldic badge by the
``Lords of Stafford'', then as a general
symbol of Staffordshire.\cite{heraldry}
It is shown in Fig. \ref{fig:heraldry}.

The content for this document
has been taken
from the wiki \cite{wiki}.
```


Further Reading and Resources

- LaTeX: A Document Preparation System (2nd Edition) by Leslie Lamport
- A (Not So) Short Introduction to LaTeX 2_ε by Tobias Oetiker
- LaTeX in Wikibooks
- TeX stackexchange forum
- LyX A combination of WYSIWYG and latex for "What You See Is What You Mean"

Sources for examples

- Example 1 and 2: Washing Dishes to Wash Them, extracted from Miracle of Mindfulness by Thich Nhat Hanh
- Example 1: Picture from https://www.flickr.com/photos/jin_aili/5923456202/sizes/l
- Example 3: A Guide to Walking Meditation
- Example 3: Picture from https://www.flickr.com/photos/thecnote/179623093/sizes/o/
- Example 4: Stir Frying Spinach
- Example 4: Picture from https://www.flickr.com/photos/jypsygen/3979161312/sizes/l
- Example 5: Quadratic Equation

Acknowledgements

- CISER
- You all