Introduction to \LaTeX

Writing papers the right way

RSI 2015 Staff

Research Science Institute
Massachusetts Institute of Technology
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**Introduction to \LaTeX**

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**\LaTeX** is...

...a sophisticated document preparation system.

**\LaTeX** has...

- Stylistic uniformity
- Bibliography support
- Sophisticated structuring abilities
- Reference tracking
- Highly extendible capabilities
\textbf{\LaTeX\ is not}... \\

... a word processor.

\textbf{\LaTeX\ does not}... \\

- Spell-check your documents\textsuperscript{1} \\
- Give you complete control over formatting \\
- Provide a graphical interface for editing

“\textit{You take care of writing, and we’ll take care of presentation.”}

\textsuperscript{1}You can use ispell to check your $\LaTeX$
Why \LaTeX?

Presentation shouldn’t get in the way of content.

For example…

- With a word processor, you spend valuable time agonizing over what font size to make the section headings.
  
  With \LaTeX, you just tell it to start a new section.

- With a word processor, changing the formatting means you have to change each instance individually.
  
  With \LaTeX, you just redefine the relevant commands.

- With a word processor, you have to carefully match any provided templates.
  
  With \LaTeX, you can be sure you’ve fit the template, and switch templates easily.
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"Hello \LaTeX!"

Creating a \LaTeX Document

- Write a `.tex` file using any text editor and save it in the MiniPaper folder
  ```latex
  \documentclass{article}
  \begin{document}
  Hello, \LaTeX!
  \end{document}
  ```

- Compile using the RSI Makefile
  ```bash
  $ cd ~/RSI/MiniPaper/
  $ make hello.pdf
  ```

- Preview the results
  ```bash
  $ evince hello.pdf &
  ```
**documentclass**

**LaTeX** has several templates, selected using \texttt{\textbackslash \documentclass}

<table>
<thead>
<tr>
<th>Classes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>book</td>
</tr>
<tr>
<td>report</td>
</tr>
<tr>
<td>article</td>
</tr>
<tr>
<td>letter</td>
</tr>
<tr>
<td>beamer</td>
</tr>
</tbody>
</table>

Etc.

You’ll be using the ‘article’ class for your paper, ‘beamer’ class for your presentation
Declarations and Environments

Declarations...

- Are stated once
- Take effect until further notice
- Can optionally be constrained

Ex. `\documentclass, \small`

Environments...

- Have matching `begin` and `end` declarations
- Must be constrained

Ex. `\begin{document} ... \end{document}`
Arguments

Required arguments...

- Are contained in curly braces
- Must be included

Ex. `\documentclass{article}`

Optional arguments...

- Are contained in square brackets
- Can be left out
- Give you more control over the commands

Ex. `\documentclass[12pt]{article}`
Special Characters

- Another type of command
- Don’t define any formatting or structure
- Print non-standard characters or characters which usually mean something else

Ex. \LaTeX, \textbackslash, \%
Note: % is a special character reserved for comments (after a %, the rest of a line is ignored by the compiler)
Packages

Packages allow you to further customize \LaTeX.

The command:
\begin{quote}
\texttt{\usepackage\{name\}}
\end{quote}

Some packages:
graphicx, epsfig, geometry, fancyhdr, setspace, amsmath, listings, xcolor, url...

Most of the packages you’ll need are already included in the template
Font Types

Font face:
\emph{Text}, \textbf{Text}, \texttt{Text}, \textit{Text}, \textsf{Text}, \textsc{Text}

Font size:
\tiny{Text}, \scriptsize{Text}, \footnotesize{Text}, \small{Text}, \normalsize{Text}, \large{Text}, \Large{Text}, \LARGE{Text}, \huge{Text}, \Huge{Text}

Alignment:
\begin{center/flushright/flushleft}
\end{center/flushright/flushleft}
Introduction to \LaTeX

--- A Basic Document

--- Basic Formatting

Spacing

Margins

The default: between 1.5 inches and 1.875 inches
Setting margins: `\usepackage[margin=0.5in]{geometry}`

Paragraphs and other breaks

Paragraphs are separated by a blank line.
You can force a new line using `\`
To force a new page, use `\newpage` or `\clearpage`

Other spacing

Force a space using `\`
Add space using `\hspace{1in}` or `\vspace{1in}`
Fill space using `\hfill` or `\vfill`
There are two main types...

**Bulleted lists:**

\begin{itemize}
\item Text
\item Text
\end{itemize}

**Numbered lists:**

\begin{enumerate}
\item Text
\item Text
\end{enumerate}
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The RSI File Structure

In your MiniPaper or Paper directory, you’ll notice several files...

- `main.tex` brings everything together, don’t edit it
- `preamble.tex` contains any additional packages or macros
- `cover.tex` contains the cover information (title, author, etc.)
- `abstract.tex` and `summary.tex` contain the text of your scientific abstract and executive summary, respectively
- `paper.tex` contains the main body of your paper, including any and all figures, tables, etc.
- `biblio.bib` is a BibTeX file containing your references
- `appa.tex` contains the text of any appendices you may have

Compile using `make main.pdf`
Introduction to \LaTeX

\LaTeX and You

The Files

The Title Page

cover.tex is where you define the content of your title page

- It includes declarations of the title, author, and date
- You should replace the title and author as needed, but leave the date alone

\begin{verbatim}
\title{Length-enhanced superlative verbiage}
\author{Joe Everystudent
  \vspace{0.5in}
  under the direction of
  Dr. Famous Person
  Massachusetts Institute of Technology
  \vspace{1in}}
\end{verbatim}

- The title page is created automatically using the \texttt{maketitle} command in main.tex
Abstract and Summary

- The minipaper only has an abstract
- Your final paper will have both a **technical** abstract and a **non-technical** summary
- All you need to do is fill in the text, and the template takes care of the rest

**Behind the Scenes**

```latex
\begin{abstract}
\input{abstract}
\vspace{1in}
\begin{center}\textbf{Summary}\end{center}
\input{summary}
\end{abstract}
```
biblio.bib acts as a database of references, and only includes in the bibliography those references you cite in your paper

**BibTeX**

```latex
@article{nameofentry,
    author = {John Backus},
    title = {Symmetric Encryption},
    journal = {Journal of Modalities},
    volume = 46,
    year = 1993,
    number = 2,
    pages = {44--57}
}
```

A more complete list of examples can be found at web.mit.edu/rsi/www/pdfs/bibtex-format.pdf
\LaTeX is built off of the idea of *structure over formatting*

\section{Introduction}

**Layers of sectioning**

- section
  - subsection
    - subsubsection
      - paragraph
      - subparagraph

These commands should be used as needed in both paper.tex and appa.tex
Referencing

References

\section{Results}\label{res}
...
As seen in Section \ref{res} ...

Footnotes

...telephony\footnote{Phony telephones}

Citations

Redundancy \cite{nameofentry}
For multiple citations:
...methodology \cite{nameofentry, nameofotherentry}
**Typesetting Math**

\( \text{\LaTeX} \) allows you to typeset any sort of equations.

\( \text{\LaTeX} \) math support

\[
\int_{a}^{b} \frac{d\theta}{1 + \theta^2} = \tan^{-1} b - \tan^{-1} a
\]

Using math mode

**Inline math mode:** $...$

\[
\int_{1}^{\infty} e^{-x} \, dx \quad \sum_{n=0}^{\infty} n!
\]

**Display math mode:** $$...$$

**Numbered equations:** \( \begin{equation} \ldots \end{equation} \)
Some Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>LaTeX Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>974</td>
<td>$974$</td>
</tr>
<tr>
<td>$4 + 2$</td>
<td>$4+2$</td>
</tr>
<tr>
<td>$\sqrt[3]{5}$</td>
<td>$\sqrt[3]{5}$</td>
</tr>
<tr>
<td>$\frac{x}{y}$</td>
<td>$\frac{x}{y}$</td>
</tr>
<tr>
<td>$A_x^y$</td>
<td>$A^x_{y}$</td>
</tr>
<tr>
<td>$\sum_{k=1}^n k$</td>
<td>$\sum_{k=1}^n k$</td>
</tr>
<tr>
<td>$2 \neq 4$</td>
<td>$\neq 4$</td>
</tr>
<tr>
<td>$\phi \in \Psi$</td>
<td>$\phi \in \Psi$</td>
</tr>
<tr>
<td>$\hat{i} \times \hat{j} = \hat{k}$</td>
<td>$\hat{i} \times \hat{j} = \hat{k}$</td>
</tr>
<tr>
<td>$f''(\xi)$</td>
<td>$f''(\xi)$</td>
</tr>
<tr>
<td>CH$_3$COOH</td>
<td>CH$_3$COOH</td>
</tr>
<tr>
<td>180°C</td>
<td>180$^\circ$C</td>
</tr>
</tbody>
</table>

...runs in $\Theta(\log n)$ time...
Math symbols resources

- Detexify: http://detexify.kirelabs.org
  - Draw a symbol, Detexify tells you a bunch of possible \LaTeX symbols

  - Also has lots of other \LaTeX resources

- RSI Website (go to “Tech help”)
Math exercises

Write the follow basic equations in \LaTeX. 

\begin{align*}
2 &= \frac{3}{2} + \frac{1}{2} \\
\frac{n(n + 1)}{2} &= \sum_{i=1}^{n} i \\
x &= \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}
\end{align*}
More math exercises

Here are some trickier equations (not just math) to try:

\[ \oint \mathbf{B} \cdot d\mathbf{S} = \mu_0 \varepsilon_0 \frac{d\Phi_E}{dt} + \mu_0 i_{\text{enc}} \]

\[ k = Ae^{-E_A/RT} \]

\[ K_a = \frac{[H_3O^+][A^-]}{[HA]} \]

\[ \mathcal{V} = \left( \bigoplus_{\lambda \in \text{Spec}(\mathcal{T})} \mathcal{V}^{(\lambda)} \right) \oplus \mathcal{V}^{\text{non-sp}} \]
Figures and Tables

Both are environments:

**Figures**
\begin{figure}
...
\end{figure}

**Tables**
\begin{table}
...
\end{table}

Positioning can be defined as an optional argument:
\begin{figure}[htbp]
**The Commands**

\subsection{Hardware Configuration}

\begin{figure}[ht]
  \centering
  \includegraphics[height=3in]{figure0.png}
\end{figure}

\begin{figure}[ht]
  \centering
  \includegraphics[width=\textwidth]{figure1.png}
\end{figure}
Formatting Tables

The `table` environment defines the figure style. The `tabular` environment defines the table itself.

\begin{table}[ht]
\centering
\begin{tabular}{|r||c|c|} \hline
Trial & $n$ & $t$ \\ \hline
1 & 23 & 2 \\ \hline
2 & 15 & 10 \\ \hline
3 & 100 & 20 \\ \hline
\end{tabular}
\end{table}
## Captions and Labels

### Captioning

```
\begin{tabular}
\caption{The data.}
\end{tabular}
```

### Labeling

```
\caption{The data.}
\label{nameoftable}
\end{table}
```

### Referencing

```
...in Table \ref{nameoftable}
```
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Getting Started

Beamer allows all the same commands as a normal \LaTeX\ document, plus some.

Adding a Slide

\begin{frame}\{Title\}
  ...
\end{frame}

Special slides

Title slide:
  \titlepage

Table of contents:
  \tableofcontents[currentsection]
Beamer at RSI

We have a template for this too! It's in the file `slides.tex`

**Title Slide**

Be sure to fill in the title, subtitle (if necessary) and author

```
\title{Witty catch-phrase}
\subtitle{Length-enhanced superlative verbiage}
\author[Joe Everystudent]{Joe Everystudent\\Research Science Institute\\Under the Direction of Dr. Famous Person\\Massachusetts Institute of Technology}
```

The template already includes a title slide!
Some special environments can be useful for presentations

**Blocks**

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

**Columns**

\begin{columns}
  \column{0.5\textwidth}
  Column 1
  \column{0.5\textwidth}
  Column 2
\end{columns}
You can also do some basic animation in beamer.
You can also do some basic animation in beamer.

- \textbackslash pause puts a pause before revealing the rest of the slide
You can also do some basic animation in beamer.

- \pause puts a pause before revealing the rest of the slide
- \textit{command\textless num–num\textgreater} makes the command apply only for some number of the “frames”
You can also do some basic animation in beamer.

- \pause puts a pause before revealing the rest of the slide
- command\<num–num> makes the command apply only for some number of the “frames”
- The previous bullet is defined by \item\<3–4>
You can also do some basic animation in beamer.

- \texttt{\textbackslash pause} puts a pause before revealing the rest of the slide
- The previous bullet is defined by \texttt{\textbackslash item<3-4>}
- The bullet disappears after the fourth “frame”
Themes

You can also choose different themes for beamer.

**Design**

\texttt{\usepackage\{theme\}}

Antibes, Berkeley, Berlin, Goettingen, Malmoe, Szeged, Warsaw...

**Color**

\texttt{\usepackage\{color\theme\}}

beaver, crane, lily, rose, seahorse, whale...
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>A Basic Document</td>
<td>Writing LaTeX Code, Basic Formatting</td>
</tr>
<tr>
<td>3</td>
<td>LaTeX and You</td>
<td>The Files, Math Mode, Figures and Tables</td>
</tr>
<tr>
<td>4</td>
<td>Beamer</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>LaTeX Extended</td>
<td>Common Errors, More Math, Macros</td>
</tr>
<tr>
<td>6</td>
<td>Conclusion</td>
<td></td>
</tr>
</tbody>
</table>
The Structure of an Error

Terminal:

```bash
(~RSI/Test) athena$ make main.pdf
/mit/hsi/scripts/maketexdmake.pl paper.tex paper.tex.d
/mit/hsi/scripts/maketexdmake.pl main.tex main.tex.d
(rubber --pdf main.tex)\n
    || (rm main.pdf && echo "YOUR FILE main.tex FAILED TO COMPILIE. SCROLL UP FOR ERRORS." && exit 2)
compiling main.tex...
paper.tex:22: Undefined control sequence \incluegraphics.
paper.tex:22: leading text: \incluegraphics
YOUR FILE main.tex FAILED TO COMPILIE. SCROLL UP FOR ERRORS.
make: *** [main.pdf] Error 2
(~RSI/Test) athena$ 
```
Missing Closing Braces

The Code

\includegraphics{picture.png}

The Error Message

~/RSI/Test) athena$ make main.pdf
(rubber --pdf main.tex)\
  || (rm main.pdf && echo "YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP FOR ERRORS." && exit 2)
compiling main.tex...
main.tex:29: File ended while scanning use of \@xdblarg.
main.tex:29: leading text: \include{paper}
YOUR FILE main.tex FAILED TO Compile. SCROLL UP FOR ERRORS.
make: *** [main.pdf] Error 2
~/RSI/Test) athena$
Introduction to \texttt{\LaTeX}

\texttt{\LaTeX} Extended

Common Errors

Missing Environment End

The Code

\begin{itemize}
\item Text.
\end{itemize}

The Error Message

(~/RSI/Test) athena$ make main.pdf
/mit/rsi/scripts/maketexdmake.pl paper.tex paper.tex.d
/mit/rsi/scripts/maketexdmake.pl main.tex main.tex.d
(rubber --pdf main.tex)\n
    || (rm main.pdf && echo "YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP
FOR ERRORS." && exit 2)
compiling main.tex...
main.tex:38: \begin{itemize} on input line 22 ended by \end{document}.
main.tex:38: leading text: \end{document}
YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP FOR ERRORS.
make: *** [main.pdf] Error 2
(~/RSI/Test) athena$
Spaces in Filenames

The Code
\includegraphics{a picture.png}

The Error Message

```
~/RSI/Test) athena$ make main.pdf
make: *** No rule to make target `a', needed by `main.pdf'. Stop.
~/RSI/Test) athena$ 
```
Forgetting to Escape

The Code

```
a_b
```

The Error Message

```bash
(~/RSI/Test) athena$ make main.pdf
/mit/rsi/scripts/maketexdmake.pl paper.tex paper.tex.d
/mit/rsi/scripts/maketexdmake.pl main.tex main.tex.d
(rubber --pdf main.tex)\|
   || (rm main.pdf && echo "YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP FOR ERRORS." && exit 2)
 compiling main.tex...
paper.tex:22: leading text: a_
paper.tex:23: Missing $ inserted.
YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP FOR ERRORS.
make: *** [main.pdf] Error 2
(~/RSI/Test) athena$ 
```
Forgetting to Use Math Mode

The Code
\frac{1}{2}

The Error Message

```bash
(~/.RSI/Test) athena$ make main.pdf
/mit/rsi/scripts/maketexdmake.pl paper.tex paper.tex.d
/mit/rsi/scripts/maketexdmake.pl main.tex main.tex.d
(rubber --pdf main.tex)
    || (rm main.pdf && echo "YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP FOR ERRORS." && exit 2)
compiling main.tex...
paper.tex:22: leading text: \frac{1}{2}
paper.tex:22: Extra }, or forgotten $.
paper.tex:22: leading text: \frac{1}{2}
paper.tex:23: Missing $ inserted.
YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP FOR ERRORS.
make: *** [main.pdf] Error 2
(~/.RSI/Test) athena$
```
Defining Theorems and More

The Code

% This is preamble.tex
\newtheorem{name}{Display Name}

Example

% This is preamble.tex
\newtheorem{thm}{Theorem}

Example, continued

% This is paper.tex
\begin{thm}
Herding cats is hard.
\end{thm}
More on Theorems

Adding a Reference
\begin{thm}[Cain, 2002]
Herding Rickoids is harder.
\end{thm}

Proving your Theorems
% This is paper.tex
\begin{proof}
...
\end{proof}
What are Macros?

- LaTeX allows you to define or redefine commands as you please.
- In fact, LaTeX itself is a set of macros on top of TeX.

\texttt{\textbackslash newcommand\{name\}[num]\{definition\}}
Resetting Commands

Changing lengths

\setlength{command}{length}

Ex.
\setlength{\parindent}{1cm}
\setlength{\parskip}{1cm plus4mm minus3mm}

Changing titles

Ex.
\renewcommand{\abstractname}{Summary}
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So, why \texttt{\LaTeX}?

- \texttt{\LaTeX} allows you to worry about the content and the structure, rather than the presentation.
- \texttt{\LaTeX} has one of the most advanced math typesetting systems around.
- \texttt{\LaTeX} is incredibly extendible.
- \texttt{\LaTeX} keeps track of references so you don’t have to.
- \texttt{\LaTeX} allows you to make more consistent, and more easily changeable, documents.
Getting Help and Learning More

- **\LaTeX{} Wikibooks:**
  en.wikibooks.org/wiki/LaTeX

- **The Not So Short Introduction to \LaTeX{} 2ε:**

- **A Short Math Guide for \LaTeX{}:**

- **The Beamer Theme Matrix:**
  www.hartwork.org/beamer-theme-matrix/

**Google is still your best friend!**