

SIAM: Getting Started with \LaTeX

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What is L^AT_EX?

- L^AT_EX is a high-quality typesetting system
- L^AT_EX markup is converted into nice looking pdf files

```
\documentclass[12pt]{article}
\usepackage{amsmath}
\title{\LaTeX}
\date{}
\begin{document}
  \maketitle
  \section{Introduction}
  \LaTeX{} is a document
  preparation system for the
  \TeX{} typesetting program.
  It offers programmable desktop
  publishing features and
  ...
  \begin{align}
    E &= mc^2 \\
    m &= \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}
  \end{align}
\end{document}
```



L^AT_EX

1 Introduction

L^AT_EX is a document preparation system for the T_EX typesetting program. It offers programmable desktop publishing features and extensive facilities for automating most aspects of typesetting and desktop publishing, including numbering and cross-referencing, tables and figures, page layout, bibliographies, and much more. L^AT_EX was originally written in 1984 by Leslie Lamport and has become the dominant method for using T_EX; few people write in plain T_EX anymore. The current version is L^AT_EX 2_ε.

$$E = mc^2 \tag{1}$$

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{2}$$



Why Use \LaTeX ?

- Produces high-quality documents
- Offers precise control over how document looks
- Excellent for typesetting mathematics
- Automated references, citations, etc.
- Widely used for academic journals
- Free
- Multi-platform



Compiling

- Installing \LaTeX on your computer
 - Mac: from MacPorts, MacTeX, TeXShop
 - Windows: TeXworks, MiKTeX
 - Helpful site: en.wikibooks.org/wiki/LaTeX/Installation
- Use `latex` or `pdflatex` command on a `.tex` file to produce output
 - `pdflatex` is recommended, since it can include `.pdf`, `.jpg`, `.png` image formats and outputs directly to `.pdf`
 - `latex` uses PostScript format
- Can also compile online at sharelatex.com



Control Sequences

- \LaTeX uses control sequences to achieve special functionality
- Control sequences start with a backslash `\`

<code>\documentclass[11pt]{article}</code>	describes appearance of document (similar to CSS)
<code>\usepackage{amsmath}</code>	include package named amsmath
<code>\begin{document}</code>	begins document environment
<code>\section{Section Title}</code>	starts a new section
<code>\subsection{Subsection Title}</code>	starts a new subsection
<code>\LaTeX{}</code>	displays \LaTeX
<code>\end{document}</code>	ends document environment



Example Document

- \LaTeX document will have information like title and date in top matter
- Contents of document belong in document environment

```
\documentclass[11pt]{article}
\usepackage{amsmath}
\title{\LaTeX}
\author{Your Name}
\date{} % omits date since this is empty
\begin{document}
  \maketitle
  \section{Introduction}
  This is the introduction of my document.
  ...
\end{document}
```



You can use LaTeX to typeset regular text. In LaTeX, using extra spaces or a newline doesn't matter.

However, using two newlines in a row results in a new paragraph.

% line comments begin with a percent sign

You can use LaTeX to typeset regular text. In LaTeX, using extra spaces or a newline doesn't matter.

However, using two newlines in a row results in a new paragraph.



Cross-Referencing

- Many things in \LaTeX , such as sections and subsections, are automatically numbered
 - Numbering can be suppressed using asterisk, e.g.
`\section*{...}`
- Automatically numbered entities in \LaTeX can be labeled using `\label{...}`
- Any labeled entity can be referenced using `\ref{...}`
- Command `\ref{...}` is often preceded by `~`, denoting a space that cannot be a line break

```
\section{Introduction}
```

```
\label{sec:intro}
```

This is the introduction.

```
\section{Results}
```

In section~\ref{sec:intro}, we provided introductory material. Now we will provide results.



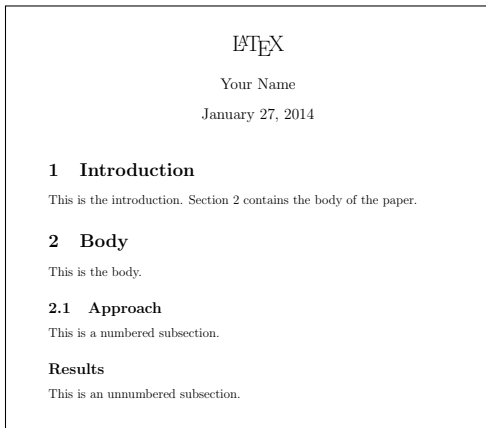
Compiling Multiple Times

- When running `pdflatex` on `example.tex`, multiple files are created
 - `example.pdf`: output file
 - `example.aux`: contains auxiliary about references, etc.
 - `example.log`, `example.synctex.gz`, etc.
- Cross-reference information in `.aux` file is not ready until after `pdflatex` is run
 - May need to run `pdflatex` twice for references to display correctly
 - Using the tool `Latexmk` can resolve this issue



Exercise 1: Sections

- Create the following document in \LaTeX



- Helpful sites:
 - http://en.wikibooks.org/wiki/LaTeX/Document_Structure
 - http://en.wikibooks.org/wiki/LaTeX/Labels_and_Cross-referencing



Exercise 1: Sections (Solution)

```
\documentclass[12pt]{article}
\title{\LaTeX}
\author{Your Name}
\begin{document}
  \maketitle
  \section{Introduction}
  This is the introduction.  Section~\ref{sec:body} contains
  the body of the paper.
  \section{Body}
  \label{sec:body}
  This is the body.
  \subsection{Approach}
  This is a numbered subsection.
  \subsection*{Results}
  This is an unnumbered subsection.
\end{document}
```



- Figures can be created using the figure environment
- Various options for placing figures
 - h: here, approximately
 - t: top
 - b: bottom
 - p: on its own page with other such figures
 - For example, `begin{figure}[ht]...` will place the figure approximately where it is listed in the markup and at the top of a page
- Figures can include a caption and be labeled

Figures

- The figure below was made with the following code:

```
\begin{figure}  
  \includegraphics[width=.6\textwidth]{siebel.jpg}  
  \label{fig:siebel}  
  \caption{A picture of Siebel Center}  
\end{figure}
```



Figure 1: A picture of Siebel Center



- BibTeX is a tool used to cite articles/books and automatically form a bibliography
- Use `cite` command to cite something in your paper
 - Example: `\cite{greenwade93}`
- Use `\bibliographystyle` and `\bibliography` commands at the end of document where bibliography should be
 - Example: `\bibliographystyle{plain}`
`\bibliography{references}{}`
- Make a `.bib` file (called `references.bib` in our example) that describes each source



■ Example .bib file:

```
@article{greenwade93,
  author   = "George D. Greenwade",
  title    = "The {C}omprehensive {T}ex {A}rchive {N}etwork
              ({CTAN})",
  year     = "1993",
  journal  = "TUGBoat",
  volume   = "14",
  number   = "3",
  pages    = "342--351"
}

@book{goossens93,
  author    = "Michel Goossens and Frank Mittelbach and
              Alexander Samarin",
  title     = "The LaTeX Companion",
  year      = "1993",
  publisher = "Addison-Wesley",
  address   = "Reading, Massachusetts"
}
```



- Text between dollar signs $\$ \dots \$$ will use math mode
- Many control sequences only work in math mode
- Can use \wedge for superscripts and $_$ for subscripts

$\$y = 3x - 4\$$	\rightarrow	$y = 3x - 4$
$\$\theta \Theta \omega \Omega\$$	\rightarrow	$\theta \Theta \omega \Omega$
$\$\sqrt{x} = x^{1/2}\$$	\rightarrow	$\sqrt{x} = x^{1/2}$
$\$\min \{x_1, x_2, x_3\}\$$	\rightarrow	$\min\{x_1, x_2, x_3\}$



- Example: $f(x) = \sum_{i=1}^{\infty} \frac{1}{g_i(x)}$
- Use dollar signs $\$ \dots \$$ for inline math
 - The equation $f(x) = \sum_{i=1}^{\infty} \frac{1}{g_i(x)}$ is displayed inline
- Use escaped brackets $\backslash[\dots \backslash]$ to display math on its own line

$$f(x) = \sum_{i=1}^{\infty} \frac{1}{g_i(x)}$$

- Use $\backslashbegin{equation} \dots \backslashend{equation}$ for automatically numbered equations

$$f(x) = \sum_{i=1}^{\infty} \frac{1}{g_i(x)} \tag{1}$$



Exercise 2: Definition of Derivative

- Produce the following equation in \LaTeX :

$$\frac{df(x)}{dx} = \lim_{\delta \rightarrow 0} \frac{f(x + \delta) - f(x)}{\delta}$$

- Start from the following:

```
\documentclass[11pt]{article}
\usepackage{amsmath}
\begin{document}
  % add your content here
\end{document}
```

- Helpful sites:

- en.wikibooks.org/wiki/LaTeX/Mathematics
- ftp.ams.org/pub/tex/doc/amsmath/short-math-guide.pdf



Exercise 2: Definition of Derivative (Solution)

- Produce the following equation in \LaTeX :

$$\frac{df(x)}{dx} = \lim_{\delta \rightarrow 0} \frac{f(x + \delta) - f(x)}{\delta}$$

- Solution:

```
\[  
  \frac{\mathrm{d}f(x)}{\mathrm{d}x}  
= \lim_{\delta \rightarrow 0} \frac{f(x + \delta) - f(x)}{\delta}  
\]
```

- Do the ds in your solution look different?
 - `\mathrm` displays upright characters in math mode



Array-Like Environments

- Use array environment or one of the matrix environments to make table of information
- Matrix environments include delimiters for convenience
 - `pmatrix ()`, `bmatrix []`, `Bmatrix {}`, `vmatrix ||`, `Vmatrix |||`
- Columns separated with `&`, rows separated with `\\`

```
A = \begin{pmatrix}
    2 & -1 & 0 \\
    -1 & 2 & -1 \\
    0 & -1 & 2
\end{pmatrix}
```

→

$$A = \begin{pmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{pmatrix}$$



Align Environment

- Use `align` environment to line up multiple equations
- Left and right sides of equation separated with `&`
- Equations separated with `\\`
- Using `align*` instead of `align` will suppress equation numbers

```
\begin{align}
x &= \cos(\theta(t)) \\
y &= \sin(\theta(t)) \\
\theta(t) &= \omega t + \phi
\end{align}
```

→

$$\begin{aligned} x &= \cos(\theta(t)) & (2) \\ y &= \sin(\theta(t)) & (3) \\ \theta(t) &= \omega t + \phi & (4) \end{aligned}$$

Resizing Delimiters

- The `\left`, `\right`, and `\middle` commands are used to automatically resize delimiters like parenthesis based on content
- Period `.` denotes an omitted left or right delimiter
- The `\big`, `\Big`, `\bigg`, and `\Bigg` commands can be used to manually resize delimiters

$$\begin{array}{ll} \$\left(\frac{x^2}{y+x}\right)^2\$ & \rightarrow \left(\frac{x^2}{y+x}\right)^2 \\ \$P\left(X=1 \middle| \frac{X}{Y} \geq 2 \right)$ & \rightarrow P\left(X=1 \middle| \frac{X}{Y} \geq 2\right) \\ \$\left.2x-\frac{2}{x^3}\right|_0^1\$ & \rightarrow 2x-\frac{2}{x^3}\bigg|_0^1 \\ \$(\big(\Big(\bigg(\Bigg($ & \rightarrow ((((($$



- Special accents over variables/expressions may be used in math mode

`$\backslash\text{bar}\{x\}$` \rightarrow \bar{x}

`$\backslash\text{dot}\{x\}$` \rightarrow \dot{x}

`$\backslash\text{ddot}\{x\}$` \rightarrow \ddot{x}

`$\backslash\text{acute}\{x\}$` \rightarrow \acute{x}

`$\backslash\text{vec}\{x\}$` \rightarrow \vec{x}

`$\backslash\text{hat}\{x\}$` \rightarrow \hat{x}

`$\backslash\text{tilde}\{x\}$` \rightarrow \tilde{x}

`$\backslash\text{grave}\{x\}$` \rightarrow \grave{x}

Exercise 3: More Math

- Produce the following equations in \LaTeX :

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$$

$$\hat{x}_i = x_i \left(\sum_{j=0}^{\infty} x_j \right)^{-1}$$

- Helpful sites:
 - en.wikibooks.org/wiki/LaTeX/Mathematics
 - ftp.ams.org/pub/tex/doc/amsmath/short-math-guide.pdf



Exercise 3: More Math (Solution)

- Produce the following equations in \LaTeX :

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$$

$$\hat{x}_i = x_i \left(\sum_{j=0}^{\infty} x_j \right)^{-1}$$

- Solution:

```
\begin{align*}
\begin{vmatrix} a & b \\ c & d \end{vmatrix} &= ad - bc \\
\hat{x}_i &= x_i \left( \sum_{j=0}^{\infty} x_j \right)^{-1}
\end{align*}
```



If You Want to Know More . . .

- en.wikibooks.org/wiki/LaTeX/ : Excellent reference for \LaTeX in general

