Introduction to \LaTeX

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Introduction

What is \LaTeX?

Figure: Donald Knuth in 2005. Source: Wikimedia Commons.
Introduction to \LaTeX

Figure: The Art of Computer Programming. Source: MSDN.
Figure: The TeX logo.
\newif\ifFPD@overflow
\newdimen\FBD@denom
\def\fpdivide#1#2{% 
  \FPD@overflowfalse
  \ifdim\AbsValD#2<1\p@
    \begingroup\FBD@denom\ifdim#2<\z@ \fi 5000#2%
    \let\next\@empty
  \fi\ifdim\AbsValD#1>\FBD@denom
    \def\next{% 
      \FPD@overflowtrue
      \debug2{Overflow dividing \the#1 by \the#2 \rightarrow \inf}%
      #1=5000\p@}%
  \fi
  \ifdim\AbsValD#2<.001\p@ \ifdim\AbsValD#2<.001\p@
    \def\next{% 
      \FPD@overflowtrue
      \debug2{Overflow dividing \the#1 by \the#2 \rightarrow 0}%
      #1=0\p@}%
  \fi\fi
  \expandafter\endgroup\next
}\fi

Figure: Some \TeX code. Source: The Lone \TeXnician.
Figure: Leslie Lamport in 2004. Source: Wikimedia Commons.
\section{Problem 4}
\begin{enumerate}
\setcounter{enumi}{24}
\item $W$ is the interior volume of a half-paraboloid opening in the $+z$ direction, truncated on the top by $z = 4 - y^2$, which looks a bit like the roof of a greenhouse, and truncated on the bottom by the $xy$ plane. The paraboloid has equation $z = x^2 + 3y^2$, and its shadow in the $xy$ plane is $x^2/4 + y^2 \leq 1$.
\item The appropriate integral is
\begin{align}
\int_0^1 \int_{-2\sqrt{1-y^2}}^{2\sqrt{1-y^2}} \int_{x^2+3y^2}^{4-y^2} & \left(x^3 + y^3\right) dz dx dy.
\end{align}
\end{enumerate}

Figure: Some \LaTeX code.
Figure: The \LaTeX\ logo.
What is \LaTeX? 

\LaTeX is a sophisticated document preparation system and desktop publishing utility.

\LaTeX has . . .

- Footnotes and endnotes
- Bibliography support
- Reference tracking
- Stylistic uniformity
- Crazy algorithms

However . . .

- \LaTeX is not a word processor!
What is \LaTeX{} not?

\LaTeX{} is a programming language, not a word processor.

\LaTeX{} will \textit{not} . . .

- Spell-check your documents
- Give you complete control over the way your document looks
- Let you see your document while you are writing it

Core \LaTeX{} philosophy:

You take care of writing; we’ll take care of presentation.

- Humans write text.
- Computers figure out how to display the text.
Why should I use \LaTeX?  

Sometimes, presentation gets in the way of content.

**Example: underlining vs. italics**
- Word processor way: set italics and/or underlining each time
- \LaTeX way: tell \LaTeX to *emphasize*; set what that means later

**Example: journal article / thesis**
- Word processor way: risk accidentally modifying provided template
- \LaTeX way: write your text, let \LaTeX worry about layout
Why should I not use \LaTeX? 

- Generally slower (exception: mathematics)
- Lack of complete control
4 basic steps

1. Write a .tex file using your favorite text editor
2. Typeset using \LaTeX{} or PDF\LaTeX{}
3. Preview the result using xdvi or xpdf (or Acrobat Reader or Evince)
4. (optional) Convert the result to PostScript and print
1. Write a .tex file

hello.tex

\documentclass{article}
\begin{document}
Hello, world!
\end{document}
2. Typeset using \LaTeX

In a terminal:

\[
\begin{align*}
\text{cd path/to/folder/containing/your/.tex/file} \\
\text{latex hello.tex}
\end{align*}
\]
2. Typeset using \LaTeX

Result:

This is pdfTeX, Version 3.1415926-1.40.10 (TeX Live 2009)
entering extended mode
./hello.tex
LaTeX2e <2009/09/24>
Babel <v3.8l> and hyphenation patterns for english, usenglishmax, dumylang, nohyphenation, german-x-2009-06-19, ngerman-x-2009-06-19, ancientgreek, ibycus, arabic, basque, bulgarian, catalan, pinyin, coptic, croatian, czech, danish, dutch, esperanto, estonian, farsi, finnish, french, galician, german, ngerman, mongol, greek, hungarian, icelandic, indonesian, interlingua, irish, italian, kurdish, latvian, lithuanian, mongolian, mongolian2a, bokmal, nynorsk, polish, portuguese, romanian, russian, sanskrit, serbian, slovak, slovenian, spanish, swedish, turkish, ukenglish, ukrainian, uppersorbian, welsh, loaded.
(/usr/local/texlive/2009/texmf-dist/tex/latex/base/article.cls)
Document Class: article 2007/10/19 v1.4h Standard LaTeX document class
No file hello.aux.
(./hello.aux)
Output written on hello.dvi (1 page, 232 bytes).
Transcript written on hello.log.
3. Preview using xdvi

New files!
- hello.aux
- hello.dvi
- hello.log

$ xdvi hello.dvi$
3. Preview using xdvi

Result:

Hello, world!
4. Convert to PostScript and print

Converting to PostScript

```
$ dvips -t letter -o hello.ps hello.dvi
```

Printing

Don’t run this command right now!

```
$ lpr -Pprintername hello.ps
```
When \LaTeX\ complains

Overfull/underfull hbox
\LaTeX\ couldn’t make your text fit nicely on one line.

Overfull/underfull vbox
\LaTeX\ couldn’t make your text fit nicely on a page.

Runaway argument
You forgot to close a brace.

Solution

1. Type \texttt{x} and hit enter
2. Fix the error
3. Re-run \LaTeX
Sample document 1

“Synthesizing Congestion Control Using Replicated Archetypes”
Generated by SCIgen, the automatic computer science paper generator
pdos.csail.mit.edu/scigen/
Declarations and environments

Declarations . . .
- Are stated once
- Take effect until further notice
- Can be constrained using curly braces

Example: \documentclass

Environments . . .
- Have corresponding \begin and \end declarations
- Apply formatting to their contents

Example: \begin{document} \end{document}
The `documentclass` declaration

\documentclass tells \LaTeX{} what basic document template to use.

Other templates ("classes"):

- book
- report
- letter
- revtex4-1
- thesis
- beamer
Sectioning declarations

- \part (book only)
- \chapter (book and report only)
- \section
- \subsection
- \subsubsection
- \paragraph
- \subparagraph
- \subsubparagraph

Example: \chapter{A Mad Tea-Party}
Arguments can be required or optional.

**Required arguments . . .**
- Are placed in curly braces
- Cause \LaTeX to complain if left out

Example: `\documentclass{article}`

**Optional arguments . . .**
- Are placed in square brackets
- Don’t cause errors if left out
- Come before required arguments

Example: `\documentclass[12pt,letterpaper]{article}`
The title

Place in preamble (before \begin{document}):
\title{Synthesizing Congestion Control Using Replicated Archetypes}
\author{Benjamin Barenblat\MIT \and SClgen\CSAIL}
\date{\today}

Place in document:
\maketitle

Some classes allow for more preamble commands.
Including graphics

Straight \LaTeX requires documents to be in encapsulated PostScript format.

Place in preamble:
\usepackage{graphicx}

Place in document:
\begin{figure}
  \begin{center}
  \includegraphics{doc1/flowchart.eps}
  \caption{The diagram used by Oxymel.}
  \end{center}
\end{figure}
Labeling figures

Place after caption:
\label{robots}

Place in appropriate location:
\ldots\  figure\sim\ref{robots}

You will have to run \LaTeX\ twice!
Labeling figures and stuff

Place after appropriate command:
\label{robots}

Place in appropriate location:
\ldots \ref{robots}

You will have to run LaTeX twice!
Tables

Recall figures:
\begin{figure}
  \begin{center}
  \includegraphics{doc1/flowchart.eps}
  \end{center}
  \caption{The diagram used by Oxymel.}
\end{figure}

Similar method for tables:
\begin{table}
  \begin{center}
  \includegraphics{doc1/datatable.eps}
  \end{center}
  \caption{Our raw data.}
\end{table}
Tabular

Code:

\begin{tabular}{lll}
 Language & Seek time & Write time \\
\hline
 BLooP & 27 & 42 \\
 FLooP & 12 & 19 \\
 GLooP & 11 & 22 \\
\end{tabular}

Result:

<table>
<thead>
<tr>
<th>Language</th>
<th>Seek time</th>
<th>Write time</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLooP</td>
<td>27</td>
<td>42</td>
</tr>
<tr>
<td>FLooP</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>GLooP</td>
<td>11</td>
<td>22</td>
</tr>
</tbody>
</table>
Lists can be numbered (enumerated) or bulleted (itemized).

**Numbered lists:**
\begin{enumerate}
  \item Item 1
  \item Item 2
\end{enumerate}

**Bulleted lists:**
\begin{itemize}
  \item Item 1
  \item Item 2
\end{itemize}
Quoting other works

\begin{quote}
  Here’s a single-paragraph quote.
\end{quote}

\begin{quotation}
  Here’s a multiparagraph quote.
  Here’s the second paragraph.
\end{quotation}

\begin{verse}
  Here’s some poetry.
  Here’s the second line.
\end{verse}
Finishing touches

The abstract:
\begin{abstract}
   Yada yada yada..... 
\end{abstract}

A title page
\documentclass[titlepage]{article}

Real headers
\pagestyle{headings}
Miscellaneous

Spaces

\sim \quad \text{nonbreaking space}
\\ \text{force normal interword space}
\text{(e.g., Steele et al. discovered)}
\\ \text{@. force end-of-sentence space}
\text{(e.g., I program in C@. You?)}
\\ \text{\hspace{1in} make horizontal space}
\\ \text{\vspace{1in} make vertical space}

Breaking

\\\\ \text{force new line}
\\ \text{\newpage force new page}
\\ \text{\noindent force no indentation of current paragraph}

Comments: Anything after \% on a single line is ignored.
Some customization commands are built-in.

Changing font face:
\textit{\textbf{\textsc{\texttt{\textsf{\textnormal{\textemph{text}}}}}}}

Changing font size:
\textit{\textbf{\textsc{\texttt{\textsf{\textnormal{\textemph{text}}}}}}}

Changing alignment:
\textit{\textbf{\textsc{\texttt{\textsf{\textnormal{\textemph{text}}}}}}}

Customizing \LaTeX

Customizations can also occur through *packages*.

**Including a package:**
\usepackage{packagename}

**Useful packages**
graphicx, geometry, setspace, fancyhdr, calc, mathpazo, microtype, amsmath, amsfonts, amsthm, amssymb, url, ulem, textcomp, listings, eco, mathtools, mhchem, units, wrapfig, color, ccaption, titlesec, epstopdf, tabularx, tocloft ...
A survey of useful packages

**geometry**

Controls margins:

\usepackage[margin=1.1in]{geometry}

**setspace**

Allows you to use double and 1.5 spacing:

\usepackage{setspace}
\doublespacing

**fancyhdr**

Controls header and footer:

\usepackage{fancyhdr}
\pagestyle{fancy}
\fancyhf{}
% Reset header and footer
\fancyhead[R]{\thepage} % This puts the page in the right of the header
Fonts are usually loaded through packages as well.
\usepackage[urw-garamond]{mathdesign} \quad \text{Garamond}
\usepackage{mathpazo} \quad \text{Palatino}
\usepackage[scaled]{helvet} \quad \text{Helvetica}
\usepackage{courier} \quad \text{Courier}
\renewcommand*{\sfdefault}{uop} \quad \text{Optima}
\usepackage{concrete} \quad \text{Computer Concrete}
\usepackage{tgbonum} \quad \text{Bookman}
\usepackage{txfonts} \quad \text{Times}

More fonts are available at The \LaTeX{} Font Catalogue, www.tug.dk/FontCatalogue/.
Typesetting mathematics

\( \text{\LaTeX}'s \) math support far outstrips that of any other available piece of software.

The Leibniz integral rule

\[
\frac{d}{d\alpha} \int_{a(\alpha)}^{b(\alpha)} f(x, \alpha) \, dx = \frac{db(\alpha)}{d\alpha} f(b(\alpha), \alpha) - \frac{da(\alpha)}{d\alpha} f(a(\alpha), \alpha) \\
+ \int_{a(\alpha)}^{b(\alpha)} \frac{\partial}{\partial \alpha} f(x, \alpha) \, dx
\]

Generalized Stokes theorem

If \( \omega \) is an \((n - 1)\)-form with compact support on \( M \) and \( \partial M \) denotes the boundary of \( M \) with its induced orientation, then

\[
\int_M d\omega = \oint_{\partial M} \omega.
\]
Text and math modes

\LaTeX{} is always operating in either text mode, display math mode, or inline math mode.

**Inline math mode**
- Enter/exit using $\ldots$ or \((\ldots\))
- Large symbols and super/subscripts are squashed:
  \[
  \int_{1}^{\infty} e^{-x} dx \quad \sum_{n=0}^{\infty} n! \quad \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}
  \]

**Display math mode**
- Enter/exit using \begin{equation} \ldots \end{equation} or \[\ldots\]
- Large symbols and super/subscripts are displayed in full glory
- Equations can be numbered
  \[
  \int_{1}^{\infty} e^{-x} dx \quad \sum_{n=0}^{\infty} n! \quad \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}
  \]
Basic mathematics

The vast majority of math commands are highly logical.

\[
974 \quad 974
\]
\[
4 + 2 \quad 4 + 2
\]
\[
\sqrt[3]{5} \quad \sqrt{[3]{5}}
\]
\[
x^2 \quad x^2
\]
\[
x \quad \pm 71
\]
\[
3 \sqrt[3]{5} \quad \sqrt[3]{5}
\]
\[
\phi \in U \quad \phi \ \in \ U
\]
\[
x \quad f''(\xi) \quad f''(\xi)
\]
\[
\forall x \exists y \quad \forall x \exists y
\]
\[
\sum_{k=1}^n k \quad \sum_{k=1}^n k
\]
\[
x \leq y \quad x \leq y
\]
\[
2 \neq 4 \quad 2 \neq 4
\]
\[
\nabla \cdot \Psi \quad \nabla \cdot \Psi
\]
\[
\hat{i} \times \hat{j} = \hat{k} \quad \hat{i} \times \hat{j} = \hat{k}
\]

Detexify\textsuperscript{2} (detexify.kirelabs.org/) gives commands for any symbol.
Mathematics packages and environments

- Use `\usepackage{amsfonts, amsmath, amssymb, amsthm}` unless you have a good reason not to.
- `\usepackage{esint}` will get you cool integral signs.

\begin{equation}
\oiint_{\partial \Omega} \mathbf{F} \cdot d\mathbf{S} = \iiint_{\Omega} \nabla \cdot \mathbf{F} \, dx\,dy\,dz \tag{1}
\end{equation}

\begin{equation*}
\oiint_{\partial \Omega} \mathbf{F} \cdot d\mathbf{S} = \iiint_{\Omega} \nabla \cdot \mathbf{F} \, dx\,dy\,dz
\end{equation*}

The Short Math Guide for \LaTeX
Mathematics packages and environments

\begin{align}
\begin{align*}
a &= \oiint_{\partial \Omega} \mathbf{F} \cdot d\mathbf{S} \\
&= \iiint_{\Omega} \nabla \cdot \mathbf{F} \, dxdydz
\end{align*}
&& \text{(3)(5 + 7) = (3)(12)} \quad (2)
\end{align}

\begin{align}
\begin{block}
\begin{align}
a &\begin{block}
\begin{align*}
&= \oiint_{\partial \Omega} \mathbf{F} \cdot d\mathbf{S} \\
&= \iiint_{\Omega} \nabla \cdot \mathbf{F} \, dxdydz
\end{align*}
\end{align}
\end{block}
\end{align}
\end{block}

\begin{align}
\begin{align*}
(3)(5 + 7) &= (3)(12) \\
&= 36
\end{align*}
\end{align}

Benjamin Barenblat (SIPB/MIT)
Labeling figures and stuff

Place after appropriate command:
\label{robots}

Place in appropriate location:
\ldots\ \ref{robots}

You will have to run \LaTeX{} twice!
Labeling figures and equations and stuff . . .

Place in environment:
\label{gaussthm}

Place in appropriate location:
\ldots\text{equation} \ref{gaussthm}

You will have to run \LaTeX{} twice!
Presentations with Beamer

Why use Beamer?

- Just as full-featured as PowerPoint, OpenOffice.org Impress, etc.
- Easy to get going (it's \LaTeX!)
- Variety of predefined themes for professional presentations
- Math support

Getting started

- \documentclass{beamer}
- frame environment
New commands

Preamble
- \documentclass{beamer}
- \usetheme{CambridgeUS} sets theme
- \institute{CSAIL\MIT} appears below author name

Document body
- frame environment
  - \frametitle{}
  - block environment
- \titlepage makes a title slide (\maketitle is for handouts)
- \tableofcontents makes an outline slide
- \section, \subsection diminish in importance
Where to go from here

Further resources

- *The Not So Short Introduction to \LaTeX\ 2\epsilon*:

- The \LaTeX\ \(2\epsilon\) cheat sheet:
  www.stdout.org/~winston/latex/latexsheet.pdf

- *A Short Math Guide for \LaTeX*:

- The texdoc command

\LaTeX\ on your own computer

- Linux: \TeX\ Live (use your package manager)
- Mac OS: Mac\TeX\: www.tug.org/mactex/
- Windows: Mik\TeX\: www.miktex.org/