A Brief introduction into the world of \LaTeX

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1 Introduction

1.1 What is \LaTeX?

“\TeX is intended for the creation of beautiful books - and especially for books that contain a lot of mathematics.”
- Donald E. Knuth

\LaTeX built on \TeX’s foundation, but with easier commands and a larger set of diagnostic messages.

1. Divides document into logical units: abstract, sections, subsections, theorems, bibliography, etc.

2. Automatically numbers elements (units, figures, tables, equations, etc.)

3. Controls the placement and formatting of each element.

4. Creates and updates bibliographies and indices as you go.

2 Getting Started

- Get a \TeX/\LaTeX Typesetting compiler
  - www.ams.org
    - PC: TeX Live, proTeXt, TeXnic Center, WinEdt, etc.
    - Mac: TeXShop, iTeXMac, XeTeX, etc.
    - Unix: teTeX, LyX, etc.
– http://www.miktex.org - MiKTeX offers a complete set of utilities, macro packages and fonts (e.g., LaTeX, pdfTeX, ConTeXt, just to name a few) SPECIFICALLY FOR PC!
– http://www.tug.org/mactex/ - MacTeX-2007 will completely install a typesetting utility called TeXShop.

- Install
- Explore

3 LaTeX-ing 101

3.1 How do I learn to use TeX/LaTeX?

1. To err is human...

ERROR!

3.2 Read a Book

2. When that doesn’t work

(a) “Math Into LaTeX,” George Grätzer

(b) “The Not So Short Introduction Into LaTeX2e,” Tobias Oetiker et al.

- Available at http://tobi.oetiker.ch/
Many other resources...you choose what suits you best (Check out Amazon.com for a comprehensive list of available books)

3. MOST other graduate students or professors

4 The Basics

4.1 Commands

Common characters and words found in \LaTeX documents:

1. \{ \} - denotes a group made of everything that is contained between the braces.

2. \ - denotes the beginning of a command.
   - Want to put a square root symbol around the group $h^2 - a^2$?
     $\sqrt{h^2-a^2}$ compiles as $\sqrt{h^2-a^2}$.

3. \begin{} and \end{} - denotes where an element of the document begins and ends. These elements are also referred to as environments.

4. Any number of spaces and a single return carriage counts as one space. Two return carriages starts a new paragraph.

5. \ \ - forced new line.

4.2 .tex Files

- Header

\documentclass[10pt]{article}
% Preamble
\begin{document}
% Body
Hello World!
\end{document}

4.3 What is a Document Class?

Controls specific parts of a document “behind the scenes.”

1. Numbering
2. Margins
3. Overall visual design

Many exist, few are standard: article, amsart, report, etc.

**Benefit:** Instead of manually changing the format of a paper to fit the requirements of a specific Journal, \TeX{} takes care of everything!

There is a standard format for thesis preparation at NCSU. Available at http://www4.ncsu.edu/jwb/tex/ncsu-thesis.sty

### 4.4 Packages and More Preamble

Between document class and the beginning of the document:

1. Load packages; `\usepackage{PackageName}`
2. Page dimensions;
3. Define elements; `\newtheorem{ax}{Axiom}`
4. Define commands; `\newcommand{\ds}{\displaystyle}`
5. Title, author, address, etc.

### 5 Time to Write

#### 5.1 Formatting and Fonts

All of the following can be accessed with AMSFonts package...

1. Typeface styles
   
   (a) **Boldface** `\textbf{text}`
   (b) *Italics* `\textit{text}` or `\emph{text}`
   (c) **Slanted** `\textsl{text}`
   (d) **SMALL CAPS** `\textsc{text}`

2. Math fonts
   
   (a) Alphabets: $\gamma, \Gamma, \delta, \Delta, \pi, \Pi, \sigma, \Sigma, \theta, \Theta, \omega, \Omega, \ldots$
   (b) Symbols: $\mathcal{f}, \nabla, [a], \ne, \doteq, \leftrightarrow, \ldots$
   (c) Punctuation: $\tilde{h}, \ddot{e}, \tilde{I}, \check{I}, \ddot{o}, \ldots$

3. List Environments (controlled by \TeX{})
5.2 Do the math

We all know how to type essays, but how do we make the math look so good? The \texttt{amsmath} package: \texttt{\usepackage{amsmath}} needs to be in the preamble.

1. **Inline math mode** ($ stuff $ or \(( stuff \))

   Evaluate $\lim_{x \to 0} \frac{f(x)}{g(x)}$ using L’hospital’s Rule.

   looks like

   Evaluate $\lim_{x \to 0} \frac{f(x)}{g(x)}$ using L’hospital’s Rule.

   More examples of inline math

   \begin{itemize}
   \item $\sum_{n=0}^{\infty} \frac{x^n}{n!};$
   \item $(\prod_{i=0, i \neq j}^{n} \frac{x-x_j}{x_i-x_j})$.
   \end{itemize}
2. Display mode ($$ stuff $$ or \[ stuff \])

Evaluate $$\lim_{x\rightarrow 0} \frac{f(x)}{g(x)}$$ using L’hospital’s Rule.

looks like:

Evaluate

$$\lim_{x\rightarrow 0} \frac{f(x)}{g(x)}$$

using L’hospital’s Rule.

- $$\sum_{n=0}^{\infty} \frac{x^n}{n!};$$

- $$\prod_{i=0, i\neq j}^{n} \frac{x-x_j}{x_i-x_j}$$

Since “Display Mode” math is used for equations, it is sometimes necessary to label the equations for future reference.

- Use the equation environment

\begin{equation}
\ln(p(r)) = c - n\left[ \frac{r}{nl}\beta + \ln\frac{\beta}{\sinh\beta} \right]
\end{equation}

\[ \ln(p(r)) = c - n \left[ \frac{r}{nl}\beta + \ln\frac{\beta}{\sinh\beta} \right] \]
6 Alignment

Alignment environments makes everything look nice; these environments are controlled by the document class. Some environments assign numbers to each line, others do not (you can also control the numbering).

6.1 Math Alignment

The *align* environment: \begin{align}
\end{align}

- Lines up multiple lines of equation(s) anywhere you choose (i.e. at = or at the beginning of each line) by using & as your alignment indicator.

\begin{align}
\frac{\partial u}{\partial t} &= \alpha \frac{\partial^2 u}{\partial x^2} + x(x-2)\sin{(3\pi t)} \\
u(t,0) &= u(t,2) = 0 \\
u(0,x) &= \sin{\left(\pi x/2\right)}
\end{align}

\frac{\partial u}{\partial t} = \alpha \frac{\partial^2 u}{\partial x^2} + x(x-2)\sin{(3\pi t)} \quad (2)

\begin{align}
u(t,0) &= u(t,2) = 0 \\
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\end{align}

\frac{\partial u}{\partial t} = \alpha \frac{\partial^2 u}{\partial x^2} + x(x-2)\sin{(3\pi t)} \\
u(t,0) &= u(t,2) = 0 \\
u(0,x) &= \sin{\left(\pi x/2\right)} \quad (4)

We can pick specific lines to not be numbered with the command \notag (also not the different placement of the alignment tabs);

\begin{align}
\frac{\partial u}{\partial t} &= \alpha \frac{\partial^2 u}{\partial x^2} + x(x-2)\sin{(3\pi t)} \\
u(t,0) &= u(t,2) = 0 \\
u(0,x) &= \sin{\left(\pi x/2\right)}
\end{align}

\frac{\partial u}{\partial t} = \alpha \frac{\partial^2 u}{\partial x^2} + x(x-2)\sin{(3\pi t)} \quad (5)

\begin{align}
u(t,0) &= u(t,2) = 0 \\
u(0,x) &= \sin{\left(\pi x/2\right)}
\end{align}
If you want to suppress the line numbering altogether, simply add an asterisk in the environment declaration: \begin{align*};

\frac{\partial u}{\partial t} = \alpha \frac{\partial^2 u}{\partial x^2} + x(x - 2) \sin (3\pi t) \\
u(t, 0) = u(t, 2) = 0 \\
u(0, x) = \sin (\pi x/2)

We can also lump multiple equations together with different alignment properties (not discussed here) using the equation-array environment \begin{eqnarray}

- Numbered

\frac{\partial u}{\partial t} = \alpha \frac{\partial^2 u}{\partial x^2} + x(x - 2) \sin (3\pi t) \quad (6) \\
u(t, 0) = u(t, 2) = 0 \quad (7) \\
u(0, x) = \sin (\pi x/2) \quad (8)

- or Unnumbered (using an asterisk)

\frac{\partial u}{\partial t} = \alpha \frac{\partial^2 u}{\partial x^2} + x(x - 2) \sin (3\pi t) \\
u(t, 0) = u(t, 2) = 0 \\
u(0, x) = \sin (\pi x/2)

6.2 Non-math alignment

- The tabbing environment: \begin{tabbing}

  Useful when inserting tabbed code into a paper.

  Each \texttt{tab} is inserted using \texttt{\>} and is aligned in the previous line using \texttt{\=}.

\begin{tabbing}
\%	exttt{COMPOSITETRAPEZOID.M}\\
\> err=zeros(300,1);\>
\> for \= j=1:300,\>
\> \> H=j; \% \# of subintervals\>
\> \> x=linspace(-1,1,H+1);\>
\> \> for \=i=1:H\>
\> \> \> err(j)=\=err(j)+(2/H)*(abs(x(i))*exp(x(i))\>
\> \> \> \> \> \> +abs(x(i+1))*exp(x(i+1)))/2;\>
\> \> end\>
\> \> err(j)=abs(err(j)-(2-2/exp(1)));\>
\> end
\end{tabbing}
Figure 1: See no evil, hear no evil, speak no evil

```matlab
% COMPOSITETRAPEZOID.M
err=zeros(300,1);
for j=1:300,
    H=j; % # of subintervals
    x=linspace(-1,1,H+1);
    for i=1:H
        err(j)=err(j)+(2/H)*(abs(x(i))*exp(x(i))
            +abs(x(i+1))*exp(x(i+1)))/2;
    end
    err(j)=abs(err(j)-(2-2/exp(1)));
end
```

7 Tables and Figures

To keep track of tables and figures for future reference, \LaTeX allows you to use a table and figure environment (much like the equation environment).

```latex
\begin{figure}
\includegraphics[height=1.5in]{./figures/sameway_right}
\caption{See no evil, hear no evil, speak no evil}
\label{Fig:Monkeys}
\end{figure}
```

The `\label{}` command labels each figure/table/equation so the reference command `\ref{}` can be used.

7.1 Tables

Inside the `\textit{table}` environment, we can create the following tables:

- \begin{tabular}{r|rr}
    a & a & b \\
    \hline
    a & a & b \\
    b & b & b \\
\end{tabular}
\begin{tabular}{|c|c|c|}
\hline
Nodes & $x_i$ & $\alpha_i$ \\
\hline
& $-1$ & $1/3$ \\
& $0$ & $4/3$ \\
& $1$ & $1/3$ \\
\hline
\end{tabular}

7.2 Arrays

\[
\begin{pmatrix}
\alpha & \beta & \gamma \\
\delta & \epsilon & \zeta \\
\eta & \theta & \iota
\end{pmatrix}
\]

1. We can use the tabular command (with a lot of $'$s);

\[
\left(\begin{tabular}{ccc}
\alpha & \beta & \gamma \\
\delta & \epsilon & \zeta \\
\eta & \theta & \iota
\end{tabular}\right)
\]

or...

2. The array function (assumes math-mode throughout)

\[
\left(\begin{array}{ccc}
\alpha & \beta & \gamma \\
\delta & \epsilon & \zeta \\
\eta & \theta & \iota
\end{array}\right)
\]
7.3 Figures

\LaTeX{} only (nicely) accepts one type of figure to import into your document. It is an “Encapsulated Post Script” or .eps file.

- Get a graphics program that supports .eps file conversion.
  - Adobe Illustrator

- To get any .eps file included in your file:
  - You must have the graphicx package loaded
  - Use the following syntax

\begin{figure}
\includegraphics{filename.eps}
\caption{Figure Description}
\end{figure}

7.4 Multiple Figures

Two pictures with individual captions can be presented in the same figure and still be reference by the same figure number.

\begin{figure}
\subfigure[Man]{\includegraphics[height = 1.5in]{./figures/man}}
\subfigure[Dog]{\includegraphics[height =
Figure 3: Man vs. Dog

8 Future Presentations

1. More details on user-controlled items;
2. User defined commands and macros;
3. Beamer (the slide program which this presentation was created using).

Thank you!

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