I ❤️ \LaTeX

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1 What is \LaTeX?

\LaTeX\ is a powerful text processing language which was developed to make your documents look beautiful. \TeX\ is a text processor rather than a word processor and it is not WYSIWYG (What You See Is What You Get) like many of the available word processors. It is arguably the premier typesetting package in the world. Knuth and Lamport have distilled for us the accumulated wisdom of generations of printers.

\LaTeX\ is a macro package which sits on top of \TeX\ and provides all the structuring facilities to help with writing large documents. \LaTeX\ has the reputation of being hard, but in fact it is effectively the same as HTML!

Why \LaTeX?  

1. It is free on virtually every computer in the world;

2. \LaTeX\ source files are purely alphanumeric so it can be read by eye or posted by e-mail with no problems associated with different versions or binary files;

3. You can use \textit{jed} to write your \LaTeX\ programs;

4. The typesetting is better, it is simply the best package for documents containing mathematics;

5. Style changes are neater in \LaTeX. Style files for many periodicals exist.

6. \LaTeX\ is extensible. If you want a new feature, you can look around for a free add-on or write one yourself.

2 What can it do?

\LaTeX\ is cool

Better ask what it can \textit{not} do. Here is an abbreviated list of things that \LaTeX\ includes:

- Great variety of fonts, page formats, and pagenuumbering styles;
- Multi-column printing;
- Plenty of special characters, foreign letters, accents, symbols, etc.;
- Footnotes\footnote{No kidding} and marginal notes;

marginal notes look like this
- Control over line and page breaks, control over word division and hyphenation;
- Cross-references;
- Tables, boxes, and mini-pages;
- Possibility to build new commands, use your own counters, redefine *everything*;
- Different document styles and classes that can be greatly expanded by usage of various packages.

\textbf{\LaTeX{} is automated}

\LaTeX{} not only allows us to write what we want and how we want but it also aids us in document preparation. \LaTeX{} can automatically generate:

- Titles (see the previous page) and title pages;
- Tables of contents;
- Lists of figures;
- Lists of tables;
- Lists of equations;
- Bibliography which is automatically built from your \BibTeX{} database file;
- Keyword indexes;
- Glossaries.

\textbf{\LaTeX{} is well suited for math}

As mentioned previously, \LaTeX{} is the best tool when you need to produce documents containing sophisticated mathematical formulas. It handles and makes statements and formulas look beautiful, starting from simple as \(y = 2x^2 + 3\) to

\[
\Gamma(x) = \lim_{n \to \infty} \prod_{v=0}^{n-1} \frac{n!}{x + v} = \int_0^\infty e^{-t}t^{x-1}dt
\]

and much more.

Here are a couple of other examples that confirm the stated above:

\[
\frac{\partial^2 U}{\partial x^2} + \frac{\partial^2 U}{\partial y^2} = 0 \Rightarrow U_M = \frac{1}{4\pi} \int \frac{1}{r} \frac{\partial U}{\partial n} ds - \frac{1}{4\pi} \oint \frac{\partial^1 U}{\partial n} ds
\]

\[
\sum_{p_1 < p_2 < \cdots < p_{n-k}} \Delta p_1 p_2 \cdots p_{n-k} q_1 q_2 \cdots q_n \begin{bmatrix}
a_{q_1, q_2} & a_{q_1, q_2} & \cdots & a_{q_1, q_n} \\
a_{q_2, q_3} & a_{q_2, q_3} & \cdots & a_{q_2, q_n} \\
\cdots & \cdots & \cdots & \cdots \\
a_{q_n, q_1} & a_{q_n, q_1} & \cdots & a_{q_n, q_n}
\end{bmatrix}
\]

\[
e^x = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots
\]

Do you like it?
3 Getting Started

The “Hello, World!” Program

1. Start your favorite editor, i.e. jed.
2. Type in file hello.tex
   \documentclass[article]
   \begin{document}
   \% this is my first beautiful paper
   Hello, World!
   \end{document}
3. Compile your program
   latex hello
dvips -o hello.ps hello
   The first command generates a .dvi (device-independent) file, or metafile, that contains the formatted text along with information about the required character fonts, but in a form that is independent of the characteristics of the printer to be used. The second command converts the .dvi file to a PostScript .ps file.
   In some cases you will need to run the first command more than once. It is needed when you use cross-references (to reference books, chapters, sections, tables, etc.). On the first run, \LaTeX produces a database of references, and it includes correct values in the document itself on the second run.
4. View your paper
   gv hello &
4 Document Layout and Organization

4.1 Structure of a \LaTeX document

In every \LaTeX file there must be a preamble and a body.

The preamble is a collection of commands that specify the global processing parameters for the following text, such as the paper format, the height and width of the text, the form of the output page with its pagination, etc. At the very least, the preamble must contain the command \texttt{\documentclass} to specify the document overall processing type.

The standard document classes are \texttt{book}, \texttt{article}, \texttt{report}, and \texttt{letter}. They can be found in \texttt{.cls} files. You can specify your own class after you have written a new \texttt{.cls} or found it somewhere else.

The preamble ends with \texttt{\begin{document}}, and everything that follows this command is interpreted as body with actual text. The general syntax of a \LaTeX file is as follows:

\begin{verbatim}
\documentclass[options]{class}
\begin{document}
Text mixed with additional commands
\end{document}
\end{verbatim}

For example, you can use:

\begin{verbatim}
\documentclass[12pt,titlepage,twocolumn]{article}
\end{verbatim}

4.2 Packages

Packages allow us to change the way certain commands behave and define new commands to add extra features that are not part of the standard \LaTeX. A package is nothing more than a set of \LaTeX commands stored in a file with the extension \texttt{.sty}. To invoke a package, simply call

\begin{verbatim}
\usepackage[options]{packages}
\end{verbatim}

in the preamble where \texttt{options} are optional. For example, you might use

\begin{verbatim}
\usepackage[dvips]{graphics,color}
\end{verbatim}

Description of a few packages that can be useful is included below.

\texttt{ifthen} — provides conditional commands \texttt{\ifthenelse{test}{then}{else}} and \texttt{\ifthenelse{test}{do}{}} where you can test for numbers, text, lengths, or switches.

\texttt{doublepage} — provides double spacing which can be required for certain types of documents

\texttt{graphics} — needless to say, this package adds additional features and commands to the standard \LaTeX that allow us to manipulate graphics easier and create more interesting solutions. The package was used to create this paper as well.

\texttt{geometry} — a useful package that makes it easier to configure many settings of your document, for instance margins, without direct manipulation with those lengths.

4.3 Special Characters

The \texttt{space} or \texttt{blank} character has some properties different from those of normal characters. During processing, blanks in the input text are replaced by rubber lengths in order to allow the line to fill up to the full line width. As a result, the following rules apply:

- one blank is the same as a thousand;
• blanks at the beginning and end of an input line and blanks terminating a command name are ignored;
• carriage returns are treated as blanks;
• two carriage returns in a row produce a new paragraph.

In book printing, the character – comes in various lengths: –, –, —. Such characters can be generated by typing the hyphen character one, two, or three times, so that – yields –, while -- makes —, and --- produces —. A forth type of dash is the minus sign −, which is entered in math mode as $\text{-}$.

The single characters # $ & _ \{ \} all have special meanings and are interpreted as commands. To print them as text, you must give a command consisting of \ plus that character.

\[
\begin{align*}
\$ & = \text{"}\$ & \text{&} & = \& & \text{\textbackslash -} & = \text{-}\ & \text{\textbackslash -} & = \text{\textbackslash -} & \text{\%} & = \% & \text{\{ & = \}\}
\end{align*}
\]

There are many more special characters, foreign letters, accents, and symbols like ö, ©, ±, †, h, and × available but you will explore them on your own.

4.4 Lengths

Lengths consist of a decimal number with a possible sign in front (+ or −) followed by a mandatory dimensional unit. Some of the permissible units are:

- cm centimeter,
- mm millimeter,
- in inch (1 in = 2.54 cm),
- pt point (1 in = 72.27 pt),
- pc pica (1 pc = 12 pt).

Values are assigned to a length parameter by means of the command \setlength. Its syntax is as following:

\[
\setlength{\text{length\_command}}{\text{length\_spec}}
\]

For example, you can use:

\[
\begin{align*}
\setlength{\text{textwidth}}{12.5cm} \\
\setlength{\text{topmargin}}{1in} \\
\setlength{\text{oddsidemargin}}{2.5cm}
\end{align*}
\]

4.5 Sections

The following commands are available for producing automatic sectioning:

\section \subsection \subsubsection

The syntax of these commands is:

\[
\begin{align*}
\text{\section{section\_name}} & \text{ creates a numbered section} \\
\text{\section*{another\_section}} & \text{ creates an unnumbered section}
\end{align*}
\]

In the first case, the section is given the next number in the sequence, which is printed together with a heading using the text section\_name. In the second case, no section number is printed and no entry in the table of contents is made.
4.6 MakeTitle

If you want to generate a title for your article (or a title page for your book), you need to copy the following commands into your document:

\title{My Sexy \LaTeX\ Paper}
\author{Scott Barron}
\date{February 29, 2001} ← optional

If you omit date declaration, \LaTeX\ will use the current date. The value of the current date can also be obtained using the command \today\. Command \maketitle will generate a title for you. You need to make sure that the commands appears after you specified the title, authors, and date and before any text in the body of your document.

5 Displayed Text

5.1 Simple Font Manipulations

5.1.1 Font Types

In case you want to change a font you are using, there are a number of font commands that set their argument in a font with the specified attribute. Some of the commands are:

\texttt{text} \quad Roman \quad \texttt{ttt} \quad Typewriter

\textsf{text} \quad Serif \quad \texttt{it} \quad \textit{Italic}

\textsl{text} \quad Slanted \quad \texttt{sc} \quad SMALL CAPS

\textbf{text} \quad \texttt{bf} \quad Bold font

\textnormal{text} \quad \texttt{roman} \quad Default

5.1.2 Font Size

The three possible basic font sizes are 10, 11, and 12pt, depending on the size options 10pt (default), 11pt, and 12pt specified in the document class. The following declarations are available in \LaTeX\ for changing the font size:

\tiny \quad \small \quad \footnotesize \quad \scriptsize \quad \scriptsize \quad \small \quad \footnotesize \quad \normalsize \quad \large \quad \LARGE

all of which are relative to the standard size selected in the document class option.

5.2 Spacing

Spacing of any desired size may be inserted into the text with the command

\hspace{space}

Vertical spacing between particular paragraphs can be increased or decreased using the command

\vspace{space}

\footnote{Other commands \texttt{\day}, \texttt{\month}, and \texttt{\year} return the current values of these parameters as numbers.}
The commands
\bigskip \medskip \smallskip

can also be used to increase the spacing between paragraphs.

To redefine spacing between paragraphs and paragraph indentation, you can use the following commands:
\setlength{\parskip}{space}
\setlength{\parindent}{space}

To suppress indentation for one paragraph or force it where it would otherwise not occur, place
\noindent or \indent

Another useful \LaTeX\ command is \textbackslash{}. It allows us to achieve a new line without going to a new paragraph.

5.3 Centering

The environment
\begin{center} line 1 \textbackslash{} line 2 \textbackslash{} … line n \end{center}
centers the sections of the text that are separated by the \textbackslash{} command. A single line may centered by typing its text as the argument of the \LaTeX\ command \texttt{centerline{text}}

5.4 Lists

There are tree environments available for producing formatted lists:
\begin{itemize}
\item list text \end{itemize}
\begin{enumerate}
\item list text \end{enumerate}
\begin{description}
\item list text \end{description}

The environment \texttt{itemize} gives us lists where individual entries are indicated with bullets, in the environment \texttt{enumerate} they are numbered, and in the environment \texttt{description} they appear as key words and their definitions. The command to produce the labels in the list text is \texttt{item} or \texttt{item[option]} for the environment \texttt{description}.

The above lists may be included within one another eitehr mixed or of one type, to a depth of four levels.

Example

You type the following text in your research paper:

\begin{verbatim}
What I learned today is:
\begin{enumerate}
\item Some basic definitions:
  \begin{description}
  \item[jed] A superior editor of all times and nations.
  \item[l\texttt{latex}] The only program that will make my documents look beautiful.
  \end{description}
\item The first commands that I type on my computer today when I come home will
  be \texttt{\'xjed latex\_my\_love.tex \&\'}}.
\end{enumerate}
\end{verbatim}
In the generated document, it will appear as:

What I learned today is:

1. Some basic definitions:
   - **jed** A superior editor of all times and nations.
   - **latex** The only program that will make my documents look beautiful.

2. The first commands that I type on my computer today when I come home will be `\texttt{xjed latex my love.tex &}`.

### 5.5 Mathematical Formulas

Mathematics is the soul of \LaTeX. Actually, Donald Knuth invented his text formatting system because the setting of mathematical formulas is so complicated in normal printing.

The processing of **math text** is carried out by switching to **math mode**. There are two different types of how math text may occur in a document which are referred as **text formulas**, for example \((a + b)^2 = a^2 + 2ab + b^2\), and **displayed formulas**, for example

\[
(a + b)^2 = a^2 + 2ab + b^2
\]

**Text formulas**, or equations, are generated with the environment

\begin{math} formula_text \end{math}

A shorthand version is available as \$\texttt{formula_text}\$.

**Displayd formulas**, or equations, are produced in the environments

\begin{displaymath} formula_text \end{displaymath}
\begin{equation} formula_text \end{equation}

The difference between these two is that the **equation** environment automatically adds a swqueenilha equation number. The **displaymath** environment may be given with the shorthand form \$\$\texttt{formula_text}\$\$.

It is worth mentioning that some characters can be displayed only in math mode. Do not get confused if you see "Missing $" error during compilation. Examples of such characters include

\[
| = $| \quad \textbackslash = \textbackslash \textbackslash backslash \quad x_n = x_n \textbackslash \textbackslash n\textbackslash \textbackslash n$

And of course there are a huge variety of mathematical symbols, letters, and signs available for creation of the most sophisticated mathematical formulas.

### 6 What to do next

Everything else that was not mentioned here can be easily found in \LaTeX documentation. There a lot of different resources on the web. Some of them are the L\TeX Project web site [Pro00] and Cambridge University Text Processing web site [UoC00]. Others can be found by typing \texttt{latex} at Google.com.

There are a number of good books listed on the L\TeX Project web site that can aid in writing \LaTeX documents [Lam94], [GMS94], [GRM97]. Another good book “A Guide to \LaTeX” by Helmut Kopka [KD99] was heavily used to create this guide.
References


