An Introduction to TEXand LATEX

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About TEXand LATEX

- TEX:

  A programmable/extensible application that formats text

- LATEX:

  A markup language written in TEX

- Descendants:

  LATEX 2ε — The most recent complete version of LATEX

  BIBTEX — An auxiliary program that automatically constructs bibliographis for LATEXdocuments

  AMS-LATEX — Extensions to LATEXwritten by the American Mathematical Society

Editors

- AUCTEX
- Eclipse (TeXlipse plugin)
- Emacs
- Gedit
- Lyx
- Many others!

The Structure of a Document

```
\documentclass{}
\begin{document}

  \section{}

    \subsection{}

    \subsection{}

  \section{}

\end{document}
```

Some Document Classes

- `article`

  The standard article class

- `book`

  The standard book class

- `beamer`

  A popular class for presentations

- `memoir`

  A popular (and flexible) class for books and other long documents

- `acm_proc_article-sp` (and `sigcomm-alternate`)

  Some classes used by the ACM

Metadata

```
\title{}

\author{}

\date{}
```

Generating Output

- The Standard Process
  1. latex *name*.tex
  2. latex *name*.tex
  3. dvips *name*.dvi -o *name*.ps
  4. ps2pdf *name*.ps *name*.pdf (Requires Ghostscript)

- An Alternate Process
  1. pdflatex *name*.tex
  2. pdflatex *name*.tex

Viewing Output

- `.dvi` Files

  xdvi

- `.ps` Files

  Ghostview

- `.pdf` Files

  Acrobat Reader

Font Attributes

Input

```
\textrm{roman},
\texttt{typewriter},
\textsf{sans serif}

\textit{italic},
\textsl{slanted},
\textsc{small caps}

\textmd{medium},
\textbf{bold}
```

Output

roman, `typewriter`, sans serif
italic, *slanted*, SMALL CAPS
medium, **bold**

Font Sizes

Input

```
\tiny tiny
\scriptsize scriptsize
\footnotesize footnotesize
\small small
\normalsize normal
\large large
\Large Large
\LARGE LARGE
\huge huge
\Huge Huge
```

Output

tiny scriptsize footnotesize small normal large

Large LARGE huge

Huge

Centering

Input

```
\begin{center}
Computer Science Dept.\\
James Madison University
\end{center}
```

Output

Computer Science Dept.
James Madison University

Indenting

Input

```
\begin{quote}
The Analytical Engine weaves Algebraical patterns just as
the Jacquard loom weaves flowers and leaves.
\end{quote}\begin{flushright}Ada Augusta\end{flushright}
```

Output

> *The Analytical Engine weaves Algebraical patterns just as the Jacquard loom weaves flowers and leaves.*
>
> Ada Augusta

Bulleted Lists

Input

```
\begin{itemize}
\item CS349
\item CS462
\end{itemize}
```

Output

- CS349
- CS462

Enumerated Lists

Input

```
\begin{enumerate}
\item Compile
\item Link
\item Execute
\end{enumerate}
```

Output

1. Compile
2. Link
3. Execute

Descriptions

Input

```
\begin{description}
  \item[multi] is from the
  Latin word ``multus'',
  which means ``numerous''
  \item[media] is from the
  Latin word ``medium'',
  which means ``center''
\end{description}
```

Output

multi is from the Latin word "multus", which means "numerous"

media is from the Latin word "medium", which means "center"

Footnotes and Marginal Notes

```
\footnote{The text of the note.}

\marginpar{Important!}
```

Colors

```
\usepackage{color}

\definecolor{cornsilk}{rgb}{1.00,0.96,0.86}
\definecolor{darkolivegreen}{rgb}{0.33,0.42,0.18}
\definecolor{gainsboro}{rgb}{0.86,0.86,0.86}
\definecolor{indianred}{rgb}{0.80,0.36,0.36}
\definecolor{khaki}{rgb}{0.94,0.90,0.55}
\definecolor{orange}{rgb}{1.00,0.65,0.00}
\definecolor{skyblue}{rgb}{0.53,0.81,0.92}

\definecolor{code-color}{rgb}{0.86,0.86,0.86}

\colorbox{cornsilk}{Text}
```

Tables

Input

```
\begin{tabular}{cc|cc}
P & Q & P or Q
& P xor (P or Q) \\
\hline
T & T & T & F \\
T & F & T & F \\
F & T & T & T \\
F & F & F & F \\
\end{tabular}
```

Output

P	Q	P or Q	P xor (P or Q)
T	T	T	F
T	F	T	F
F	T	T	T
F	F	F	F

Floating Tables

```
\begin{table}[tb]
\begin{tabular}{lrl}
\hline\hline
Course & Enrollment & Prerequisites \\
\hline
CS239 & 150 & CS139 \\
CS462 & 65  & CS240, CS460 \\
\hline\hline
\end{tabular}
\caption{Computer Science Courses}
\end{table}
```

Floating Tables (cont.)

Course	Enrollment	Prerequisites
CS239	150	CS139
CS462	65	CS240, CS460

Table: Computer Science Courses

Figures

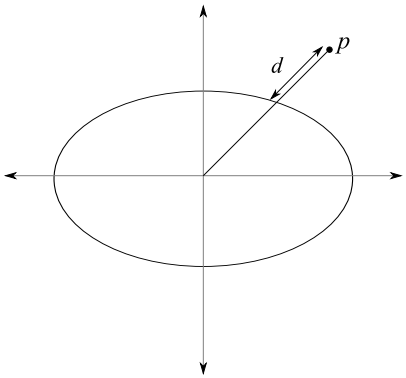
```
\usepackage{graphics}
```

Figures (cont.)

Input

```
\includegraphics[width=1in]{ellipse-radialdistance.eps}
```

Output



Floating Figures

```
\begin{figure}[tb]
\includegraphics[width=1in]{ellipse-radialdistance.eps}
\caption{The Radial Distance}
\end{figure}
```

Mathematical Environments

Text:

```
\begin{math} formula \end{math}
\( formula \)
$ formula $
```

Displayed:

```
\begin{equation} formula \end{equation}
\begin{equation*} formula \end{equation*}
\begin{displaymath} formula \end{displaymath}
\begin{eqnarray} formula \end{eqnarray}
\begin{eqnarray*} formula \end{eqnarray*}
\[ formula \]
```

Constants and Variables

Input

```
$x y z$

$5x 3y 2z$

$3.1415$

$\alpha \beta \gamma$

$\Gamma \Delta \Theta$
```

Output

xyz

$5x3y2z$

3.1415

$\alpha\beta\gamma$

$\Gamma\Delta\Theta$

Math Accents

Input

```
$\hat{a} \tilde{b} $

$\dot{u} \ddot{v} $

$\bar{x} \vec{y} $
```

Output

$\hat{a}\tilde{b}$

$\dot{u}\ddot{v}$

$\bar{x}\vec{y}$

Operators

Input

```
$x + 5 + 9 = z$

$(3 + x) \approx (2+y)$

$x > 7 \forall x \in X$

$
(x \leq 7)
\Rightarrow
(A \cup B \subseteq C)
$
```

Output

$x + 5 + 9 = z$

$(3 + x) \approx (2 + y)$

$x > 7 \forall x \in X$

$(x \leq 7) \Rightarrow (A \cup B \subseteq C)$

Functions

Input

```
$\sin(x)$

$\log(100)$

$a = \max(x,y,z)$
```

Output

$\sin(x)$
$\log(100)$
$a = \max(x, y, z)$

Exponents and Indices

Input

```
$a^2 + b^2 = c^2$

$x^{2n}$

$y^2_i$

$\lim_{x\to\infty} x/x^2$

$A^{x^2_i}$
```

Output

$a^2 + b^2 = c^2$

x^{2n}

y_i^2

$\lim_{x\to\infty} x/x^2$

$A^{x_i^2}$

Fractions

Input

```
$\frac{1}{x}$

\[
\frac{\frac{a}{x-y}+\frac{b}{x+y}}
     {1 + \frac{a^2 - b^2}{a + b}}
\]
```

Output

$\frac{1}{x}$

$$\frac{\frac{a}{x-y}+\frac{b}{x+y}}{1+\frac{a^2-b^2}{a+b}}$$

Roots

Input

```
\[\sqrt{x^2 + y^2 + 2xy} = x + y\]

\[\sqrt[n]{\frac{1}{x+y}}\]
```

Output

$$\sqrt{x^2 + y^2 + 2xy} = x + y$$

$$\sqrt[n]{\frac{1}{x+y}}$$

Sums, Products, Integrals, etc...

Input

```
\[\sum_{a \in A}\int_0^{f_a} c(x) dx\]
\[\prod_{i=0}^{n} x_i\]
\[ \bigcup_{A \subset X} A\]
```

Output

$$\sum_{a \in A} \int_0^{f_a} c(x) dx$$

$$\prod_{i=0}^{n} x_i$$

$$\bigcup_{A \subset X} A$$

Binomial Coeficients

Input

```
\[
{n+1 \choose k} = {n \choose k} + {n \choose k-1}
\]
```

Output

$$\binom{n+1}{k} = \binom{n}{k} + \binom{n}{k-1}$$

An Example of Text and Displayed Formulae

Input

```
$\sum_{n=0}^\infty (n+1) x^n =
\frac{1}{(1-x)^2} \mbox{ for } |x|<1$

\begin{equation}\sum_{n=0}^\infty (n+1) x^n =
\frac{1}{(1-x)^2} \mbox{ for } |x|<1\end{equation}
```

Output

$\sum_{n=0}^{\infty}(n+1)x^n = \frac{1}{(1-x)^2}$ for $|x|<1$

$$\sum_{n=0}^{\infty}(n+1)x^n = \frac{1}{(1-x)^2} \text{ for } |x|<1 \tag{1}$$

Introduction

- The Issue:

  It is often necessary to refer to items in a document (e.g., a particular equation or figure).

- The Problem with the Traditional Approach:

  When you move an item its number changes and, hence, all references to it must change.

- The Approach in LaTeX:

  Associate items with textual labels

  Refer to those textual labels

An Ordinary Reference

Input

```
\begin{equation}
\sum_{j=0}^8 (2^{j+1}-2^j)\label{telescoping-sum}
\end{equation}
Now, since  $(2^{j+1}-2^j) = (2 \cdot 2^j - 2^j) = 2^j$,
it follows that (\ref{telescoping-sum}) is just the sum of
```

Output

$$\sum_{j=0}^{8}(2^{j+1} - 2^j) \tag{2}$$

Now, since $(2^{j+1} - 2^j) = (2 \cdot 2^j - 2^j) = 2^j$, it follows that (2) is just the sum of

A Forward Reference

Input

```
Consider the conjecture given in (\ref{conjecture}) below:

\begin{equation}
\frac{1}{1 \cdot 2} + \frac{1}{2 \cdot 3} + \cdots
 + \frac{1}{n \cdot (n+1)} = \frac{n}{n+1}\label{conjecture
\end{equation}
```

Output

Consider the conjecture given in (3) below:

$$\frac{1}{1 \cdot 2} + \frac{1}{2 \cdot 3} + \cdots + \frac{1}{n \cdot (n+1)} = \frac{n}{n+1} \tag{3}$$

Setup

```
\usepackage{listings}

\lstset{language=Java}
\lstset{basicstyle=\small\ttfamily}
\lstset{commentstyle=\small\ttfamily}
\lstset{morecomment=[is]{/*}{*/}}  % Discard comments
\lstset{backgroundcolor=\color{code-color}}
```

Literal Code

Input

```
\begin{lstlisting}
public int gcd(int a,int b)
{
  int x = Math.abs(a);
  int y = Math.abs(b);
  while (y != 0) {
    int r = x % y;
    x = y;  y = r;
  }
  return x;
}
\end{lstlisting}
```

Output

```
public int gcd(int a,int b)
{
  int x = Math.abs(a);
  int y = Math.abs(b);
  while (y != 0) {
    int r = x % y;
    x = y;  y = r;
  }
  return x;
}
```

Including External Code

```
\lstinputlisting{RectilinearMetric.java}
```

Including External Code (cont.)

```
public class      RectilinearMetric implements Metric
{

    public double distance(double[] x, double[] y)
    {
        double  result;
        int     n;

        result = 0.0;
        n      = Math.min(x.length, y.length);
        for (int i=0; i<n; i++) result += Math.abs(x[i]-y[i]);

        return result;
    }
}
```

Including a Fragment

Setup:

```
\lstset{rangeprefix=//}
\lstset{rangesuffix=.}
\lstset{includerangemarker=false}
```

An Example:

```
\lstinputlisting[linerange=\[quadcurve-\]quadcurve]
                {SimpleShapeCanvas.java}
```

A State Space Schema

Input

```
\begin{schema}{DateBook}
  known: \power NAME \\
  bd: NAME \pfun DATE
\where
  known=\dom bd
\end{schema}
```

Output

DateBook

$$known : \mathbb{P}\, NAME$$
$$bd : NAME \pfun DATE$$

$$known = \mathrm{dom}\, bd$$

An Operation Schema

Input

```
\begin{schema}{AddBday}
  \Delta DateBook \\
  name?: NAME \\
  date?: DATE
\where
  name? \notin known
\also
  bd' =
  bd \cup
  \{name? \mapsto date?\}
\end{schema}
```

Output

AddBday

$$\Delta DateBook$$
$$name? : NAME$$
$$date? : DATE$$

$$name? \notin known$$

$$bd' = bd \cup \{name? \mapsto date?\}$$

Two Approaches

- LaTeX

  A bibliography can be created using the `thebibliography` environment (which contains `bibitem` elements).
  The problem is that one often refers to the same book/article in multiple documents.

- BibTeX

  A bibliographic database that can be used with LaTeX

An Example Database

```
@BOOK{Fox,
AUTHOR = "Christopher Fox",
TITLE = "Introduction to Software Engineering Design",
PUBLISHER = "Addison-Wesley Publishing Company",
ADDRESS = "Reading, Massachusetts",
YEAR = "2006" }

@BOOK{GOF,
AUTHOR = "Erich Gamma and Richard Helm and Ralph Johnson
                  and John Vlissides",
TITLE = "Design Patterns: Elements of Reusable
                  Object-Oriented Software",
PUBLISHER = "Addison-Wesley Publishing Company",
ADDRESS = "Reading, Massachusetts",
YEAR = "1995" }
```

Referring to the Database

```
As defined, for example, in \cite{Fox}, a
{\em method signature} includes the name,
parameters (including types), return type,
``receiver'', and scope.
```

Including the Database

In the LaTeXDocument:

```
\bibliographystyle{abbrv}
\bibliography{design}  % The file is design.bib
```

In the Command Shell:

bibtex *name*.tex

creates the `.bbl` file that is used in the last pass of `latex`.

Beamer

- Explained:

  A document class that can be used to create presentation materials.

- An Example:

  This presentation.

The Slides

Individual slides are created using the `frame` environment.

Environments in Slides

```
\begin{itemize}\end{itemize}

\begin{enumerate}\end{enumerate}

\begin{block}\end{block}

\begin{exampleblock}\end{exampleblock}
```

Motivation for Overlays

- A Common Need:

  Slides that change in response to key presses/mouse clicks.

- The Solution:

  Include different versions of the slide in sequence.

An Example

```
\begin{itemize}\spread
  \item<1-> \texttt{article}: The standard article class

  \item<2-> \texttt{book}: The standard book class

  \item<3-> \texttt{beamer}: A popular class for
                             presentations

  \item<4-> \texttt{memoir}: A popular (and flexible)
                             class for books and
                             other long documents
\end{itemize}
```

The Output of the Example

- `article`: The standard article class
- `book`: The standard book class
- `beamer`: A popular class for presentations
- `memoir`: A popular (and flexible) class for books and other long documents

The Output of the Example

- `article`: The standard article class
- `book`: The standard book class
- `beamer`: A popular class for presentations
- `memoir`: A popular (and flexible) class for books and other long documents

The Output of the Example

- `article`: The standard article class
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The Output of the Example

- `article`: The standard article class
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Other Extensions

- Hypertext:
  - href
- Internationalization:
  - babel
- Layout:
  - longtable
  - multicols
- Textual References (e.g., on the previous page):
  - varioref

Documentation

- Books:

  Kopka, H. and P.W. Daly (2003) *A Guide to LaTeX*, Addison-Wesley.
  Mittelbach, F., M. Goossens, J. Braams, D. Carlisle, and C. Rowley (2004) *The LaTeXCompanion*, Addison-Wesley.

- WWW Sites:

  TeXUsers Group (http://www.tug.org/)

Resources

Comprehensive TEXArchive Network
http://www.ctan.org/
ftp://ctan.org/