

Introduction to L^AT_EX

Benjamin Barenblat
bbaren@mit.edu

Student Information Processing Board
Massachusetts Institute of Technology

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Figure: Donald Knuth in 2005. *Source: Wikimedia Commons.*

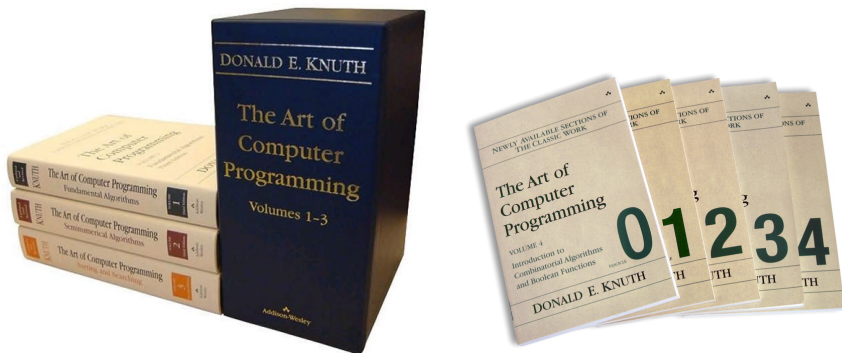


Figure: *The Art of Computer Programming*. Source: MSDN.

The image shows the TeX logo, which consists of the letters 'T', 'E', and 'X' in a large, black, serif font. The letters are bold and have a classic, slightly ornate design. The 'T' is on the left, the 'E' is in the middle, and the 'X' is on the right. The letters are set against a plain white background.

Figure: The T_EX logo.

```

\newif\ifFPD@overflow
\newdimen\FBD@denom
\def\fpdivide#1#2{%
  \FPD@overflowfalse
  \ifdim\AbsValD#2<1\p@
    \begingroup\FBD@denom\ifdim#2<\z@-\fi5000#2%
    \let\next\@empty
    \ifdim\AbsValD#1>\FBD@denom
      \def\next{%
        \FPD@overflowtrue
        \debug2{Overflow dividing \the#1 by \the#2 -> 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 -> 0}%
      #1=0\p@}%
  \fi\fi
  \expandafter\endgroup\next
\fi

```

Figure: Some T_EX code. Source: *The Lone T_EXnician*.

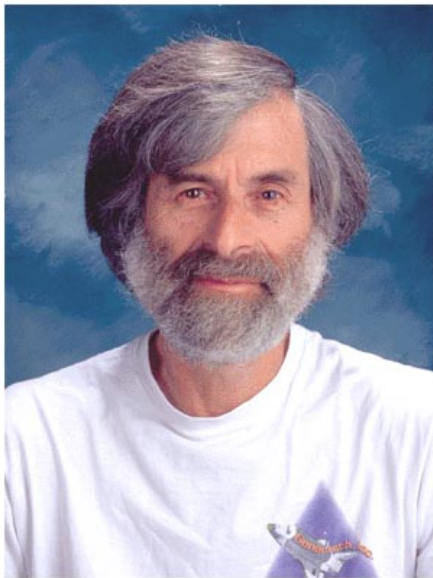


Figure: Leslie Lamport in 2004. *Source: Wikimedia Commons.*

```

\section{Problem 4}
\begin{enumerate}
  \setcounter{enumi}{24}
\item
  \begin{enumerate}
\item  $V$  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}} \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}
\end{enumerate}

```

Figure: Some L^AT_EX code.

L^AT_EX

Figure: The L^AT_EX logo.

What is L^AT_EX?

L^AT_EX is a sophisticated document preparation system and desktop publishing utility.

L^AT_EX has ...

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

However ...

- *L^AT_EX is not a word processor!*

What is L^AT_EX not?

L^AT_EX is a programming language, not a word processor.

L^AT_EX will *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 L^AT_EX 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 L^AT_EX?

Sometimes, presentation gets in the way of content.

Example: underlining vs. italics

- Word processor way: set italics and/or underlining each time
- L^AT_EX way: tell L^AT_EX to *emphasize*; set what that means later

Example: journal article / thesis

- Word processor way: risk accidentally modifying provided template
- L^AT_EX way: write your text, let L^AT_EX worry about layout

Your first L^AT_EX document

4 basic steps

- 1 Write a .tex file using your favorite text editor
- 2 Typeset using L^AT_EX or PDFL^AT_EX
- 3 Preview the result using xdvi or xpdf (or Acrobat Reader or Evince)
- 4 (optional) Print

1. Write a .tex file

hello.tex

```
\documentclass{article}  
\begin{document}  
Hello , world!  
\end{document}
```

2. Typeset using L^AT_EX

In a terminal:

```
$ cd path/to/folder/containing/your/.tex/file  
$ pdflatex hello.tex
```

2. Typeset using L^AT_EX

Result:

```
This is pdfTeX, Version 3.1415926-1.40.10 (TeX Live 2009/Debian)
```

```
entering extended mode
```

```
(./test.tex
```

```
LaTeX2e <2009/09/24>
```

```
Babel <v3.81> and hyphenation patterns for english, usenglishmax, dumylang, nohyphenation, farsi, arabic, croatian, bulgarian, ukrainian, russian, czech, slovak, danish, dutch, finnish, french, basque, ngerman, german, german-x-2009-06-19, ngerman-x-2009-06-19, ibycus, monogreek, greek, ancientgreek, hungarian, sanskrit, italian, latin, latvian, lithuanian, mongolian2a, mongolian, bokmal, nynorsk, romanian, irish, coptic, serbian, turkish, welsh, esperanto, uppsorbian, estonian, indonesian, interlingua, icelandic, kurmanji, slovenian, polish, portuguese, spanish, galician, catalan, swedish, ukenglish, pinyin, loaded.
```

```
(/usr/share/texmf-texlive/tex/latex/base/article.cls
```

```
Document Class: article 2007/10/19 v1.4h Standard LaTeX document class
```

```
(/usr/share/texmf-texlive/tex/latex/base/size10.clo))
```

```
No file test.aux.
```

```
/var/lib/texmf/fonts/map/pdftex/updmap/pdftex.map(./test.aux) )</usr/share/texmf-texlive/fonts/type1/public/amsfonts/cm/cmr10.pfb>
```

```
Output written on test.pdf (1 page, 12624 bytes).
```

```
Transcript written on test.log.
```


3. Preview using evince

New files!

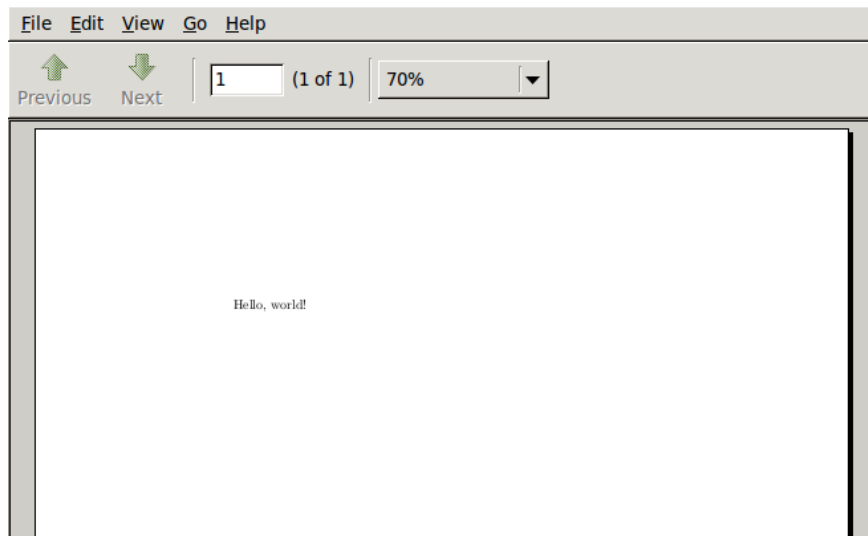
- hello.aux
- hello.log
- hello.pdf

hello.pdf

```
$ evince hello.pdf
```

3. Preview using evince

Result:



When L^AT_EX complains

Overfull/underfull hbox

L^AT_EX couldn't make your text fit nicely on one line.

Overfull/underfull vbox

L^AT_EX couldn't make your text fit nicely on a page.

Runaway argument

You forgot to close a brace.

Solution

- 1 Type x and hit enter
- 2 Fix the error
- 3 Re-run L^AT_EX

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 L^AT_EX 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

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 SCIGen\\CSAIL}  
\date{\today}
```

Place in document:

```
\maketitle
```

Some classes allow for more preamble commands.

Including graphics

Place in preamble:

```
\usepackage{graphicx}
```

Place in document:

```
\begin{figure}  
  \begin{center}  
    \includegraphics{doc1/flowchart.png}  
  \end{center}  
  \caption{The diagram used by Oxymel.}  
\end{figure}
```

Labeling figures

Place after caption:

```
\label{robots}
```

Place in appropriate location:

```
... figure~\ref{robots}
```

You will have to run \LaTeX twice!

Labeling figures and stuff

Place after appropriate command:

```
\label{robots}
```

Place in appropriate location:

```
... \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}{l l l}  
  Language & Seek time & Write time\\  
  \hline  
  BLoop & 27 & 42\\  
  FLoop & 12 & 19\\  
  GLoop & 11 & 22  
\end{tabular}
```

Result:

Language	Seek time	Write time
BLoop	27	42
FLoop	12	19
GLoop	11	22

Lists

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

quote

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

quotation

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

verse

```
\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

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

Breaking

<code>\\</code>	force new line
<code>\newpage</code>	force new page
<code>\noindent</code>	force no indentation of current paragraph

Comments: Anything after `%` on a single line is ignored.

Customizing L^AT_EX

Some customization commands are built-in.

Changing font face:

```
\emph{text}, \textnormal{text}, \textrm{text}, \textsf{text},  
\texttt{text}, \textbf{text}, \textit{text}, \textsc{TEXT}
```

Changing font size:

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

Changing alignment:

```
\begin{center}, \begin{flushright}, \begin{flushleft}
```

Customizing L^AT_EX

Customizations can also occur through *packages*.

Including a package:

```
\usepackage{packagename}
```

Useful packages

graphicx, geometry, setspace, fancyhdr, calc, mathpazo, microtype, amsmath, amssymb, 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
```

Changing fonts

Fonts are usually loaded through packages as well.

<code>\usepackage[urw-garamond]{mathdesign}</code>	Garamond
<code>\usepackage{mathpazo}</code>	Palatino
<code>\usepackage[scaled]{helvet}</code>	Helvetica
<code>\usepackage{courier}</code>	Courier
<code>\renewcommand*\sfdefault{uop}</code>	Optima
<code>\usepackage{concrete}</code>	Computer Concrete
<code>\usepackage{tgbonum}</code>	Bookman
<code>\usepackage{txfonts}</code>	Times

More fonts are available at The L^AT_EX Font Catalogue,
www.tug.dk/FontCatalogue/.

Typesetting mathematics

L^AT_EX's math support far outstrips that of any other available piece of software.

The Leibniz integral rule

$$\begin{aligned} \frac{d}{d\alpha} \int_{a(\alpha)}^{b(\alpha)} f(x, \alpha) dx &= \frac{db(\alpha)}{d\alpha} f(b(\alpha), \alpha) - \frac{da(\alpha)}{d\alpha} f(a(\alpha), \alpha) \\ &\quad + \int_{a(\alpha)}^{b(\alpha)} \frac{\partial}{\partial \alpha} f(x, \alpha) dx \end{aligned}$$

Generalized Stokes theorem

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

$$\int_M d\omega = \oint_{\partial M} \omega.$$

Text and math modes

L^AT_EX is always operating in either text mode, display math mode, or inline math mode.

Inline math mode

- Enter/exit using `$...$` or `\(...\)`
- 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}... \end{equation}` or `\[...\]`
- 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	974	x	x
$4 + 2$	$4 + 2$	49 ± 71	49 ± 71
$\sqrt[3]{5}$	<code>\sqrt[3]{5}</code>	$\phi \in U$	<code>\phi \in U</code>
x_1^2	x_1^2	$f''(\xi)$	<code>f''(\xi)</code>
$\frac{x}{y}$	<code>\frac{x}{y}</code>	$\forall x \exists y$	<code>\forall x \exists y</code>
$\sum_{k=1}^n k$	<code>\sum_{k=1}^n k</code>	$U \cap V$	<code>U \cap V</code>
$x \leq y$	<code>x \leq y</code>	$P \Leftrightarrow Q$	<code>P \Leftrightarrow Q</code>
$2 \neq 4$	<code>2 \neq 4</code>	$\mathbb{R} \subset \mathbb{C}$	<code>\mathbb{R} \subset \mathbb{C}</code>
$\nabla \cdot \Psi$	<code>\nabla \cdot \Psi</code>		<code>\mathbb{C}</code>
$\hat{i} \times \hat{j} = \hat{k}$	<code>\hat{i} \times \hat{j} = \hat{k}</code>		

Detexify² (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.

equation

$$\oiint_{\partial\Omega} \mathbf{F} \cdot d\mathbf{S} = \iiint_{\Omega} \nabla \cdot \mathbf{F} dx dy dz \quad (1)$$

equation*

$$\oiint_{\partial\Omega} \mathbf{F} \cdot d\mathbf{S} = \iiint_{\Omega} \nabla \cdot \mathbf{F} dx dy dz$$

The Short Math Guide for \LaTeX

(<ftp://ftp.ams.org/pub/tex/doc/amsmath/short-math-guide.pdf>) has a full listing.

Mathematics packages and environments

align

```

\begin{align}
a &= \oiint_{\partial\Omega} \mathbf{F} \cdot d\mathbf{S} & (3)(5 + 7) &= (3)(12) \\
&= \iiint_{\Omega} \nabla \cdot \mathbf{F} dx dy dz & &= 36
\end{align}

```

$$a = \oiint_{\partial\Omega} \mathbf{F} \cdot d\mathbf{S} \qquad (3)(5 + 7) = (3)(12) \qquad (2)$$

$$= \iiint_{\Omega} \nabla \cdot \mathbf{F} dx dy dz \qquad = 36 \qquad (3)$$

Labeling figures and stuff

Place after appropriate command:

```
\label{robots}
```

Place in appropriate location:

```
... \ref{robots}
```

You will have to run \LaTeX twice!

Labeling figures and equations and stuff ...

Place in environment:

```
\label{gaussthm}
```

Place in appropriate location:

```
... equation \ref{gaussthm}
```

You will have to run \LaTeX twice!

Presentations with Beamer

Why use Beamer?

- Just as full-featured as PowerPoint, LibreOffice 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 L^AT_EX 2_ε*:
www.ctan.org/tex-archive/info/lshort/english/lshort.pdf
- The L^AT_EX 2_ε cheat sheet:
www.stdout.org/~winston/latex/latexsheet.pdf
- *A Short Math Guide for L^AT_EX*:
<ftp://ftp.ams.org/pub/tex/doc/amsmath/short-math-guide.pdf>
- The texdoc command

L^AT_EX on your own computer

- GNU/Linux: T_EX Live (use your package manager)
- Mac OS: MacT_EX: tug.org/mactex/
- Windows: MikT_EX: miktex.org/