

# A Practical Introduction to $\text{\LaTeX}$

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March 6-7, 2024

School of Information Science and Technology,  
ShanghaiTech University



上海科技大学  
ShanghaiTech University

# What is L<sup>A</sup>T<sub>E</sub>X



- Definition: A typesetting system with elegance.
- Pronunciation: lay-tech, lah-tech, and *lay-teks*.
- Check “answer” from the author **Donald Knuth** and **Stack Exchange** discussion.

# Outline

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Why Does One Use  $\text{\LaTeX}$

How Does  $\text{\LaTeX}$  Work

The Ultimate Solution to Confusions

Recommended Resources

Practical  $\text{\LaTeX}$  Usage

Side Advice

# Outline

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Why Does One Use  $\text{\LaTeX}$

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Side Advice

# Notes

$\frac{\partial Y}{\partial X} \underset{m \times n}{\cancel{\otimes}} \rightarrow m_p, n_p$   $\overset{?}{\otimes} \underset{m \times n}{Y} \underset{p, q}{\cancel{\otimes}} \underset{m, n}{\cancel{\otimes}} m_p, n_q$

$\frac{\partial Ax}{\partial A} = x^T \otimes I_m = AER_{mn}$

$\frac{\partial Ax}{\partial x} = \frac{\partial x^T a}{\partial x} = a$   $\frac{\partial Ax}{\partial x} = A^T$  ??  
This has to be column vector

$\frac{\partial x^T Ax}{\partial x} = (A+A^T)x$  when  $A$  is  $S^+$

$\frac{\partial x^T Ax}{\partial x} = 0 \left[ \frac{\partial s}{\partial x} \right]^T Ax + \left[ \frac{\partial r}{\partial x} \right] A^T x$

②  $SA$  is const and  $Ar$  is const.

$\frac{\partial f(A)}{\partial A}$  and  $\nabla f(A)$  are the same.  
with different notation

$\frac{\partial x^T Ax}{\partial A}$  ?  $\frac{\partial x x^T}{\partial x}$  ?  $x \otimes_{\text{from } y^T} y$   
 $= x \otimes_{\text{inner } y} y$

$\nabla_x a^T X b$   
 $= \frac{\partial a^T X b}{\partial X}$

??  $A \otimes B = \begin{bmatrix} a_{ij} B \end{bmatrix}_{p, q \times m, n}$   $p, q$  block matrix

??  $\frac{\partial A}{\partial B} = \begin{bmatrix} \frac{\partial a_{ij}}{\partial B} \end{bmatrix}_{p, q \times m, n}$   $p, q$  block matrix

## 2 Jacobian formulation (numerator layout convention)

In the following, we mainly follow the Jacobian formulation or numerator layout convention since it can be seen as a natural extension of multivariate derivatives to matrix form.

### 2.1 Vector-by-vector identities

$$\begin{aligned}\frac{\partial x}{\partial x} &= I, \frac{\partial x^T}{\partial x} = \frac{\partial x}{\partial x^T} = \left( \frac{\partial x}{\partial x} \right)^T \\ \frac{\partial Ax}{\partial x} &= A \frac{\partial u}{\partial x} \frac{\partial Ax}{\partial x} = A \cdot \frac{\partial x^T A}{\partial x} = A^T \\ \frac{\partial u}{\partial x} &= \frac{\partial u}{\partial x} + u \frac{\partial u}{\partial x} \\ \frac{\partial f(g(u))}{\partial x} &= \frac{\partial f(g)}{\partial g} \frac{\partial g(u)}{\partial u} \frac{\partial u}{\partial x}\end{aligned}$$

### 2.2 Scalar-by-vector identities

Vector-by-scalar identities are quite naturally formed by thinking element-wise.

$$\begin{aligned}\frac{\partial u^T Ax}{\partial x} &= u^T A \frac{\partial v}{\partial x} + v^T A^T \frac{\partial u}{\partial x} \\ \frac{\partial b^T Au}{\partial x} &= b^T A \frac{\partial u}{\partial x} \frac{\partial b^T Ax}{\partial x} = b^T A \cdot \frac{\partial x^T Ax}{\partial x} = x^T (A + A^T) \\ \frac{\partial f(g(u))}{\partial x} &= \frac{\partial f(g)}{\partial g} \frac{\partial g(u)}{\partial u} \frac{\partial u}{\partial x}\end{aligned}$$

### 2.3 Scalar-by-matrix identities

$$\frac{\partial a^T X b}{\partial X} = b a^T, \frac{\partial (Xa + b)^T C (Xa + b)}{\partial X} = ((C + C^T)(Xa + b)a^T)^T$$

### 2.4 Remarks

Check out the following derivative in Hessian formulation:

$$\frac{\partial(a, x)}{\partial x} = a$$

where  $a$  is a constant vector. Note that the Hessian formulation or denominator layout convention maybe be more natural since  $\frac{\partial(a, x)}{\partial x}$  can be seen as the gradient of function  $(a, x)$  and it should be an endomorphism or linear operator as usually used, i.e.,  $f : \mathbb{R}^n \rightarrow \mathbb{R}^n$ , the dimension of pre-image and image spaces is the same.

Figure 1: Transcribed notes from handwritten drafts.

# Integrated Writing



1 seconds\_in\_a\_week = 7 \* seconds\_in\_a\_day  
2 seconds\_in\_a\_week

604800

对于 Colab 笔记本，您可以将可执行代码、富文本以及图像、HTML、`LaTeX` 等内容合入 1 个文档中。当您创建自己的 Colab 笔记本时，系统会将这些笔记本存储在您的 Google 云端硬盘帐号名下。您可以轻松地将 Colab 笔记本共享给同事或好友，允许他们评论甚至修改笔记本。要了解详情，请参阅 [`/notebooks/basic\\_features\\_overview`](#)。  
`ipython`>Colab 预览</a>。要创建新的 Colab 笔记本，您可以使用上方的“文件”菜单，也可以使用以下链接：[创建新的 Colab 笔记本](http://colab.research.google.com#create=true)。

Colab 笔记本是由 Colab 托管的 Jupyter 笔记本。如需详细了解 Jupyter 项目，请访问 [jupyter.org](https://www.jupyter.org)。

对于 Colab 笔记本，您可以将可执行代码、富文本以及图像、HTML、`LaTeX` 等内容合入 1 个文档中。当您创建自己的 Colab 笔记本时，系统会将这些笔记本存储在您的 Google 云端硬盘帐号名下。您可以轻松地将 Colab 笔记本共享给同事或好友，允许他们评论甚至修改笔记本。要了解详情，请参阅 [Colab 概览](#)。要创建新的 Colab 笔记本，您可以使用上方的“文件”菜单，也可以使用以下链接： [创建新的 Colab 笔记本](#)。

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Figure 2: A snapshot of Colab code blocks.

# Curriculum Vitae (CV)

Quan Ho

Last update: July 29, 2016

CONTACT  
INFORMATION

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Hai Ba Trung,  
Hanoi, Vietnam  
Tel: 1800-8198

Homepage: <http://www.hust.edu.vn/web/vi/home>  
Linkedin: [www.linkedin.com/in/XVanNguyen](http://www.linkedin.com/in/XVanNguyen)  
✉ E-mail: [xvannguyen@abc.edu](mailto:xvannguyen@abc.edu)

RESEARCH  
BACKGROUND

- Social Network: more descriptions here.
- Advanced Vietnamese: descriptions.

EDUCATION

**Stanford University**, State College, PA

2013–2018 (expected)

- Ph.D. in Department of Computer Science, GPA: 4/4 – via 40 credits.
- Advisor: Prof. Stephen P. Boyd.

**Hanoi University of Science and Technology (HUST)**, Vietnam.

2007–2012

- B.Sc., Electronics and Telecommunications. GPA: 3.51/4 – via 181 credits, Rank: 1/5000.
- Thesis: *Thesis title*.

TECHNICAL  
SKILLS

- Programming Languages: C/C++, Python, Java, Javascript, VHDL, Verilog.
- Technical Softwares: MATLAB, OpenCV, Simulink.

RESEARCH  
EXPERIENCE

• **Embedded Systems and Reconfigurable Computing Laboratory**

School of Electronics and Communications, Hanoi University of Science and Technology.  
Implementations for the project below were done in a mix of VHDL/Verilog and C/C++.

- FPGA-based Intellectual Property camera systems: Applications in remote supervising and controlling systems. The whole system is a combination of an ARM-based Board and a Xilinx platform.

**Figure 3:** An example CV from Overleaf.

# Graduation Thesis



上海科技大学  
ShanghaiTech University



上海科技大学

Contents

A Brilliant Work

## Bachelor's Thesis

|  |           |
|--|-----------|
| <b>摘要</b>  | <b>I</b>  |
| <b>Abstract</b>                                  | <b>II</b> |
| <b>1 The First Chapter of My Thesis</b>          | <b>1</b>  |
| 1.1 Sample Section .....                         | 1         |
| 1.1.1 The subsection .....                       | 2         |
| <b>2 This is the second chapter of my thesis</b> | <b>3</b>  |
| <b>Bibliography</b>                              | <b>5</b>  |
| <b>Acknowledgement</b>                           | <b>7</b>  |

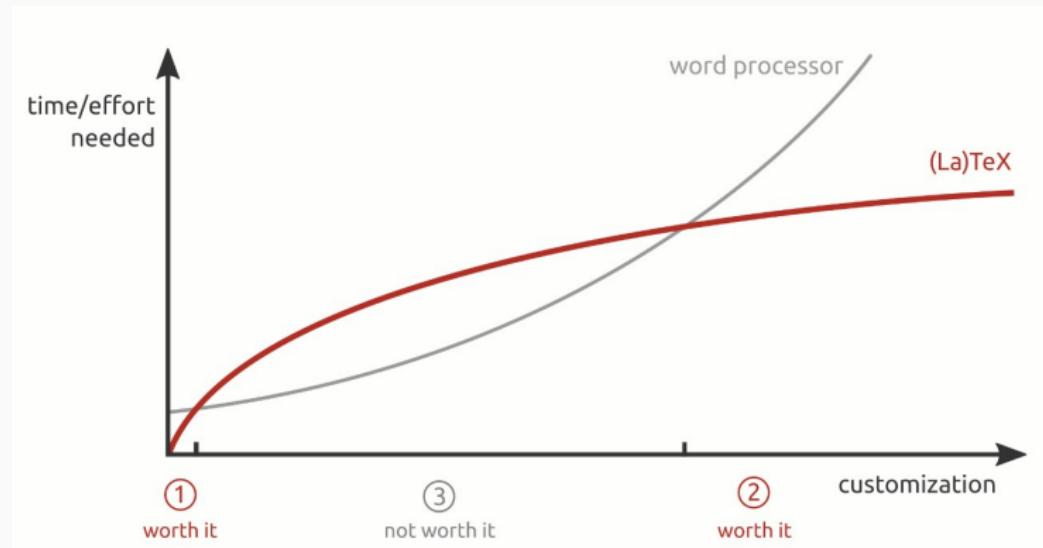
Topic: A Brilliant Work  
Student Name: Fake Name  
Student ID: 12345678  
Year of Attendance: 2014  
Department: School of Information Science and Technology  
Advisor: Prof. Foo Bar  
Major: Electrical and Electronic Engineering

Made by Office of Academic Affairs, ShanghaiTech University  
Date: / /

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**Figure 4:** Snapshots of graduation thesis from ShanghaiTech university.

# Learning Curve



**Figure 5:** A figure from Stack Overflow discussion.

# Outline

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Recommended Resources

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Side Advice

# Installation and Setup

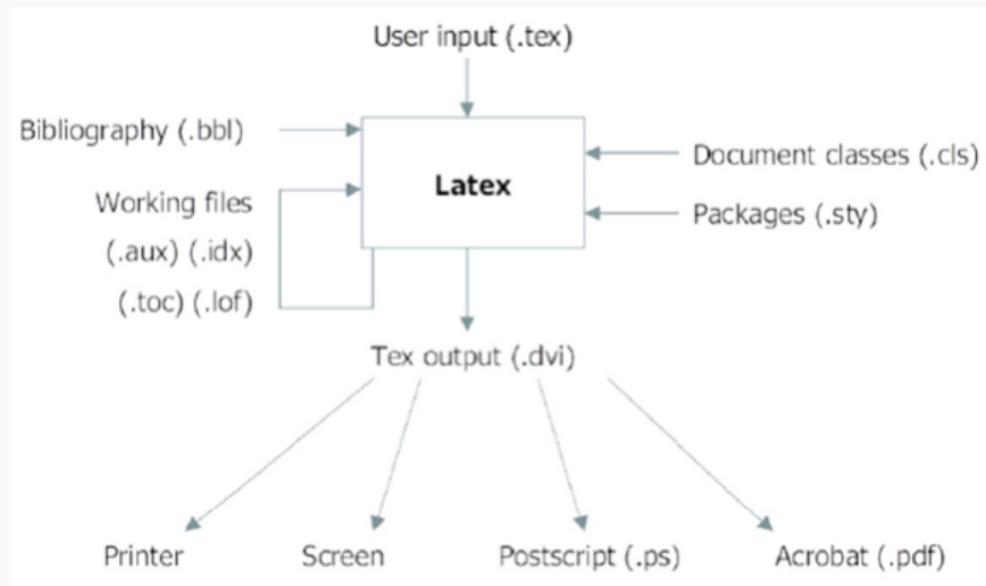
Recall the first time you encounter Python

- Python version: Exe file on Windows, apt-get on Linux, and Homebrew on Mac.
- Editor: VS Code, Atom, Sublime, Pycharm, etc.

Similar procedure for LaTeX

- TeX: **TeX Live** and **MiKTeX** on Linux and Windows or **MacTeX** on Mac.
- Editor: **Texstudio**, **Texpad**, **LyX**, and extension on **VS Code**, **Atom**, **Sublime**, etc.

# The Mechanism of Tex



**Figure 6:** The basic structure of Tex system from Byungwon Woo.

# Basic Document Structure

- **Preamble:** Documentclass, packages, and macro
- **Front matter:** Title, author, and other information
- **Body:** Main contents
- **Back matter (optional):** Bibliography

# Core Feature for a Math Course: the Math Mode

## Contents

|  |    |
|--|----|
| Math Mode . . . . .                                | 1  |
| Types of Math Mode . . . . .                       | 2  |
| Using Math Mode . . . . .                          | 3  |
| Example . . . . .                                  | 4  |
| Typing Mathematical Expressions . . . . .          | 5  |
| Typefaces in Math Mode . . . . .                   | 6  |
| Super- and Subscripts . . . . .                    | 7  |
| Nonmath Uses of Math Mode . . . . .                | 8  |
| Variables and Symbols in Math Mode . . . . .       | 9  |
| Assignment 1 solution . . . . .                    | 10 |
| Fractions and Roots . . . . .                      | 11 |
| Assignment 2 solution . . . . .                    | 12 |
| Common Mathematical Functions . . . . .            | 13 |
| Common Mathematical Symbols . . . . .              | 14 |
| Assignment 3 solution . . . . .                    | 15 |
| Bounded Sums and Such . . . . .                    | 16 |
| Sum, Integral, Limit Examples . . . . .            | 17 |
| Union and Intersection Examples . . . . .          | 18 |
| Assignment 7—Integrals, roots, exponents . . . . . | 19 |
| Assignment 7 solution . . . . .                    | 20 |
| Mathematical fonts . . . . .                       | 21 |
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| Common Error Messages . . . . .                    | 23 |
| Common Error Messages . . . . .                    | 24 |
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| Common Error Messages . . . . .                    | 26 |

Figure 7: The outline of MIT tutorial for LaTeX math mode.

# Outline

Why Does One Use  $\text{\LaTeX}$

How Does  $\text{\LaTeX}$  Work

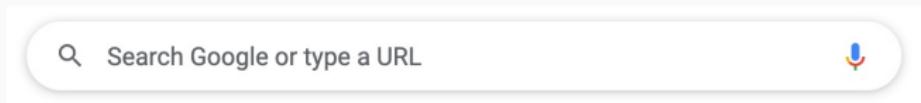
The Ultimate Solution to Confusions

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Side Advice

# You Can Google it



**Figure 8:** Just google it (include LaTeX as a keyword).

- Aligned equations
- Equation without number
- Different matrix representations
- Greek letters
- Insert figures
- Pseudo code
- ...

# You Can Google It

- Stack Exchange
- Youtube
- Bilibili
- CSDN
- Zhihu
- Overleaf

# ChatGPT

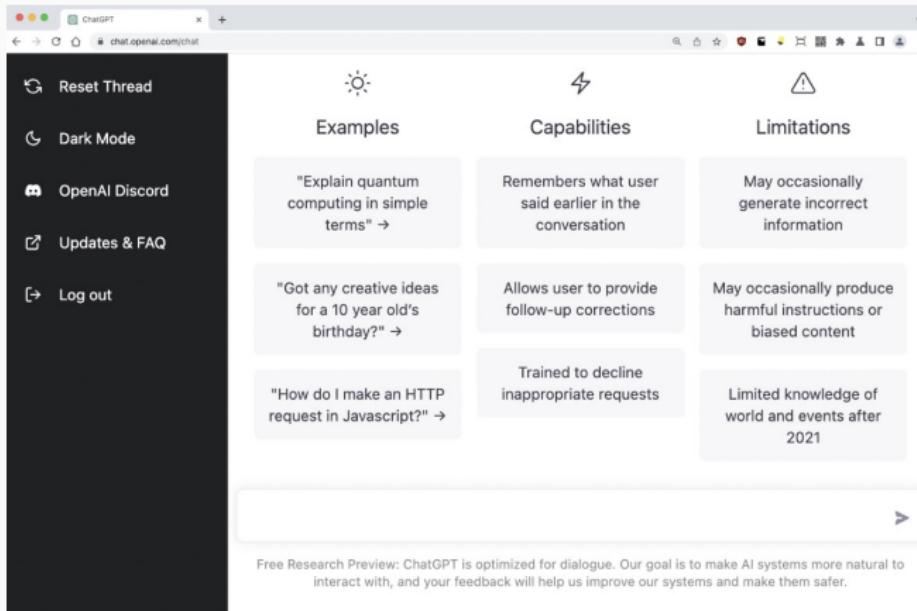


Figure 9: ChatGPT from OpenAI.

# Stack Exchange



**Figure 10:** A snapshot of **several sites** from Stack Exchange.

# Outline

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- An Interactive Introduction to LaTeX
- Tutorial from Overleaf: [Learn LaTeX in 30 minutes](#)
- Tutorial using Overleaf: [Intro to LaTeX tutorial: learn to write beautiful math documents](#)
- Tutorial from Youtube: [How to elegantly write math equations](#)
- Tutorial from Bilibili: [A quick introduction to Latex](#)
- Blog from Zhihu: [Latex introduction](#)
- Long PDFs:
  - [The LaTeX companion](#)
  - [The not so short introduction to LaTeX 2 \$\epsilon\$](#)

# L<sup>A</sup>T<sub>E</sub>X Wiki Book

**L<sup>A</sup>T<sub>E</sub>X**

 **L<sup>A</sup>T<sub>E</sub>X** is a [featured book](#) on Wikibooks because it contains substantial content, it is well-formatted, and the Wikibooks community [has decided](#) to feature it on the [main page](#) or in other places. Please continue to improve it and thanks for the great work so far! You can edit its [advertisement template](#). This book is also available as a [print version](#) and as a [PDF version](#).

This is a guide to the [L<sup>A</sup>T<sub>E</sub>X typesetting](#) system. It is intended as a useful resource for everybody, from new users who wish to learn, to old hands who need a quick reference.

## TeX and L<sup>A</sup>T<sub>E</sub>X

TeX is a typesetting computer program created by [Donald Knuth](#), originally for his magnum opus, *The Art of Computer Programming*. It takes a "plain" text file and converts it into a high-quality document for printing or on-screen viewing. L<sup>A</sup>T<sub>E</sub>X is a macro system built on top of TeX that aims to simplify its use and automate many common formatting tasks. It is the de-facto standard for academic journals and books in several fields, such as mathematics and physics, and provides some of the best typography free software has to offer.

**Figure 11:** A snapshot of the L<sup>A</sup>T<sub>E</sub>X wiki book.

# LATEX CheatSheet

AMS-**L**A**T**E**X** Reference Card #1

See the TeX Reference Card for additional commands.  
Required packages are indicated as `(package)`.

Document Structure

- ```

* Preamble
  <document-class [option(s)]> {class}
  <usepackage [option(s)]> {package(s)}
  <begin[document]>
  <end[document]>

* Main Matter
  * From Matter (frontmatter in book classes)
    * Top Matter
      <ttitle{...}>
      <title{...}> {main title} (or head)
      <subtitling> {head} ... alternative headline
      <date{...}> {date}
      <date{today}> {give current date}
      <author{...}> {author}
      <copyright{...}> {copyright} (not in book classes)
      * Additional Items -> amss classes only
        <translators{...}>
        <dedicatory{...}>
        <address{optional name}{...}>
        <curaddr{...}>
        <email{optional name}{...}>
        <thank{...}>
        <subclass{Primary: IXX; Secondary: IXX}>
        <keywords{...}>
        <chapters{...}>
        <abstracts{...}>
        <chapter[Introduction]> {in book classes}
      * Abstract (not in book classes)
        <begin[abstract]> ... <end[abstract]>
  * Main Matter (backmatter in book classes)
    * Section{...}
    * Subsection{...}
    * Appendix{...}
  * Back Matter (backmatter in book classes)
    * Bibliography{...} {bibliography} (99) ... <end[...]
    * Segment{...}

```

Page Style

- ```


pagestyle@{style} set page style to one of:  

  plain    empty header, number footer  

  empty   empty header and footer  

  headings header filled by dict class, empty footer  

  myheadings empty footer, SfI header with info in  

               file, and unnumbered (fragile)  

  and unnumbered (fragile)


```

**thispagestyle@{style}** set **pagestyle@{style}**, only current page  
**renewcommand{\baselinestretch}{2}** force an extra line  
**renewcommand{\headsep}{1cm}** double spaced  
**fancyheadings** package allows custom headers and footers

  - **Fancy Page Headers**

first page header, right, down  
 pagewidth, *pageheight*, *textheight*, *textwidth*  
*topmargin*, *headheight*, *headsep*, *footskip*  
*papername*(...), e.g., arabic, roman

## Classes and Packages

- ```

\documentclass[options]{class}           % Document class
\usepackage[options]{package}          % Packages
\NeedsTeXFormat{LaTeX2e}[1994/12/01]
\begin{document}
  \begin{titlepage}                         % Document title
    \begin{center}
      \textbf{Article Title} \\[1ex]
      \textbf{Author Name} \\[1ex]
      \textbf{Institution} \\[1ex]
      \textbf{Date} \\[1ex]
      \textbf{Version} \\[1ex]
    \end{center}
  \end{titlepage}
  \begin{abstract}                          % Abstract
    Abstract Text
  \end{abstract}
  \begin{article}                           % Article body
    \begin{section}                         % Section
      \begin{list}{\bf \it \textbullet}        % List
        \item Section Text
        \item Section Text
        \item Section Text
      \end{list}
    \end{section}
    \begin{list}{\bf \it \textbullet}          % List
      \item List Item
      \item List Item
      \item List Item
    \end{list}
  \end{article}
  \begin{acknowledgments}                  % Acknowledgments
    Acknowledgments Text
  \end{acknowledgments}
  \begin{bibliography}                     % Bibliography
    \begin{list}{\bf \it \textbullet}          % List
      \item Bibliography Item
      \item Bibliography Item
      \item Bibliography Item
    \end{list}
  \end{bibliography}
  \begin{appendix}                          % Appendix
    \begin{list}{\bf \it \textbullet}          % List
      \item Appendix Item
      \item Appendix Item
      \item Appendix Item
    \end{list}
  \end{appendix}
\end{document}

```

## Bibliography (see also BIBTEX)

- ```
\begin{thebibliography}(99)...\end{document}

bibliography with widest label specified
\bibitem(name) named bibliography item
\bibitem[label](name) with alternative label to print
\byname use long title for same author
\renewcommand{\bibname}(title) use custom title
\cite(name) print number of named bib item
\cite{text}(name) with extra text
```

## Cross Referencing and Numbering

- ```
\label{name}           assign label name to numbered item
\ref{name}            print number of named item
\egref{name}          print number in parentheses (amsmath)
\pageref{name}         print page location of named item
\citeitem{name}        print number of named bibliography item
\cite{text}{name}      with extra text
\numberwithin{section}{equation}(section) number by section
```

## **Sectioning and Table of Contents**

- ```

\Sectioning{commands}
\command{title}      sectioning command with title
\command{[line]}{title} with alternative running head
\command{[title]}{title} with number suppressed

\part{...}           \section{...}          \paragraph{...}
\chapter{...}         \subsection{...}        \subparagraph{...}
\subchapter{...}       \subsubsection{...}    \subsubparagraph{...}

\appendix{...}        start appendix

\TableOfContents{...} Table of Contents

\tableofcontents{...}  create and print contents
\filename{...}.toc     contents associated to \filename.toc
\addcontentsline{...}{...}[...]{...} (line) to add
\addtocontents{...}{...}[...]{...} (material) to add
\setcounter{tocdepth}{...} set amount to print

```

## Lists

- |                                  |                   |
|----------------------------------|-------------------|
| \item                            | item within list  |
| \item[ <i>label</i> ]            | item with label   |
| \begin{enumerate}... \end{...}   | numbered items    |
| \begin{itemize}... \end{...}     | bulleted items    |
| \begin{description}... \end{...} | captioned items   |
| \setlength{\itemsep}{0pt}        | move items closer |
| enumitem package                 | extends enumerate |

#### Displayed Text Material

- |   |                       |
|---|-----------------------|
| <code>\begin{center}... \end{center}</code>         | centered material     |
| <code>\begin{flushright}... \end{flushright}</code> | flush right material  |
| <code>\begin{flushleft}... \end{flushleft}</code>   | flush left material   |
| <code>\begin{center}... \end{center}</code>         | centered material     |
| <code>\begin{short}... \end{short}</code>           | short quote           |
| <code>\begin{long}... \end{long}</code>             | long quote            |
| <code>\begin{poem}... \end{poem}</code>             | poetry                |
| <code>\begin{verse}... \end{verse}</code>           | verse material        |
| <code>\verb ... </code>                             | verbatim material     |
| <code>\verb* ... </code>                            | verbatim with spaces  |
| <code>\verb+...+</code>                             | verbatim package      |
| <code>\verb  ...  </code>                           | verbbatim with spaces |
| <code>\verb  ...  </code>                           | extends verbbatim     |

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Math. Dept., Brown Univ., Providence, RI 02912 USA.  
This version is granted for noncommercial distribution provided the copy-  
right notice and this disclaimer notice are contained on all copies.

**Figure 12:** A snapshot of The L<sup>A</sup>T<sub>E</sub>X reference card.

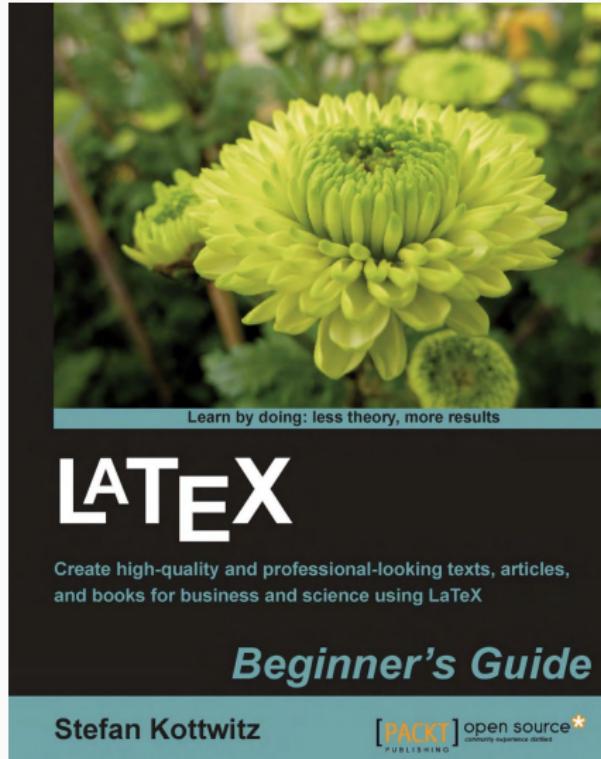


Figure 13: LaTeX - beginner's guide.

## LaTeX – A document preparation system

LaTeX is a high-quality typesetting system; it includes features designed for the production of technical and scientific documentation. LaTeX is the de facto standard for the communication and publication of scientific documents. LaTeX is available as [free software](#).

## Recent News

6 September, 2022

[Talks from the online TUG Conferences 2021 and 2022](#)

14 June, 2022

[June 2022 LaTeX release available](#)

27 May, 2022

[Final pre-release of LaTeX 2022-06-01 is available for testing](#)

**Figure 14:** A snapshot of the front page from [Latex-project.org](#).

# Outline

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Side Advice

## What If I Am Writing Something Formal (Academic)

Just stick to LaTeX.



**Figure 15:** Ligatures comparison between Microsoft (above) and LaTeX (below) from [Baochun Li](#).

# What If I Want to Have a Complex Table

It is quite tedious to write a complex table in LaTeX.

|  |             | Scalar $y$                      |                         | Column vector $y$ (size $m \times 1$ ) |                         | Matrix $Y$ (size $m \times n$ ) |                     |
|--|-------------|---------------------------------|-------------------------|--|-------------------------|---------------------------------|---------------------|
|  |             | Notation                        | Type                    | Notation                               | Type                    | Notation                        | Type                |
| Scalar $x$                             | Numerator   | $\frac{\partial y}{\partial x}$ | Scalar                  | $\frac{\partial y}{\partial x}$        | Size- $m$ column vector | $\frac{\partial Y}{\partial x}$ | $m \times n$ matrix |
|  | Denominator |                                 |                         |  | Size- $m$ row vector    |                                 |                     |
| Column vector $x$ (size $n \times 1$ ) | Numerator   | $\frac{\partial y}{\partial x}$ | Size- $n$ row vector    | $\frac{\partial y}{\partial x}$        | $m \times n$ matrix     | $\frac{\partial Y}{\partial x}$ |                     |
|  | Denominator |                                 | Size- $n$ column vector | $\frac{\partial y}{\partial x}$        | $n \times m$ matrix     |                                 |                     |
| Matrix $X$ (size $p \times q$ )        | Numerator   | $\frac{\partial y}{\partial X}$ | $q \times p$ matrix     | $\frac{\partial y}{\partial X}$        |                         | $\frac{\partial Y}{\partial X}$ |                     |
|  | Denominator |                                 | $p \times q$ matrix     | $\frac{\partial y}{\partial X}$        |                         |                                 |                     |

**Figure 16:** Showcase of matrix layout convention table from [Wiki](#).

- Table Generator

## What If I Am A Fan of PowerPoint

The support for math equations in PPT is not comprehensive. The typeset equations are not in standard LaTeX format.

$$P(a|b) = \frac{P(b|a)P(a)}{P(b)} \quad P(a|b) = \frac{P(b|a)P(a)}{P(b)}$$

**Figure 17:** Equations from PPT (left) and LaTeX in IEEE paper (right).

- **LaTeXiT**

# What If I Am A Fan of PowerPoint

Find proper add-ons for LaTeX equations.

## IguanaTex

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A Free LaTeX Add-In for PowerPoint on Windows and Mac

IguanaTex is a PowerPoint add-in which allows you to insert [LaTeX](#) equations into your PowerPoint presentation. It is distributed completely for free, along with its source code.

## Usage

If you know how to use LaTeX, it is very easy to use IguanaTex. Select **New LaTeX display** from the **IguanaTex** tab of the ribbon, and you will get a dialog box where you can type your equation:



Figure 18: PPT IguanaTex Add-on.

# What If I Want to Utilize Existing L<sup>A</sup>T<sub>E</sub>X Equations

**Proof:**(of Theorem 2.6) The proof consists of bounding the terms in Lemma 2.5. We have:

$$\begin{aligned} & \gamma \|(I - \gamma \hat{P}^{\pi^*})^{-1}(P - \hat{P})V^*\|_\infty \\ & \leq c\gamma \sqrt{\frac{\log(c|\mathcal{S}||\mathcal{A}|/\delta)}{N}} \|(I - \gamma \hat{P}^{\pi^*})^{-1}\sqrt{\text{Var}_{\hat{P}}(\hat{V}^{\pi^*})}\|_\infty + \frac{c\gamma}{(1-\gamma)^2} \left(\frac{\log(c|\mathcal{S}||\mathcal{A}|/\delta)}{N}\right)^{3/4} \\ & \quad + \frac{c\gamma}{(1-\gamma)^3} \frac{\log(c|\mathcal{S}||\mathcal{A}|/\delta)}{N} \\ & \leq \gamma \sqrt{\frac{2}{(1-\gamma)^3}} \sqrt{\frac{\log(c|\mathcal{S}||\mathcal{A}|/\delta)}{N}} + \frac{c\gamma}{(1-\gamma)^2} \left(\frac{\log(c|\mathcal{S}||\mathcal{A}|/\delta)}{N}\right)^{3/4} + \frac{c\gamma}{(1-\gamma)^3} \frac{\log(c|\mathcal{S}||\mathcal{A}|/\delta)}{N} \\ & \leq 3\gamma \sqrt{\frac{1}{(1-\gamma)^3}} c \sqrt{\frac{\log(c|\mathcal{S}||\mathcal{A}|/\delta)}{N}} + 2 \frac{c\gamma}{(1-\gamma)^3} \frac{\log(c|\mathcal{S}||\mathcal{A}|/\delta)}{N}, \end{aligned}$$

where the first step uses Corollary 2.14; the second uses Lemma 2.12; and the last step uses that  $2ab \leq a^2 + b^2$  (and choosing  $a, b$  appropriately). The proof of the lower bound is analogous. Taking a different absolute constant completes the proof. ■

**Figure 19:** Example "complex" proof.

- LaTeXLive
- Mathpix Snip

# Outline

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Why Does One Use  $\text{\LaTeX}$

How Does  $\text{\LaTeX}$  Work

The Ultimate Solution to Confusions

Recommended Resources

Practical  $\text{\LaTeX}$  Usage

Side Advice

# When Is Not Appropriate to Use L<sup>A</sup>T<sub>E</sub>X



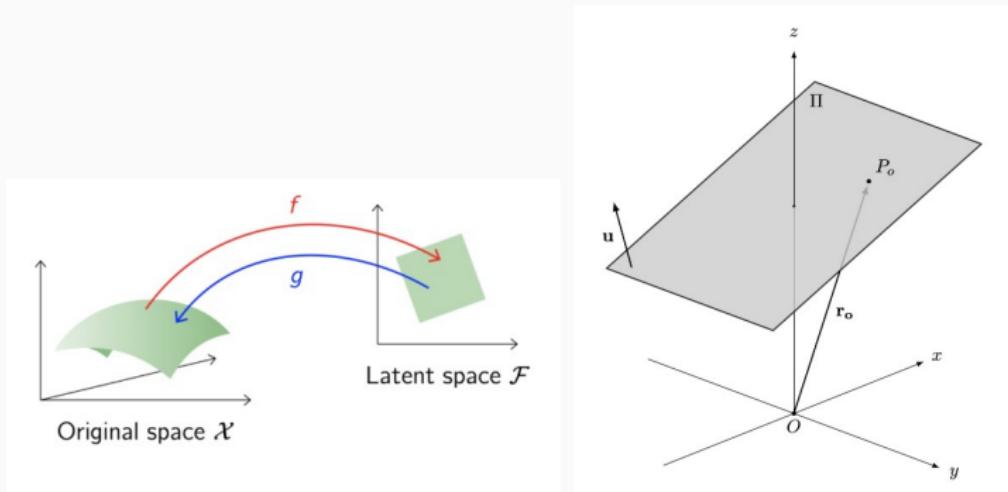
**Figure 20:** A common situation in math classes.

Do not handle **content** and **typesetting** at the same time.

# Handwriting and Note-Taking Tools

- PDF Expert
- Prodrafts (Infinite width)
- Notion (Infinite depth)
- Typora
- Bear
- Obsidian (Graph view and dot-connecting)

# When Is “Not” Appropriate to Use L<sup>A</sup>T<sub>E</sub>X



**Figure 21:** Example **Tikz** figures.

May refer to more convenient tools like [draw.io](#) or just PPT.