

# Intro to L<sup>A</sup>T<sub>E</sub>X

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

L<sup>A</sup>T<sub>E</sub>X is a document preparation system used to create professional-looking documents. It compiles unformatted text and commands it into a prepared document without having to worry too much about the layout or appearance of the content. L<sup>A</sup>T<sub>E</sub>X is especially useful when writing complicated mathematical equations for homeworks, projects, reports, etc.

You could say, it's like a programming language. It expects a particular syntax, or else it won't work.

You may be asking yourself, why should I use L<sup>A</sup>T<sub>E</sub>X? Totally, valid question! Personally, L<sup>A</sup>T<sub>E</sub>X is appealing because it allows for precise and concise presentations of mathematical ideas. You are able to implement professional-looking tables, figures, and equations to help aid your presentations and research!

Now, let's dive into some basics!

## 2 Where to use L<sup>A</sup>T<sub>E</sub>X

- **Overleaf** is an easy-to-use online L<sup>A</sup>T<sub>E</sub>X editor, comparable to Google Docs. This is my preferred method when creating documents or homework assignments that don't involve a lot of R code. **Note:** use your Columbia email to access a premium account! You add unlimited collaborators to a project.
- **RMarkdown** allows for a seamless incorporation of L<sup>A</sup>T<sub>E</sub>X. In order to use L<sup>A</sup>T<sub>E</sub>X in an .RMD file, you must enclose any L<sup>A</sup>T<sub>E</sub>X language in `$`'s.
- There are editor desktop apps like **Texmaker** and **TexShop**, comparable to Word. Note that these do not require internet and are great for on-the-go.

Regardless, they all use the same L<sup>A</sup>T<sub>E</sub>X syntax!

## 3 Starting a document in Overleaf

Create a New Project to access a `.tex` file, where you will compile the source file with text and/or L<sup>A</sup>T<sub>E</sub>X. To your right, the compiled `.pdf` file will appear.

Now, some layout/aesthetic basics:

1. `\documentclass`: general format of the document (`article`, `book`, etc)
2. Font size: 10pt, 11pt, 12pt

3. `\usepackage{}`: lots of packages available on Overleaf (no installation needed)
4. `\begin{document}... \end{document}`
5. All commands start with a backslash `\`

### 3.1 Useful Packages

- `\usepackage{graphicx}`: required for inserting images
- `\usepackage[margin=_in]{geometry}`: customize page layout (i.e. margin size)
- `\usepackage{url}`: add url's to pdf
- `\usepackage{float}`: define placement for 'floating' figures/images
- `\usepackage{amsmath}`: gives options for displaying equations

## 4 Mathematical Environments

### 4.1 In-line

In-line  $\LaTeX$  is created when surrounding syntax with only one  $\$$  on either side. This is similar to in-line R code.

An example of in-line  $\LaTeX$ : The  $\$\sqrt{25} + \sqrt{9}\$$  is 8.

This render to: The  $\sqrt{25} + \sqrt{9}$  is 8.

### 4.2 Single-line equations

Sometimes you'd like to showcase an important result or a longer mathematical expression. To do so, you enclose the mathematical object with `\begin{equation}` and `\end{equation}`. As an example, let's look at the PMF of a Poisson random variable,

$$f(x) = \frac{\lambda^x e^{-\lambda}}{x!} \tag{1}$$

### 4.3 Multi-line equations

A natural extension to single-line equations is a multi-line equations. This is useful for proofs or presenting all your steps to your audience. Here's an output example,

$$\begin{aligned}
 x \in (A \cup B)^c &= x \notin A \cup B && \text{(step 1)} \\
 &= x \notin A \wedge x \notin B && \text{(step 2)} \\
 &= x \in A^c \wedge x \in B^c && \text{(step 3)} \\
 &= x \in A^c \cap B^c && \text{(step 4)}
 \end{aligned}$$

To create multi-line equations, enclose your objects with commands `\begin{align}... \end{align}` or `\begin{align*}... \end{align*}` to suppress number tags and/or add your own tags. To add your own tag to any line, use command `\tag{tag here}`. To align your equations, add `&` to create vertical line breaks. To end a line, use `\\` to create horizontal line breaks.

## 5 Structure

### 5.1 Sections

`\section`  
`\subsection`  
`\subsubsection`

### 5.2 Lists

- Add bullet points using the commands `\begin{itemize}...\end{itemize}`
- 1. Add number lists using the commands `\begin{enumerate}...\end{enumerate}`

Note: each item in the lists are identified by the `\item` command.

## 6 Useful Expressions & Commands

Remember to enclose any L<sup>A</sup>T<sub>E</sub>X syntax or commands with `$`'s.

$$\text{\frac{x}{y}} = \frac{x}{y}$$

$$\text{e^x} = e^x$$

$$\text{X_{i + j}} = X_{i+j}$$

$$\text{\bar{X}} = \bar{X}$$

$$\text{\mu} = \mu$$

$$\text{\hat{\sigma}} = \hat{\sigma}$$

$$\text{\sum} = \sum$$

$$\text{\prod} = \prod$$

$$\text{\in} = \in$$

$$\text{\cup or \bigcup} = \cup \text{ or } \bigcup$$

$$\text{\cap or \bigcap} = \cap \text{ or } \bigcap$$

$$\text{\infty} = \infty$$

$$\text{\int} = \int$$

$$\text{X_1, \ldots, X_n} = X_1, \dots, X_n$$

`\{ \}` = `{ }` (Add a backslash before a symbol if you'd like for it to appear in text or an equation.)

`\textbf{ }`: bold text

## 7 Tables

There are now two different ways to create a table with  $\text{\LaTeX}$ .

yes	no
2	10
5	50

Table 1: Example Table

One way is using the commands `\begin{table}[H]... \end{table}`. In between the two commands and after the command `\begin{tabular}`, you will see some preset lines with `&` signs. On either side of the `&` sign, you can add values or words to fill in the table. Include `\hline` before and after lines to enclose values into a table. Also, include a label to refer back to it within your text using `\ref{tab:name of table}`.

An easier way to create a table in Overleaf is using the Visual Editor. Once in Visual Editor, click on the three dots (...) to access the **Insert Table** option.

## 8 Figures

$\text{\LaTeX}$  also allows for the incorporation of figures and images into your document. In Overleaf, upload your image into the left-hand side. Using the commands `\begin{figure}... \end{figure}`, include the file name in command `\includegraphics{file_name_here}`. Similar to tables, you can label your figures to refer back to it within your text using `\ref{fig:name of image}`. Here is an output example,



Figure 1: NYC Skyline

## 9 Extra Resources

- Here is a website that has compiled various sources related to L<sup>A</sup>T<sub>E</sub>X: <https://texblog.org/tex-resources/>
- If you'd like more information on citations for papers/reports: <https://libguides.eur.nl/overleaf/bibliographies-and-citing#:~:text=Citing%20in%20LaTeX,is%20also%20a%20popular%20option.>
- To get started on Overleaf, the basefiles and templates provided are a great start!