LaTex for Scientific Writing

Day 1

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What is Latex

A very powerful text (markup) processing system designed to produce quality typeset documents.

- The de facto standard for the communication and publication of scientific documents.
- It is based on the TEX: A typesetting system
  - TEX was designed and created by Donald Knuth in 1978 $\Rightarrow$ to produce high-quality books using a reasonably minimal amount of effort.
- LaTeX is a user-friendly extension of TeX $\Rightarrow$ a slightly higher-level language built on top of TEX.
  - TeX and LaTeX $\Rightarrow$ assembly language and C

What is Latex

The most important fact about Latex

- You can't learn how to use it by watching someone else use it.
- Google knows everything about it.

Why Latex

LATEX strength:

- Less focus on formatting and more on content.
- It makes beautiful documents.
- Superior and flexible equation presentation.
- It was created by scientists, for scientists $\Rightarrow$ A large and active community
- Fast, stable, extensible, and free (distribution dependent).

How does it work?

- You write your document in plain text with commands that describe its structure and meaning.
- The latex program processes your text and commands to produce a beautifully formatted document.
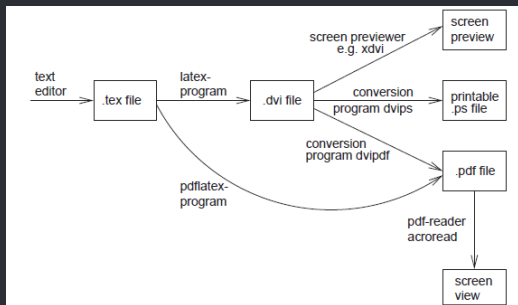
Installation

First you need a TEX Distribution: contains all the software that you need to create a LATEX document.

- MiKTeX: A a free TeX distribution for Windows systems.
- MacTeX: A a free TeX distribution for Mac.
- TeXLive: A a free TeX distribution for for most flavors of Unix and windows.
- For more Latex info: https://www.latex-project.org/

Installation

You also need a text editor: To create a LATEX source file

- Texmaker.
- TexStudio.
- We will use TexStudio with MiKTex
  - Download TexStudio for your distribution
  - Install TexStudio when MiKTeX installation is completed.
  - TexStudio will automatically configure the settings for you.
- The installation of LaTeX is now complete.

Online versions

Three popular online versions

- Overleaf [https://www.overleaf.com/].
- Papeeria [https://papeeria.com/].
- Sharelatex [https://www.sharelatex.com/].
- Authorea [https://www.authorea.com/].

Activity 1

Commands

A LATEX document is mainly defined through commands.
Commands are case sensitive, and take one of the following two
formats:

- They start with a backslash \ and then a name consisting of
  letters only.

- Some commands need an argument, which has to be given
  between curly braces { }.

- Some commands support optional parameters, which are
  added in square brackets [ ].

Commands
Arguments and Options

- Many commands require a single argument, and some commands require even multiple arguments.

- Some commands can have several options.

Example:

```
\usepackage{graphicx} % single argument
\usepackage{amsmath, amssymb} % multiple arguments
\documentclass[a4paper,11pt]{article} % several options
\usepackage[final]{microtype}  % single options
```

Commands
Environment

An environment is be marked by,
\begin{environment} ... \end{environment}.

- These initiate and exit an environment.
- The type of environment is applied to everything between the begin and end commands.

Example:

```
\begin{document}
content...              % document environment
\end{document}
```

Special Character

There are ten characters which, like the backslash, are used by latex for special purposes.

Character	Purpose	Input for literal output
\	Special symbols and instructions	`$\backslash$`
{	Open group	`$\{$`
}	Close group	`$\}$`
%	Comments	`\%`
&	Tabs and table alignments	`\&`
~	Unbreakable space	`\~{}`
$	Starting or ending math text	`\$`
^	Math superscripts	`\^{}`
_	Math subscripts	`\_{}`
#	Defining replacement symbols	`\#`

Document Structure

Every LaTeX document has the following form:

```
\documentclass[options]{class name}
%Preamble
\begin{document}
%Body
\end{document}
```

Document Class

- The command `\documentclass[options]{class name}` specify type of document you wants to create.
  - **class name**: specifies the type of document to be created.
  - **options parameter**:customises the behaviour of the document class.
    Example:
    `\documentclass[11pt,a4paper]{article}`

Document Class

Lists of the document classes type.

Class	Description
article	For articles in scientific journals, presentations, short reports, program documentation, invitations etc.
report	For longer reports containing several chapters, small books, thesis etc.
book	For real books.
letter	For writing letters.
beamer	For writing presentation
exam	For writing exams.

Document Class: Options

The document classes options.

Options	Description
10pt, 11pt, 12pt	Sets the size of the main font in the document. Default is 10pt.
a4paper,letterpaper..	Defines the paper size.The default size is letterpaper.Besides that, a5paper, b5paper, executivepaper, and legalpaper can be specified.
twocolumn	Instructs LaTeX to typeset the document in two columns instead of one.
twoside, oneside	For writing letters.
landscape	Changes the layout of the document to print in landscape mode.
titlepage, notitlepage	Specifies whether a new page should be started after the document title or not. The article class does not start a new page by default, while report and book do.

Activity 2

The Preamble

The preamble is where you define the style of your document and load any packages you need to use.

```
\documentclass[options]{class name}

%Preamble

\begin{document}
```

- It normally contains commands, variables or other things needed that affect the entire document.
- Load needed packages along with any options for those packages.

The Preamble

The preamble is also used to load any other options or information that isn't necessarily a part of the document's content such as:

- Setting lengths of spaces before/after paragraphs, line height, etc

- Specifying author/title/date, etc. (important if you will be making a title page).

The Preamble
Document Tittle

There are two steps to give your document a title.

- Tell LaTeX what to put in the title, and tell LaTeX to typeset the title.

- To specify title use the following commands in preamble:
  `\title{...}`, `\author{...}`, `\date{..}`.

- To display the title, use `\maketitle` just after
  `\begin{document}`.

Example:

```
\title{Scintific Writing using LaTeX}
\author{M.~Chuwa \and S.~Nyondo}
\date{\today}
```

The Preamble: Packages

Packages extend the basic LATEX commands.

- To use packages, include the following command:

  \usepackage[options]{package}

- This command goes into the preamble of the document.

Example:

```
%To set margin
\usepackage[top=2in,bottom=1in,left=1in,right=1in]{geometry}
\usepackage{microtype} %improves the spacing between words and le
\usepackage{amsmath} %introduces several improvements for math en
\usepackage{graphicx} % for inserting image in latex document
```

Activity 3

The Body of the Document

After the preamble comes the body.

- Starts with `\begin` {document} and ends with
  `\end` {document}
- This is where you fill in the actual content of your document.
- Contains all text, fgures, tables, etc.

The Body of the Document

You can organize your document using the following commands.

Level	Article	Report/Book
Part		`\part{}`
Chapter		`\chapter{}`
Section	`\section{}`	`\section{}`
Subsection	`\subsection{}`	`\subsection{}`
Subsubsection	`\subsubsection{}`	`\subsubsection{}`
Paragraph	`\paragraph{}`	`\paragraph{}`

- Your PDF output will include these sections as bookmarks.

- The above commands have a *-version and using these results in no number and no entry in the table of contents.

- Example: `\subsection *{Acknowledgement}`

Activity 4

Font Sizes and Colors

To change the font size in LaTeX

Commands	Output
\tiny	LaTex
\small	LaTex
\normalsize	LaTex
\large	LaTex
\Large	LaTex
\LARGE	LaTex
\huge	LaTex
\Huge	LaTex

Font Sizes and Colors

To change text color use `\usepackage {color}` or `\usepackage {xcolor}`

- command: `\textcolor {color}{text}`
- Example:
  - `\textcolor {red}{Hello} world` ⇒ Hello world
  - `Hello \textcolor {blue}{world}` ⇒ Hello world

Font Types and Style

To change the font itself to different styles

Style	Commands	Output
Bold	\textbf {LaTex}	**LaTex**
Italic	\textit {LaTex}	*LaTex*
Underline	\underline {LaTex}	LaTex
Typewriter	\texttt {LaTex}	LaTex
Sans-Serif	\textsf {LaTex}	LaTex
Serif (Roman)	\textrm {LaTex}	LaTex

Spacing

LaTex treats any number of spaces as a single space.

- Single new lines are treated as if there is no new line.

- Multiple blank lines are treated as a single new line or you may use \newline command.

- You can force horizontal and vertical space using the \hspace {length} and \vspace {length}
  - You have to give each command a length commands:

\hspace {0.1cm},

\hspace {1in} or

\hspace {10pt}

Lists

There are three list environments

- itemize ⇒ for a bullet list.
- enumerate ⇒ for an ordered list and
- description ⇒ for a descriptive list.

All lists follow the following format:

```
\begin{list_type}
\item The first item
\item The second item
\item The third etc
\end{list_type}
```

Lists

```latex
\begin{itemize}
\item The first item
\item The second item
\item  The third item
\end{itemize}
```

- The first item
- The second item
- The third item

Lists

```
\begin{enumerate}
\item The first item
\item The second item
\item The third item
\end{enumerate}
```

1. The first item
2. The second item
3. The third item

Lists

The description list used to explain notations or terms

```
\begin{description}
\item[Itemize] used for a bullet list.
\item[Enumerate] used for a ordered list.
\item[Description] used for a descriptive list.
\end{description}
```

output

Itemize used for a bullet list.

Enumerate used for a ordered list.

Description used for a descriptive list.

Nested Lists

```
\begin{enumerate}
\item Item one
    \begin{enumerate}
      \item Subitem one
      \item Subitem two
    \end{enumerate}
\item Item two
\end{enumerate}
```

1. Item one
   1.1 Subitem one
   1.2 Subitem two
2. Item two

Activity

Activity 6

Cross-reference

With the commands `\label{key}` and `\ref{key}` it is possible to refer to section numbers.

- The command `\label{key}` is used to set an identifier that is later used in the command `\ref{key}` to set the reference.

Example:

Create label:

```
\section {Cross-Reference}\label {cross-ref}
```

Reference:

```
It is not difficult to refer to Section \ref {cross-ref}
```

Output: It is not difficult to refer to Section 5

Math mode

The amsmath package is the backbone of using LaTex for typesetting math.

- Include in preamble: \usepackage{amsmath}

The math environment" comes in two different forms:

Inline mode ⇒ format the math within existing lines of text.

Display mode ⇒ sets the math apart and centers it on the page.

Math mode
Inline mode

Several options exist:

- Use:`\begin{math} x + y = 2 \end{math}` $\Rightarrow x + y = 2$
- Surround the math with `\(x+y = 2\)` $\Rightarrow x + y = 2$
- Surround the math with single dollar signs `$x + y =2$` $\Rightarrow$ $x + y = 2$

Math mode
Inline mode

Subscripts and superscripts in math mode are formed using the _ and the ^.
Example:

$$a_n = n^2 + 1 \Rightarrow \texttt{\$a\_n = n\^{}2 + 1\$}$$

When the subscript or superscript is more than one character, you must wrap it in {...} to group it together.
Example:

$$y_{n+1} = e^{n^2-1} + 1 \Rightarrow \texttt{\$y\_\{n + 1\} = e\^{}\{n\^{}2-1\} + 1\$}$$

Math mode
Inline mode

Some common math symbols:

Symbol	Output
\alpha ,\beta ,\lambda ,\gamma ,\theta ,\mu etc	$\alpha, \beta, \lambda, \gamma, \theta, \mu,$ etc
\infty ,\exists ,\forall ,\pm ,\leq ,\geq etc.	$\infty, \exists, \forall, \pm, \leq, \geq$ etc
\int _0^{\infinity },\sum _{i=1}^n,\prod _{n=1}^N	$\int_0^\infty, \sum_{i=1}^n, \prod_{n=1}^N$ etc
\ldots , \cdots ,\vdots ,\colon etc	$\ldots, \cdots, \vdots, :$ etc
\frac {x}{y}, \sqrt {x},\bar {x},\lim _{x \to \infty }	$\frac{x}{y}, \sqrt{x}, \bar{x}, \lim_{x\to\infty}$ etc

More math symbols and formulas: Latex Symbols

Math mode
Common Math Formula

$\frac{\partial y}{\partial x}$ ⇒ `$\frac {\partial y}{\partial x}$`

$\int_a^b f(x)\,dx$ ⇒ `$ \int _a^b f(x)\,dx $`

Math mode
Display mode

Several options exist:

- Using
  `\begin{displaymath} x + y = 2 \end{displaymath}` $\Rightarrow$

$$x + y = 2$$

- Surround the math with `\[x+y = 2\]` $\Rightarrow$

$$x + y = 2$$

- Surround the math with double dollar signs `$$x + y =2$$` $\Rightarrow$

$$x + y = 2$$

Math mode
Numbered Equation

The equation environment:
\begin{equation}...\end{equation} creates a displayed
formula and automatically generates an equation number.
Example:

$$\int_0^\pi \sin x \, dx = 2 \tag{1}$$

$$\Downarrow$$

`\begin{equation}\int_{0}^{\pi}\sin x \,dx = 2\end{equation}`

Math mode
Referencing equations

The amsmath package provides `\eqref{key}` for referencing equations.

Example:

$$\sum_{i=0}^{\infty} a_i x^i \qquad (2)$$

The equation 2 is a typical power series.

```
\begin{equation} \label{eq:1}
\sum_{i=0}^{\infty} a_i x^i
\end{equation}
The equation \ref{eq:1} is a typi
```

Activity 7

Math mode
Multiple Equations

The `\begin{align}..\end{align}` environment is used group together several formulas or, equations with more than one lines.

Example:

$$\alpha + \beta^2 = 0 \tag{3}$$

$$\log_{10} 2\alpha = e^\beta - 1 \tag{4}$$

```
\begin{align}
\alpha + \beta^2 &= 0 \\
\log_{10}2\alpha &=e^{\beta}-1
\end{align}
```

Math mode
Multiple Equations

To align several formulas or equations with more than one lines.
Example:

$$
\begin{aligned}
y &= x^2 + 2x - 1\\
&= (x + 1)(2x + 1)\\
&= (x + 1)^2
\end{aligned}
$$

```
\begin{align*}
y &=x^2 + 2x -1\\
&=(x+1)(2x+1) \\
&=(x+1)^2
\end{align*}
```

Math mode
Matrices and Array

A basic matrix may be created using the `matrix` environment.

Plain Matrix

$$\begin{matrix} \alpha & \beta^{*} \\ \gamma^{*} & \delta \end{matrix}$$

```
\[
\begin{matrix}
\alpha& \beta^{*}\\
\gamma^{*}& \delta
\end{matrix}
\]
```

Math mode
Matrices and Array

Bracketed matrix; typically represents the matrix itself

$$\begin{bmatrix} \alpha & \beta^{*} \\ \gamma^{*} & \delta \end{bmatrix}$$

```
\[
\begin{bmatrix}
\alpha& \beta^{*}
\gamma^{*}& \delta
\end{bmatrix}
\]
```

Math mode
Matrices

Parenthesized matrix

$$\begin{pmatrix} \alpha & \beta^{*} \\ \gamma^{*} & \delta \end{pmatrix}$$

```
\[
\begin{pmatrix}
\alpha& \beta^{*}\\
\gamma^{*}& \delta
\end{pmatrix}
\]
```

Math mode
Matrix

Example: let type the following matrix

$$A_{m,n} = \begin{pmatrix} a_{1,1} & a_{1,2} & \cdots & a_{1,n} \\ a_{2,1} & a_{2,2} & \cdots & a_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m,1} & a_{m,2} & \cdots & a_{m,n} \end{pmatrix}$$

Math mode
Matrix

Example: let type the following matrix

```
\[
A_{m,n} =
\begin{pmatrix}
a_{1,1} & a_{1,2} & \cdots & a_{1,n} \\
a_{2,1} & a_{2,2} & \cdots & a_{2,n} \\
\vdots  & \vdots  & \ddots & \vdots  \\
a_{m,1} & a_{m,2} & \cdots & a_{m,n}
\end{pmatrix}
\]
```

Math mode
The Case Environment

The cases environment allows the writing of piecewise functions.
Consider the following:

$$
f(x) =
\begin{cases}
x & \text{if } x \neq 0 \\
\frac{\sin x}{x} & \text{otherwise}
\end{cases}
$$

```
\[
f(x) =
\begin{cases}
x & \text{if } x \neq 0 \\
\frac{\sin x}{x}& \text{otherwise}
\end{cases}
\]
```

Activity

Activity 7

THANK YOU