Department of
Computer Science and Engineering

Lab No. 02

Title: Introduction to Technical Report Writing Using LaTeX (Part 1)

Integrated Design Project I

CSE 324

Green University of Bangladesh

1 Objective(s)

- To learn typesetting of journal articles, technical reports, books, and slide presentations.
- To learn formatting documents containing sectioning, cross references, tables, equations and figures.
- To learn typesetting of complex mathematical formulae.

2 LaTeX

LATEX is used all over the world for scientific documents, books, as well as many other forms of publishing. Not only can it create beautifully typeset documents, but it allows users to very quickly tackle the more complicated parts of typesetting, such as inputting mathematics, creating tables of contents, referencing and creating bibliographies, and having a consistent layout across all sections. Due to the huge number of open source packages available (more on this later), the possibilities with LATEX are endless. These packages allow users to do even more with LATEX, such as add footnotes, draw schematics, create tables etc.

One of the most important reasons people use LATEX is that it separates the content of the document from the style. This means that once you have written the content of your document, we can change its appearance with ease. Similarly, you can create one style of document which can be used to standardise the appearance of many different documents. This allows scientific journals to create templates for submissions. These templates have a pre-made layout meaning that only the content needs to be added. In fact there are hundreds of templates available for everything from CVs to slideshows.

3 Getting Started with LaTeX

Link: https://www.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes#What_is_LaTeX.3F

Getting started

- A minimal LaTeX document:

```
\documentclass{article}
\begin{document}
Hello World! % your content goes here...
\end{document}
```

- Commands start with a *backslash* \ .
- Every document starts with a `\documentclass` command.
- The *argument* in curly braces { } tells LaTeX what kind of document we are creating: an `article`.
- A percent sign % starts a *comment* — LaTeX will ignore the rest of the line.

Getting started with **Overleaf**

- Overleaf is a website for writing documents in LaTeX.
- It 'compiles' your LaTeX automatically to show you the results.

Click here to open the example document in **Overleaf**

For best results, please use Google Chrome or a recent FireFox.

- As we go through the following slides, try out the examples by typing them into the example document on Overleaf.
- **No really, you should try them out as we go!**

Typesetting Text

- Type your text between `\begin{document}` and `\end{document}`.
- For the most part, you can just type your text normally.

```
Words are separated by one or more
spaces.

Paragraphs are separated by one
or more blank lines.
```

Words are separated by one or more spaces.

Paragraphs are separated by one or more blank lines.

- Space in the source file is collapsed in the output.

```
The   rain       in Spain
falls mainly on the plain.
```

The rain in Spain falls mainly on the plain.

Typesetting Text: Caveats

- Quotation marks are a bit tricky:
  use a backtick ` on the left and an apostrophe ' on the right.

`Single quotes: `text'.`	Single quotes: ‘text’.
`Double quotes: ``text''.`	Double quotes: “text”.

- Some common characters have special meanings in LaTeX:
  - % percent sign
  - # hash (pound / sharp) sign
  - & ampersand
  - $ dollar sign
- If you just type these, you'll get an error. If you want one to appear in the output, you have to *escape* it by preceding it with a backslash.

`\$\%\&\#!`	$%&#!

Handling Errors

- LaTeX can get confused when it is trying to compile your document. If it does, it stops with an error, which you must fix before it will produce any output.
- For example, if you misspell `\emph` as `\meph`, LaTeX will stop with an “undefined control sequence” error, because “meph” is not one of the commands it knows.

Advice on Errors

1. Don't panic! Errors happen.
2. Fix them as soon as they arise — if what you just typed caused an error, you can start your debugging there.
3. If there are multiple errors, start with the first one — the cause may even be above it.

Typesetting Exercise 1

Typeset this in LaTeX: [1]

In March 2006, Congress raised that ceiling an additional $0.79 trillion to $8.97 trillion, which is approximately 68% of GDP. As of October 4, 2008, the "Emergency Economic Stabilization Act of 2008" raised the current debt ceiling to $11.3 trillion.

Click to open this exercise in **Overleaf**

- Hint: watch out for characters with special meanings!
- Once you've tried, click here to see my solution.

[1] http://en.wikipedia.org/wiki/Economy_of_the_United_States

Typesetting Mathematics: Dollar Signs

- Why are dollar signs $ special? We use them to mark mathematics in text.

```
% not so good:
Let a and b be distinct positive
integers, and let c = a - b + 1.

% much better:
Let $a$ and $b$ be distinct positive
integers, and let $c = a - b + 1$.
```

Let a and b be distinct positive integers, and let c = a - b + 1.

Let a and b be distinct positive integers, and let $c = a - b + 1$.

- Always use dollar signs in pairs — one to begin the mathematics, and one to end it.
- LaTeX handles spacing automatically; it ignores your spaces.

```
Let $y=mx+b$ be \ldots

Let $y = m x + b$ be \ldots
```

Let $y=mx+b$ be \ldots

Let $y = m x + b$ be \ldots

Typesetting Mathematics: Displayed Equations

- If it's big and scary, *display* it on its own line using `\begin{equation}` and `\end{equation}`.

```
The roots of a quadratic equation
are given by
\begin{equation}
x = \frac{-b \pm \sqrt{b^2 - 4ac}}
         {2a}
\end{equation}
where $a$, $b$ and $c$ are \ldots
```

The roots of a quadratic equation are given by

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad (2)$$

where a, b and c are ...

Caution: LaTeX mostly ignores your spaces in mathematics, but it can't handle blank lines in equations — don't put blank lines in your mathematics.

Interlude: Environments

- `equation` is an *environment* — a context.
- A command can produce different output in different contexts.

```
We can write
$ \Omega = \sum_{k=1}^{n} \omega_k $
in text, or we can write
\begin{equation}
  \Omega = \sum_{k=1}^{n} \omega_k
\end{equation}
to display it.
```

We can write $\Omega = \sum_{k=1}^{n} \omega_k$ in text, or we can write

$$\Omega = \sum_{k=1}^{n} \omega_k \quad (3)$$

to display it.

- Note how the Σ is bigger in the `equation` environment, and how the subscripts and superscripts change position, even though we used the same commands.

In fact, we could have written `$...$` as `\begin{math}...\end{math}`.

Interlude: Environments

- The `\begin` and `\end` commands are used to create many different environments.
- The `itemize` and `enumerate` environments generate lists.

```
\begin{itemize} % for bullet points
\item Biscuits
\item Tea
\end{itemize}

\begin{enumerate} % for numbers
\item Biscuits
\item Tea
\end{enumerate}
```

- Biscuits
- Tea

1. Biscuits
2. Tea

Interlude: Packages

- All of the commands and environments we've used so far are built into LaTeX.
- *Packages* are libraries of extra commands and environments. There are thousands of freely available packages.
- We have to load each of the packages we want to use with a `\usepackage` command in the *preamble*.
- Example: `amsmath` from the American Mathematical Society.

```
\documentclass{article}
\usepackage{amsmath} % preamble
\begin{document}
% now we can use commands from amsmath here...
\end{document}
```

Typesetting Mathematics: Examples with amsmath

- Use `equation*` ("equation-star") for unnumbered equations.

```
\begin{equation*}
  \Omega = \sum_{k=1}^{n} \omega_k
\end{equation*}
```

$$\Omega = \sum_{k=1}^{n} \omega_k$$

- LaTeX treats adjacent letters as variables multiplied together, which is not always what you want. `amsmath` defines commands for many common mathematical operators.

```
\begin{equation*} % bad!
 min_{x,y} (1-x)^2 + 100(y-x^2)^2
\end{equation*}
\begin{equation*} % good!
\min_{x,y}{(1-x)^2 + 100(y-x^2)^2}
\end{equation*}
```

$$min_{x,y}(1-x)^2+100(y-x^2)^2$$

$$\min_{x,y} (1-x)^2 + 100(y-x^2)^2$$

- You can use `\operatorname` for others.

```
\begin{equation*}
\beta_i =
\frac{\operatorname{Cov}(R_i, R_m)}
     {\operatorname{Var}(R_m)}
\end{equation*}
```

$$\beta_i = \frac{\operatorname{Cov}(R_i, R_m)}{\operatorname{Var}(R_m)}$$

Typesetting Mathematics: Examples with amsmath

- Align a sequence of equations at the equals sign

$$\begin{aligned}(x+1)^3 &= (x+1)(x+1)(x+1) \\ &= (x+1)(x^2+2x+1) \\ &= x^3+3x^2+3x+1\end{aligned}$$

with the `align*` environment.

```
\begin{align*}
(x+1)^3 &= (x+1)(x+1)(x+1) \\
        &= (x+1)(x^2 + 2x + 1) \\
        &= x^3 + 3x^2 + 3x + 1
\end{align*}
```

- An ampersand `&` separates the left column (before the =) from the right column (after the =).
- A double backslash `\\` starts a new line.

Typesetting Exercise 2

Typeset this in LaTeX:

Let $X_1, X_2, \ldots, X_n$ be a sequence of independent and identically distributed random variables with $\mathrm{E}[X_i] = \mu$ and $\mathrm{Var}[X_i] = \sigma^2 < \infty$, and let

$$S_n = \frac{1}{n} \sum_{i=1}^{n} X_i$$

denote their mean. Then as n approaches infinity, the random variables $\sqrt{n}(S_n - \mu)$ converge in distribution to a normal $N(0, \sigma^2)$.

Click to open this exercise in **Overleaf**

- Hint: the command for ∞ is `\infty`.
- Once you've tried, click here to see my solution.

End of Part 1

- Congrats! You've already learned how to ...
  - Typeset text in LaTeX.
  - Use lots of different commands.
  - Handle errors when they arise.
  - Typeset some beautiful mathematics.
  - Use several different environments.
  - Load packages.
- That's amazing!
- In Part 2, we'll see how to use LaTeX to write structured documents with sections, cross references, figures, tables and bibliographies. See you then!

Algorithm:

```
\documentclass{article}
\usepackage{algpseudocode}
\begin{document}
\begin{algorithmic}
\State $i \gets 10$
\If{$i\geq 5$}
    \State $i \gets i-1$
\Else
    \If{$i\leq 3$}
        \State $i \gets i+2$
    \EndIf
\EndIf
\end{algorithmic}

\end{document}
```

Open this algpseudocode short example in Overleaf

Here's the result output:

$i \leftarrow 10$
if $i \geq 5$ **then**
    $i \leftarrow i - 1$
else
    if $i \leq 3$ **then**
        $i \leftarrow i + 2$
    end if
end if

Note that the command names provided by algpseudocode are typically title-cased, e.g. \State, \While, \EndWhile.

If you would like to add line numbers to the algorithm, you can add the first line number to the algorithmic environment like this: \begin{algorithmic}[1] and get this output:

1: $i \leftarrow 10$
2: **if** $i \geq 5$ **then**
3: $\quad i \leftarrow i - 1$
4: **else**
5: $\quad$ **if** $i \leq 3$ **then**
6: $\quad\quad i \leftarrow i + 2$
7: $\quad$ **end if**
8: **end if**

The above algorithm example is not captioned nor numbered. If you need a captioned algorithm, you will also need to load the algorithm package, and add

```
\begin{algorithm}
\caption{...}
...
\end{algorithm}
```

Using listings to highlight code :

To use the lstlisting environment you have to ad \usepackagelistings

```
\begin{lstlisting}
import numpy as np
def incmatrix(genl1,genl2):
    m = len(genl1)
    n = len(genl2)
    M = None #to become the incidence matrix
    VT = np.zeros((n*m,1), int)  #dummy variable

    #compute the bitwise xor matrix
    M1 = bitxormatrix(genl1)
    M2 = np.triu(bitxormatrix(genl2),1)

    for i in range(m-1):
        for j in range(i+1, m):
            [r,c] = np.where(M2 == M1[i,j])
            for k in range(len(r)):
                VT[(i)*n + r[k]] = 1;
                VT[(i)*n + c[k]] = 1;
                VT[(j)*n + r[k]] = 1;
                VT[(j)*n + c[k]] = 1;

                if M is None:
                    M = np.copy(VT)
                else:
                    M = np.concatenate((M, VT), 1)

                VT = np.zeros((n*m,1), int)

    return M
\end{lstlisting}
```

4 Lab Task (Please implement yourself and show the output to the instructor)

1. Show the output learnt from the link to the Course instructor.

5 Policy

Copying from internet, classmate, seniors, or from any other source is strongly prohibited. 100% marks will be *deducted* if any such copying is detected.