# Latex Introduction Exercise

## 1. Introduction

This document[1] has been put together to introduce you to LaTeX, give you an idea how to layout a document and show you how to use the main functionality you are likely to need. For the coursework you will be given preexisting LaTeXtemplate like this, where all you should need to change is the body text to represent your work.

## 2. How to use LaTeX?

LaTeXis a word processing application now which has been increasing with popularity over recent years. Especially in some academic circles it has begun to be regarded as a de-facto standard word processing application. The following is quick guide for the anatomy of a LaTeXdocument.

- `T0-Exercise.tex` is the file you are inside now which contains all the information you want to appear in your document, including the title, the main body text, etc
- The `.sty` files controls all of the default page layout and functions used by your LaTeXfile. If you get into using LaTeXyou may want to start altering these, but for the purposes of this module you can (and should!) leave them as they are.
- `T0-Exercise.bib` file manages and references you want to use in your document, which you can copy into this file in a `BibTex` format from google scholar or elsewhere. However, for this coursework module I will **not** require you to use any references in the coursework report, but you are encouraged to include them if you feel it is appropriate.
- You can see a folder called 'Images' which contains some `.png` files I want to load into the document. Images you use have to be uploaded into the file system on the left, but they don't need to be inside a folder (I just think it makes things much neater when you start getting lots of images).
- Some basic LaTeXcommands lets you make text **bold**, *italic* and underlined.
- You can insert a line break using `\\` or by leaving a blank line in the source code.
- The configuration is described before `\begin{document}` command, and the body text (anything you want to appear in your document) should be described between `\begin{document}` and `\end{document}` commands.
- You can change the title by editing the operands of `\cwtitle` commands. You can find this before `\begin{document}`.
- You can use `\section`, `\subsection`, `\subsubsection` to create a section, subsection, and subsubsection headings in the body text. Partitioning a text using these commands may improve the readability.
- You can use numerous commands to write mathematical symbols, lists, images, tables, etc. A cheat sheet of many of the key ones can be found in this Quick guide to LaTeX which should help you do most things you would want to do.
- I will show you how to add tables and figures to a LaTeXdocument below. However, LaTeXwill try and put decide for you the best way to insert these images into your final PDF to make the best page layout. While this is usually good, sometimes you will want to override LaTeXat the expense of good page layout. You can find the positioning parameters here

[1]This template and document is based on ICML 2021 LaTeX style file (`https://media.icml.cc/Conferences/ICML2021/Styles/icml2021_style.zip`)

## 3. Comments

You've probably noticed by now, but like in most coding languages, LaTeXallows you to make comments in the source code which have no impact on how the code runs (or in this case, the PDF compiled). You can do this using the `%` symbol at the start of a line in the source code.

## 4. lists

While I have used one above, it is also worth noting that you can make bullet point lists in LaTeXusing `itemize` like so:

- Point 1
- Point 2
- Point 3

and you can get numbered lists using `enumerate`:

1. Numbers are generated automatically.
2. Every new enumerate will start at 1 again.
3. And the list goes on...

## 5. Examples of mathematical symbols

Equations play an essential role when defining a computer science method clearly, and writing mathematical notation easily is another of LaTeX's strengths. It has a bit of a learning curve, but I now find it much easier writing equations in LaTeXthan using the equation function in Word. There are many codes for writing equations in LaTeX, too many to cover here You can check some of them in A quick guide to LaTeX `https://v1.overleaf.com/latex/templates/a-quick-guide-to-latex/fghqpfgnxggz.pdf`. Also, this template includes `amssymb`, `amsmath`, `physics` to provide useful commands. Please see AMS-LaTeX Reference Card (`https://www.math.brown.edu/johsilve/ReferenceCards/LaTeXRefCard.v2.0.pdf`) and The physics package documentation (`http://mirrors.ibiblio.org/CTAN/macros/latex/contrib/physics/physics.pdf`) for further details.

The following is an example of explaining the linear regression model. In the following, we denote by $\mathbb{R}$ and $\mathbb{Z}_{\geq 0}$ the set of real values and nonnegative integers, respectively. For $n \in \mathbb{Z}$, $\mathbb{R}^n$ denotes the set of $n$-dimensional real vectors. For $\boldsymbol{x} \in \mathbb{R}^n$, we denote its transpose by $\boldsymbol{x}^\top$. Let $m, n \in \mathbb{Z}$. Linear regression aims to predict the target value $y \in \mathbb{R}$ from a feature vector $\boldsymbol{x} \in \mathbb{R}^n$. The model has a $n$-dimensional vector $\boldsymbol{\theta}$ as a parameter, and its hypothesis function $h_{\boldsymbol{\theta}} : \mathbb{R}^n \to \mathbb{R}$ is defined by

$$h_{\boldsymbol{\theta}}(\boldsymbol{x}) = \boldsymbol{x}^\top \boldsymbol{\theta}. \tag{1}$$

Suppose that we have training data $(\boldsymbol{x}_0, y_0), (\boldsymbol{x}_1, y_1), \ldots, (\boldsymbol{x}_{m-1}, y_{m-1})$, where $\boldsymbol{x}_i \in \mathbb{R}^n$ and $y_i \in \mathbb{R}$ are the feature vector and target value of the $i$-th data point, respectively. The loss function $l : \mathbb{R}^n \to \mathbb{R}$ of linear regression is the mean squared error, defined as follows:

$$\frac{1}{2} \cdot \frac{1}{m} \sum_{i=0}^{m-1} (y_i - \boldsymbol{x}_i^\top \boldsymbol{\theta})^2. \tag{2}$$

#### 5.0.1. Exercise

Write the quadratic formula by LaTeXcommand. (Hint: quadratic equation: $a_2 x^2 + a_1 x + a_0 = 0$)

## 6. Tables

Having data tables is another very good way of displaying information about your models: either the Hyperparameters used, accuracy metrics or any output data you want to share.

See an example below with some Hyperparameter settings for a SVM model:

*Table 1.* Hyperparameter settings for the support vector machine (SVM) (Cortes and Vapnik 1995).

| Parameter name | Value |
|---|---|
| Regularization strength $C$ | $1.0 \times 10^{\pm 0}$ |
| Kernel | RBF kernel |
| Kernel coefficient $\gamma$ | $1.0 \times 10^{-2}$ |

You can also have sub-tables which are part of one main table object if you have multiple similar tables you wish to group together.

| Day | Max Temp | Min Temp |
|---|---|---|
| Mon | 20 | 13 |
| Tue | 22 | 14 |
| Wed | 23 | 12 |
| Thurs | 25 | 13 |
| Fri | 18 | 7 |
| Sat | 15 | 13 |
| Sun | 20 | 13 |

(a) First Week

| Day | Max Temp | Min Temp |
|---|---|---|
| Mon | 17 | 11 |
| Tue | 16 | 10 |
| Wed | 14 | 8 |
| Thurs | 12 | 5 |
| Fri | 15 | 7 |
| Sat | 16 | 12 |
| Sun | 15 | 9 |

(b) Second Week

*Table 2.* Max and min temps recorded in the first two weeks of July

### 6.1. Exercise

For a Dataset we have obtained an $R^2$ score using three different models. A Linear Regression Model with $R^2 = 0.6273$, an SVR model with $R^2 = 0.8320$ and an RFR model with $R^2 = 0.7519$. Put this information into a table and highlight the best model (largest $R^2$) by making it bold.

## 7. Adding Figures

For your coursework you will want to include some figures in your report to help you explain how you chose your ML models.

### 7.1. Single Figure

You can include images in your document such as figure 1. Note we are referring to figure 1 in the body text by using the `ref` command on the figures label.

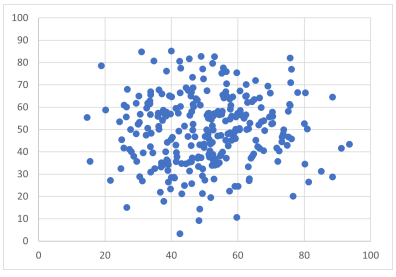


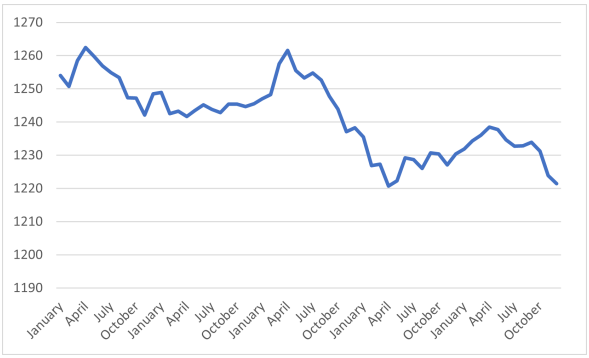

*Figure 1.* Just some scattered data.

#### 7.1.1. Exercise

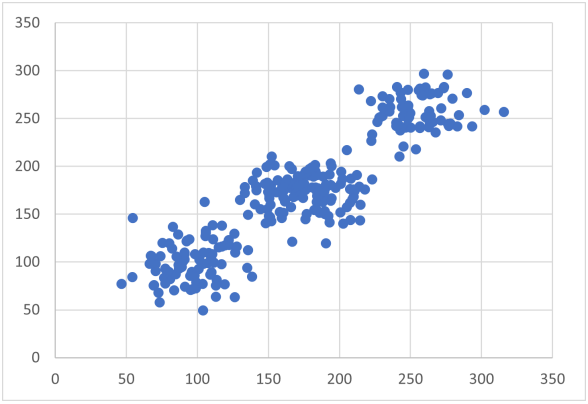
Try adding the "Pie.png" image which is in the "Images" folder as a new figure. Note that all images you load must first be uploaded to the file system to the left of the page.

### 7.2. Multiple Figures

If you are comparing multiple figures, it might be helpful to embed them into a single figure as subfigures as we can see in figure 2.




(a) A time series of some stock.




(b) A scatter plot showing some clustering.

*Figure 2.* Two figures.

#### 7.2.1. Exercise

You can embed many subfigures into a single figure, but make sure you alter the figure width and use the `\hfill` commands to make the figure look neat! For this exercise, find some images on the internet, upload them to your file system and try making a figure with 3 or more subfigures.

## 8. Citation examples

When writing academic reports it is very important to use citations to correctly credit other authors. Note that any quotes, images or ideas that you utilise in your work without a reference is **plagiarism** and will be punished. However, the nature of coursework for this module means that references are not strictly required, and you should be able to gain top marks without any citations, but if you feel that your work would be improved by referencing another source you are free to do so, and should then include the correct citations and a bibliography. Regardless, using citations in LaTeXis one of it's great strengths, so I have left in a small section going over the basics. In our school (especially for the final year project), it is recommended to adopt the Harvard style as a citation style. The followings are examples of citations using the Harvard style given in A simple example showing how to create Harvard style referencing in LaTeX. Wherever students cite some papers to reinforce their description, they shall summarise the discussion in the paper correctly. The following is examples of citations[2].

1. A citation command in parentheses (Smith and Jones 2012): `\parencite` command (Smith and Jones 2012).

2. A citation command for use in the flow of text: `\textcite` command: As Jones and Smith (2013) said ...

These citations is realized by BiBLaTeX commands. A quick cheat sheet for BibLaTeX commands is available in Biblatex Cheat Sheet.

[2]these are examples given in https://www.overleaf.com/latex/examples/a-simple-example-showing-how-to-create-harvard-style-referencing-in-latex/mnwzgkyvdbyy

### 8.1. Exercise (Citation) 1

Try citing "Neocognitron: A hierarchical neural network capable of visual pattern recognition" authored by Kunihiko Fukushima using Google Scholar to obtain the BibTex information.

### 8.2. Exercise (Citation) 2

Try citing "Very deep convolutional networks for large-scale image recognition" authored by Simonyan and Zisserman using Google Scholar to obtain the BibTex information.

## 9. Conclusion

I hope this introduction to LaTeXhas been helpful for you, however this document really is just scratching the surface of what you can do with the software The best way to learn is to start writing documents in LaTeXand seeing what problems you encounter and what solutions are suggested on the internet, as there is now a large community of people who use LaTeXfor their word processing every day, with there being a plethora of writing guides and forums where every problem you can think of has (probably) been answered. If you want to learn more I would recommend going through the page Learn Latex in 30 Minutes on Overleaf to introduce you to even more functionality.

## References

Cortes, Corinna and Vladimir Vapnik (1995). "Support-vector networks". In: *Machine learning* 20.3, pp. 273–297.
Jones, A. B. and J. M. Smith (Mar. 2013). "Article Title". In: *Journal title* 13.52, pp. 123–456.
Smith, J. M. and A. B. Jones (2012). *Book Title*. 7th. Publisher.