A Short LaTeX Worksheet

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1 Introduction

This worksheet has been created using the LaTeX typesetting system. By reproducing this document you should be able to develop your skills with LaTeX. Start by copying the basic example from the talk into a new tex file and then *typesetting* your file to produce a PDF. To make a document with a title and some *sections*, see the second example from the talk. You should *typeset* your file regularly to see whether it is looking correct. Try it now if you haven't already. If everything has worked properly you should now have a PDF file of the worksheet up to this point.

2 Content

Sections allow us to add structure our documents. For a short document such as this, we will use *sections* and *subsections*. A longer document such as a thesis would also use *chapters* (and the *report* document class). The first thing we will discuss is how to typeset mathematics. To start with, ignore the 'verbatim' code and hyperlinks in the following subsection, these will be explained later. A good reference for some of the symbols and commands in the following subsections is the LaTeX 2$_{\varepsilon}$ cheat sheet.

2.1 Typesetting Mathematics

One of the reasons to use LaTeX is that it can produce very good looking mathematical formulae. We have already seen some examples in the talk. LaTeX only recognises mathematical commands while in 'maths mode'. There are a few ways to enter maths mode – which one we use depends on how we want the output to be formatted. If I want the maths to be 'inline', part of the current line, then I place it between dollar symbols. Therefore \$ x = 4 \$ produces $x = 4$. If I want to produce an equation which is placed on its own line then I can use the ***equation*** *environment*.

```
\begin{equation}
    x^3 + 2 \ge 6.
\end{equation}
```

This produces

$$x^3 + 2 \geq 6. \tag{1}$$

See this webpage for more information on mathematics modes. Try to reproduce the rest of this subsection as closely as you can.

A *bijection* is a map between two sets which is both *injective* and *surjective*. Let us now define these terms. Given two sets A and B, a map $\phi : A \to B$ is said to be injective if

$$\phi(a_1) = \phi(a_2) \iff a_1 = a_2, \ \forall \ a_1, a_2 \in A. \tag{2}$$

Furthermore, the map is surjective if

$$\forall \ b \in B, \ \exists \ a \in A \mid \phi(a) = b. \tag{3}$$

The talk also covered the import result of the *Gaussian integral*

$$\int_{-\infty}^{\infty} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2} dx = \sigma\sqrt{2\pi}. \tag{4}$$

In the partitions project, we saw how the geometric progression formula

$$\frac{1}{1-x} = 1 + x + x^2 + \ldots + x^n + \ldots = \sum_{n=0}^{\infty} x^n, \tag{5}$$

could be used to deduce the generating function for the partition number $p(n)$,

$$\sum_{n=0}^{\infty} p(n) x^n = \prod_{n=1}^{\infty} \frac{1}{1-x^n}. \tag{6}$$

2.2 Verbatim

In order to explain some of the commands that you will need to add to your file, we will need to show the names of the commands on the worksheet. In order for LaTeX to display the command rather than process it we use an *environment* called **Verbatim**.

```
\begin{verbatim}
    \LaTeX{} is now printed rather than processed.
\end{verbatim }
```

We can also produce verbatim output in the middle of a line using `\verb|\LaTeX{}|`.

2.3 Packages

One of the advantages of LaTeX (or TeX) is that it can be extended using *packages*. A package is *loaded* by adding the the line

```
\usepackage{package_name}
```

into the *preamble* of your tex file. The preamble is the part of the file before the line `\begin{document}`. Everything between `\begin{document}` and `\end{document}` is called the *body* of the document. We can use a package called lipsum to produce dummy text. This hyperlink was in turn created with a package called hyperref and the command used was

```
\href{https://ctan.org/pkg/lipsum?lang=en}{lipsum}.
```

The following paragraph is produce using the lipsum package, you can read about how to use this package from the package documentation on the previously linked webpage for lipsum – the following is the lipsum paragraph 66.

Nunc sed pede. Praesent vitae lectus. Praesent neque justo, vehicula eget, interdum id, facilisis et, nibh. Phasellus at purus et libero lacinia dictum. Fusce aliquet. Nulla eu ante placerat leo semper dictum. Mauris metus. Curabitur lobortis. Curabitur sollicitudin hendrerit nunc. Donec ultrices lacus id ipsum.

Two packages that we will often want to use are the amsmath and amssymb packages, which are documented at the previously linked page. They add more mathematical commands that you can then use in you documents, such as matrices, unnumbered environments and mathematical fonts. Once I have loaded amsmath and amssymb, I can prodcue the output

$$A = \begin{pmatrix} 4-2i & i \\ -i & a \end{pmatrix} \in M_2(\mathbb{C}).$$

These packages also allow us to align equations using the **align** environment. We can use this to define two block matrices B and C. We can then give the multiplication of these matrices in a new equation environment. If

$$\begin{aligned} B &= \left(\begin{array}{c|c} P & Q \\ \hline R & S \end{array}\right), \\ C &= \left(\begin{array}{c|c} W & X \\ \hline Y & Z \end{array}\right), \end{aligned} \tag{7}$$

then

$$BC = \left(\begin{array}{c|c} PW+QY & PX+QZ \\ \hline RW+SY & RX+SZ \end{array}\right). \tag{8}$$

3 Images

You may want to include images in a LaTeX document. If you already have the image file saved on your computer, you can do this using the command

```
\includegraphics[scale=1]{imagename}
```

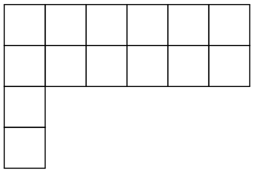
For this to work, the image must be in the same folder as your tex file and we must include the *graphicx* package. This adds an image like so, .

The easiest way to add an image to a LaTeX document is therefore to create an image file (using a drawing tool, or by hand and then taking a picture of your drawing) and then to include the image using the `\includegraphics` command.

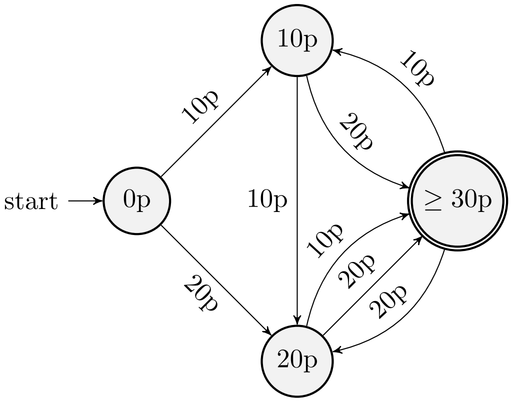
Images often look better when included in a *figure* environment as shown in figure 1. This also allows us to label the image and add a caption. See the documentation at Overleaf for more details.

Figure 1: The Durham University Logo

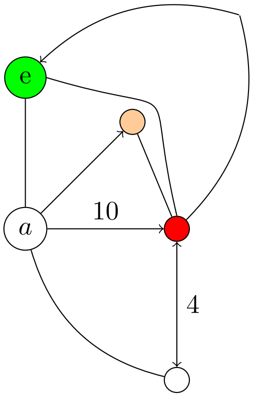
There also exist many packages for creating images. Those on the partitions project may want to know about youngtab or ytableau. The image below was created with the command `\ydiagram{6,6,1,1}` from the ytableau package.



Another more advanced package is called Ti*k*Z. Using Ti*k*Z we can create much more complicated diagrams such as the following diagrams for finite state automata and graphs (or trees, networks etc.). These commands are very complicated, have a look at the source tex file to see how they were produced.



(a) The transition diagram for a vending machine



(b) A simple graph

4 Conclusion

Regardless of how much of this sheet you have been able to reproduce, I hope you have learnt something about LaTeX. In my opinion, it is best to learn LaTeX simply by starting to use it, and answering any questions you have as you go by using the many excellent resources online. The Overleaf website contains a lot of useful help, as does The Not So Short Introduction To LaTeX 2_ε. The tex file used to produce this talk will be available shortly so that you can compare it with your tex file. I have also added some comments to my file to explain some additional things, so I encourage you to read through if you are interested.