MAS115 PRESENTATION LAB 3

This week we'll use a different text editor as an alternative to TeXworks.

> *Remember, text editors are just software used to type in LATEX commands, so all the things learnt so far still apply.*

On the Start Menu, search for *TeXmaker* and start it. If it's not there, install it from the Software Center.

> *If you can't get TeXmaker to work, you will have to use TeX-works instead for this week.*

Once TeXmaker has started, create a LATEX document (using File, New on the menu bar). Include the usual preamble (using documentclass, begin and end document commands etc). Save it as 'week3.tex'.

> *I often borrow the preamble from a previous .tex file. For example, you could my Week 2 lab attempt from the course website.*

Put any text in the body of the file and process it by pressing the blue arrow next to 'Quick build'. A PDF should be created. Add the title 'MAS115: Week 3 Experiments'. Include the AMS packages with the command `\usepackage{amsmath,amsthm,amssymb}` in the preamble.

> *If you have problems running TeXmaker on the University computers, see the advice on the course webpage.*

Some people prefer TeXmaker to TeXworks (but some don't!). Here are some features of TeXmaker.

TYPESETTING PRACTICE

(1) Start a section called 'Typesetting practice'. Begin an enumerate environment and typeset the following as the first `\item`.

> The formula for the addition of velocities in relativistic mechanics is
> $$f(u,v) = \frac{u+v}{1 + \frac{uv}{c^2}}.$$

Once you've typed it in, see what happens as you move past the brackets in the code.

(2) By clicking on the small $\boxed{\lambda}$ and $\boxed{\Rightarrow}$ buttons on the left-hand side of the screen, typset the following as the second `\item` on your list.

> TeXmaker makes it easy to find Greek letters, and typeset things like
> $$\Xi^{\Psi\Omega} = \frac{\theta}{\gamma} \Longleftrightarrow \chi = v(\rho).$$

(3) Explore the buttons on the left further to see if you can add another item with

> Pointing and clicking in TeXmaker also helps with things like
> $$\underbrace{\circlearrowleft \ldots \circlearrowleft}_{n \text{ times}}.$$

(Hint: '...' is best achieved with the `\ldots` command, and the `\text{}` command allows text in math-mode.)

Theorems

Start a new section called 'The square-root of 2'. Here we're going to experiment further with environments.

(4) Start with the text

> Here, we're going to investigate a solution of the equation
> $$x^2 = 2.$$

(5) Try using `\begin{equation}` and `\end{equation}` rather than double-dollars around the equation $x^2 = 2$. You should find that the *equation* environment numbers the displayed equation. If your want to put the equation numbers on the right (respectively on the left) add `reqno` (respectively `leqno`) to your document class command options, as in

    \documentclass[11pt,reqno]{...}.

(6) We want to refer to the equation we've just created later. To make this easy to do, put `\label{eq:root 2}` after `\begin{equation}`.

(7) Now type

    The positive solution to equation \ref{eq:root 2} is
    denoted $\sqrt{2}$.

and process the file. Does it work? If you see '??' on your PDF, run it again. (LaTeX has to run twice to get autoreferencing to work.)

Now let's make our first theorem. Add the following to the preamble.

`\newtheorem{thm}{Theorem}[section]`

This will create a new environment called 'thm' which we'll use shortly. In the body, write

```
\begin{thm}
The real number $\sqrt{2}$ is irrational.
\end{thm}
```

Process the file, and look at the output. Underneath the theorem, write

```
\begin{proof}
This is a famous proof by contradiction.
\end{proof}
```

The proof that $\sqrt{2}$ is irrational relies on the fact that any rational number can be written in the form $\frac{a}{b}$ with a and b coprime integers. Let's include this as a lemma[1].

To do this, first add the following in the preamble just after the `\newtheorem{thm}` command.

```
\theoremstyle{plain}
\newtheorem{lem}[thm]{Lemma}
```

This creates a new environment called 'lem'. Using this, put a lemma before the statement of the theorem that looks like the following.

> **Lemma 0.1.** *Any rational number can be written in the form $\frac{a}{b}$ with a and b coprime integers.*
>
> *Proof.* Cancel if necessary.   □

When you process the file, notice how the numbering for the theorem automatically changes.

Add the commands

```
\theoremstyle{definition}
\newtheorem{defn}[thm]{Definition}
```

in the preamble, after the `\newtheorem{lem}` command. Now change the line where you defined $\sqrt{2}$ into a definition using `\begin{defn}` and `\end{defn}` to make

> **Definition 0.2.** The positive solution to equation (1) is denoted $\sqrt{2}$.

Again, the numbering will automatically change.

Experiment with labelling and referencing your definition, lemma and theorem which is done in the same way as for equations.

You can read more about how the `\newtheorem` command works on the webpage `http://en.wikibooks.org/wiki/LaTeX/Theorems`.

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[1] A *lemma* is a short, usually uninteresting result in its own right which is used as an intermediate step towards a proposition or theorem. In order of importance, theorems come above propositions, which come above lemmas.

Homework

Create a document with title 'MAS115: Homework 3' and your name on as author. Using the structure you started in this sheet, give a good account of the square root of 2 by modifying what you wrote to provide proper proofs of the lemma and theorem.

More specifically, you need to include a more detailed account of why any rational number can be written as $\frac{a}{b}$ in such a way that a and b are coprime, and you also need a full proof that $\sqrt{2}$ is irrational.

- Write these proofs in your own words! You may be able to find versions of the proofs on the web, so the idea is to first understand them, and then write your own accounts.
- Remember that rational numbers are defined to be those of the form $\frac{a}{b}$ for integers a and b with $b \neq 0$, so the key is proving that they can be chosen to be coprime.
- Your document should read well from start to finish, so take some care in how it's presented, including a section title and introductory paragraph.
- You can start by looking at my lab attempt from this sheet, found on the course webpage, for how this week's work was supposed to look by the end.

Hand the homework in at next week's Friday lab, as usual.