MAS115 PRESENTATION LAB 4

IMPORTANT! If you are asked to install packages when processing your file, click 'yes' then wait. You may need to do this for multiple packages. It may look as though nothing is happening, but your PDF will appear eventually. Interrupting the process can cause problems.

Open TeXworks or TeXmaker (whichever you prefer). Find the preamble template on the course webpage in the 'Extras' section, and use this to start a new document.

> *Some people had problems with TeXmaker last week, but the advice on the course webpage should get it working.*

1. PGFplots

Let's create some graphs using `pgfplots`. Make sure `\usepackage{pgfplots}` is in your preamble. Start a new section called 'Graphs created with PGFplots' then type the following (or copy and paste from the sheet on the webpage).

```
\begin{tikzpicture}
\begin{axis}[
    title={$y=\sin x$},
    xlabel=$x$,
    ylabel=$y$
]
\addplot[smooth,domain=-360:360]{sin(x)};
\end{axis}
\end{tikzpicture}
```

(1) See what happens to the axes when you add

```
axis lines=center,
```

below the `title={$y=\sin x$},` line.

(2) Graphs won't be centered on the page by default. To change this, put the whole thing in a *center* environment.

(3) Try changing `sin(x)` to `sin(deg(x))` and the domain to `-2*pi:2*pi`. What's happened now?

PGFplots's trigonometric functions are in degrees. The `deg(x)` function takes a number (in radians) and turns it into the value in degrees; that is, $\deg(x) = \frac{180x}{\pi}$. If you think about it, this is precisely what's needed to change the plot to radians.

Try a 3D plot, using the following code.

```
\begin{tikzpicture}
```

```
\begin{axis}[xlabel=$x$,ylabel=$y$]
\addplot3[domain=-1.5:1.5,surf]{-exp(-x^2-y^2)};
\end{axis}
\end{tikzpicture}
```

(4) What was the main difference in the code here compared to before?
(5) What does the `surf` option do?
(6) What does putting `colormap/blackwhite` after `ylabel=$y$` do?

Occasionally, PGFplots doesn't behave the way you would expect it to, especially when discontinuities appear.

(7) By copying your code from the graph of $y = \sin x$, make a graph of $y = \tan x$ instead. It probably looks horrible.
If you get error messages about the dimension being too large, in TeXworks enter 'q' for 'quiet' into the box at the bottom of the screen to make PDFLaTeX finish, and in TeXmaker press the blue arrow next to 'View PDF'.
(8) Restrict the range of y-values by adding `ymin=-3, ymax=3,` under you `title=...` command.
(9) Improve the number of points being used to plot the graph by adding `samples=500` to your `addplot` command.
(10) Another improvement is to split the graph up into multiple pieces, as in

```
\addplot[smooth,domain=-4.7:-1.6,samples=200]{tan(deg(x))};
\addplot[smooth,domain=-1.5:1.5,samples=200]{tan(deg(x))};
\addplot[smooth,domain=1.6:4.7,samples=200]{tan(deg(x))};
```

There are many more examples of graphs — with source code — on the PGFplots website, `http://pgfplots.sourceforge.net/gallery.html`.

2. Including image files

Now let's try including an image from an external package. Check to see if *Geogebra* is listed in All Programs. If not, install it from the Software Center. Once installed, start Geogebra.

Geogebra is a point-and-click geometry package which can do more than just create pictures for including in documents.

(11) Try typing $x^2 + y^2 = 9$ into the bar at the bottom.
(12) Find the button to add a new point, and put it at $(-5, 0)$.
(13) Find the 'Tangents' button to get the equations of the tangent lines to $x^2 + y^2 = 9$ which pass through $(-5, 0)$.
(14) Use the arrow button to drag your point around and see the tangents move.

Play around further if you like. Once you have a picture you are happy with, go to File, Export, Graphics View as Picture. Select PDF as the file type and save the image as `geogebra_image.pdf` in the same folder as your current LaTeX document.

Return to your LaTeX document. Put `\usepackage{graphicx}` in your preamble. Start a new section called 'Including image files' and put the command `\includegraphics{geogebra_image.pdf}` underneath. Your picture should appear. Zoom in to convince yourself the picture stays smooth.

(15) Alter your LaTeX so that it reads `\includegraphics[scale=0.5]{...}` (where the `...` is your image file name). What's changed?
(16) Try `\includegraphics[width=8cm]{...}`.
(17) Try `\includegraphics[width=1\textwidth]{...}`.
(18) Try `\includegraphics[width=0.8\textwidth]{...}`.
(19) Put the image inside a *center* environment.

In fact, the proper way to include images is using the *figure* environment. Try this instead of using *center*, so that your LaTeX reads

```
\begin{figure}[h]
\includegraphics[width=0.8\textwidth]{...}
\caption{My first Geogebra picture}
\end{figure}
```

Change the figure caption to 'A work of art using Geogebra'. Change the `[h]` to `[t]` or `[b]`. Do you notice any change? In fact, `h` stands for 'here', `t` stands for 'top' and `b` stands for 'bottom'. When the figure is included amongst lots of text, this tells LaTeX where to place the figure on the page.

Add `\label{fig:geogebra}` after the `\caption{...}` command, then write the following sentence underneath the figure environment

```
Geogebra creates good diagrams; see Figure \ref{fig:geogebra}.
```

Process your file twice to see the figure being referenced. Finally, if you find large amounts of white space above and below Geogebra PDF images, look at the comments on the course webpage in the Extras section.

3. Citations and references

Here we look at how to cite books or internet pages. Citations are important for attributing results to the people who did them and allowing the reader to check material themselves. Citations should appear naturally in the text. Here are some examples.

- **Theorem 4** (See [1].) *Let x be a number...*
- Wikipedia [2] provides some interesting biographical details about Newton.
- The following equation was first written down by Maxwell [3].

The citations refer to entries in the bibliography at the end of this lab-sheet (have a look!). Let's create a bibliography to cite from.

(20) Create a section at the bottom of your document called 'Recommended fiction'. In it, type the sentence 'A friend recommended I read some Raymond Carver, starting with ...'. (We'll replace the ... in a minute.)

(21) Enter the following at the end of your LaTeX document.

```
\begin{thebibliography}{99}

\bibitem{Carver:Cathedral}
R.~Carver,
\emph{Cathedral},
Vintage Classics,
2009.

\end{thebibliography}
```

(22) Go back to your section on recommended fiction, and replace the ... with `\cite{Carver:Cathedral}`. Process your document twice.

(23) Think of a favourite book and find its details using Google. Add this to the bibliography, then add a sentence to your section on recommended fiction, referencing this new book.

(24) Change the order of the two `\bibitem`s. Process the document twice.

Notice that the reference to the website in the bibliography in this document contains both the date it was visited and the date it was updated. This is to allow the reader to check out the exact pages that you are referring to.

Homework

Create a document with title 'MAS115: Homework 4' and your name on as author. Your task this week is to look up *Lagrange Interpolation* and to write a page or so of LaTeX explaining why the function

$$f(x) = \frac{(x-x_1)(x-x_2)}{(x_0-x_1)(x_0-x_2)}y_0 + \frac{(x-x_0)(x-x_2)}{(x_1-x_0)(x_1-x_2)}y_1 + \frac{(x-x_0)(x-x_1)}{(x_2-x_0)(x_2-x_1)}y_2$$

is a quadratic polynomial which passes through (x_0, y_0), (x_1, y_1) and (x_2, y_2). You could look on the internet, or in the library or Information Commons (e.g. [4] covers the theory, as will most books near it in the library).

Things to think about:

- What is a quadratic polynomial? Why is $f(x)$ one?
- What is $f(x_0)$? And $f(x_1)$? And $f(x_2)$?
- As an example, use the points $(0, 0)$, $(\frac{\pi}{4}, \frac{1}{\sqrt{2}})$ and $(\frac{3\pi}{4}, \frac{1}{\sqrt{2}})$, and include the graph of $y = f(x)$ alongside $y = \sin x$.
- Reference the sources you use, including webpages.

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

References

[1] A. Wiles, *Modular elliptic curves and Fermat's Last Theorem*, Annals of Mathematics **141** (1995) 443–551.

[2] Wikipedia contributors, *Isaac Newton*, Wikipedia. Visited 18 October 2011, updated 16 October 2011, `http://en.wikipedia.org/wiki/Isaac_Newton`.

[3] J. C. Maxwell, *A Treatise on Electricity and Magnetism Volume 1*, Dover Publications Inc., 3rd edition, 2003.

[4] E. Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 2011.