Lab 1 Thursday September 1

Important reminders

- Case matters! `Sin[x]` is the function sin; `sin[x]` is creating a new variable.
- Built-in mathematica commands are capitalised, often in CamelCase. Examples include `PlotRange` (which is not `Plotrange` or `plotrange`).
- Types of parentheses matter! `()` is used for grouping. `[]` is used for function inputs. `{}` is used for lists.
- Pay attention to colors. Black means Mathematica knows what you're talking about. Blue means a so-far-undefined variable. Light green means a bound variable. Purple means parentheses you need to match. Red means something is wrong.
- The syntax for defining functions is very picky. Don't forget the underscore or colon.
- Watch your punctuation! The most common errors are minor punctuation and spelling errors.

Mathematica Basics

1. Use Mathematica to do some basic arithmetic operations. Run the commands `3+4`, `3 - 5`, `7*12`, `6/3`, and `2^8`. Try a few more, of your own choice. What happens if you divide by zero?
2. Enter the command `171/7`. Notice the answer isn't terribly helpful. Why do you think this is? Now enter `N[171/7]`. What happens? (`N` stands for "Numeric").
3. Now try arithmetic with some variables. Enter `x+3`, `3*y`, `x/y`, and `elephant - 7`.
4. Now set `y=x^2-1` and run all your previous code again. What changes?
5. Set `x = 3` and run your code again. Then run `Clear[x]` and run your code again.
6. Enter `seven = 8` and then enter `seven + 3`. Then enter `Clear[seven]` and never, ever do that again.
7. Run `Sin[Pi]`. Note the capitalization! Try a couple other trig commands.
8. Define a function by entering `f[x_]:=x^2-1`. Calculate `f[3]` and `f[7]`.

Graphs and Functions

1. Plot a parabola by entering the command `Plot[x^2,{x,-3,3}]` Try changing the domain (given by `{x,-3,3}`) and see what happens.
2. Now plot the function `f[x]` in the same way. Pick a couple other functions and plot them; they can be as complicated as you like.
3. Now let's plot two functions on the same graph. Enter the command `Plot[{f[x],x+1},{x,-2,2}]` (Note the `{}` here; they are important!) Again, play with the domain.
4. Try plotting three functions at once. Choose your own! Play with the domain again.
5. Now explore the online help features. Click "Theme" under your graph and see what it looks like with different themes. Click "Done" to see the code you would need to type in to get this result. What happens if you change it? (Note that the little arrow can be typed with `->`).
6. Now click on "More" and then choose "plot style." Play around with the options. Again, click "Done" to see the resulting code. Change it around and see what happens.
7. Now go to the Help menu, load the online documentation, and search for "Plot." Go to "Examples" and under it "Options" and then "PlotStyle", and figure out how to choose three different colors for the three functions you have plotted.
8. Plot the function `x` on the domain $[-5, 5]$. Then on a separate graph plot `5x` on $[-5, 5]$. Notice that these graphs look nearly identical, despite having very different functions, which makes them hard to compare. Look up the `PlotRange` option and make a better pair of graphs.
9. Plot the functions `x` and `x^10` on one graph, on the interval $[0, 10]$. What happens? Do it again with domain $[0, 1]$.
10. Finally we'll learn about Tables. Enter `Y= Table[{x,f[x]},{x,-2,2,.5}]`. What do you get? What does the .5 signify? Try using some other functions.
11. Enter the commands `TableForm[Y]` and `ListPlot[Y]`. What do they do?

Absolute Value and the Triangle Inequality

1. Mathematica uses `Abs[x]` for $|x|$. Plot a graph of $|x|$ on $[-3, 3]$.
2. Plot $|x^2 - x - 4|$ and $|x^3 - x - 4|$. What looks weird? Why does that happen?
3. Plot the functions $|x + 1|$ and $|x| + 1$ on the same graph. Can you see a relationship to the triangle inequality? What if you use $|x| - 1$ instead? $1 - |x|$?
4. Plot $|x^3 - 5x|$ and $|x^3| - |5x|$ on the same graph. Now try $|x^3| + |5x|$ instead.
5. Plot $|x^2 + 2x|$ and $|x^2| + 2x$ on the same graph. What "mistake" did I make in my attempt to use the triangle inequality? What should the second function have been? Now try $|x^2| - 2x$, and fix that. What about $|2x| - x^2$?
6. Plot the function $|x^4 - 5x^2 - 6|$. Find upper and lower bounds using the triangle inequality and reverse triangle inequality.