

# MATH 111, EXPLORATION 1

Due Friday, September 1

This semester, you will use Wolfram Mathematica as a computational aide. Your first exploration is an introduction to this program. To get started, download and install Mathematica from the Reed CIS website:

<http://www.reed.edu/cis/help/software/mathematica.html>

Alternatively, you can use Mathematica on the computers in the IRCs. Please see Wolfram's documentation website to learn more about Mathematica:

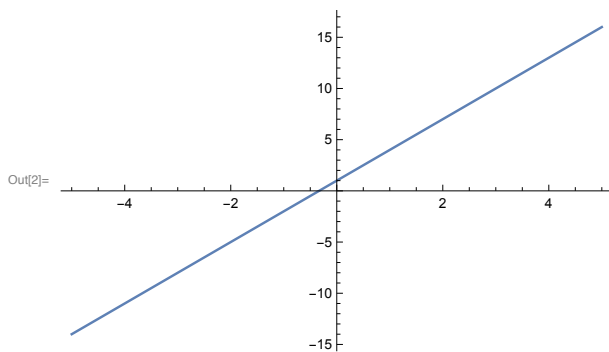
<http://reference.wolfram.com>

There are also various resources online. I will encourage you to learn basic Mathematica techniques on your own, but I am always happy to help!

Mathematica is like a graphing calculator with incredible computational powers. You can graph functions using Mathematica. For example, here are the commands to define the function  $f(x) = 3x + 1$  and graph it on the interval  $-5 \leq x \leq 5$ :

```
In[1]:= f[x_] := 3 x + 1
```

```
In[2]:= Plot[f[x], {x, -5, 5}]
```

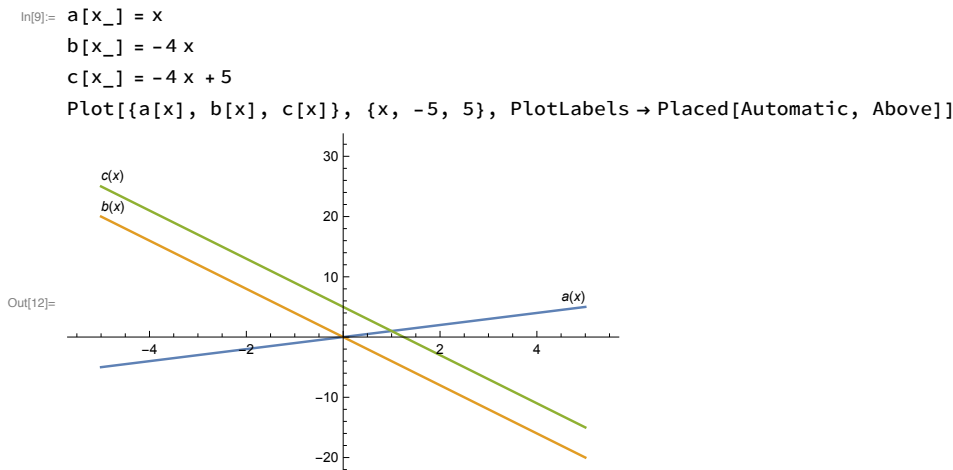


To tell Mathematica to run your code and produce output, press **shift-enter** while the cursor is on the code that you wish to run. In this example, I didn't need to define  $f(x)$  first—I could have simply typed

```
In[1]:= Plot[3 x + 1, {x, -5, 5}]
```

to generate the graph. But it is good practice to define your functions since you can refer to them later without retyping formulae.

You can graph multiple functions on the same set of axes, and label each graph:



You can also find intersection point(s). Here I find the intersection point  $(1, 1)$  of  $a(x) = x$  and  $c(x) = -4x + 5$ :

```
In[16]:= NSolve[{y == a[x], y == c[x]}, {x, y}]
Out[16]= {{x -> 1., y -> 1.}}
```

Use Mathematica to perform the following tasks. You should turn in a printed copy of your Mathematica notebook, annotated with any necessary explanations of your work.

- Graph the function  $f(x) = 60x - 146$ .
- Graph the functions  $p(x) = x^2$ ,  $q(x) = -2x^2$ ,  $r(x) = -2x^2 + 4$ , and  $s(x) = -2x^2 + 3x + 4$  on the same pair of axes, including labels for each graph.
- Find the points in the plane where  $f(x) = 60x - 146$  and  $r(x) = -2x^2 + 4$  intersect. Graph these functions together and visually confirm your answer.
- Consider a general quadratic function  $q(x) = ax^2 + bx + c$  with  $a \neq 0$ . Experiment with different values of the constants  $a$ ,  $b$ , and  $c$  to explain the geometric aspects of the graph that are controlled by:
  - the sign of  $a$ , i.e. whether  $a > 0$  or  $a < 0$ ,
  - the size of  $a$ , i.e. its absolute value  $|a|$ ,
  - the sign of  $b$ ,
  - a large increase in the constant  $c$
- Which of the following functions are tangent to each other? At which points?

$$f(x) = 3x^2 + 6x + 4, \quad g(x) = -x^2 + 2x + 3, \quad \text{and} \quad h(x) = \frac{x + 1}{x - 1}.$$