

In this lab, you will learn the basics of using *Mathematica* to evaluate expressions, plot functions and work with matrices.

Getting Started

When you first open *Mathematica*, you will see a blank screen. You can type in any *Mathematical* expression (try $2 + 2$). To get *Mathematica* to evaluate the expression, either press SHIFT+ENTER, or press the ENTER key on the number pad at the right edge of your keyboard.

Mathematica will try to give the exact answer at all times. For example, to find the square root of 2, type in `Sqrt[2]` (make sure you use a capital S and square brackets) and tell *Mathematica* to evaluate it. Notice that the answer it gives is simply $\sqrt{2}$. If you want a decimal approximation of $\sqrt{2}$, we can use the `N` command in one of the following ways:

- `N[Sqrt[2]]` This tells *Mathematica* to decide how many decimal places to use.
- `N[Sqrt[2],20]` This tells *Mathematica* to use 20 decimal places.

In general, if you want to use a built-in *Mathematica* function (like `Sqrt`, `N`, `Cos`, etc.), make sure you start with a capital letter, and use square brackets.

Using Variables

Sometimes you will want to save values or function definitions for future use. To do this, we can define variables in *Mathematica*. For example, suppose we have a complicated expression that we want to use in several computations:

- `a = (Sqrt[37] - 3)/2` This assigns the value $\frac{\sqrt{37}-3}{2}$ to the variable a . Now every time we refer to a , it will be the value we assigned to it.
- `a^2 + 3a - 7` This plugs the complicated value into the expression $x^2 + 3x - 7$.

We can also define functions within *Mathematica* in order to make our commands closely mirror the way we ask mathematical questions. For example, suppose we have a function $f(x) = x^2 + 3x - 7$, and we want to evaluate $f(f(2))$. Function definitions are a little different from normal variables, so we have to use a special notation for them.

- `f[x_] := x^2 + 3x - 7` This defines the function $f(x)$. Notice the underscore (“_”) and the colon (“:”). Both of these are necessary for the function to work properly.
- `f[f[2]]` Now *Mathematica* simply evaluates $f(f(2))$ using our defined function.

Plotting Functions

We can use *Mathematica's* `Plot` command to plot functions. The basic format of a `Plot` command looks like this:

```
Plot[ function, {x, xmin, xmax} ]
```

The `function` should be the function that you want to plot, which could be a built-in function, a function you have defined yourself, or simply a formula that you type in directly. The `x` should be the name of the variable you want to use. Finally, `xmin` and `xmax` define the interval that you want to plot your function over.

- `Plot[x^2, {x, -5, 5}]` This command plots $y = x^2$ over the interval $-5 \leq x \leq 5$.
- `Plot[Cos[x], {x, 0, 2 Pi}]` This command plots $y = \cos x$ over the interval $0 \leq x \leq 2\pi$.

Mathematica can also plot multiple functions on the same graph:

- `Plot[{Cos[x], 1 - x^2/2}, {x, -3, 3}]` This plots the curves $y = \cos x$ and $y = 1 - x^2/2$ on the same axes.
- `Show[Plot[Cos[x], {x, -3, 3}], Plot[1 - x^2/2, {x, -3, 3}]]` Does the same thing but allows the possibility of combining different graphics commands.

Matrices and the Basic Math Assistant Palette

There are multiple ways to input a matrix in *Mathematica*:

- To input $m = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$, type in `m = {{1,2},{3,4}}`.
- Alternatively, choose Basic Math Assistant from the Palettes menu. Click the advanced tab, then click the button that looks like a two-by-two matrix. You can add rows or columns using the Row+ and Col+ buttons, or delete them by selecting what you want to delete and pressing the Delete key on your keyboard.

Note that *Mathematica* by default will display matrices in simple row-by-row notation. The `MatrixForm` command forces *Mathematica* to display matrices in a more visual way. For example, try the following version of the same command:

```
m = MatrixForm[{{1,2},{3,4}}]
```

We can easily use *Mathematica* to solve systems of equations using matrices. For example, consider this system:

$$\begin{array}{rclcl} x_1 & - & 2x_2 & + & x_3 & = & 7 \\ x_1 & & & - & 2x_3 & = & -1 \\ 2x_1 & + & x_2 & + & 2x_3 & = & 8 \end{array} \quad (1)$$

Recall from class that we can represent this system by the augmented matrix:

$$\left[\begin{array}{cccc} 1 & -2 & 1 & 7 \\ 1 & 0 & 2 & -1 \\ 2 & 1 & 2 & 8 \end{array} \right]$$

Now we can type this matrix into *Mathematica* (and we might as well give it a name to make it easier to refer to): `m = {{1,-2,1,7},{1,0,2,-1},{2,1,2,8}}`. Now to row-reduce this matrix, we simply enter the command: `RowReduce[m]`

Help Files

To ask *Mathematica* for help, you can either search the Document Center (which opens from the Help menu) or you can highlight the command on which you want help and hit the F1 key on your keyboard. The help files are hyperlinked so that you can jump to related topics if your first query is not the right question to have asked.

Names: _____

Exercises

Turn in this sheet at the end of class today.

- Given $f(x) = \frac{x}{x-1}$, what is the value of $f(f(f(f(3))))$? ANSWER: _____
- How many times do the curves $y = \frac{x}{3}$ and $y = \sin(\pi x)$ intersect? ANSWER: _____
- Use trial and error to estimate a value of k for which the curves $y = \frac{x}{k}$ and $y = \sin x$ intersect exactly 3 times? ANSWER: _____
- If we want to show the graph of $y = \sin x$ with the region between the curve and the x -axis shaded, what should go in the blank below?

Plot[Sin[x], {x, -10, 10}, _____]

- Find the solution to the system given in (1) using row reduction. ANSWER: $x_1 =$ _____, $x_2 =$ _____, $x_3 =$ _____

Names: _____

Exercises

Turn in this sheet at the end of class today.

- Given $f(x) = \frac{x}{x-1}$, what is the value of $f(f(f(f(3))))$? ANSWER: _____
- How many times do the curves $y = \frac{x}{3}$ and $y = \sin(\pi x)$ intersect? ANSWER: _____
- Use trial and error to estimate a value of k for which the curves $y = \frac{x}{k}$ and $y = \sin x$ intersect exactly 3 times? ANSWER: _____
- If we want to show the graph of $y = \sin x$ with the region between the curve and the x -axis shaded, what should go in the blank below?

Plot[Sin[x], {x, -10, 10}, _____]

- Find the solution to the system given in (1) using row reduction. ANSWER: $x_1 =$ _____, $x_2 =$ _____, $x_3 =$ _____