

# MATHEMATICA LAB SKILLS ACTIVITY 2: ANALYZING DATA IN MATHEMATICA

## LEARNING GOALS

You will be...

1. ...able to define and use functions in Mathematica.
2. ...able to scale and shift lists (arrays) of data.
3. ...able to generate combine plots of data and functions.
4. ...able to create pretty looking plots.

## REALLY HELPFUL TOOL / HINT

1. At this point if you haven't found it, Ben Zwickl (he's a hero to us around here) has a great tool for you.
2. Find it.
3. Hint: [http://www.colorado.edu/physics/phys3330/phys3330\\_sp14/how\\_to\\_do\\_it.html](http://www.colorado.edu/physics/phys3330/phys3330_sp14/how_to_do_it.html)
4. While you're at it, you might benefit from the other mathematica summaries there.

## A FEW MORE MATHEMATICA BASICS

Defining functions that perform a sequence of mathematical or logical steps is a key part of every programming language. Watch the [screencast on defining and using functions in Mathematica](http://www.youtube.com/watch?v=1A4f91yMVhA) (www.youtube.com/watch?v=1A4f91yMVhA).

<b>Question 1</b>	<ol style="list-style-type: none"><li>a. Define a function in Mathematica that represents <math>f(x) = \sin(x)/x</math></li><li>b. Explain the difference between how Mathematica interprets the following two expressions:<ul style="list-style-type: none"><li>• <math>y = x^2</math></li><li>• <math>y[x] := x^2</math></li></ul></li></ol>
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A “List” in Mathematica is the equivalent of an “array” in most other programming languages (like C, Python, MATLAB). This exercise requires you to create a list and perform the basic list manipulations like shifting and scaling all list values by a constant. You may need to consult the Mathematica help documentation.

<b>Question 2</b>	<ol style="list-style-type: none"><li>Create a list named <code>sinTable</code> using the <code>Table</code> function to evaluate the expression <code>Sin[x]</code> at 100 points between 0 and <math>4\pi</math>.</li><li>Increase all values of the list <code>sinTable</code> by a constant (e.g., 1).</li><li>Multiply all the values of the list <code>sinTable</code> by a constant value (e.g., 10).</li></ol>
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## CREATING PLOTS OF DATA AND FUNCTION TOGETHER

In Mathematica `Plot` is used for plotting functions and `ListPlot` is used for plotting data. If we want to combine a plot of a theoretical prediction or a best fit curve with our data we need to combine these two different kinds of plots. The key method is Mathematica's `Show` function.

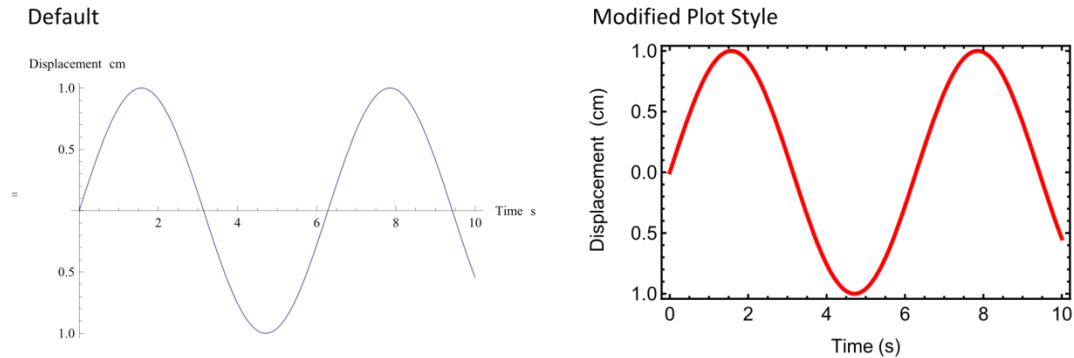
Watch the screencast on [combining plots of data and functions](http://www.youtube.com/watch?v=NDA90htObC4). ([www.youtube.com/watch?v=NDA90htObC4](http://www.youtube.com/watch?v=NDA90htObC4)).

<b>Question 3</b>	<ol style="list-style-type: none"><li>Write down a mathematical expression for the predicted output signal of your waveform generator from one of the conditions you used in Lab 1 that was <b>not</b> a sine wave. [This does not have to be a formal math expression.. you can use the built-in Mathematica functions Mathematica has built in functions for <code>Sin</code>, <code>SquareWave</code>, <code>SawtoothWave</code>, and <code>TriangleWave</code>. Consult Mathematica's help for using these appropriately.]</li><li>Make a plot of your prediction.</li><li>Scale your <code>sinTable</code> function to the same frequency, amplitude, and offset as the expression in part (a)</li><li>Combine the <code>sinTable</code> and the non-sine plot from parts (a) and (b). Do they match up as they should?</li></ol>
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## MAKING CLASSY PLOTS IN MATHEMATICA

The default plot style in Mathematica does not look very good for presentation quality graphics. This screencast give some options for changing the plot style. Figure 1 shows an example of the plot style changes you will be able to implement after watching the screencast. The screencast also demonstrates the use of the `SetOptions` function which allows you to set the default plot options.

Watch the screencast on [changing the plot style](http://www.youtube.com/watch?v=KolZZm8lf9Q). ([www.youtube.com/watch?v=KolZZm8lf9Q](http://www.youtube.com/watch?v=KolZZm8lf9Q))



**Figure 1:** Plot of  $\sin(t)$  for  $t$  between 0 and 10. Modifying the plot options can improve the viewing of the plot within Mathematica and for printing. Notice that the default axes and sine curve are very thin when printed.

Default	<pre>Plot[Sin[x], {x, 0, 10},   AxesLabel -&gt; {"Time (s)", "Displacement (cm)"}]</pre>
Modified	<pre>Plot[Sin[x], {x, 0, 10},   Frame -&gt; True,   Axes -&gt; False,   LabelStyle -&gt; {FontFamily -&gt; "Arial", FontSize -&gt; 13},   FrameLabel -&gt; {"Time (s)", "Displacement (cm)"},   FrameStyle -&gt; Thickness[0.005],   PlotStyle -&gt; {Red, Thickness[0.01]}]</pre>

<b>Question 4</b>	Modify any one of the plots produced earlier in this activity and make it "classier"
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