First Day Survey

1. What name would you prefer to be called? (Please include any tips about pronunciation.)

2. Name (as it appears on my.harvard)

3. If your pronouns differ from the ones you've given on my.harvard, what are your pronouns?

4. Class year

5. Why are you taking multivariable calculus this semester?

6. What was the last math class that you took? How long ago?

7. What other courses do you think you're taking this semester?

Background Activity Answer Sheet

Make note of your answers here. Submit this sheet along with the survey on the front. Keep your actual work as part of your notes.

1. $a =$

2. Simplified expression:

   Plot:

3. $a =$

4. Plot:

Topic: Functions of two variables (two inputs, one output).

Background Activity:
- Solve for both roots of a quadratic equation.
- Use the distance formula in 2-space.
- Manipulate an equation to make plotting easier.
- Plot a parameterized curve in 2-space.
- Translate from a description to an integration problem.

For your reference:
A *function* is a rule that returns output given input.

The input variable(s) to the function are called *independent variables*. The *domain* of the function is the set of allowable inputs.

The output variable(s) of the function are called *dependent variables*. When there is just one output variable we call the function a *scalar function*.

An *equation* consists of two expressions connected by an equals sign (and often involves variables).

A *graph* is a plot of the points that satisfy an equation. For a function of one variable, $f(x)$, the corresponding equation $y = f(x)$ has a graph consisting of the points (x, y) (in 2-space) that satisfy the equation. We refer to this graph as the *graph of the function* $f(x)$.

The graph of a function of one variable (where there is one input and one output) is a *curve*. Think of a curve as a deformed line.

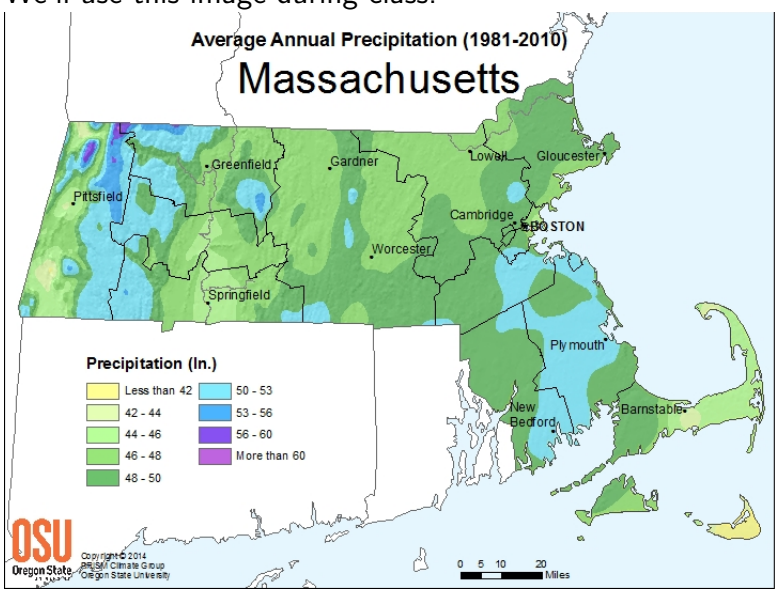
Examples:
- The snowfall (output) in the northern hemisphere over the course of the winter is a function of the position (two input variables) and date (a third input variable). $s = h(x, y, t)$
- The monthly payment on a loan (output) is a function of the loan amount (one input) and the interest rate (a second input). $m = f(a, r)$
- Annual rainfall in Massachusetts as a function of position. $z = f(x, y)$.
- Height of a vibrating guitar string as a function of position along the guitar and of time. $y = f(x, t)$

Today:
- ☐ Find the value of a scalar function using a graphical or symbolic representation.
- ☐ Determine the sign of the derivative of a scalar function along a cross-section based on a graphical representation.
- ☐ Describe in words the inputs and outputs of a scalar function.
- ☐ Find the single variable function that is produced by holding constant one of the inputs to a function of two variables.

Next time: 3-space, distance, graphs

Graphical representation:

We'll use this image during class.



Symbolic to numerical. Make a table from this formula. $f(x, y) = x^2 - y^2$

x \ y	-1	0	a
-1			
0			
a^2			

Example: A guitar string is stretched tight along the x-axis, from $x = 0$ cm to $x = 30$ cm, and is attached at its ends. The string is plucked so that it vibrates. $h(x, t) =$ displacement above or below the axis, x centimeters from its attachment point at $x = 0$, at time t milliseconds.

What do the graphs of $h(x, 10)$ and of $h(10, t)$ represent (in terms of the information they convey)?

A possible formula for the motion of the guitar string is $h(x, t) = \cos t \ \sin\left(\frac{\pi x}{30}\right)$.

Matlab Example:

```
syms x
f = @(x) sin(x*pi/30)
fplot(x,f(x),[0,30],...
    'LineWidth',3)
xlabel('x')
ylabel('y')
title('curve: y = sin(\pi x/30)')
set(gca,'FontSize',14)
```

```
% Choose an axis range.
axis equal
axis([0 30 -2 2])
```

Command list

%	pi	title
syms	fplot	set
@ ()	...	axis equal
* /	xlabel	axis
sin	ylabel	

Background Activity

Answer these questions as best you can. We'll go over them together.

1. Solve for a: $a^2 = -2a$.

2. Simplify and plot

$$\sqrt{(x-1)^2 + (y-1)^2} = \sqrt{(y+1)^2}.$$

3. A triangle has vertices $(0,0)$, $(a,0)$, $(a,1)$. Find all values of a so that one of the three sides of the triangle has length 2.

4. Let $x(t) = \sin t$, $y(t) = \cos t$, $0 \leq t \leq \pi$. Sketch the curve $(x(t), y(t))$.