1 Questions to be handed in for project 3:

Read about this here: Graphing Functions with Julia.

To get started, execute this command to load in a `plot` function:

```
using Gadfly            # ignore any warnings
```

When done with this project, you can print it by *first* selecting the parts to print, the printing the selection.

- Make a plot of $f(x) = \exp(x) - x^3$ over the interval $[3, 5]$. Estimate any values where the graph crosses the x axis.

- For the same function $f(x) = \exp(x) - x^3$ make graphs over different domains until you can find another zero.

- Graph the function $f(x) = 2x^3 - 5x^2 + x$. By graphing different domains, approximate the location of the three zeros.

- A cell phone plan has 700 minutes of talking for 20 dollars with each additional minute over 700 minutes costing 10 cents per minute. Make a function representing this rate for any positive time t. Then graph the function between 0 and 1000.

- Graph the rational function $f(x) = (x^2 + 1)/(x - 1)$. Do you see any asymptotes? If so, describe them.

- Make a graph of the rational function $f(x) = (x^2 - 2x + 1)/(x^2 - 4)$. use a suitable domain so that any horizontal asymptotes can be seen.

The following function can be used to restrict the range of a mathematical function:

```
trim(f::Function; cutoff=10) = x -> abs(f(x)) > cutoff ? NaN : f(x)
```

- Try plotting `trim(f)` when $f(x) = (x^2 - 2x + 1)/(x^2 - 4)$ over $[-3, 3]$. What do you see as compared to the previous graph of $f(x)$?

- Make a plot of $f(x) = \cos(x)$ and $g(x) = 1 - x^2/2$. How many times to the graphs intersect? Can you even tell? If not, why not?

- Make a plot of `f(x) = max(0, 1-abs(x))` and `g(x) = 1 + 2*f(x-3)`. Describe the relationship of `g` and `f` in terms of the values 1, 2 and 3.

- Make a plot of `f(x) = sin(x)` and `g(x) = cos(x) > 0 ? 0.0 : NaN` over $[0, 2\pi]$. What is the relationship? (The graph of $g(x)$ shows only when $\cos(x)$ is positive.)

1.1 creating sequences

(There are two ways to generate sequences of numbers: the range operator `a:h:b` and `linspace`.)

- write a simple command to produce the values: $1, 3, 5, \ldots, 99$

- write a simple command to produce 100 values between 0 and 2π

- Do these two commands produce similar outputs? `5 + 2*0:4` and `5:2:13`? (Try them to tell.)

```
## type true or false, or change to markdown mode and elaborate...
```

1.2 mapping a function

- If `a = [1,2,3,4,5]` find `a^3` for each value. (There are many different ways: using `map`, using a comprehension, using a "dot", ...)

- Do these two commands produce identical outputs: `map(sind, 0:15:90)` and `[sind(x) for x in 0:15:90]`?

1.3 Parametric plots

A parametric plot is one where both the x and y coordinate vary as a function of a third variable, say t. A familiar example is the relationship between the angle t and the point (x, y) on the unit circle. We have:

$$(x(t), y(t)) = (\sin(t), \cos(t))$$

where t is a reference angle. To plot this one could do:

```
t = linspace(0, 2pi, 1000)  #  equally spaced points between 0, 2pi
plot(x=sin(t), y=cos(t), Geom.line(preserve_order=true))
```

More interesting is a plot of related functions. For example, the epicycloid:

$$x(t) = (R + r)\cos(t) + p \cdot \cos((R + r)t/r) \quad y(t) = (R + r)\sin(t) + p \cdot \sin((R + r)t/r)$$

In julia these can be written as

```
x(t; R=1, r=1, p = 0) = (R+r)*cos(t) + p*cos((R+r)*t/r)
y(t; R=1, r=1, p = 0) = (R+r)*sin(t) + p*sin((R+r)*t/r)
```

- make a plot with the defaults, what shape do you get? E.g,:

```
x(t; R=1, r=1, p = 0) = (R+r)*cos(t) + p*cos((R+r)*t/r)
y(t; R=1, r=1, p = 0) = (R+r)*sin(t) + p*sin((R+r)*t/r)
#
t = linspace(0, 10*pi, 1000)
plot(x=x(t), y = y(t), Geom.line(preserve_order=true))
```

- Make a plot with $R = 1, r = 1, p = 1$. What shape do you get? (Use something like `x(t, p=1)`.)

- Make a plot with $R = 1, r = 2, p = 2$. What shape do you get?

- Make a plot with $R = 1, r = 2, p = 3$. What shape do you get?