LARSON—MATH 255–CLASSROOM WORKSHEET 21
More Files—Interacts

1. (a) Start the Chrome browser.
   (b) Go to `http://cocalc.com`
   (c) Login using **your VCU email address** .
   (d) Click on our class Project.
   (e) Click "New", then "Worksheets", then call it **c21**.
   (f) For each problem number, label it in the Sage cell where the work is. So for Problem 2, the first line of the cell should be `#Problem 2`.

Files

Reading in, and working with, data files is an important ability. Last class we created a data file (`one_hundred_numbers.txt`), learned how to read it in line-by-line, and work with the data.

An important thing to know/note is that a file is actually a big *string*. You can read the lines of a file with `readline()`. Those lines are also strings (and not numbers - despite how they look). If you want numbers they must be converted to numbers.

2. Here's **a multi-step problem that builds on what we did last class**. We'll create a new file `two_hundred_numbers.txt` that consists of each line from `one_hundred_numbers.tx` written twice.

Interacts

There is a collection of examples of Sage INTERACTS at `http://wiki.sagemath.org/interact/`. Let's look at a few of these examples to see the kinds of things you can do with Sage.

3. Here is a simple Sage INTERACT with *default* values for a function f to be graphed, and the interval (a, b) that f will be graphed on. The Interact function is named "_", which is standard—as we will never refer to this function by name.

```
@interact
def _(f=x^2, a=-3, b=3):
    show(plot(f,(x,a,b)))
```

4. Now let's make this fancy with some *options*.

```
@interact
def _(f=input_box(x^2,width=20),
    axes=True,
    fill=True,
    zoom=range_slider(-3,3,default=(-3,3))):
    show(plot(f,(x,zoom[0], zoom[1]), axes=axes,fill=fill))
```

5. **Prime Numbers**. Try the following Sage Interact which visualizes the Prime Number Theorem (PNT).

```
@interact
def pnt(N=input_box(200)):
    show(plot(prime_pi,0,N,color="red")+plot(x/(log(x)-1),5,N,color="blue"))
```

Try putting different numbers in the input box.

6. Let's do the same thing in a new way. Try:

```
@interact
def pnt2(N=(100,(2..1000000))):
    show(plot(prime_pi,0,N,color="red")+plot(x/(log(x)-1),5,N,color="blue"))
```

What part of the code is producing the *slider*?

7. **Eigenvalues**. Try `M=identity_matrix(3)`. Evaluate M to see the entries. Change the upper right corner entry to 3. Use `M.` and TAB to find the eigenvalues and eigenvectors of M

8. Here's an INTERACT with an *update* button.

```
@interact
def _(m=('matrix', identity_matrix(2)), auto_update=False):
    print(m.eigenvalues())
```

Try different values in the matrix and then and then click the update box. Now make a 3×3 matrix.

Problems

9. The sum of the reciprocals of the positive integers

$$\sum_{n=1}^{\infty} \frac{1}{n}$$

diverges (that is, the sum goes to infinity).

(a) Find the smallest integer m so that $\sum_{n=1}^{m} \frac{1}{n}$ is at least 2.

(b) Find the smallest integer m so that $\sum_{n=1}^{m} \frac{1}{n}$ is at least 3.

(c) Find the smallest integer m so that $\sum_{n=1}^{m} \frac{1}{n}$ is at least 4.

Getting your classwork recorded

When you are done, before you leave class...

(a) Click the "Make pdf" (Adobe symbol) icon and make a pdf of this worksheet. (If Cocalc hangs, click the printer icon, then "Open", then print or make a pdf using your browser).

(b) Send me an email with an informative header like "Math 255—c21 worksheet attached" (so that it will be properly recorded).

(c) Remember to attach today's classroom worksheet!