LARSON—MATH 255–CLASSROOM WORKSHEET 18
Files and Integration

1. (a) Start the Chrome browser.
   (b) Go to `http://cocalc.com`
   (c) You should see an existing Project for our class. Click on that.
   (d) Click "New", then "Sage Worksheet", then call it **c18**.
   (e) For each problem number, label it in theSAGE cell where the work is. So for Problem 1, the first line of the cell should be `#Problem 1`.

Working with Files

2. We will create a file `testio.txt` in *write* mode (hence the "w"), and write something to it. The *close* command forces the writing to happen and flushes the *buffer*. Now you can't write anything else to the file without reopening it.

```
datafile=open("testio.txt","w")
datafile.write("hello world!")
datafile.close()
```

3. Go to Files, find `testio.txt` and click on it to see what's in there.

4. Now try:

```
datafile=open("testio.txt","w")
datafile.write("hello again!")
datafile.close()
```

5. Go back and take a look at `testio.txt`. The old data is gone. It was overwritten. To add data you need to open the file for *appending* (with an "a"). Try:

```
datafile=open("testio.txt","a")
datafile.write("hello again again!")
datafile.close()
```

6. Go back and take a look at `testio.txt`. The new data got mushed together with the old data.

7. Let's start over and give a new line for each input string.

```
datafile=open("testio.txt","w")
datafile.write("2nd try \n")
datafile.write("hello world! \n")
datafile.close()
```

8. Go back and take a look at `testio.txt`. Now let's open up the file to read its contents—without having any danger of modifying the data (hence the "r") and see what's in there.

```
datafile=open("testio.txt","r")
dline=datafile.readline()
```

Evaluate `dline` to see what that variable holds. Now repeat the last line of the code and reevaluate `dline`.

9. (**Challenge**) Use `open` to create a file "primes.txt" and write the first one hundred primes to that file, one per line, and close the file. Remember to check if your file exists and has the data you expect!

Riemann Integration

Given a continuous function $f(x)$ on an interval $[a, b]$ we want to find the *area* between the curve, the x-axis and the lines $y = a$ and $y = b$. One way to do this is to use the Fundamental Theorem of Calculus and integrate. Unfortunately, it is difficult to find anti-derivatives for many (most) functions. So we need a different approach to get at least an approximate integral.

One way to do this is to slice up $[a, b]$ into n equal-sized intervals $[a_0, a_1]$, $[a_1, a_2]$,..., $[a_n, a_{n+1}]$ (where $a_1 = a$ and $a_{n+1} = b$), pick a point c_i from each interval $[a_i, a_{i+1}]$ and compute the area $f(c_i) \cdot \Delta$ of a rectangle, where Δ is the interval length $a_{i+1} - a_i$. There are different ways to pick the c_i's. You could pick the leftmost point of the interval, the midpoint, the rightmost point, or even a random point.

The *Riemann Integral* is defined to be the *limit* of these area approximations as n goes to infinity of this quantity.

Here is a function `leftpoint_riemann(f,a,b,n)` which computes the leftpoint Riemann sums for n equal intervals.

```
def leftpoint_riemann(f,a,b,n):
    area=0
    Delta=(b-a)/n
    for i in [0..(n-1)]:
        leftpoint=a+i*Delta
        area=area+f(leftpoint)*Delta
    return area*1.0
```

10. Find the integral of f(x)=x**2 on [0,3] (by hand).

11. Find the value of `leftpoint_riemann(f,a,b,n)` for f(x)=x**2 on [0,3] with $n = 2$, $n = 5$, $n = 10$ and $n = 100$. Here you are making the intervals smaller and smaller, giving a better and better approximation.

12. Given a continuous function f(x) on [a,b], define a function `rightpoint_riemann(f,a,b,n)` which computes the rightpoint Riemann sums for n equal intervals.

13. Find the values of `rightpoint_riemann(f,a,b,n)` for f(x)=x**2 on [0,3] with $n = 2$, $n = 5$, $n = 10$ and $n = 100$. Compare with your results for `leftpoint_riemann(f,a,b,n)`.

Getting your classwork recorded

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

1. 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).
2. Send me an email with an informative header like "Math 255 - c18 worksheet attached" (so that it will be properly recorded).
3. Remember to attach today's classroom worksheet!