Assignment #6
# Integration: Loops and Functions
Due: Sunday, 10/30/16, 11:59pm

You need to use the TAs office hours and class exercise groups to get extra help in understanding the material and what is required from an assignment or lab!!!

In this assignment, you will design a computer program using sequential, conditional, looping, and functions We are going to write a program to use the area of rectangles and/or trapezoids to find the area under a curve. We take the integral of a function to find the area under a curve, but how does a computer evaluate an integral? Is there an integrate function? Is there an integration symbol? **Before you freak out, just remember that all we are doing is adding the area of rectangles or trapezoids together!!!** ☺

Objectives:
Analyze the different methods, rectangle vs. trapezoid methods, for solving integration problems. Write a program to calculate the area under a function using both the rectangle and trapezoid methods. Gain experience writing a short program, which uses selection, repetition, and functions/procedures.

Background/Example:
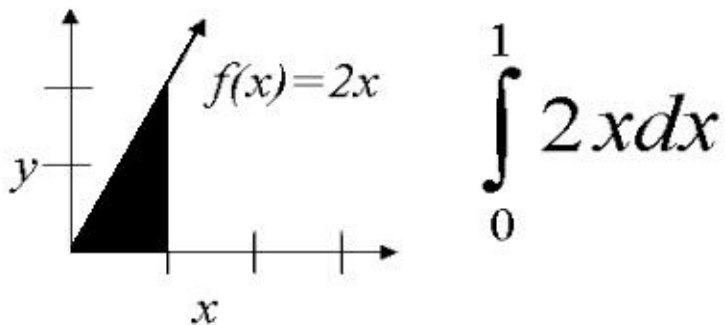
Basic Numerical Methods (Rectangle vs. Trapezoid):
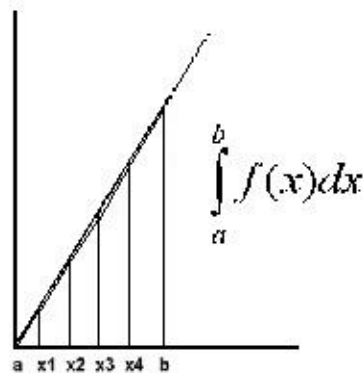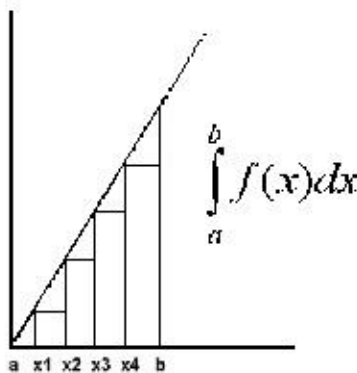
n = number of rectangles and/or trapezoids
a = beginning x value
b = ending x value
w = width of each rectangle/trapezoid, (b-a)/n
f(x) = height of rectangle
(f(x1)+f(x2))/2 = height of trapezoid
Area = width*height

Integration Program Definition:
Your program should determine the area under these different functions,

$f1(x) = 5x^4 + 3x^3 - 10x + 2$
$f2(x) = x^2 - 10$
$f3(x) = 40x + 5$
$f4(x) = x^3$
$f5(x) = 20x^2 + 10x - 2$

The functions are bounded by any interval on the x-axis, including both positive and negative values!!!. The area calculated will be determined by the **user's choice of function and method** to use to calculate the integral, and it is possible for the user to choose to see the area for one function calculated by both methods. **For example:**

Choose a function (1, 2, 3, 4, 5, other(quit)): **1**
Would you like to calculate the area using the rectangle, trapezoid, or both (1, 2, 3): **2**
How many trapezoids do you want? **1000**
Please select a starting point, a = **1**
Please select an ending point, b = **2**
The area under $5x^4 + 3x^3 - 10x + 2$ between 1 and 2 is 29.25

Program Description in more detail:
Your program needs to adhere to the following guidelines:

- **If the user chooses to see the area calculated by both methods, each method should receive their own number of rectangles or trapezoids as input and return the value from the calculation.**
- **Your program should continue running until the user no longer wants to calculate the area under a curve.**
- **You should use procedural decomposition and have functions for f1(x), f2(x), f3(x), f4(x), and f5(x), as well as functions for calculating the area using the rectangle vs. trapezoid method.**

Program Input:
- Starting and ending points for the area
- Function to calculate the area, i.e. f1, f2, f3, f4, f5
- Function/Procedure(s) for calculating the area, i.e. rect, trap, both
- Number of rectangles and/or trapezoids to use

Program Output:
- The function being evaluated
- Starting and ending points for the integral
- Number of rectangles and/or trapezoids used
- The area calculated by the method(s)

Begin by designing you program using these steps, and write steps 1, 2, and 4 on paper or in a text editor. Then, implement the program using Python.

- **Step 1: Problem Analysis**. (20 pts)
  a. Comments about the problem to aid in understanding it.
  b. Description of the knowledge base (this list would include what you would be expected to know to follow the solution).
- **Step 2: Program Design**. (30 pts) List the specific steps needed to calculate the area using rectangles and trapezoids. Remember, you have to be very explicit here to make sure the computer can accomplish the task using your directions.
  1. Define all the functions needed.
  2. What are the preconditions, post conditions, and return values?
  ….
- **Step 3: Program Implementation**. (30 pts) This is the Python code that calculates the area under a given function, i.e. your .py file that gets saved before running your program.
- **Step 4: Program Testing**. (20 pts)
  Create a Test Plan with several test cases including the average and extreme cases.

Electronically submit your two Python programs **as a .py** and design document **as a pdf** by the assignment due date, using TEACH:
https://secure.engr.oregonstate.edu:8000/teach.php?type=want_auth