CS100 Fall 2015

Name _____

CPADS Lab Activity 3 – Due 11-2-15

"Graphing x^2"

The goal of this lab activity is to expand on the loops assignment, while also introducing you to programming some mathematical functions and providing additional tools for you to use in future programming assignments.

As part of the computer science curriculum, each of you will have to take at least two semesters of calculus, which involve concepts such as differentiation and integration. This lab will demonstrate how "simple" it is to calculate discrete derivative and discrete integral numerical approximations.

A derivative measures the slope of a curve at a particular point computed by finding the slope of the line tangent to the curve at that point. Integration can be used to measure the area under a curve. This lab will show you how to graph both the derivative and integral of the x^2 function. It will also provide a numeric and visual representation of the growth rate of the x^2 function along with its derivative and integral.

The first part of the lab asks you to define several functions in Python. The primary function (***move_turtle***) allows you to move the cursor from its current location to a specific set of coordinates. You will use the Pythagorean theorem to calculate the distance from the current location of the turtle to the desired location. You will then use the arctangent function to determine the new heading of the turtle that will move it directly to its new location. You will then use the ***move_turtle*** function to create two additional functions: ***move_turtle_no_draw*** to reposition the turtle without drawing a line to a new position and ***move_turtle_draw*** to draw a line of a specific color from the turtle's current location to the specified coordinates.

The lab will then use these turtle drawing functions to draw two graphs: a linear graph as an example and test of your new movement functions, and a graph of the x^2 function with its derivative and integral curves. You will have to calculate the slope (derivative), and sum (integral) of the x^2 function at each iteration of the loop. The bar graph, the x^2 curve, the derivative curve, and the integral curve will all be drawn at the same time using four different color turtles.

Most of the structure of the program is supplied for you. Your tasks are to:

1. Complete the three **move_turtle** functions, following the comments in the code. You can use the linear graph to test the **move_turtle** functions.
2. Finish the x^2 graph function, again following the instructions in the code.

To start, download the **Lab_Activity_3** Python project from the **CS100 Assignments** page, and open the project in **PyCharm**. The file you will be working in is **graphs.py**.

CS100 Fall 2015

Name _____

1. Moving the Turtle

We will work on the turtle movement functions in class. We will also look at using the Python debugger to work on this assignment during class. By the end of class, you should be well on your way to having those functions working. Over the weekend, you will then finish the portion of the code that graphs the x^2 functions.

You will need to use some new Python functions to get the turtle's current location and heading. They are:

t.get_x() – which returns the current x coordinate of the turtle
t.get_y(() – which returns the current y coordinate of the turtle
t.get_heading – which returns the current heading (in degrees) of the turtle
atan2(y,x) – which returns angle (in radians) for the rise (y) and run (x) values.

Do not modify any of the other code.

2. Graphing

Most of the graphing function is supplied for you. The turtles have all been defined, their positions initialized, and their colors set. The axes are also drawn for you. The first graph is complete – the graph of the linear function. It is there so that you can test your ***move_turtle*** functions. You will see a blue bar graph, as in the previous assignment, as well as a red line that traces the outline of the bar graph.

For the x^2 graph, you must fill in the code for the TODO's for calculating the various values to be graphed. When you have defined the variables required for those calculations and added code to perform the necessary calculations, you will then need to uncomment three lines of code: two that draw the derivative and integral curves, and a third that prints the values.

Do not modify any of the other code.

Once you have successfully completed the code, the graph will have four turtles running simultaneously – a blue one that draws the bar graph, a red one that traces the outline of the bar graph, a green one that traces the derivative curve, and a violet one that traces the integral curve. Notice the contrast of the shapes and growth rates of the 3 curves.

The axes are big enough to accommodate a run of up to 300 values. In order to do so, the origin has been offset to the lower left corner by 600 pixels. Once you start the program, you will need to click on the full screen button in the upper right corner of the turtle display window in order to see the graphs being drawn.