Instructions: The following problems are worth extra credit. The number of potential credits varies per problem and correlates to the difficulty of the exercise. Partial credit will be given for correct, but incomplete work (i.e., partially solved problems). No points will be deducted for incorrect or incomplete submissions. Digital drop boxes have been created on Blackboard for each individual extra credit problem. Please submit solutions to the appropriate boxes to avoid confusion. To receive credit, all solutions are due Friday April 11, by 5 pm.

1. Write a function that calculates the standard deviation (σ) of a list of numerical (integer or float) data. ***The solution may not use Pylab***.

   HINT 1:

   $$\sigma = \sqrt{\frac{\sum_{x=0}^{N-1}(x_i - \bar{x})^2}{N-1}}$$

   where, x_i is the element at the i^{th} index of the list X, $\bar{x}$ is the mean value of the list X, and N is the number of elements in the list.

   In other words, standard deviation equals the square-root of the variance, which equals the sum of the squared differences between each element in the list and the list mean, divided by the number of elements in the list minus one.

   HINT 2: How can you calculate a square root using one of the built-in mathematical operators?

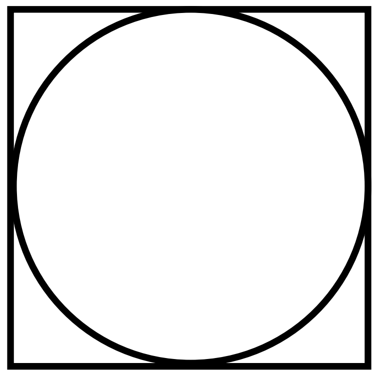
   (20 EC Points Possible)

2. Write a program that draws a right triangle. The program should request the user for the lengths of the two sides of the triangle and then calculate the length of the hypotenuse using the Pythagorean theorem. (10 EC Points Possible).

   Additional credit will be given for programs that allow the user more control over the look of the triangle (e.g., color, placement in the window, etc.).

3. The mathematical constant Pi (π) represents the ratio of the area of the circle to the square of its radius. Many formulas and relationships in mathematics, physics, and other sciences rely on the value of π, which is surprising, if we consider that it is an irrational number; i.e., its decimal representation never ends, and never repeats and no set of finite operations on integers can ever produce it. How then, can we calculate the approximations to its value that we use in every day math (e.g., 3.14257)? One way is through a computational technique called Monte Carlo Simulation.

   Let's start by thinking about the area of a circle and the following image:



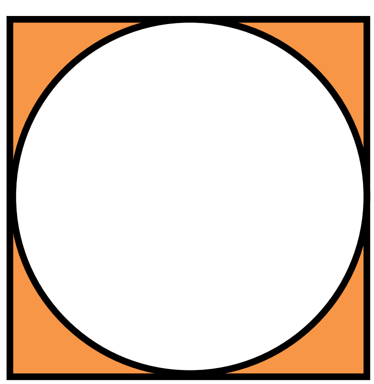
   The above figure shows a circle (with radius = 1) inscribed in a square (length of a side = 2). The area of the circle can be calculated as $A_c = \pi r^2$, or $A_c = \pi 1^2$, or $A_c = \pi$. The area of the square is equally simple to calculate: $A_s = (2r)^2$, or $A_s = (2 * 1)^2$, or $A_s = 4$. The ratio of the area of the circle to the area of the square is:

$$\frac{Area\ of\ Circle}{Area\ of\ Square} = \frac{\pi r^2}{(2r)^2} = \frac{\pi}{4}$$

   Thus, if we know the area of the circle and we know the area of the square, we can calculate the value π by the following:

$$\frac{Area\ of\ Circle}{Area\ of\ Square} * 4 = \pi$$

   But…how do we figure out the Area of the Circle, if we do not know the value of π?! Well, if we consider out circle inscribed in the square again, we can get some insight into the answer:



The area of the circle is equal to the area of the square minus the area of the regions of the square that are not contained within the circle (colored orange). So, how do we determine the area of the orange part?
Consider the following: