CSC 230: Elementary Data Structures and Algorithms

Spring 2018

Assignment 1(CSC 130 Review)

Instructions:

- Programs that you write will be evaluated not only for the final output but also for the clarity and proper coding practices. Make sure to use Java doc comments to explain what each method does.
- For each question create a separate NetBeans project. Once you are done with all questions, zip them in a folder with the name "Assignment-1" and upload it to Canvas.
- You must provide test cases for each problem to justify that your program works. Sometimes you may want to test more than one case. As an example, if your program needs an integer as an argument, you must test, at least, one positive integer, one negative integer as well as zero as arguments to show me that your code handles each case gracefully. If there are no adequate test cases provided, 50% of the question's grade will be deducted!
- Please do not upload multiple times to the Canvas. Also please do not email me your code as an attachment (It will be deleted and will not be graded!)
- Assignments are not group work. You should work independently.
- If you need clarifications, you can ask from me but I will NOT code for you. So please do not send me code in emails to check for errors. It is your homework assignment.
- Do not use any GUI components in your code.

Question 1 (10 points): Write a program to evaluate the value of the following real valued function.

$$f(x, y, z) = x^3 + y^3 + z^4 + (x + y)^4 z$$

Question 2 (20 points): Write a program that inputs a 5-digit integer, separates the integer into its digits and prints them separated by tabs each. For example, if the user types in 42339, the program should print:

4 2 3 3 9

Note: Do not convert your integer to a String and use String class methods to print it. You need to have a method that takes any arbitrary positive integer as an argument.

Question 3 (10 points): Solutions for a quadratic equation $ax^2 + bx + c = 0$ where $a \neq 0$ are as follows.

$$r_1 = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

$$r_2 = \frac{-b - \sqrt{b^2 - 4ac}}{2a}$$

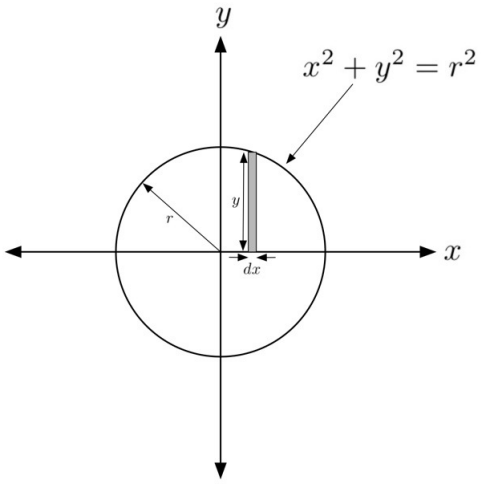
if $b^2 - 4ac < 0$, equation doesn't have real roots. If it is 0 there is one root($r_1 = r_2$). Write a Java program to read a, b and c from keyboard and find the roots, if they exist.

Note: You need to have a method that takes 3 real values as arguments.

Question 4 (20 points): Write a program to determine all pairs of positive integers, (a, b), such that $a < b < 1000$ and $(a^2 + b^2 + 1)/(ab)$ is an integer.

Note: Your program should have a method that takes 1000 as a parameter, say n, and print all valid pairs as (a, b).

Question 5 (20 points) Write a program to approximate the area under a circle with radius r. Note that you should forget the existence of the well known formula $area = \pi r^2$.

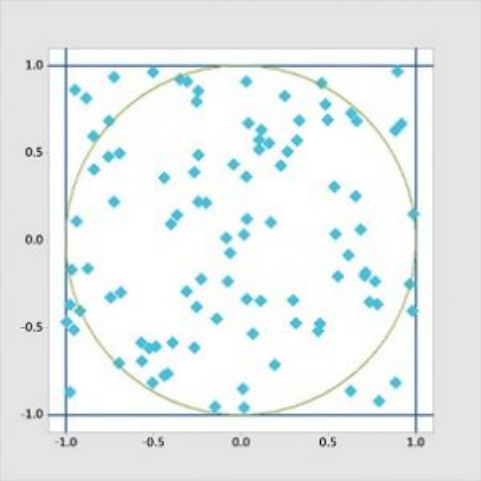


Method: The equation of a circles with radius r, centered at origin is $x^2 + y^2 = r^2$. Divide the area under the top of half (above x axis) in to small rectangles of width of your choice – smaller the better and you should pass this as a parameter to your method– and add these areas of all these rectangles to approximate the area of the upper half of the circle. Multiplying that value by 2 give the approximate area of the circle.

You must test your results with known radius values.

Question 6 (20 points) *Monte Carlo methods* are a broad class of computational algorithms that rely on repeated random sampling to obtain numerical results. One of the basic examples of getting started with the Monte Carlo algorithm is the estimation of Pi.

Basic Idea: The idea is to simulate random (x, y) points in a 2-D plane with domain as a square of side 1 unit. Imagine a circle inside the same domain with same diameter and inscribed into the square. We then calculate the ratio of number points that lied inside the circle and total number of generated points. Refer to the image below:



We know that area of the square is 1 unit sq while that of circle is $\pi * (\frac{1}{2})^2 = \frac{\pi}{4}$. Now for a very large number of generated points,

$$\frac{\text{Area}_{circle}}{\text{Area}_{square}} = \frac{\text{Number of points generated inside cicle}}{\text{Total number of points generated}}$$

$$\text{i.e. } \pi = 4 \times \frac{\text{Number of points generated inside cicle}}{\text{Total number of points generated}}$$

The beauty of this algorithm is that we don't need any graphics or simulation to display the generated points. In randomized and simulation algorithms like Monte Carlo, the more the number of iterations, the more accurate the result is. Thus, it is "estimating the value of π" and not "Calculating the value of π". Implement this algorithm in Java and estimate the value of π.