CSE105 Introduction to Programming in Java, 2013

Assignment 1 , prepared by Bailing Zhang

Instruction

(1) There are 10 questions prepared for the first assignment, each with different points. **You only need to choose SOME of them** with accumulated points 100 to complete Assignment 1. If you complete questions more than 100 points, lecturers will only randomly mark some of them which are worth of 100 points.
(2) Plagiarism will be very closely monitored. You should be very cautious when you discuss with classmates. Two similar answers will all get zeros marks or more serious consequences. After the marking, some of the students will be interviewed to confirm their independence in the completion of the assignments.
(3) The deadline for submission of Assignment 1 is: **6:00pm, October 8, Tuesday**. You should pack all of your code with WinRAR, using your student ID as the file name and then upload it to ICE. The uploading link will be automatically stopped after 6:00pm. Each student should also submit a hardcopy of your assignment. The content must be identical to the electronic version.

Question 1

Write a program that computes mortgage payments. The program lets the user enter the interest rate, year, and loan amount, and then compute the monthly payment and the total payment. Finally, it will display the monthly and total final payments.

The formula to compute the monthly payment is as follows:

$$\frac{loanamount \times monthlyInterestRate}{1 - \frac{1}{(1 + monthlyInterestRate)^{numOfYears \times 12}}}$$

You don't have to know how this formula is derived. Nonetheless, given the monthly interest rate, number of years and loan amount, you can use it to compute the monthly payment.

[**20 points]**

Question 2

Suppose you have just started a sales job in a department store. Your pay consists of a base salary and a commission. The base salary is $5000. The following scheme is used to determine the commission rate:

Sales Amount	Commission Rate
$0.01 – $5,000	8 percent
$5,001.01 – $10,000	10 percent
$10,001.01 and above	12 percent

Your goal is to earn $30,000 in a year. Write a program to find out the minimum sales that you have to generate in order to make $30,000.

[20 points]

Question 3

Write a program that displays the first fifty prime numbers in five lines, each of which contain ten numbers. An integer greater than 1 is prime if its only positive divisor is 1 or itself. For example, 2,3,5 and 7 are prime numbers, but 4,6,8,and 9 are not.

[20 points]

Question 4

The quadratic formula gives the solution(s) to a quadratic equation of the form $ax^2+bx+c=0$. For given values of the parameters a, b and c, the formula solves the equation for x. This is the general quadratic formula:

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

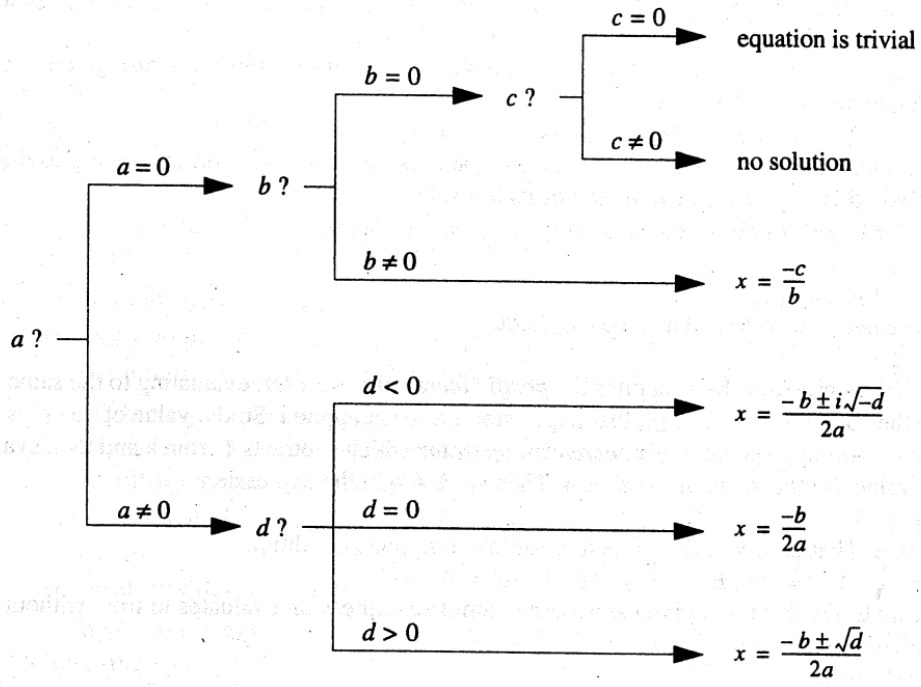
Its implementation requires the consideration of special cases. For example, if a =0, the division cannot be performed. Define d as the discriminant $d = b^2 - 4ac$. An analysis of the different possibilities is shown one next page.

In the implementation, we can define 9 Boolean variables, one for each of the branches in the analysis. Write a program that generates its own random coefficients for the quadratic equation, applies the analysis, and prints the results.

Hint:

You can use the Random class from the util library to generate three random numbers as in the following:

```
Random  randomObj = new Random();
float a = randomObj.nextFloat();
float b = randomObj.nextFloat();
float c = randomObj.nextFloat();
```



Here are the examples of two sample runs:

```
The coefficients of the function f(x) = a*x^2 + b*x + c are:
    a = 0.21762687
    b = 0.14400232
    c = 0.36107045
The equation f(x) = 0 is quadratic with complex solutions:
    x1 = -0.3308468163013458 + 1.2448561059400642i
    x2 = -0.3308468163013458 - 1.2448561059400642i
```

```
The coefficients of the function f(x) = a*x^2 + b*x + c are:
    a = 0.17408675
    b = 0.6870155
    c = 0.1355514
The equation f(x) = 0 is quadratic with real solutions:
    x1 = -0.20829920536441746
    x2 = -3.738098068431407
Check:f(x1) = -1.1046030534700435E-8
    f(x2) = -1.104603031265583E-8
```

Note that the values f(x1) and f(x2) in the second run. Algebraically, they should be exactly 0. The letter “E” in the value -1.1046030534700435E-8 stands for “exponent”.

[20 points]

Question 5

The ***Euclidean Algorithm*** computes the greatest common divisor (g.c.d) of two given positive integers. The g.c.d. of two integers is the largest integer that divides both of them. For example, the g.c.d. of 66 and 84 is 6 because it is the largest in the set of their common divisors {1,2,3,6}. A common use of the g.c.d. is to reduce fractions, For example the fraction 66/84 is reduced to 11/14 simply by dividing both 66 and 84 by their g.c.d. 6.

Write a Java program that generates two random integers in the range 2 to 1000 and then reduce them until one of them reaches 0; at that point, Euclid proved, the other must equal the greatest common divisor of the two original numbers.

Here are two sample runs:

m= 832	n = 752
m=752	n=80
m=80	n=32
m=32	n=16
The g.c.d of m and n is 16	

---

m = 141	n = 488
m=488	n=141
m=141	n=65
m=65	n=11
m=11	n=10
m=10	n=1
The g.c.d of m and n is 1	

```
Euclid's Algorithm:

while m is greater than zero:
   If n is greater than m, swap m and n.
         Subtract n from m.
      n is the GCD
```

[**10 points]**

Question 6

(a) You put $1000 in the bank at 5% annual interest. Calculates how long it will take to become a millionaire

Usually banks pay interest daily or monthly, but for simplicity let us stick with interest paid once at the end of each year. At the end of the second year you will have $1050 + $1050*0.05 = $1102.50. Here is what your account looks like at the end of the first several years:

year	Interest for the Year	End of Year Amount
1	1000*0.05=50	1050.00
2	1050*0.05=52.5	1102.50
3	1102.50*0.05=55.125	1157.625
4	1157.625*0.05=57.88125	1215.50625
5	1215.50625*0.05=60.77531	1276.28156

(b) Suppose you put an extra $1000 into your bank account at the end of every year. Now how long will it take to reach your million dollar goal?

(c) We need to find a bank with an interest rate higher than five percent. Say that you are willing to wait 40 years for your million dollars. How high must the interest rate be?
Hint: One way to answer this question is to try out various interest rates until you find one that works.

[30 points]

Question 7

Newton's method of computing a square root of a number N is to make a first guess, then to improve that guess to get a better guess, then to improve the better guess to get an even better guess, and so on. The guess improvement process is given by a formula:

```
newGuess = N/(2*oldGuess) + oldGuess/2
```

For example, you want the square root of N = 3.00. The first guess can be nearly any value. 1.0 is good enough.

oldGuess	N/(2*oldGuess)	oldGuess/2	newGuess
1.0	**1.5**	**0.5**	**2.0**
2.0	**0.75**	**1.0**	**1.75**
1.75	**0.85714**	**0.875**	**1.73214**
1.73214	**0.86598**	**0.86607**	**1.73205**

[10 points]

Question 8

The **Bisection method** is a simple example of numerical algorithms for solving equations. The algorithm uses the classic divide and conquers strategy. Begin with an interval that contains the unknown solution. Divide it in half, discard the half that does not contain the solution, and repeat.

Write a program that implements the Bisection Algorithm to solve the equation

$$\sqrt{x} = \cos x$$

It has the same solution as the equation

$$\sqrt{x} - \cos x = 0$$

Its solution is the x-intercepts of the graph of the equation $y = \sqrt{x} - \cos x$

We know that there must be a solution within the interval from 0 to π/2 because at x=0, $y = \sqrt{0} - \cos 0 = 0 - 1 = -1 < 0$, and at x=π/2, $y = \sqrt{\pi/2} - \cos \pi/2 = \sqrt{\pi/2} - 0 > 0$. A continuous curve cannot be below the x-axis at one point and above it at another without crossing it in between.

[**10 points]**

Question 9

The following two questions are about the simulation of rolling a pair of dice.

(a) Write a program to compute and print the number of rolls it takes to get snake eyes. (Snake eyes means that the total showing on the dice is 2.)

(b) Write a program that simulates rolling a pair of dice until the total on the dice comes up to be a given number (one of the possible totals: 2, 3, ..., 12) . The number that you are rolling for is entered from the keyboard. The number of times you have to roll the dice is printed out.

[**20 points]**

Question 10

For this case study you are required to investigate a game of chance called Lucky Sevens, which seems like an attractive proposition, but as usual a sure loser for the gambler. The rule of the game is simple:

1) Role a pair of dice
2) If the sum of the spots equals 7, the play wins $4; else the player losses $1.

To entice the gullible, the casino tells players that there are lots of ways to win: (1,6), (2,5), et al. A little mathematical analysis reveals that there are not enough ways to win to make the game worthwhile. Write a program that demonstrate the futility of playing the game

Hint: We can use random number generator to write a program that simulates the game. The program asks the user how many dollars he has, plays the game repeatedly until the money is gone, and displays the number of rolls taken. The program also displays the maximum amount of money held by the player, thus demonstrating the getting ahead at some point does not avoid the inevitable outcome. Here is a sample output:

How many dollars do you have? 100
You are broke after 543 rolls.
You should have quit after 47 rolls when you had $113.

[**20 points]**