FAST-NUCES

Fall Term 2022

Programming Fundamentals (H section) Assignment 3

Instructions:

- Code the given questions in Visual Studio Editor.
- Use meaningful variable names and follow naming convention discussed in class.
- Your code should be understandable and readable.
- Any kind of Plagiarism wouldn’t be tolerated.
- Submit your assignment on **16th October 2022 before 12:00 am**. Any late submission wouldn’t be accepted.

Question 1

Write a program to simulate a very simple version of Snakes & Ladders. This game contains no snakes and no ladders. Two players compete in this game and the first player that reaches 20 points wins the game. The gameplay is really simple: two players keep on rolling the dice in turn until one of them reaches exact 20 points. If a player rolls a dice and the total points cross 20, this turn is discarded, and the total points don’t change.

User is prompted to press any key to roll the dice (explore *getch()* to implement this behavior). You can use *rand()* to implement rolling a dice functionality.

A sample run of this program is given below:

```
Player 1’s turn: 5
Player 1’s total: 5
Player 2’s turn: 4
Player 2’s total: 4

Player 1’s turn: 2
Player 1’s total: 7
Player 2’s turn: 1
Player 2’s total: 5

Player 1’s turn: 5
Player 1’s total: 12
Player 2’s turn: 6
Player 2’s total: 11

Player 1’s turn: 1
Player 1’s total: 13
Player 2’s turn: 3
Player 2’s total: 14

Player 1’s turn: 4
Player 1’s total: 17
Player 2’s turn: 5
Player 2’s total: 19
Player 1’s turn: 1
Player 1’s total: 18
Player 2’s turn: 3
Player 2’s total: 19 (move not possible)

Player 1’s turn: 2
Player 1’s total: 20

Player 1 Won!!!
```

Question 2

Write a program in C to Check Whether a Number can be Express as Sum of Two Prime Numbers.

Test Data :

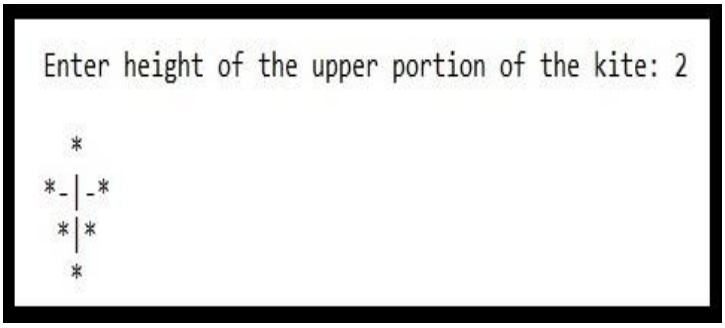
Input a positive integer: 16

Expected Output :

16 = 3 + 13
16 = 5 + 11

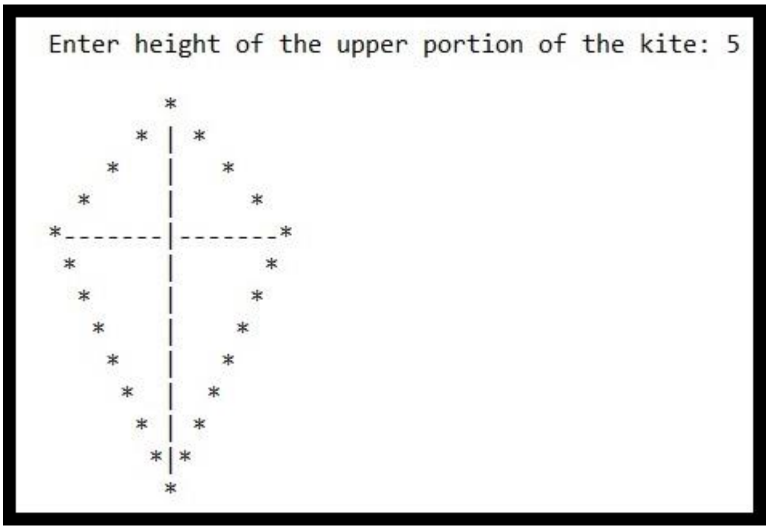
Question 3

Write a C++ **code** to print the pattern of a kite. The program takes the height of the upper portion of the kite as parameter. Some samples are given below:



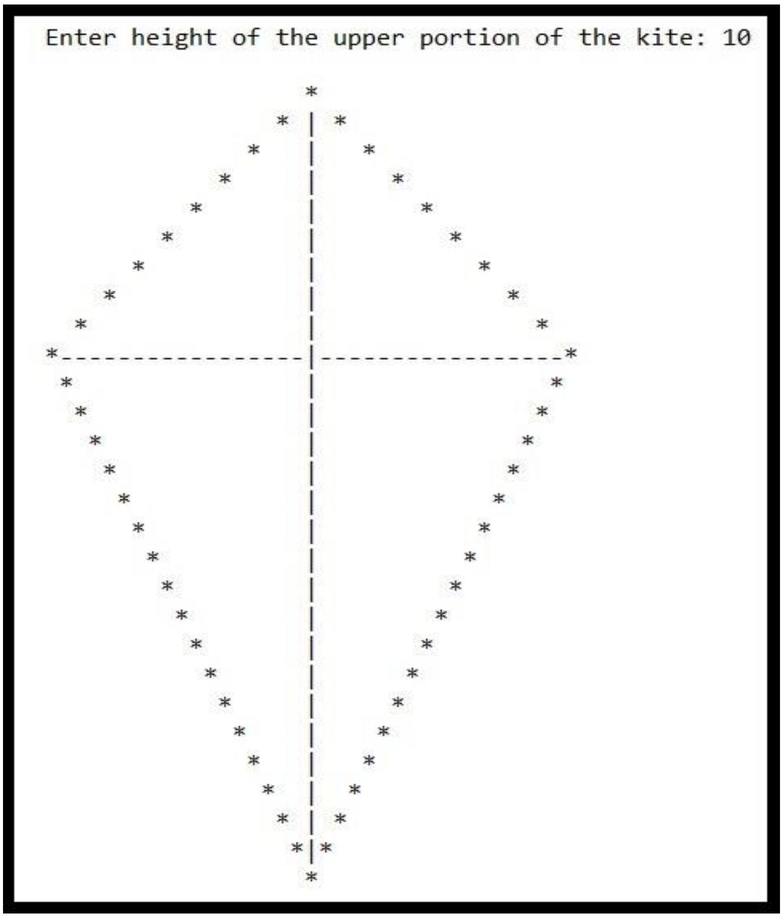
```
Enter height of the upper portion of the kite: 2

  *
*-|-*
 *|*
  *
```



```
Enter height of the upper portion of the kite: 5

        *
      * | *
    *   |   *
  *     |     *
*-------|-------*
 *      |      *
  *     |     *
   *    |    *
    *   |   *
     *  |  *
      * | *
       *|*
        *
```



```
Enter height of the upper portion of the kite: 10

                  *
                * | *
              *   |   *
            *     |     *
          *       |       *
        *         |         *
      *           |           *
    *             |             *
  *               |               *
*-----------------|-----------------*
 *                |                *
  *               |               *
   *              |              *
    *             |             *
     *            |            *
      *           |           *
       *          |          *
        *         |         *
         *        |        *
          *       |       *
           *      |      *
            *     |     *
             *    |    *
              *   |   *
               *  |  *
                * | *
                 *|*
                  *
```

Question 4

It is known from Babylonian times that the square root of a number can be approximated by a method now known as ‘divide and average’ method. Since the Babylonians used it, it is also called the Babylonian algorithm.

METHOD: Suppose we want to compute the square root of a number N. Let A>0 be a guess for square root (N), then a better approximation is given by: B=(A+N/A)/2.
We can then improve the approximation B using C=(B+N/B)/2.

EXAMPLE: For example, let’s compute: square root of N=2. Let our initial guess be 1.
The next better approximation is (1+2/1)/2=1.5
The next better approximation is (1.5+2/1.5)/2=1.416667
The next better approximation is (1.416667+2/1.416667)/2=1.414216
And so on. The more you repeat this, the closer you will get to the actual answer. Just keep in mind that the square root of 2 is an irrational number, which means that you can keep on improving your approximation forever.

1. Write a C++ code that takes a number N and implements above mentioned method of calculating the square root and prints the calculated final square root. You have to run 10 iterations for approximation.

2. Keep repeating the code until the user enters ‘-1’ for terminating the program

Question 5

Write a C++ program for the following:

1. The factorial of a number is the product of all the integers from 1 to that number. For example, the factorial of 6, 6! = 1*2*3*4*5*6 = 720. Factorial is not defined for negative numbers, and the factorial of zero is one, 0! = 1

2. Write code which will take two inputs and find nPr (number of permutations).

nPr (n, r) = n! / (n-r)!

3. Write code which will take two inputs and find nCr (number of combinations)

nCr (n, r) = n! / (n-r)! * r!

4. Write a function which will take two inputs and find nCr (number of combinations) where

nCr(n,r) = nPr(n,r) / r!

5. Design a menu function that will take a number from the user as input and then perform specific operation based on input value.

Sample Output:

a. On ‘1’ print factorial of number.
b. On ‘2’ print nPr.
c. On ‘3’ print nCr designed in part 3.
d. On ‘4’ print nCr designed in part 4.
e. On ‘5’ Exit Program.

Question 6

The last digit of a credit card number is the *check digit*, which protects against transcription errors such as an error in a single digit or switching two digits. The following method is used to verify actual credit card numbers but, for simplicity, we will describe it for numbers with 8 digits instead of 16:

- Starting from the rightmost digit, form the sum of every other digit. For example, if the credit card number is 4358 9795, then you form the sum 5 + 7 + 8 + 3 = 23.
- Double each of the digits that were not included in the preceding step. Add all digits of the resulting numbers. For example, with the number given above, doubling the digits, starting with the next-to-last one, yields 18 18 10 8. Adding all digits in these values yields 1 + 8 + 1 + 8 + 1 + 0 + 8 = 27.
- Add the sums of the two preceding steps. If the last digit of the result is 0, the number is valid. In our case, 23 + 27 = 50, so the number is valid.

Write a program that implements this algorithm. The user should supply an 8-digit number, and you should print out whether the number is valid or not. If it is not valid, you should print the value of the check digit that would make it valid.

Question 7

The following experiment was devised by Comte Georges-Louis Leclerc de Buffon (1707–1788), a French naturalist. A needle of length 1 inch is dropped onto paper that is ruled with lines 2 inches apart. If the needle drops onto a line, we count it as a *hit*. (See 1 & 2). For the Buffon needle experiment, you must generate two random numbers: one to describe the starting position and one to describe the angle of the needle with the *x*-axis. Then you need to test whether the needle touches a grid line.

Generate the *lower* point of the needle. Its *x*-coordinate is irrelevant, and you may assume its *y*-coordinate *ylow* to be any random number between 0 and 2. The angle α between the needle and the *x*-axis can be any value between 0 degrees and 180 degrees (π radians). The upper end of the needle has *y*-coordinate

$$y_{\text{high}} = y_{\text{low}} + \sin\alpha$$

The needle is a hit if *yhigh* is at least 2, as shown in Figure 9. Stop after 500 tries and print the quotient *tries*/*hits*. (This program is not suitable for computing the value of π. You need π in the computation of the angle.)

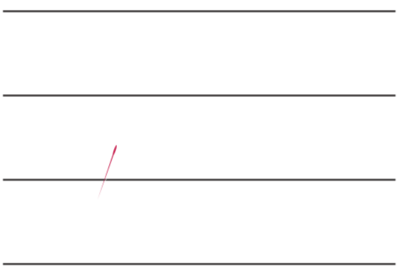


Figure 1: Buffon Needle Experiment

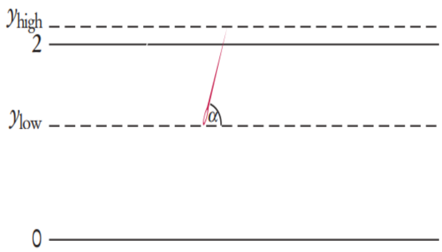


Figure 2: A Hit in the Buffon Needle Experiment

Question 8

This is a well-known game with a number of variants. The following variant has an interesting winning strategy. Two players alternately take marbles from a pile. In each move, a player chooses how many marbles to take. The player must take at least one but at most half of the marbles. Then the other player takes a turn. The player who takes the last marble loses.

Write a program in which the computer plays against a human opponent. Generate a random integer between 10 and 100 to denote the initial size of the pile. Generate a random integer between 0 and 1 to decide whether the computer or the human takes the first turn. Generate a random integer between 0 and 1 to decide whether the computer plays ***smart*** or ***stupid.***

In stupid mode the computer simply takes a random legal value (between 1 and *n* / 2) from the pile whenever it has a turn. In smart mode the computer takes off enough marbles to make the size of the pile a power of two minus 1—that is, 3, 7, 15, 31, or 63. That is always a legal move, except when the size of the pile is currently one less than a power of two. In that case, the computer makes a random legal move.

You will note that the computer cannot be beaten in smart mode when it has the first move, unless the pile size happens to be 15, 31, or 63. Of course, a human player who has the first turn and knows the winning strategy can win against the computer.

Question 9

The following iterative sequence is defined for the set of positive integers:

$$\begin{array}{ll} n \to \dfrac{n}{2} & \text{n is even} \\ n \to 3n+1 & \text{n is odd} \end{array}$$

Using the rule above and starting with 13, we generate the following sequence:

$$13 \to 40 \to 20 \to 10 \to 5 \to 16 \to 8 \to 4 \to 2 \to 1$$

It can be seen that this sequence (starting at 13 and finishing at 1) contains 10 terms. Although it has not been proved yet (Collatz Problem), it is thought that all starting numbers finish at 1. Which starting number**,** ≤ ***N*** produces the longest chain? If many possible such numbers are there print the maximum one.

In simple words, input N from the user and tell in the range from 1 to N at which **n** it has the largest sequence.

Note: Once the chain starts the terms are allowed to go above.

Example:

Input=10

Output=9

Explanation:

Collatz sequence for $n = 9$ is,

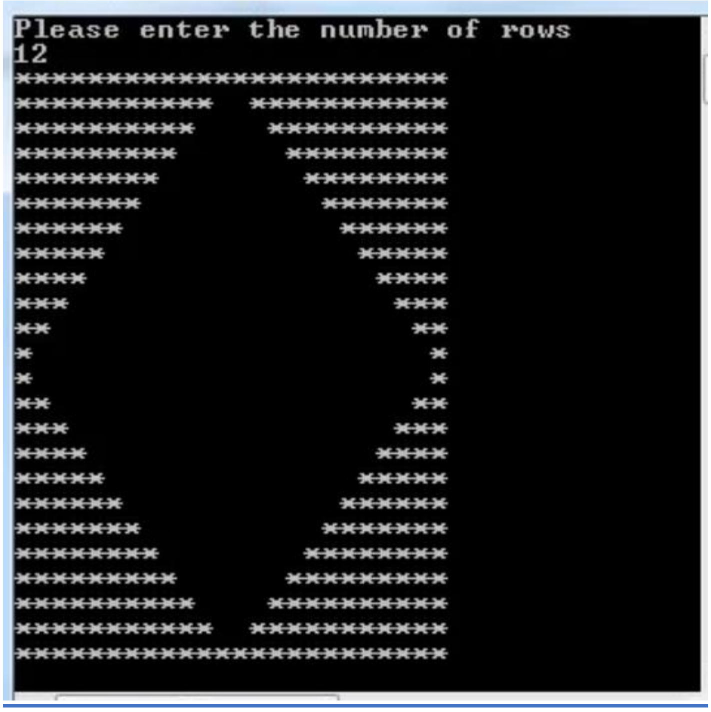
$$9 \rightarrow 28 \rightarrow 14 \rightarrow 7 \rightarrow 22 \rightarrow 11 \rightarrow 34 \rightarrow 17 \rightarrow 52 \rightarrow 26 \rightarrow 13 \rightarrow 40 \rightarrow 20 \rightarrow 10 \rightarrow 5 \rightarrow 16 \rightarrow 8 \rightarrow 4 \rightarrow 2 \rightarrow 1$$

containing 19 steps and is the longest for $n \leqslant 10$

Question 10

Draw following Patterns for positive values of integers provided by user as input**.**

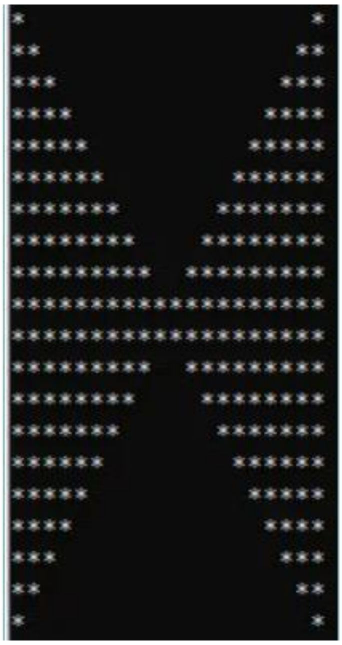
Part A



```
Please enter the number of rows
12
************************
***********  ***********
**********    **********
*********      *********
********        ********
*******          *******
******            ******
*****              *****
****                ****
***                  ***
**                    **
*                      *
*                      *
**                    **
***                  ***
****                ****
*****              *****
******            ******
*******          *******
********        ********
*********      *********
**********    **********
***********  ***********
************************
```

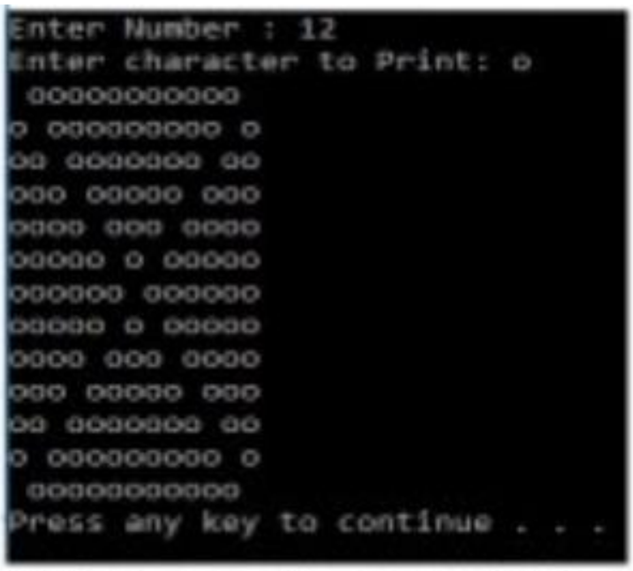
Part B

For rows=10



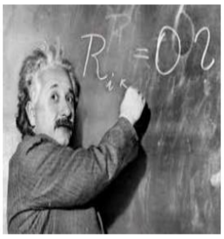
```
*                  *
**                **
***              ***
****            ****
*****          *****
******        ******
*******      *******
********    ********
*********  *********
********************
********************
*********  *********
********    ********
*******      *******
******        ******
*****          *****
****            ****
***              ***
**                **
*                  *
```

Part C



```
Enter Number : 12
Enter character to Print: o
 ooooooooooo
o ooooooooo o
oo ooooooo oo
ooo ooooo ooo
oooo ooo oooo
ooooo o ooooo
oooooo oooooo
ooooo o ooooo
oooo ooo oooo
ooo ooooo ooo
oo ooooooo oo
o ooooooooo o
 ooooooooooo
Press any key to continue . . .
```

A black cross sign of provided size.



I never teach my pupils; I only attempt to provide the conditions in which they can learn.

[--- ALBERT EINSTEIN ---]