Tutorial Series N° 4

Course question

Question 1.

Consider the following algorithm

Algorithm guessing;
Var x, y, a, b : integer ;
Begin
read (x,y) ;
a←0 ; b←x ;
while (b>y)
begin
b←b-y ;
a←a+1 ;
End;
write (a, b) ;
end.

x	y	a	b

1. Run this algorithm with x=17, y=4.
2. What does this algorithm do?
3. What does variable ***a*** represent?
4. What does variable ***b*** represent?

Question 2.

1. Write an algorithm to calculate the average of ***N*** real numbers entered by the user. The user provides the value of ***N***, then the ***N*** values.
2. Modify the algorithm to calculate the average of the positive values only.

Ex 01

Write an algorithm that prompts the user for a real number ***M*** and returns the value of the first integer ***n*** such that the following sum is strictly greater than ***M***: $S = \sum_{i=1}^{i=n} \frac{1}{i}$

Ex 02

Write an algorithm that prompts the user to enter a positive non-zero integer and displays the number of its digits.

Ex 03

Write an algorithm that takes a positive non-zero integer ***N*** as input, checks if it is binary, and then prints the number of zeros (0) and ones (0) it contains.

Example:

- N=101101, your algorithm should display:
  This is a binary number, which contains 4 ones, and 2 zeros.
- N=10211, your algorithm should display:
  This is not a binary number.

Ex 04

Write an algorithm to determine whether an integer is a perfect square. A perfect square is an integer that can be expressed as the square of another integer. For example, 0, 1, 4, 9, 16, 25, 36, and 49 are all perfect squares.
The function sqrt() is forbidden. Loops must be used.

Ex 05

We want to test the Syracuse conjecture using an algorithm. We start with a positive integer different from 1.

- If it is odd, we multiply it by 3 and add 1;
- Otherwise, we divide it by 2.

We repeat these steps with the new number obtained until it reaches the value 1. In this case, we observe an infinite cycle {• • •, 1, 4, 2, 1, • • •}. Regardless of the starting integer, we will always end up with the value 1. For example: 5, 16, 8, 4, 2, 1, 4, 2, 1, ...

Write an algorithm that allows entering a positive integer, not equal to 1. The algorithm should count the number of iterations of the Syracuse sequence until it reaches the value 1.

Ex 06

1. Write an algorithm that takes an integer ***N*** as input and then calculates and prints its factorial, defined as follows: *N! = 1*2*3*.... *N*
2. We can approximate ***e*** using the following series: $\sum_{i=1}^{\infty} \frac{1}{i!}$

   Write an algorithm that allows entering a positive non-zero integer ***N*** and calculates an approximation of ***e*** up to the ***Nth*** term: $e = 1 + \frac{1}{2!} + \frac{1}{3!} + \cdots + \frac{1}{N!}$

Ex 07

Consider the sequence defined by:

$U_0=1$

$U_{n+1}=3U_n-2$

Write an algorithm that allows you to enter a positive integer ***n*** and calculate and display the n^{th} term of the sequence U_n.

Additional Exercises

Ex 08

A tenant rents an apartment for 6,500 DA per month. The landlord increases the rent by 18% each year. The tenant wants to move out of the apartment just before the rent exceeds 8,000 DA.

Write an algorithm that calculates and prints the number of years the tenant will stay in the apartment.

Ex 09

Write an algorithm that reads a positive integer N and a base B less than 10, then checks and prints whether N belongs to the base B or not.
Example: N = 743

- 743 belongs to the octal base B = 8 because the digits of 743 (3, 4, and 7) are all less than 8.
- However, 743 does not belong to the base B = 4 or to the base B = 7.

Ex 10

Write an algorithm that prompts the user to enter a positive integer N and then prints whether or not the integer is a palindrome.

Definition: A palindrome is a number that reads the same forward and backward.

Example: 44, 252, 1441 and 3567653 are palindrome numbers.