Algorithms and Data Structures

Assignment 1: Recursion

1. Write and test a recursive function that returns the sum of the squares of the first n positive integers.

   $1^2 + 2^2 + \ldots + n^2$

   Sample Input: n = 4

   Sample Output: $1^2 + 2^2 + 3^2 + 4^2 = 30$

2. Write and test a recursive function that returns the sum of the first n elements of an array.
3. Write a recursive method to compute the sum of the first n positive integers.
4. Write and test a recursive function that returns the sum of the first n powers of a base b.

   $b^0 + b^1 + b^2 + \ldots + b^n$

   Sample Input: b = 4, n = 3

   Sample Output: $4^0 + 4^1 + 4^2 + 4^3 = 85$

5. Given a positive integer N and a sequence of N elements. You have to display given sequence in reverse order.

   Note. The program is forbidden to declare arrays, and use the cycles (even for input).

   Sample Input: 3

   1 2 3

   Sample Output: 3 2 1

6. Given a positive integer N and a sequence of N strings. You have to display given sequence in reverse order.

   Note. The program is forbidden to declare arrays (only one char array in function is allowed), and use the cycles (even for input).

   Input: First line contains n (1<=n<=100). The next n lines contain one-dimension char arrays. Array is no longer that 20 symbols.

   Output: The sequence of element in reverse order.

Sample Input:

3
Abc
bcdh
abcdef

Sample Output:

abcdef
bcdh
abc

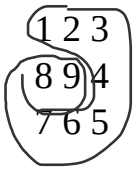
7. Print the square that consists of NxN cells filled with numbers from 1 to N*N in a spiral mode (see examples).

   Note. Use recursion for solving this problem.

   Sample Input 1:

   3

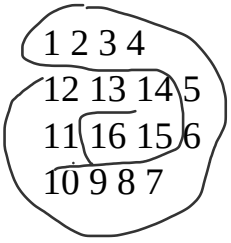
   Sample Output 1:



   Sample Input 2:

   4

   Sample Output 2:



8. Given two positive integers n and k. Your task is to output all sequences like: $x_1, x_2, ..., x_N$ such that x_i - natural and $1<=x_i<=k$.

   Note. Use recursion for solving this problem.

   Sample Input 1:

   2 3

Sample Output 1:

1 1
1 2
1 3
2 1
2 2
2 3
3 1
3 2
3 3

Sample Input 2:

3 3

Sample Output 2:

1 1 1
1 1 2
1 1 3
1 2 1
1 2 2
1 2 3
1 3 1
1 3 2
1 3 3
2 1 1
2 1 2
2 1 3
2 2 1
2 2 2
2 2 3
2 3 1
2 3 2
2 3 3
3 1 1
3 1 2
3 1 3
3 2 1
3 2 2
3 2 3
3 3 1
3 3 2
3 3 3

9. Given a string (one dimention char array) consisting of M distinct symbols. Print all the permutations (all possible variants) of the symbols of this string.

   Sample Input 1:

   AB

   Sample Output 1:

   ABBA

   Sample Input 2:

   IOX

   Sample Output 2:

   XOI
   OIX
   IXO
   XIO
   OXI
   IOX

10. For the following task:
    - Any other libraries except very basic ones are NOT allowed.
    - Global and Static variables are not allowed.
    - You can't add more parameters or call helper functions.

    Power of two. Given 1 parameter - an *integer* n, return true if it is a power of two. Otherwise, return false.

    An integer $\boldsymbol{n}$ is a power of two, if there exists an integer $\boldsymbol{x}$ such that $\boldsymbol{n} = 2^{x}$

    Test the function properly in main and give the output as shown in Figure 1.

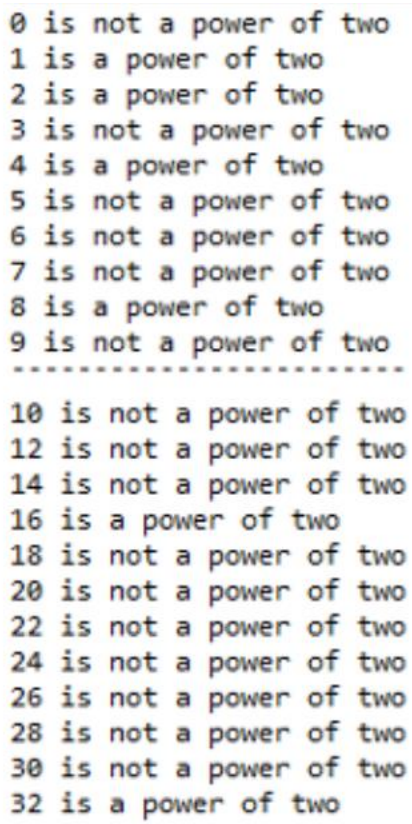

0 is not a power of two
1 is a power of two
2 is a power of two
3 is not a power of two
4 is a power of two
5 is not a power of two
6 is not a power of two
7 is not a power of two
8 is a power of two
9 is not a power of two
10 is not a power of two
12 is not a power of two
14 is not a power of two
16 is a power of two
18 is not a power of two
20 is not a power of two
22 is not a power of two
24 is not a power of two
26 is not a power of two
28 is not a power of two
30 is not a power of two
32 is a power of two

Figure 1.