Shiv Nadar University

CSD101: Introduction to Computing and Programming

Lab #9

Recursion

```
Max marks:80
Due on/before:22.00, 31-Oct-2021.                                        24-Oct-2021
```

1. Write recursive functions with the prototype *long <power>(int m, int n)* that efficiently (and inefficiently - see below) calculate m^n where m , n are non-negative integers. The recursive definition is as follows:

```
0. if m, n both 0 then Indeterminate.
1. if m is 0, n>0 then 0.
2. if m>0, n is 0 then 1.
3. if m>0, n>0 and n is odd then m*power(m, n-1)
4. if m>0, n>0 and n is even then power(m, n/2)*power(m, n/2)
```

   In your function definition you should also measure how many times the *power* function is called for specific values of m and n. Using a `static` counter variable count the number of times *power* is called.

   If you call *power* twice in line 4 of the definition then you are redoing a calculation that has already been done - this is inefficient. For efficient calculation you should not call *power* twice in line 4 of the given definition.

   Compare the number of calls made to *power* in the inefficient and efficient versions of *power* if $m = 2$ and $n = 20$.

   [30]

2. Some times two or more functions can be recursive by being mututally recursive. That is f calls g and g calls f. One nice example of this is the formula for calculating the *determinant* of a square matrix using the Laplace expansion.

   So, for a square matrix A of dimension $n \times n$. The determinant is: $det(A) = \sum_{j=1}^{n} a_{1j}C_{1j}$ where we have chosen to use the first row for the expansion. Note that one can use any row or column to do the expansion. C_{1j} is the cofactor of element $(1, j)$. More generally, cofactor C_{ij} is defined as: $C_{ij} = (-1)^{(i+j)}M_{ij}$. The minor M_{ij} in turn is defined as: $M_{ij} = det(A')$ where A' is an $(n-1) \times (n-1)$ dimensional square matrix obtained by deleting the ith row and jth column from A.

   The base cases for finding the determinants of matrices of dimension 1×1 and 2×2 are respectively $det(A) = a_{11}$ and $det(A) = a_{11} \times a_{22} - a_{12} \times a_{21}$.

   Define mutually recursive functions *determinant* and *cofactor* to calculate the determinant of a square matrix using the Laplace expansion.

   In the *main* program read n the dimension of the square matrix and the matrix values row wise. Then calculate the determinant by Laplace's method and print it.

   [50]