Indian Institute of Technology, Kharagpur

CS19001: Programming and Data Structures Laboratory
Assignment for Week 7
Duration: 4 hours

March 6, 2018

INSTRUCTIONS

1. All programs should be written in C.
2. The file containing your solution to problem i should be named **<roll>-week7-prob$i$.c** where 'roll' is your roll number.
3. Evaluation will be based on the following criteria: correctness, handling corner cases/border conditions and programming style (indentation, commenting, naming variables, ...).

PROBLEMS

1. Write a program that takes an array of n non-negative integers as input, and rearranges them such that, when concatenated, they form the largest possible number. Assume that $1 \leq n \leq 15$.

Sample output

```
Enter the size of the list: 4
Enter the non-negative integers: 50 2 1 9

The number should be arranged as 9, 50, 2, 1 in order
to form the largest number (95021).
```

You are allowed to temporarily modify the contents of the array and later restore the original contents. You may also need a sorting routine that arranges the contents of the array in ascending/descending order. Below is the *insertion sort* algorithm for sorting an array `A` of length `n` in ascending order.

```
i = 1;
while (i < n){
  j = i - 1;
  t = A[i];
```

```
    while (j>=0 && A[j] > t){
      A[j+1] = A[j];
      j--;
    }
    A[j+1] = t;
    i = i+1;
  }
```

Changing the condition `A[j] > t` to `A[j] < t` will sort the array in descending order.

Marks: 50

2. [1] The goal of this problem to determine real roots of a polynomial $f(x) = a_d x^d + a_{d-1}x^{d-1} + \cdots + a_1 x + a_0$. Store the coefficients of the polynomial in an array in the order $a_0, \ldots, a_d$. Assume that $2 \leq d \leq 10$ and that the coeffcients are real numbers (floating-point values). We are interested in a root of this polynomial in the range $0 \leq x \leq 10$. Write a program which performs the following tasks.

   (a) Read the degree d and the coefficients $a_0, a_1, \ldots, a_d$ of $f(x)$ from the user and store d as a global `int` value and the coefficients in a global array of `float` variables.

   (b) Write a function *evalpoly*(x) to evaluate the polynomial at a floating-point value x.

   (c) Evaluate the polynomial at the integer points $x = 0, 1, \ldots, 10$. If some $f(x)$ is close to 0, then return x as an integer root and terminate.

   (d) Find out whether there is an integer $x = 1, 2, ..., 9, 10$ such that $f(x)$ and $f(x-1)$ have opposite signs. If no such integer is found, report failure and terminate. Otherwise, let $a = x - 1$ and $b = x$. In Step 5, (a, b) is the search interval in which a root of $f(x)$ must exist.

   (e) Evaluate the polynomial at $m = (a + b)/2$. If $f(m)$ is close to 0, report m as an approximate root of f and terminate. Otherwise replace the search interval (a, b) by (a, m) or (m, b) The new interval (a, b) should be chosen such that $f(a)$ and $f(b)$ have opposite signs. Repeat Step 5. (This method is called *successive bisection.*)

   Testing *closeness to 0*: With finite-precision arithmetic, it is not always possible to find a root x at which $f(x)$ is exactly equal to zero. However, if $|f(x)| < 10^{-10}$, we accept x as an approximate root of $f(x)$. Submit a single C source file solving all the five parts. [50]

[1] Taken verbatim from the assignment questions of Spring 2015 PDS lab course offered by Prof. Abhijit Das, Dept. of CSE, IIT KGP.

Sample Output 1

```
Enter degree (2 <= d <= 9): 5
Coefficient of x^0 = 2.000000
Coefficient of x^1 = 3.000000
Coefficient of x^2 = -4.000000
Coefficient of x^3 = 2.000000
Coefficient of x^4 = 2.000000
Coefficient of x^5 = -5.000000
The input polynomial is:
        f(x) = (-5)*x^5+(2)*x^4+(2)*x^3+(-4)*x^2+(3)*x^1+(2)*x^0
+++ Integer root located: 1
```

Sample Output 2

```
Enter degree (2 <= d <= 9): 4
Coefficient of x^0 = 5.000000
Coefficient of x^1 = 1.000000
Coefficient of x^2 = 0.000000
Coefficient of x^3 = 5.000000
Coefficient of x^4 = -5.000000
The input polynomial is:
        f(x) = (-5)*x^4+(5)*x^3+(0)*x^2+(1)*x^1+(5)*x^0
+++ Real root located: 1.435290245463
```

Sample Output 3

```
Enter degree (2 <= d <= 9): 4
Coefficient of x^0 = 4.000000
Coefficient of x^1 = 4.000000
Coefficient of x^2 = 0.000000
Coefficient of x^3 = 2.000000
Coefficient of x^4 = 3.000000
The input polynomial is:
        f(x) = (3)*x^4+(2)*x^3+(0)*x^2+(4)*x^1+(4)*x^0
!!! Failure to detect a root
```