CS19001/CS19002 PROGRAMMING AND DATA STRUCTURES LABORATORY
Assignment No: 3
Last Date of Submission: 09–February–2015

In this assignment, you attempt to determine real roots of a polynomial $f(x) = a_d x^d + a_{d-1} x^{d-1} + \ldots + a_1 x + a_0$. You store the polynomial in an array as follows:

a_0	a_1	…	a_{d-1}	a_d

Assume that $2 \leq d < 10$, that is, an array of size ten suffices to store your polynomial. Treat the polynomials as real polynomials, that is, each a_i is assumed to be a floating-point value. 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.

1. Read the degree d and the coefficients $a_0, a_1, \ldots, a_{d-1}, a_d$ of $f(x)$ from the user. Store d as a global integer value, and the coefficients in a global array of floating-point variables.

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

3. Evaluate the polynomial at the integer points $x = 0, 1, 2, \ldots, 10$. If some $f(x)$ so evaluated is (close to) zero, return x as an integer root, and terminate.

4. Find out whether there is an integer $x = 1, 2, \ldots, 9, 10$ 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.

5. Evaluate the polynomial at $m = (a + b) / 2$. If $f(m)$ is (close to) zero, 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*.)

A note about the proximity of $f(x)$ to zero is in order. 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.

Sample output

```
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

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

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
```