Programming Assignment 3: Polynomial Operations

A polynomial $p(x) = a_n x^n + a_{n-1} x^{n-1} + \ldots + a_1 x + a_0$, where $-10<a_i<10$ and $a_n \neq 0$, is represented using an ordered single link linear list. Suppose the highest term and coefficients are generated using random numbers; and there is only 33% chance that the coefficients are not 0 except for the coefficient of the highest degree term. Write a C project to perform the following steps:

1. Define and implement functions of polynomial addition, subtraction, and multiplication as below:
   Polynomial polyAdd(Polynomial P1, Polynomial P2); // (P1+P2)(X)
   Polynomial polyMinus(Polynomial P1, Polynomial P2); // (P1-P2)(X)
   Polynomial polyTime(Polynomial P1, Polynomial P2); // (P1*P2)(X)
2. Declare, generate, and print polynomial P1(X) and P2(X), with degree between 0 and 100 and coefficients between -10 and 10.
3. Enter a floating point number a, for $-1.0<a<1.0$.
4. Evaluate and print P1(a) and P2(a).
5. Compute and print polynomials (P1+P2)(X), (P1-P2)(X), and (P1*P2)(X).
6. Evaluate and print (P1+P2)(a), (P1-P2)(a), and (P1*P2)(a).
7. Prove or disprove P1(a)+P2(a) = (P1+P2)(a), P1(a)-P2(a) = (P1-P2)(a), and P1(a)*P2(a) = (P1*P2)(a). Consider precision error is less than 10^{-4}.

Let $P1(X) = a_m X^m + a_{m-1} X^{m-1} + \ldots + a_1 X + a_0$, and $P2(X) = b_n X^n + b_{n-1} X^{n-1} + \ldots + b_1 X + b_0$. Polynomial addition, subtraction, and multiplication are defined as below:

$$(P1 + P2)(X) = \sum_{i=0}^{\max(m,n)} (a_i + b_i)X^i$$

$$(P1 - P2)(X) = \sum_{i=0}^{\max(m,n)} (a_i - b_i)X^i$$

$$(P1 * P2)(X) = \sum_{i=0}^{m} \sum_{j=0}^{n} (a_i * b_i)X^{i+j}$$

In this assignment, you must submit five files: project, header, and source files **assgn3_DXXXXXXX.dev**, **assgn3_DXXXXXXX.h**, **assgn3_DXXXXXXX.c**, and **assgn3_DXXXXXXX_main.c** (80%) and the assignment report **assgn3_DXXXXXXX.pdf** (20%), where DXXXXXXX is your student ID. In the assignment report, you should explain how image rotation is performed. The assignment is due by **23:59 pm, Thursday, April 6, 2023**. Program execution example:

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Enter degree of the polynomial P1 (between 0 and 100): 8
Enter degree of the polynomial P2 (between 0 and 100): 6
Enter value of a (between -1.0 and 1.0): 0.75

>>>>Polynomial P1(X) has 4 non-zero coefficient terms.
-2.150 X^8+1.460 X^4-3.590 X^3+0.360 X

>>>>Polynomial P2(X) has 2 non-zero coefficient terms.
-0.270 X^6+7.970 X

>>>> a=0.750
>>>> Evaluation of Polynomial P1(a): -9.9782E-001
>>>> Evaluation of Polynomial P2(a): 5.9294E+000

>>>>Polynomial (P1+P2)(X) has 5 non-zero coefficient terms.
-2.150 X^8-0.270 X^6+1.460 X^4-3.590 X^3+8.330 X

>>>>Polynomial (P1-P2)(X) has 5 non-zero coefficient terms.
-2.150 X^8+0.270 X^6+1.460 X^4-3.590 X^3-7.610 X

>>>>Polynomial (P1*P2)(X) has 7 non-zero coefficient terms.
0.581 X^14-0.394 X^10-16.166 X^9-0.097 X^7+11.636 X^5-28.612 X^4+2.869 X^2

>>>> Evaluation of Polynomial (P1+P2)(a): 4.9316E+000
>>>> Evaluation of Polynomial (P1-P2)(a): -6.9273E+000
>>>> Evaluation of Polynomial (P1*P2)(a): -5.9165E+000

>>>> Prove: P1(a)+P2(a) == (P1+P2)(a)
>>>> Prove: P1(a)-P2(a) == (P1-P2)(a)
>>>> Prove: P1(a)*P2(a) == (P1*P2)(a)
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