Data Structure Program Assignment #3
(Due: PM: 6:00, March 17, 2022)

Polynomial class and data structure

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- **Introduction**

In lecture 2, we introduced three methods to store polynomial data. This program is designed based on the method1 data structure to perform polynomial addition, subtraction, and multiplication operations. In addition, how to evaluate a polynomial by a value, i.e., x=2, and how to perform polynomial derivations are provided. This program provides the required basic operation and program design layout, and you had to make it complete such that the instructions in the main program listed below can be executed correctly.

The main.cpp and input polynomial data, poly_input.txt, is shown below:

```
#include "Polynomial.h"
int main()
{
    Polynomial a, b, c, d;
    a.set ( 1, 1 ); //1 x^1
    a.set ( 2, 2 ); //2 x^2
    b.set ( 5, 0 ); //5 x^0
    b.set ( 3, 3 ); //3 x^3
    b.set (4,4);     // 4 x^4
    c = a-b;          // (1x^1 + 2 x^2) - (5 + 3 x^3 + 4x^4) operator overloading of "-"
    cout <<a << " - " << b << " = " << c << endl;   // print out the c polynomial

    c = a + b;
    cout << a << " + " << b << " = " << c << endl;   // operator overloading of "+"

    c = a * b; // (7x^4 + x^2) * (6x^3 - 3x^2), operator overloading of "*"
    cout << a << " * " << b << " = " << c << endl;   // operator overloading for
output polynomial

    d = c.differentiate().differentiate(); cout << "differentiate " << c <<
       "two times lead to: "<< endl;
    cout << d << endl;     // operator overloading <<
    cout << c(2) << endl; // evaluate the polynomial with x=2 by horner's method
    cin.get();
}
```

poly_input1.txt - 記事本

檔案(F) 編輯(E) 格式(O) 檢視(V) 說明

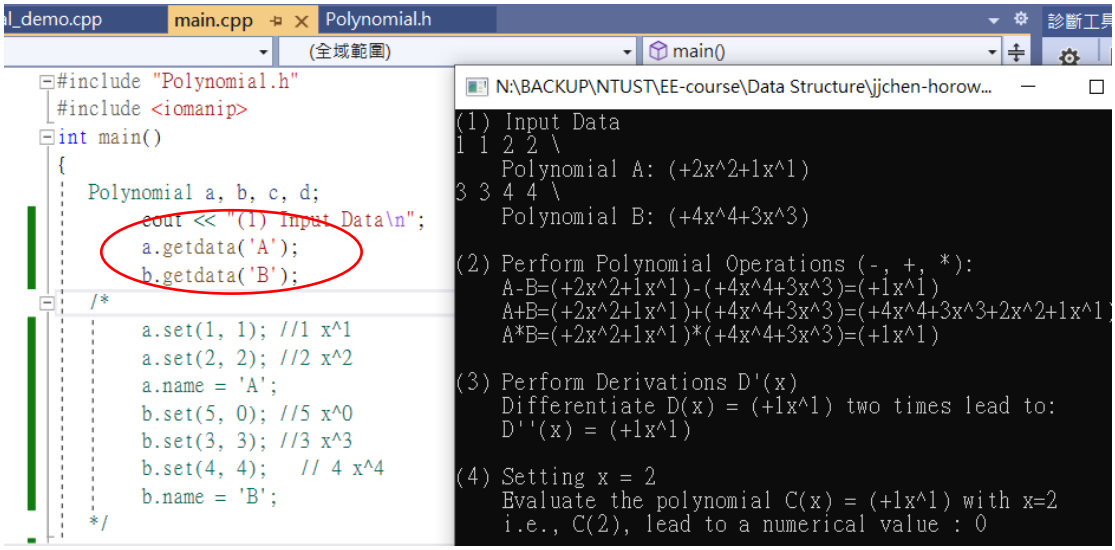
```
1 1 2 2     /*polynomial A = 1 x^1+ 2 x^2*/

5 0 3 3 4 4  /*polynomial B = 5 + 3 x^3 + 4^4 */
```

The execution results would look like the following figure.

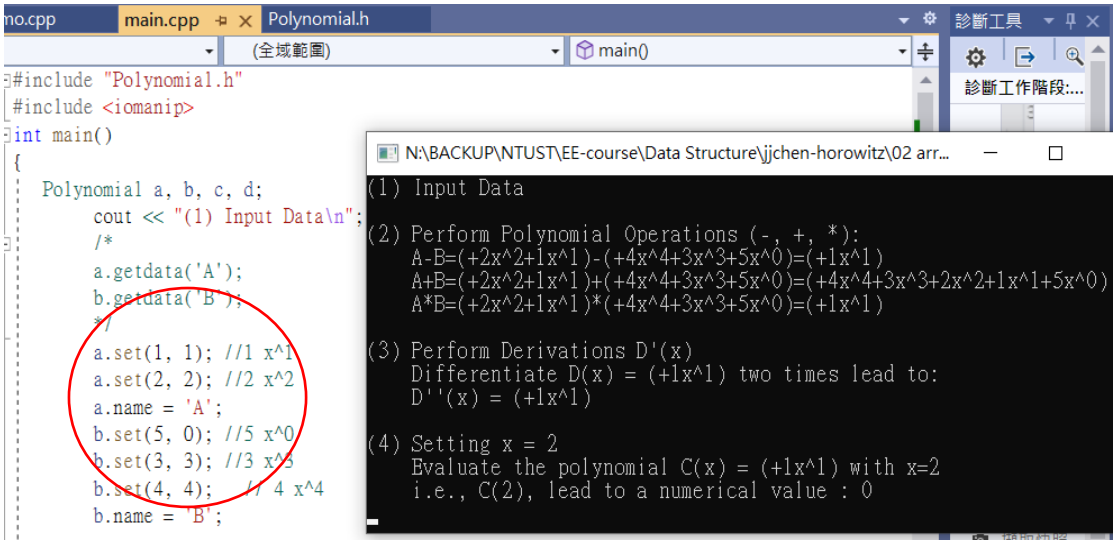
```
(1) Input Data
    Polynomial A: (+2x^2 +1x^1 )
    Polynomial B: (+4x^4 +3x^3 +5x^0 )

(2) Perform Polynomial Operations (-, +, *):
    A-B= (+2x^2 +1x^1 )-(+4x^4 +3x^3 +5x^0 )=(-4x^4 -3x^3 +2x^2 +1x^1 -5x^0 )
    A+B=(+2x^2 +1x^1 )+(+4x^4 +3x^3 +5x^0 )=(+4x^4 +3x^3 +2x^2 +1x^1 +5x^0 )
    A*B=(+2x^2 +1x^1 )*(+4x^4 +3x^3 +5x^0 )=(+8x^6 +10x^5 +3x^4 +10x^2 +5x^1 )

(3) Perform Derivations D'(x)
    Differentiate D(x) = (+8x^6 +10x^5 +3x^4 +10x^2 +5x^1 ) two times lead to:
    D''(x) = (+240x^4 +200x^3 +36x^2 +20x^0 )

(4) Evaluate the polynomial C(x) =(+8x^6 +10x^5 +3x^4 +10x^2 +5x^1 ) with value 2,
    i.e., C(2), lead to a numerical value : 930
```

- Steps:

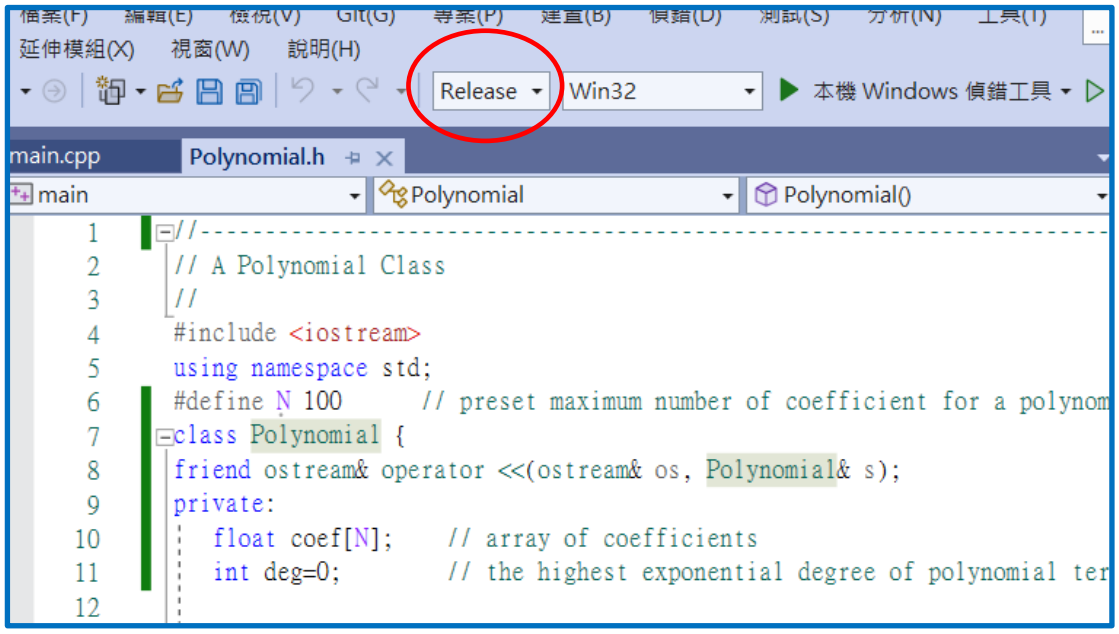
1. A demo project is provided for you to quickly start the design work. You can select interactive input mode and the execution result looks like below:



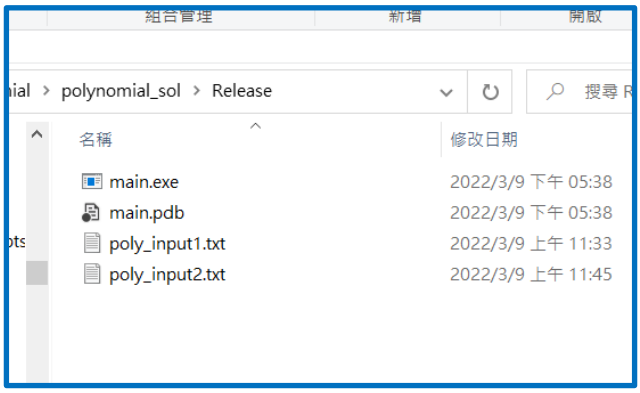
You can also use **preset mode** for easy design and debugging.

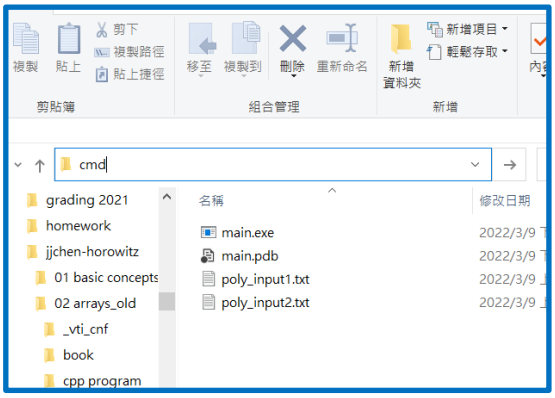


2. Design the polynomial class such that it is function complete, i.e., it can perform polynomial addition, subtraction, multiplication, derivation and evaluation.
3. After finishing your program, you had to rebuild your program in Release mode.

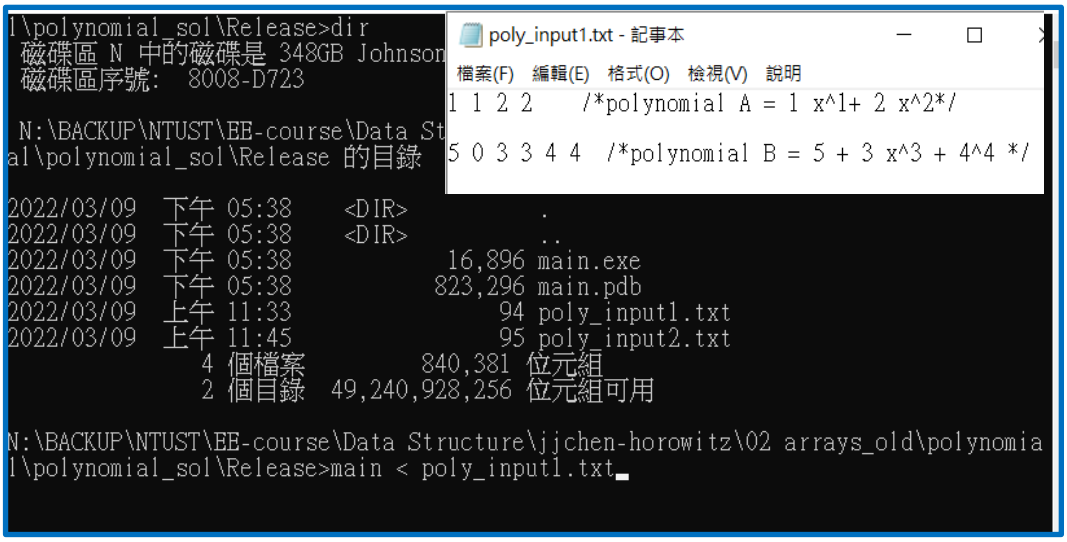


4. Go to the Release directory and open the cmd window.

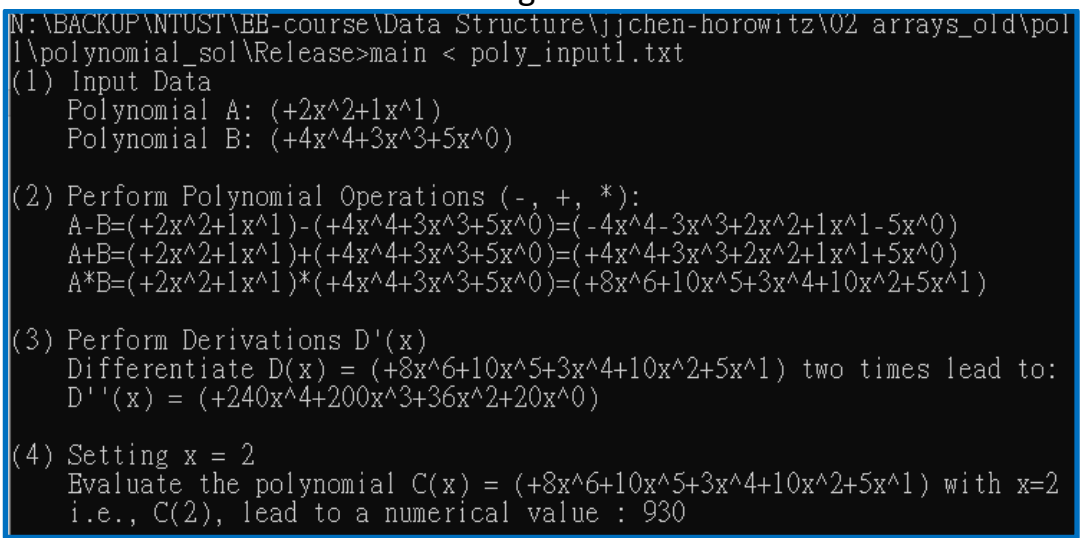




5. Type **main< poly_input1.txt** to check correctness.



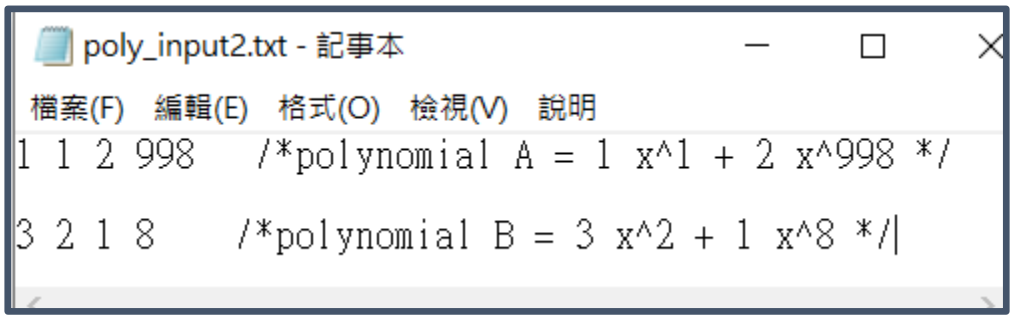
The result should look like the figure.



- **Requirement (75%)**

1. You had to submit the complete project such that the TA can recompile your programs to verify correctness.
2. Write a short report to describe
   (1) What is all about the program?
   (2) Describe your program by writing notes for each instruction.
   (3) What is the time complexity reduction (%) when using Horner's method instead of the brute force method?
   (4) How you improve this program? List your contributions.

- **Bonus: (25%)**
  You can try your best to modify the program such that representation 3 in the lecture note can be utilized to improve the program storage and operational efficiency. For example, you can redesign the program such that it can process polynomial with any order, such as the one below.



- Note: For this homework, you can discuss with other classmates about the program design instead of copying programs. If you finished the project very early, don't share your program to others. Otherwise, the credits will also be shared by students who submit the same program contents.