

Midterm Spring 2023

A polynomial in one variable is an arithmetic expression of the form

$$a_n x^n + \dots + a_2 x^2 + a_1 x^1 + a_0$$

where x is a variable that can take on different numeric values and a_n, \dots, a_2, a_1 , and a_0 are constants called the coefficients of the polynomial. The highest exponent with non-zero coefficient, n , is called the degree of the polynomial. For example, $0x^2 + 2x + 3$ is normally written as $2x + 3$ and has degree 1. Note that x^1 is the same as x , and x^0 is 1. A polynomial whose coefficients are all zero has degree -1. Note that a polynomial with degree 2 is called a quadratic polynomial.

One way to represent a polynomial is to use a dynamically resizable array to hold the coefficients and the power. You may want to define a struct called Term that contains the degree and coefficient, and define a pointer of Terms in your Polynomial class to store the terms of the polynomial.

Code for a Polynomial class that uses a dynamically resizable array to store the coefficients and exponents:

```
// Polynomial class header file
// Polynomial.h

// Struct Term
// {
//     int exponent;
//     float coefficient;
// };

// CONSTRUCTOR
//     Term *polyterm - dynamically resizable array of Term
//
//     Polynomial();
//     Postcondition: A polynomial has been created. All coefficients are zero
// and
//                     the degree is -1.
//     Polynomial(vector<Term>) - Initialize a polynomial from a vector of
// Term
//     Polynomial(Polynomial const &) - copy constructor
//     ~Polynomial() - destructor

// MODIFICATION MEMBER FUNCTIONS

//     setCoef( ) - set a coefficient of the polynomial
//     void setCoef( int k, double value );
//     Precondition: The exponent k is less than or equal to MAX_DEGREE.
```

```

//      Postcondition: The coefficient of the x^k term has been set to value.
//                      The degree of the polynomial has been adjusted as
// necessary.

//      clear - set all coefficients to zero
//      void clear( );
//      Postcondition: All coefficients of the polynomial have been set to zero
//                      and the degree has been set to -1.

// ACCESSOR MEMBER FUNCTIONS

//      getCoef( ) - returns a coefficient
//      double getCoef( int k ) const;
//      Postcondition: If k is less than or equal to the degree of the
// polynomial,
//                      the return value is the coefficient of x^k. Otherwise,
// the
//                      return value is zero.

//      getDegree( ) - returns the degree
//      int getDegree( ) const;
//      Postcondition: The return value is the degree of the polynomial.

//      evaluate( ) - evaluate the polynomial
//      double evaluate(double value) const;
//      Postcondition: The return value is the value of the polynomial at x =
// value.

//      operator+( Polynomial const & rightPoly ) - defines the sum of two
// polynomials
//      operator-( Polynomial const & rightPoly ) - defines the difference of
// two polynomials
//      operator=( Polynomial const & rightPoly ) - defines the assignment
// operator
//      operator==( Polynomial const & rightPoly ) - defines the logical
// equality operator
//      operator*( Polynomial const & rightPoly ) - defines the
// multiplication operator

//      addTerm(Term const &)

// NON-MEMBER FUNCTIONS

//      operator<<( ) - display the polynomial
//      ostream & operator<<(ostream & out, const Polynomial & p);
//      Postcondition: A character representation of Polynomial p has been
// inserted into
//                      output stream out.

```

Provide a main function to test your code. Something like this:

```

int main( )
{
    char choice;    // Command entered by the user
    int num, exp;
    double value;

```

```

Polynomial poly1, poly2;

cout << "creating 2 polynomials" << endl;
cout << "Initialize polynomial 1" << endl;
poly1 = readPolynomial( );
cout << "Initialize polynomial 2" << endl;
poly2 = readPolynomial( );

do
{
    print_menu( );
    cout << "Enter choice: ";
    cin >> choice;
    choice = toupper(choice);

    switch (choice)
    {
        case 'C': // clear
            break; case
        'E': // evaluate
            break;
        case 'P': // print polynomial
            cout << "Print polynomial 1 or 2: ";
            cin >> num;
            if ( num == 1 )
                cout << "poly1 is " << poly1 << endl;
            else if ( num == 2 )
                cout << "poly2 is " << poly2 << endl;
            else
                cout << "There are only 2 polynomials - 1 and 2" <<
endl;
            break;
        case 'S': // set a polynomial
            cout << "Set polynomial 1 or 2: ";
            cin >> num;
            if ( num == 1 )
            {
                cout << "Enter exponent to select term (or a
negative number to quit): ";
                cin >> exp;
                while ( exp >= 0 )
                {
                    cout << "Enter value of coefficient: ";
                    cin >> value;
                    poly1.setCoef( exp, value );
                    cout << "Enter exponent to select term (or a
negative number to quit): ";
                    cin >> exp;
                }
                cout << "poly1 is " << poly1 << endl;
            }
            else if ( num == 2 )
            {
                cout << "Enter exponent to select term (or a
negative number to quit): ";
                cin >> exp;
                while ( exp >= 0 )

```

```

        {
            cout << "Enter value of coefficient: ";
            cin >> value;
            poly2.setCoef( exp, value );
            cout << "Enter exponent to select term (or a
negative number to quit): ";
            cin >> exp;
        }
        cout << "poly2 is " << poly2 << endl;
    }
    else
        cout << "There are only 2 polynomials - 1 and 2" <<
endl;

    break;

    case '+': // add polynomials 1 and 2
        cout << "The sum of " << poly1 << endl;
        cout << "          and " << poly2 << endl;
        cout << "          is " << (poly1 + poly2) << endl;
        break;

    case '+': // add polynomials 1 and 2
        cout << "The sum of " << poly1 << endl;
        cout << "          and " << poly2 << endl;
        cout << "          is " << (poly1 + poly2) << endl;
        break;

    case 'Q':
        cout << "Test program ended." << endl;
        break;

    default:
        cout << choice << " is invalid." << endl;

    }
}
while ((choice != 'Q'));

return EXIT_SUCCESS;
}

void print_menu( )
{
    cout << endl;
    cout << "The following choices are available: " << endl;
    cout << " C   Clear a polynomial" << endl;
    cout << " E   Evaluate a polynomial" << endl;
    cout << " P   Print a polynomial with degree" << endl;
    cout << " S   Set a polynomial" << endl;
    cout << " +   Add 2 polynomials" << endl;
    cout << " Q   Quit this test program" << endl;
}

char get_user_command( )
// Library facilities used: iostream
{
    char command;

    cout << "Enter choice: ";
    cin >> command; // Input of characters skips blanks and newline character

    return command;
}

```