University American College Skopje

Course: Object Programming

Operator Overloading

Exercises

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Assignment 1

- Create class **Fraction**, with the following fields:
  - Private:
    - int *num*, *den* – representing the numerator and denominator of the fraction, respectively
  - Public:
    - A default constructor, to set the *num* to zero and *den* to one
    - A parameterized constructor, taking one integer parameter, setting *num* to the value of the parameter, and *den* to one
    - A parameterized constructor, taking two integer parameters, setting both *num* and *den* to the values of the respective parameters
      - This constructor performs a check: if the value of the denominator is negative, it then switches the sign of both the numerator and denominator
        - » The idea is to make the denominator always positive

Assignment 1

- A void show() function, which will display the fraction in the form “*num / den*”
- A double value() function, which will return the value of the fraction (i.e. numerator / denominator)
- A friend **Fraction** operator+, taking two **Fraction** objects as parameters, and returning their sum
- A friend **Fraction** operator-, taking two **Fraction** objects as parameters, and returning their difference
- A friend **Fraction** operator*, taking two **Fraction** objects as parameters, and returning their product
- A friend **Fraction** operator/, taking two **Fraction** objects as parameters, and returning their quotient
  - Operation definitions follow

Assignment 1

$$a = \frac{a_{num}}{a_{den}}$$

$$b = \frac{b_{num}}{b_{den}}$$

$$a + b = \frac{a_{num} \cdot b_{den} + b_{num} \cdot a_{den}}{a_{den} \cdot b_{den}}$$

$$a - b = \frac{a_{num} \cdot b_{den} - b_{num} \cdot a_{den}}{a_{den} \cdot b_{den}}$$

$$a \cdot b = \frac{a_{num} \cdot b_{num}}{a_{den} \cdot b_{den}}$$

$$a \,/\, b = \frac{a_{num} \cdot b_{den}}{a_{den} \cdot b_{num}}$$

<u>**NOTE**</u>: If the denominator of the resulting **Fraction** is negative, switch the sign of both the numerator and denominator (again, to obtain a fraction with a positive denominator)

Assignment 1

- In the main() function
  - Declare two integer variables
  - Input the numerator and denominator through the keyboard and instantiate a **Fraction** object out of them (e.g. call it *a*)
  - Use the show() function to display it on the screen and the value() function to obtain its value (also display it on the screen)
  - Repeat the previous procedure to create and display another **Fraction** object (e.g. call it *b*)

Assignment 1

– Create a new, third **Fraction** object (e.g. call it *c*)
– Give the third **Fraction** object the sum of the previous two **Fraction** objects (use the + operator)
– Display the newly obtained **Fraction** object on the screen and also obtain and display its value
– Repeat the previous procedure for subtraction (operator -), multiplication (operator *) and division (operator /) of the two **Fraction** objects input through the keyboard

Assignment 1

```
Enter the numerator and denominator (both integer) of fraction a: 1 -2
a = -1/2          Its value is -0.5

Enter the numerator and denominator (both integer) of fraction b: -3 4
b = -3/4          Its value is -0.75

a+b = -10/8       Its value is -1.25
a-b = 2/8         Its value is 0.25
a*b = 3/8         Its value is 0.375
a/b = 4/6         Its value is 0.666667
Press any key to continue_
```

Assignment 2

- Create class **Vector**, with the following fields:
  - Private:
    - double *x*, *y*, *z* – representing the 3D coordinates of the vector
  - Public:
    - A default constructor, to set all three coordinates to zero
    - A parameterized constructor, taking three double parameters, to set the coordinates to the values of the respective parameters
    - A void show() function, that displays the vector in the form “(*x*, *y*, *z*)”

Assignment 2

- A friend **Vector** operator+, taking two **Vector** objects as parameters, and returning their sum
- A friend **Vector** operator-, taking two **Vector** objects as parameters, and returning their difference
- A friend double operator*, taking two **Vector** objects as parameters, and returning their dot product
- A friend **Vector** operator^, taking two **Vector** objects as parameters, and returning their cross product

  – Operation definitions follow

Assignment 2

$$\vec{a} = (a_x, a_y, a_z)$$
$$\vec{b} = (b_x, b_y, b_z)$$

$$(a + b)'_x = a_x + b_x$$
$$(a + b)'_y = a_y + b_y$$
$$(a + b)'_z = a_z + b_z$$

$$(a - b)'_x = a_x - b_x$$
$$(a - b)'_y = a_y - b_y$$
$$(a - b)'_z = a_z - b_z$$

$$\vec{a} \cdot \vec{b} = a_x \cdot b_x + a_y \cdot b_y + a_z \cdot b_z$$

$$(a \wedge b)'_x = a_y \cdot b_z - a_z \cdot b_y$$
$$(a \wedge b)'_y = a_z \cdot b_x - a_z \cdot b_z$$
$$(a \wedge b)'_z = a_x \cdot b_y - a_y \cdot b_x$$

Assignment 2

- In the main() function
  - Declare three double variables
  - Input the three coordinates through the keyboard and instantiate a **Vector** object out of them (e.g. call it *a*)
  - Use the show() function to display it on the screen
  - Repeat the previous procedure to create and display another **Vector** object (e.g. call it *b*)

Assignment 2

- Create a new, third **Vector** object (e.g. call it *c*)

- Give the third **Vector** object the sum of the previous two **Vector** objects (use the + operator)
- Display the newly obtained **Vector** object on the screen

- Repeat the previous procedure for subtraction (operator -), dot product (operator *) and cross product (operator ^) of the two **Vector** objects input through the keyboard
  - <u>NOTE:</u> the result of the dot product is a double, instead of a **Vector**

Assignment 2

```
Enter the coordinates of vector a: 1.2 -2.3 3.4
a = (1.2, -2.3, 3.4)
Enter the coordinates of vector b: -4.5 5.6 -6.7
b = (-4.5, 5.6, -6.7)

a+b = (-3.3, 3.3, -3.3)
a-b = (5.7, -7.9, 10.1)
a*b = -41.06
a^b = (-3.63, -7.26, -3.63)
Press any key to continue
```

Assignment 3

- Create class **Complex**, with the following fields:
  - Private:
    - double *r*, *i* – representing the real and imaginary part of the complex number respectively
  - Public:
    - A default constructor, to set both the real and the imaginary part to zero
    - A parameterized constructor, taking two double parameters, to set the real and imaginary part to the values of the respective parameters
    - A void show() function, to display the complex number in a form “*r* + *i**i”
      - The last part, “*i”, is a string constant

Assignment 3

- A friend **Complex** operator+, taking two **Complex** objects as parameters, and returning their sum
- A friend **Complex** operator-, taking two **Complex** objects as parameters, and returning their difference
- A friend **Complex** operator*, taking two **Complex** objects as parameters, and returning their product
- A friend **Complex** operator/, taking two **Complex** objects as parameters, and returning their quotient
  - Operation definitions follow

Assignment 3

$$a = a_r + a_i \cdot i$$
$$b = b_r + b_i \cdot i$$

$$(a + b)_r = a_r + b_r$$
$$(a + b)_i = a_i + b_i$$

$$(a - b)_r = a_r - b_r$$
$$(a - b)_i = a_i - b_i$$

$$(a \cdot b)_r = a_r \cdot b_r + a_i \cdot b_i$$
$$(a \cdot b)_i = a_r \cdot b_i + a_i \cdot b_r$$

$$(a/b)_r = \frac{a_r \cdot b_r + a_i \cdot b_i}{{b_r}^2 + {b_i}^2}$$
$$(a/b)_i = \frac{a_i \cdot b_r - a_r \cdot b_i}{{b_r}^2 + {b_i}^2}$$

Assignment 3

- In the main() function
  - Declare two double variables
  - Input the two values through the keyboard and instantiate a **Complex** object out of them (e.g. call it *a*)
  - Use the show() function to display it on the screen
  - Repeat the previous procedure to create and display another **Complex** object (e.g. call it *b*)

Assignment 3

- Create a new, third **Complex** object (e.g. call it *c*)
- Give the third **Complex** object the sum of the previous two **Complex** objects (use the + operator)
- Display the newly obtained **Complex** object on the screen
- Repeat the previous procedure for subtraction (operator -), multiplication (operator *) and division (operator /) of the two **Complex** objects input through the keyboard

Assignment 3

```
Enter the real and imaginary parts of the first Complex number: 1.2 -3.4
a = 1.2 + -3.4*i
Enter the real and imaginary parts of the second Complex number: -5.6 7.8
b = -5.6 + 7.8*i

a+b = -4.4 + 4.4*i
a-b = 6.8 + -11.2*i
a*b = -33.24 + 28.4*i
a/b = -0.360521 + 0.104989*i
Press any key to continue_
```

Assignment 4

- Modify Assignment 3, such that you'll extend class **Complex** with the following fields:
  - Public:
    - A parameterized constructor, taking <u>one</u> double parameter, to set the real part to the value of the parameter, and the imaginary part to zero
    - Two additional overloads for each of the operators (+, -, *, /), which will take a **Complex** and a double value (second overload) and a double and a **Complex** value (third overload)
      - The first overload is the original version of each operator, i.e. the one taking two **Complex** values as parameters

Assignment 4

- For each of the additional overloads of the operators:
  - If the first parameter is **Complex**, create a new **Complex** object, passing the double parameter as the parameter to the **Complex** constructor
  - Return the **Complex** value that would be obtained upon invoking the operation using the overload of the corresponding operator that takes two **Complex** objects as parameters

Assignment 4

- In the main() function
  - Declare a new double variable (e.g. call it *d*)
  - Input it through the keyboard and display its value
  - Invoke all operations with the first argument being the first **Complex** object (*a*), and the <u>second</u> argument being the double value (*d*)
    - show() all the **Complex** objects obtained through those operations
  - Invoke all operations with the <u>first</u> argument being the double value (*d*) and the second object being the **Complex** object (*b*)
    - show() all the **Complex** objects obtained through those operations

Assignment 4

```
Enter the real and imaginary parts of the first Complex number: 1.2 -3.4
a = 1.2 + -3.4*i
Enter the real and imaginary parts of the second Complex number: -5.6 7.8
b = -5.6 + 7.8*i

a+b = -4.4 + 4.4*i
a-b = 6.8 + -11.2*i
a*b = -33.24 + 28.4*i
a/b = -0.360521 + 0.104989*i

Enter a double number: -9.10
d = -9.1

a+d = -7.9 + -3.4*i
a-d = 10.3 + -3.4*i
a*d = -10.92 + 30.94*i
a/d = -0.131868 + 0.373626*i

d+b = -14.7 + 7.8*i
d-b = -3.5 + -7.8*i
d*b = 50.96 + -70.98*i
d/b = 0.552711 + 0.769848*i
Press any key to continue_
```