

(7 - 1) Operator Overloading

D & D Chapter 10

Instructor - Andrew S. O'Fallon
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Washington State University

Key Concepts

- Keyword `operator`
- Operator overloading



What is Operator Overloading?

- A generalization of function overloading
- An extension to C++ standard operators to define how they should work with user-defined types such as classes



Why Overload Operators?

- Improves readability
- Allows for a more natural way to implement code



Rules and Restrictions on Operator Overloading

- The precedence of an operator cannot be changed
- The associativity of an operator cannot be changed, i.e. left-to-right or right-to-left
- The “arity” of an operator cannot be changed, i.e. if the operator accepts one operand (unary) or two operands (binary)
- Only existing operators may be overloaded



Which Operators Cannot be Overloaded?

- .
- .* (pointer to member)
- ::
- ?:



Recall Class ComplexNumber's Add () Function

- Let's write the definition for the `add ()` member function

```
// Prototype: ComplexNumber add (const ComplexNumber &operand);

// Definition - notice the binary scope resolution operator
ComplexNumber ComplexNumber::add (const ComplexNumber &operand)
{
    // This adds the real part of the "operand" object
    // to the real part of the object that invokes the
    // call to the function; it also adds the imaginary
    // parts
    ComplexNumber result; // Declare local ComplexNumber

    // Recall we use the dot member operator (.) to access
    // members of a class; no dot (.) denotes accessing the
    // instantiated object's members; note we don't have to apply "special"
    // operators to access an object passed by reference!
    result.mRealPart = mRealPart + operand.mRealPart;
    result.mImaginaryPart = mImaginaryPart + operand.mImaginaryPart;
    // Don't want to pass back by reference; cause undefined behavior
    return result;
}
```



We Can Replace Add () by Overloading + (Using a Friend Function)

- Let's write a function to overload the binary + operator; this function is a *non-member* function, but is a friend of `ComplexNumber`

```
// Prototype: friend ComplexNumber operator+ (const ComplexNumber &lhs,
                                             const ComplexNumber &rhs);

// Definition - notice the operator is not preceded by ComplexNumber::, because
// it's a non-member operator. Made this function a friend of ComplexNumber
// to efficiently access the private data members of ComplexNumber.
ComplexNumber operator+ (const ComplexNumber &lhs, const ComplexNumber &rhs)
{
    ComplexNumber result; // Declare local ComplexNumber

    result.mRealPart = lhs.mRealPart + rhs.mRealPart;
    result.mImaginaryPart = lhs.mImaginaryPart + rhs.mImaginaryPart;

    // Don't want to pass back by reference; cause undefined behavior
    return result;
} A. O'Fallon, J. Hagemeister
```



We Can Replace Add () by Overloading + (without Using a Friend Function)

- Let's write a function to overload the binary + operator; this function is a *non-member* function, but is NOT a friend of `ComplexNumber`

```
// Prototype: ComplexNumber operator+ (const ComplexNumber &lhs,
                                        const ComplexNumber &rhs);

// Definition - notice the operator is not preceded by ComplexNumber::, because
// it's a non-member operator. This function is NOT a friend of ComplexNumber.
// Need to use setters/getters now!
ComplexNumber operator+ (const ComplexNumber &lhs, const ComplexNumber &rhs)
{
    ComplexNumber result; // Declare local ComplexNumber

    result.setRealPart (lhs.getRealPart() + rhs.getRealPart());
    result.setImaginaryPart (lhs.getImaginaryPart() +
                             rhs.getImaginaryPart());

    // Don't want to pass back by reference; cause undefined behavior
    return result;
}
```



Why Non-Member Overloaded Operators?

- Enables “symmetry” and *commutativity* among operators, i.e.
 - `ComplexNumber operator+ (const ComplexNumber &lhs, int rhs);`
 - `ComplexNumber operator+ (int lhs, const ComplexNumber &rhs);`
 - Important to make non-member operator+ when lhs is not a class! Since lhs is not an object in this case!



References

- P.J. Deitel & H.M. Deitel, *C++: How to Program* (9th ed.), Prentice Hall, 2014
- J.R. Hanly & E.B. Koffman, *Problem Solving and Program Design in C* (7th Ed.), Addison-Wesley, 2013



Collaborators

- Jack Hagemeister

