Function and Operator Overloading

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Function Overloading

- C++ allows functions to have the same names
 - But the parameters, number or types, need to be different
 - Function overloading
 - To have similar functions with different data types
 - Return type is irrelevant
- C++ compiler will use the best matched function
 - Argument promotion might be performed
- Example: exq1.cpp

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Operator Overloading

- Operators: shorthand representations help in technical and nontechnical communications
- C++ provides user-defined types, classes, and most of the operators are not defined for these classes
- Operators for classes are user-defined
- For example, + and * are well known for complex numbers
- Define these operators can help program development
- Many of the most obvious uses of operator overloading are for concrete types.
- But the usefulness of user-defined operator is not restricted to concrete types
- Example: exq20.h, exq21.cpp, exq2.cpp

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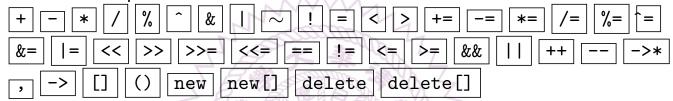
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Operator Functions

Most of the operators can be defined for classes



- The following operators can not be redefined
 - :: scope resolution
 - member selection
 - .* member selection through pointer to member
 - ? : ternary condition expression
 - sizeof
 - typeid
- The first 3 operators take a name, rather than value, as the second operand

Operator Functions

- It is not possible to define new operator token
 - For example: ** is not defined
- The name of an operator function is the keyword operator followed by the operator itself
 - For example: operator+
- Two ways of using operator function
 - Shorthand:

```
a + b
```

Explicit function call:

```
a.operator+(b); // a function call
```

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Binary Operators

- A binary operator can be defined by either a nonstatic member function taking one argument or a nonmember function taking two arguments.
 - Example:

Usage:

```
c = a + b;
c = a.operator+(b);
c = operator-(a, b);
```

Unary Operators

- A unary operator, whether prefix or postfix, can be defined by either a nonstatic member function taking no argument or a nonmember function taking one argument.
- Example:

```
class myClass {
    myClass operator++(); //nonstatic member function
}
myClass operator--(myClass a); // utility function
```

Usage:

```
++a;
a.operator++();
operator++(a);
```

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Postfix Unary Operator

- For any postfix unary operator a++, it can be interpreted as either a.operator++(int) or operator++(a,int)
- Example:

```
class myClass {
    myClass operator++(int); //nonstatic member function
}
myClass operator--(myClass a, int n); // utility function
```

Usage:

```
a++;
a.operator++(1);
operator++(a, 1);
```

 Please note the differences in implementation for prefix and postfix unary operators

Binary and Unary Operator Examples

```
class X {
   X* operator&(); // prefix unary operator &
   X operator&(X); // binary &
   X operator++(int); // postfix increment
   X operator&(X, X); // error ternary
   X operator/(); // error unary
};
                  // prefix unary minus
// binary minus
X operator-(X);
X operator-(X, X);
X operator--(&X, int); // postfix decrement
X operator-();
                      // error no argument
X operator-(X, X, X); // error, ternary
                       // error, unary
X operator%(X);
```

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Operators and User-Defined Types

- An operator function must be a member function or takes at least one user-defined type argument
 - Thus not changing existing expression (without user-defined objects)
- Operator function with a basic type as the first argument cannot be a member function
- =, [], (), -> must be nonstatic member function so that the first operand is an lvalue.
- Combinations of operators are not assumed
 - += is not + and =
 ++ is not +1 or += 1
- [=](assignment), & (address of) and , (sequencing) are predefined
 - but can be made to be private and thus not available to general users

Operators in Namespaces

- Operator function can be defined in namespaces
- Operator function is resolved for X@Y by
 - If X is a class, look for @ as member function of X or the base of X
 - Look for declarations of opertor@ in the context surrounding X@Y
 - If X is defined in namespace N, look for @ in N
 - If Y is defined in namespace M, look for @ in M
- Unary operator is resolved analogously

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Complex Number Type

- Operators can be defined such that most math shorthand symbols can be applied directly
 - Need copy assignment, assign with scalar, addition with scalar, adding to scalar, unary —, multiplication, etc
 - Minimize the number of functions that directly manipulate the representation of an object
 - Keep as member function
 - Other operators defined as nonmember functions
- Example: exq30.h, exq31.cpp, exq3.cpp

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Friends

- Member functions specify 3 things
 - They can access private data members
 - Function is in the scope of the class
 - The function must be invoked through an object of the class
- Static member function has only the first two properties
- A friend function has only the first property
- A friend function can be declared in either private or public part
- A member function can be a friend of another class
- All the member functions can be Friends of another. Shorthand representation

• Choose between making a class a member (nested class) or nonmember friend

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Subscripting

- The operator[] function can be used to give subscripts a meaning for a class object.
- The second argument, the subscript, may be of any type
- It can be used to define vectors, associative arrays, etc
- Example: exq4.cpp

```
i = tw["新竹"];
```

Constructors and Destructors

- A constructor is called when an object is created
- Three types of constructors exq5.cpp
 - Constructor without initialization

Complex z1;

Initialization constructor

Complex One(1, 0);

Copy constructor

Complex z2 = One;

- In function call, the constructor is called for
 - Arguments passed by value
 - And may be for return value
- A destructor is called when a variable is no longer needed
 - A variable is going out of scope
 - End-of-block for local variables
 - End-of-function-call for Passing-by-value arguments

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Summary

- Function overloading
- Operator overloading
- Operator functions
 - Binary operators
 - Unary operators
 - Postfix unary operators
 - Operator and user-defined types
- Complex numbers
- Subscripting

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