Operator Overloading

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Operator Overloading

- It is possible to overload the built-in C++ operators such as **+**, **>=**, and **++** so that they invoke different functions, depending on their operands.
- That is, the + in **a+b** will call one function if **a** and **b** are integers, but will call a different function if **a** and **b** are objects of a class you've created.

Operator Overloading, con't

- Overloading doesn't actually add any capabilities to C++. Everything you can do with an overloaded operator you can also do with a function.
- However, overloaded operators make your programs easier to write, read, understand and maintain.
- Remember, code is read much more than it is written.

Operator Overloading - limitations

- You can't overload operators that don't already exist in C++. You can't make up a ** operator for (say) exponentiation. **You can overload only the built-in operators**.
- Even a few of these, such as the dot operator (.), the scope resolution operator (::), the conditional operator (?:), and **sizeof**, can't be overloaded.
- The C++ operators can be divided roughly into binary and unary.
- Binary operators take two arguments. Examples are **a+b**, **a-b**, **a/b**, and so on. Unary operators take only one argument: **-a**, **++a**, **a--**.
- If a built-in operator is binary, then all overloads of it remain binary. It is also true for unary operators.
- Operator precedence and syntax (number of arguments) cannot be changed through overloading. For example operator * has always higher precedence than operator +.
- All the operators used in expressions that contain only built-in data types cannot be changed. For example you can never overload operator '+' for integers so that **a = 1 + 7;** behaves differently.
- At least one operand must be of a user defined type (class).

Overloading the '+' operator

```
// A class to define complex numbers
class ComplexT{
    double re, im;
  public:
            :                                        // Member functions
    ComplexT operator+(const ComplexT&) const;       // prototype of
                                                     operator+ function
};
// The Body of the function for operator +
ComplexT ComplexT::operator+(const ComplexT& z) const{
   double re_new, im_new;
   re_new = re + z.re;
   im_new = im + z.im;
   return ComplexT(re_new, im_new);  //constructor ComplexT(double,double)
                                          is needed
}
int main(){
     ComplexT z1(1,1), z2(2,2) , z3;
      :                                  // Other operations
     z3 = z1 + z2;                       // like z3 = z1.operator+(z2);
```

See Example e51.cpp

Overloading the '=' operator

- Because assigning an object to another object of the same type is an activity most people expect to be possible, the compiler will automatically create a **type::operator=(const type &)** if you don't make one.
- The behavior of this operator is member wise assignment. It assigns (copies) each member of an object to members of another object.
- If this operation is sufficient you don't need to overload the assignment operator.
- For example, overloading of assignment operator for complex numbers is not necessary.

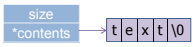
```
void ComplexT::operator=(const ComplexT& z){    // unnecessary
    re = z.re;                  // Member wise assignment
    im = z.im;
}
```

See Example e52.cpp

- You don't need to write such an assignment operator function, because the operator provided by the compiler does the same thing.

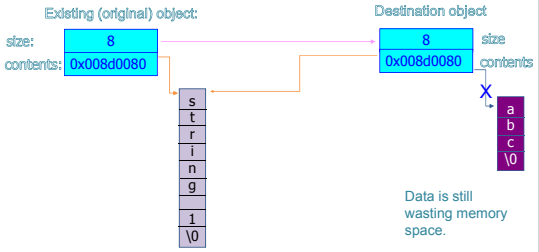
Overloading the '=' operator, con't

- In general, you don't want to let the compiler do this for you. With classes of any sophistication (especially if they contain pointers!) you want to explicitly create an **operator=**.
- **Example**, the **String** class:

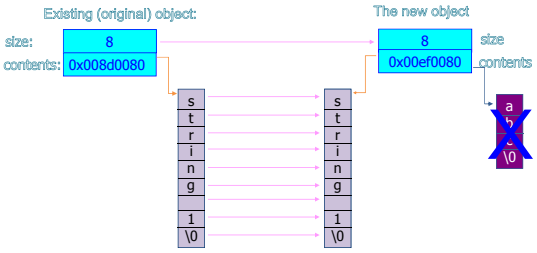



```
class String{
    int size;
    char *contents;
 public:
    void operator=(const String &);          // assignment operator
    :                                        // Other methods
};
void string::operator=(const String &in_object)  {
   if (size != in_object.size){  // if the sizes of the source and
       size = in_object.size;    // destination objects are different
       delete [] contents;       // The old contents is deleted
       contents = new char[size+1];   // Memory alloc. for the new contents
   }
   strcpy(contents, in_object.contents);    // not a memberwise assignment
}
```


'=' operator provided by the compiler



'=' operator provided by the programmer



Return value of the Assignment Operator

- When there's a void return value, as shown in the previous example, you can't chain the assignment operator (as in **a = b = c**).
- To fix this, the assignment operator must return a **reference to the object** that called the operator function (its address).

```
// Assignment operator , can be chained as in  a = b = c
const String& String::operator=(const String &in_object){
    if (size != in_object.size){ // if the sizes of the source and
       size = in_object.size;    // destination objects are different
       delete [] contents;       // The old contents is deleted
       contents = new char[size+1]; // Memory alloc. for the new contents
   }
   strcpy(contents, in_object.contents);
   return *this;                    // returns a reference to the object
}
```

- The difference between the assignment operator and the copy constructor is that the **copy constructor** actually **creates a new object** before copying data from another object into it, whereas **the assignment operator** copies data into **an already existing** object.

See Example e53.cpp

Overloading the Subscript operator '[]'

- Same rules apply to all operators. So we don't need to discuss each operator. However, we will examine some interesting operators.
- One of the interesting operators is the subscript operator.
- It is declared usually, in two different ways:

```
class C{
   returntype & operator [] (paramtype); // for the left side of an
                                          assignment
         or
   const returntype & operator [] (paramtype) const; // for the right side
};
```

The first declaration can be used when the overloaded subscript operator modifies the object. The second declaration is used with a const object; in this case, the overloaded subscript operator can access but not modify the object.

If **c** is an object of class **C**, the expression

c[i] is interpreted as **c.operator[ ](i)**

Overloading the Subscript operator '[]', con't

- **Example:** Overloading of the subscript operator for the **String** class. The operator will be used to access the ith character of the string. If i is less then zero then the first character and if i is greater than the size of the string the last character will be accessed.

```
// Subscript operator
char & String::operator[](int i)  {
    if(i < 0)
       return contents[0];         // return first character
    if(i >= size)
       return contents[size-1];            // return last character
    return contents[i];                    // return i th character
}
int main(){
    String s1("String 1");
    s1[1] = 'p';                    // modifies an element of the contents
    s1.print();
    cout << " 5 th character of the string s1 is: " << s1[5] << endl;
    return 0;
}
```

See Example e54.cpp

Overloading the function call operator '()'

- The function call operator is unique in that it allows any number of arguments.

```
class C{
   returntype  operator ( ) (paramtypes);
};
```

If **c** is an object of class **C**, the expression **c(i, j, k)** is interpreted as **c.operator()(i, j, k)**

- **Example:** The function call operator is overloaded to print complex numbers on the screen. In this example the function call operator does not take any arguments.

```
// The function call operator without any argument, it
   prints a complex number
void ComplexT::operator( )( ) const {
    cout << re << " , " << im <<  endl ;
}
```

See Example e55.cpp

Overloading the function call operator '()'

Example: The function call operator is overloaded to copy a part of the contents of a string into a given memory location.

In this example the function call operator takes two arguments: the address of the destination memory and the numbers of characters to copy.

```
// The function call operator with two arguments
void String::operator( )( char * dest, int num) const {
    if (num > size) num=size;                // if num is greater the size
   of the string
    for (int k=0; k < num; k++)  dest[k]=contents[k];
}
// ----- Main function -----
int main( ){
    String s1("Example Program");
    char * c = new char[8];        // Destination memory
    s1(c,7);               // First 7 letters of string1 are copied into c
    c[7] = '\0';           // End of string (null) character
    cout << c;
    delete [] c;
    return 0;
}
```

See Example e56.cpp

Overlaoding Unary Operators

- Unary operators operate on a single operand. Examples are the increment (++) and decrement (--) operators; the unary minus, as in -5; and the logical not (!) operator.
- Unary operators take no arguments, they operate on the object for which they were called. Normally, this operator appears on the left side of the object, as in !obj, -obj, and ++obj.
- **Example:** We define ++ operator for class ComplexT to increment the real part of the complex number by 0.1 .

```
void ComplexT::operator++(){
     re=re+0.1;
}
int main(){
    ComplexT z(1.2, 0.5);
    ++z;                // operator++ function is called
    z.print();
    return 0;
}
```


Overloading the operator '++'

- To be able to assign the incremented value to a new object, the operator function must return a reference to the object.

```
// ++ operator
// increments the real part of a complex number by 0.1
const ComplexT & ComplexT::operator++(){
     re=re+0.1;
     return *this;
}
int main(){
    ComplexT z1(1.2, 0.5), z2;
    z2 = ++z1;// ++ operator is called, incremented value is
   assigned to z2
    z2.print();
    return 0;
}
```

See Example e57.cpp

"Pre" and "Post" forms of operators "++" and "--"

- Recall that ++ and -- operators come in a "pre" and "post" form. If these operators are used with an assignment statement than different forms have different meanings.

```
z2= ++ z1;      // preincrement
z2 = z1++;      // postincrement
```

- The declaration, **operator ++ ( )** with no parameters overloads the preincrement operator.
- The declaration, **operator ++ (int)** with a single **int** parameter overloads the postincrement operator. Here, the int parameter serves to distinguish the postincrement form from the preincrement form. This parameter is not used.

```
ComplexT ComplexT::operator++(int) { // postincrement operator
     ComplexT temp;
     temp = *this;            // old value (original objects)
     re= re + 0.1;            // increment the real part
     return temp;             // return old value
}
```

See Example e58.cpp