5 Operator Overloading

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.
- ► **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.
- ► Operator overloading makes your program **easier** to write and to understand.
- ► Overloading does not 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, and maintain.

Operator Overloading

- ►Operator overloading is only another way of calling a function.
- ►You have no reason to overload an operator except if it will make the code involving your class easier to write and especially easier to read.
- ►Remember that code is read much more than it is written

Limitations

- You can’t overload operators that don’t already exist in C++. You can overload only the built-in operators.
- You can not overload the following operators

.

*

->

,

::

?:

sizeof

Limitations

- ►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.
- ►All the operators used in expressions that contain only built-in data types cannot be changed. At least one operand must be of a user defined type (class).

Overloading the + operator for ComplexT

```
/* A class to define complex numbers */
class TComplex {
    float real,img;
  public:
          :   // Member functions
    TComplex operator+(TComplex&); // header of operator+
function
};
/* The Body of the function for operator + */
TComplex TComplex::operator+(TComplex& z) {
   TComplex result;
   result.real = real + z.real;
   result.img = img + z.img;
   return result;
}
```

```
int main() {
   TComplex z1,z2,z3;
    :    // Other operations
    z3=z1+z2; like z3 = z1.operator+(z2);
}
```

Overloading the Assignment 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. (Shallow Copy)
- 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.

Overloading the Assignment Operator (=)

```
void ComplexT::operator=(const ComplexT& z)
{
    re = z.re;
    im = z.im;
}
```

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

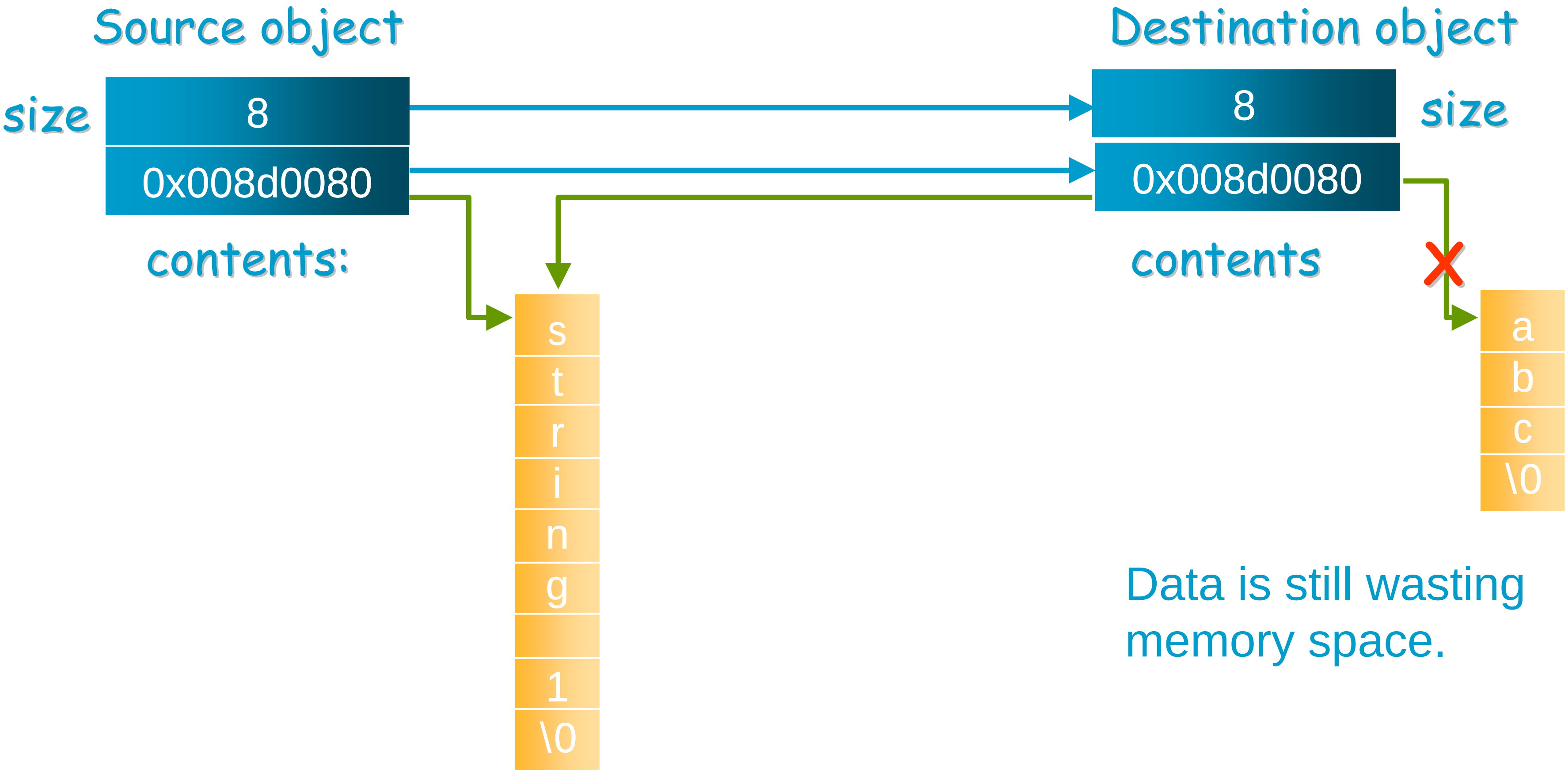
Overloading the Assignment Operator (=)

- 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

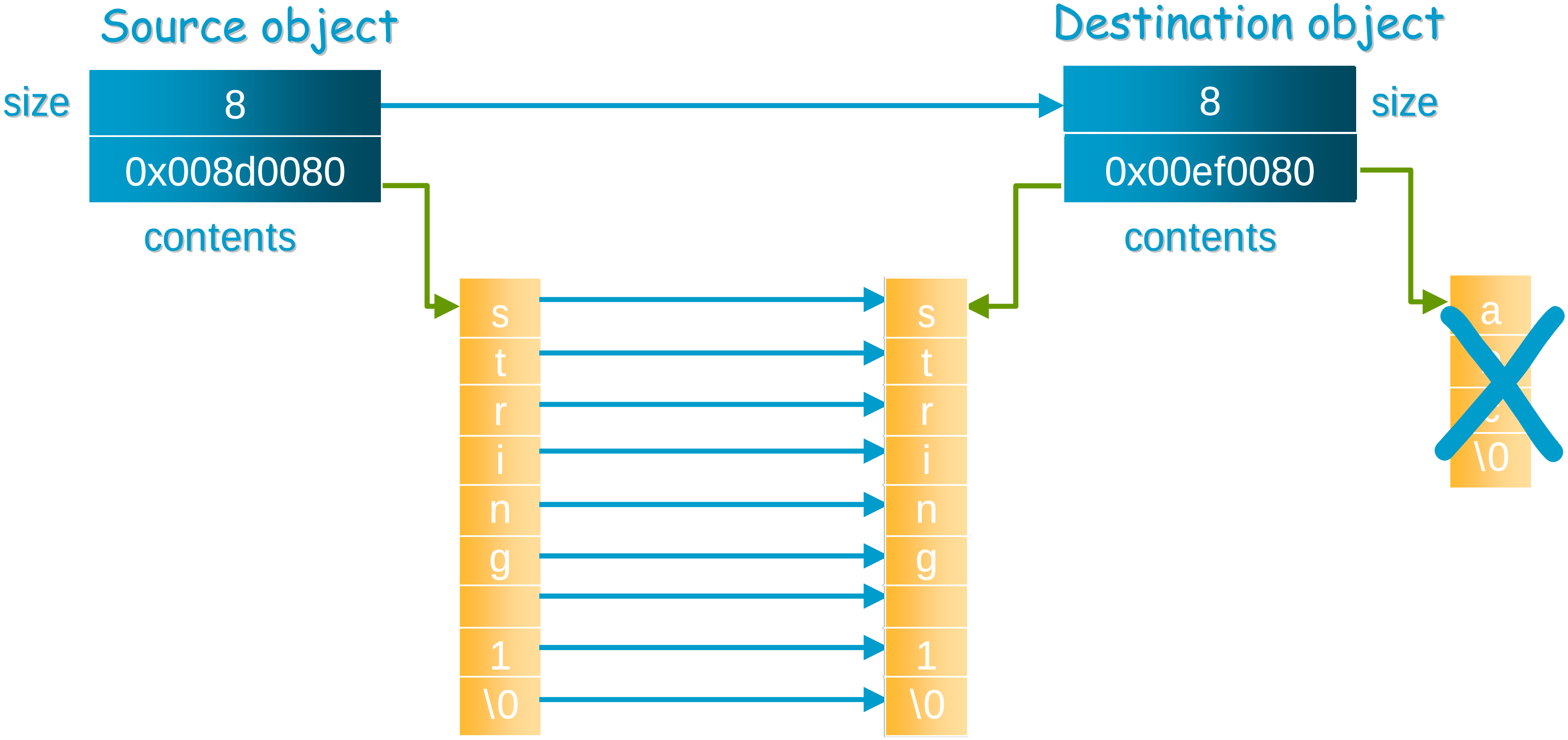
```
class string {
   int size;
   char *contents;
 public:
   void operator=(const string &);  // assignment operator
   :         // Other methods
};
void string::operator=(const string &s)
{
   size = s.size;
   delete []contents;
   contents = new char[size+1];
   strcpy(contents, s.contents);
}
```

Operator Provided by the Compiler



Data is still wasting memory space.

Operator of the Programmer



5 Operator Overloading

Return value of the assignment operator

- When there’s a void return value, 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 destination
       size = in_object.size;    // objects are different
       delete [] contents;      // The old contents is deleted
       contents = new char[size+1]; // Memory allocation for the new contents
   }
   strcpy(contents, in_object.contents);
   return *this;         // returns a reference to the object
}
```

Copy Constructor *vs.* Assignment Operator

- 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.

Copy Constructor *vs.* Assignment Operator

- A a;
- A b(a);
- b=a;
- A c=a;

Overloading 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 .

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

```
void ComplexT::operator++() {
    re=re+0.1;
}
```

►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;
}
```

Overloading the “[]” 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 can be declared in two different ways:

```
class C {
   returntype & operator [] (paramtype);
        or
   const returntype & operator [] (paramtype) const;
};
```

Overloading the “[]” Operator

►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)

►Example: Overloading of the subscript operator for the String class. The operator will be used to access the **i**th character of the string. If **i** is less the 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;
}
```

Overloading the “()” 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 ;
}
```

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];
}

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;
}
```

"Pre" and "post" form of operators ++ and --

►Recall that ++ and -- operators come in “pre” and “post” form.

►If these operators are used with an assignment statement than different forms has 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.

Post-Increment Operator

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

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Pre-Increment Operator

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