Operator Overloading

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Administrivia

- If you submitted GraphViz and haven't gotten an email, you got credit!
- Keep working on Evil Hangman

Correction to Last Lecture

I deleted the wrong function when showing why we needed a const return type.

Let’s review that issue really quickly...

Correction to Last Lecture

See code in ConstCorrection.pro

Why Operator Overloading?

Let's say we were using our good old point class again:

```
Point a(1, 2);
Point a(2, 1);
```

Why Operator Overloading?

I want to be able to add points together and produce a result:

```
Point a(1, 1);
Point b(1, 2);
Point c = a + b;
```

Why Operator Overloading?

Unfortunately, the compiler doesn't know how to add points:

```
main.cpp:6: error: no match for
'operator+' (operand types are 'Point'
and 'Point')
     Point c = a + b;
                   ^
```

Operator Overloading

Operator Overloading allows us to define the meaning of "+" and other operators when used on a type we defined

What Can I Overload?

Here's a sample of some of the operators you can overload (there are many more):

Arithmetic	`+, -, *, /, %`
Comparison	`!=, ==, <, <=, >, <=`
Access	`[], *, ->`
Stream	`<<, >>`
Scary	`new, delete, ','`

Operator Overloading

Let’s start by overloading a simple operator: the == operator.

Operator Overloading

- Two `Point`s are equal if there `x` and `y` coordinates are the same.
- How can we write this as an operator overload?
- Two ways:
  - Member function syntax
  - Free function syntax

Operator Overloading

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Member Function Syntax

- The preferred way to overload an operator is to add a member function with a special name (`operator==` in this case)
- The left hand side of the operator is the object whose member function is called
- The member function takes one argument, which is the right hand side of the operator
- By convention, `operator==` returns a `bool`

Member Function Syntax

```
Class Point { // abbreviated
   int x, y;
    bool operator==(const Point& rhs) {
       return (x == rhs.x  && y == rhs.y);
    }
};
```

Member Function Syntax

```
Class Point { // abbreviated
   bool operator==(const Point& rhs) {
      return (x == rhs.x  && y == rhs.y);
   }
};
Point p1(3, 2);
Point p2(3, 2);
if (p1 == p2)
   cout << “Points are equal!” << endl;
```

Member Function Syntax

```
Class Point { // abbreviated
   bool operator==(const Point& rhs) {
      return (x == rhs.x  && y == rhs.y);
   }
};
Point p1(3, 2);
Point p2(3, 2);
if (p1.operator==(p2))
   cout << “Points are equal!” << endl;
```

Operator Overloading

- Two `Points` are equal if there `x` and `y` coordinates are the same.
- How can we write this as an operator overload?
- Two ways:
  - Member function syntax
  - Free function syntax

Free Function Syntax

```
bool operator==(Point l, Point r) {
   return l.x == r.x && l.y == r.y;
}
Point p1(1, 2);
Point p2(1, 2);
if (p1 == p2)
   cout << “Points are equal!” << endl;
```

Free Function Syntax

```
bool operator==(Point l, Point r) {
   return l.x == r.x && l.y == r.y;
}
Point p1(1, 2);
Point p2(1, 2);
if (operator==(p1, p2))
   cout << “Points are equal!” << endl;
```

Free Function Syntax

Here’s a better example of when you need free function syntax -- multipliplying a point by a scalar.

Free Function Syntax

```
Point operator*(double l, Point r) {
   Point result(l * r.x, l * r.y);
   return result;
}
Point p(1, 1);
Point result = 5 * p;
result.print(); // prints (5, 5)
```

A Word of Caution

Operator Overloading should only be used when the meaning of the operator is obvious:

```
Point p1, p2;
Point result = p1 + p2;
Point scaledResult = 5 * result;

string one = “hi”, two = “hello”;
bool stringsSame = (one == two);
```

A Word of Caution

Operator overloading can be abused, and the results are scary:

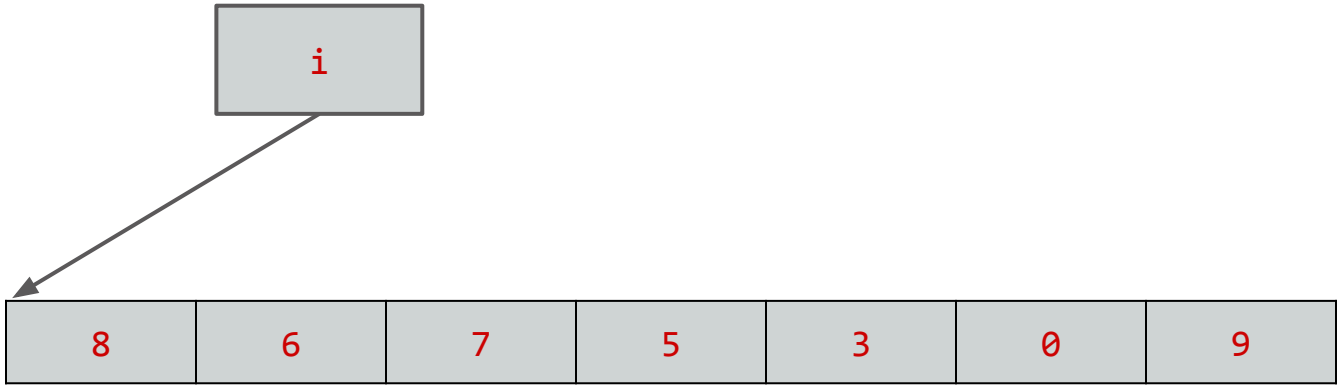
```
// This works with a Stanford vector
Vector<int> v;
1, 2, v, 4;
cout << v[0] << endl; // ?
```

A Slightly More Advanced Overload

Let’s try adding some overloads to our vector type.

Vector Iterator

Remember how we could just a pointer for a `vector`'s iterator?



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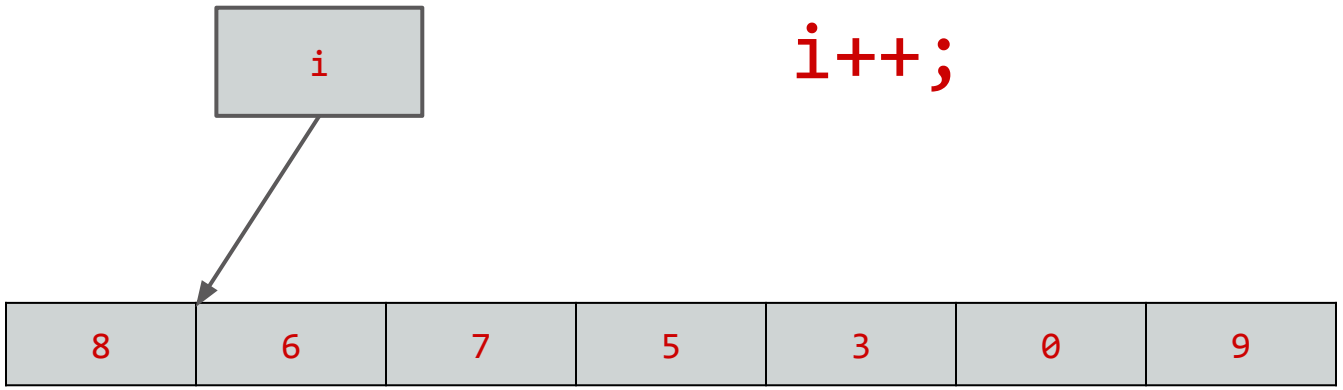

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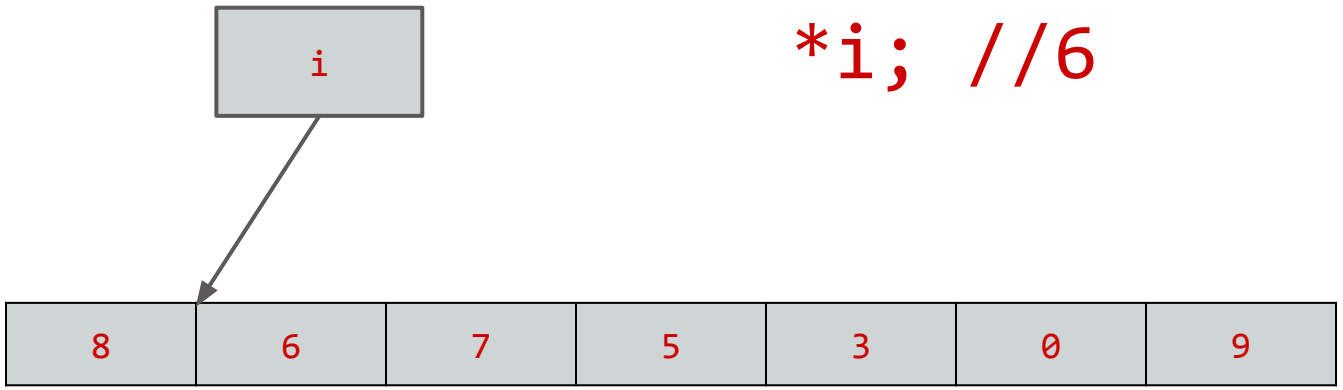
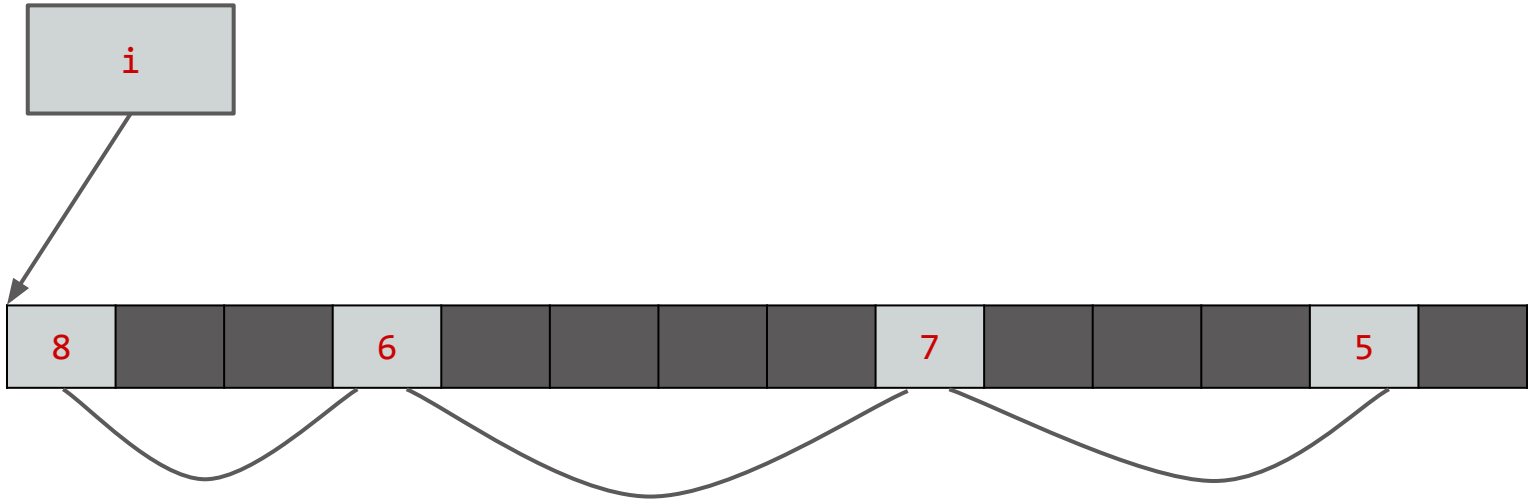


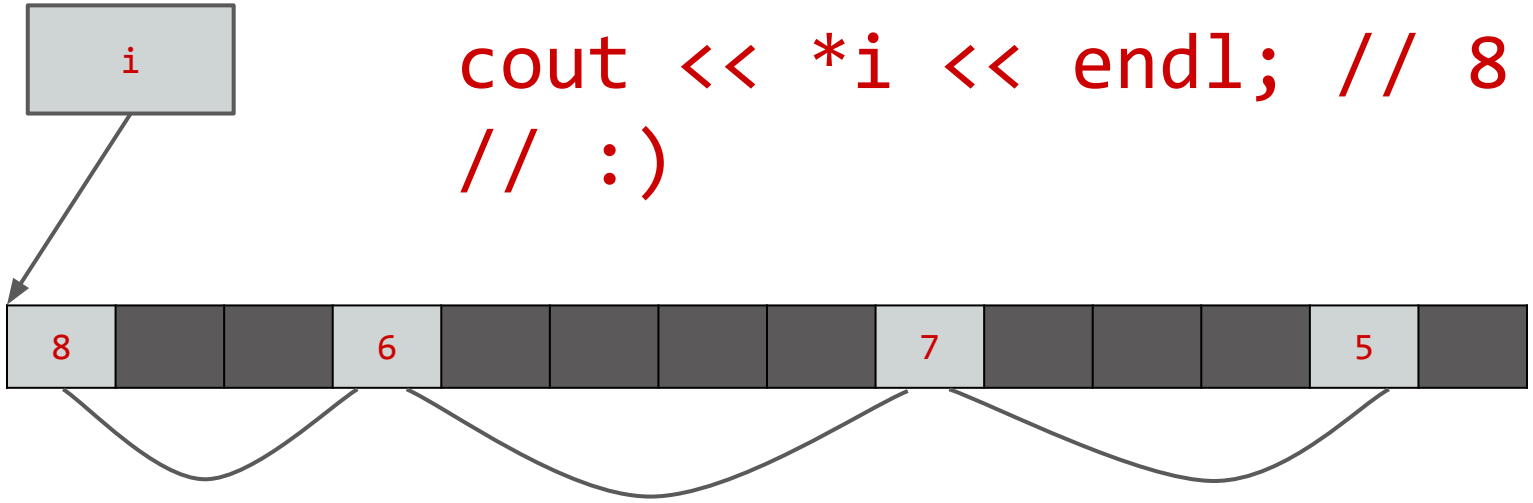
Linked List Iterator

Can we do the same thing for linked lists?

Linked List Iterator

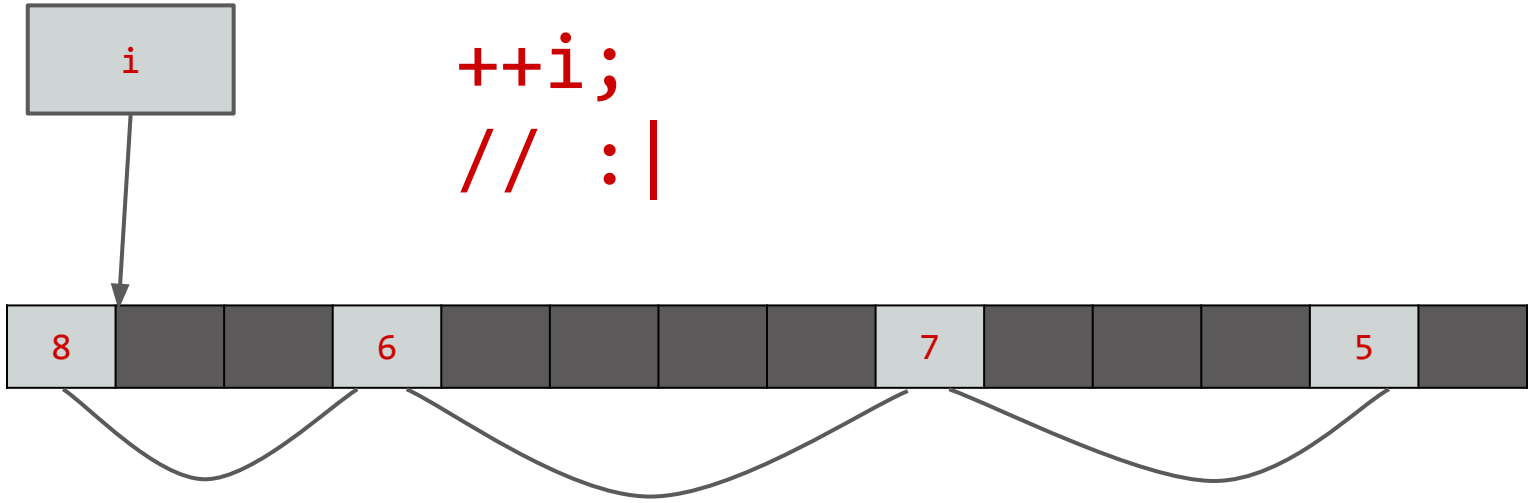


Linked List Iterator

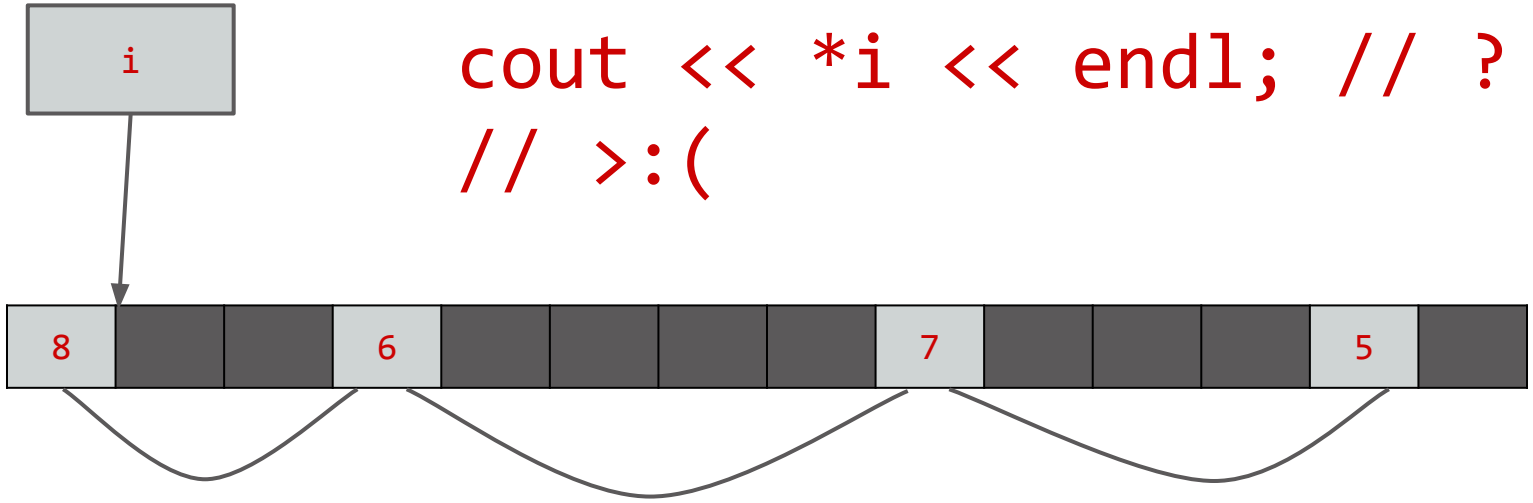



```
cout << *i << endl; // 8
// :)
```

Linked List Iterator



Linked List Iterator




```
cout << *i << endl; // ?
// >:(
```

++i vs i++

```
int i = 1;    // i = 1
int j = i++; // j = 1, i = 2
int k = ++i; // k = 3, i = 3
```

++i vs i++

```
// create a vector of ints called nums
vector<int>::iterator i = nums.begin();

vector<int>::iterator j = i++;
vector<int>::iterator k = ++i;
```

++i vs i++

```
class foo {
  // Define ++foo
  foo operator++() {

  }
  // Define foo++
  foo operator++(int) {

  }
}
```