

Objects and classes, advanced topics

Victor Eijkhout, Susan Lindsey

Fall 2023

last formatted: November 6, 2023

Operator overloading

1. Better syntax

Operations that ‘feel like arithmetic’“

So far:

```
Point p3 = p1.add(p2);  
Point p4 = p3.scale(2.5);
```

Improved:

```
Point p3 = p1+p2;  
Point p4 = p3*2.5;
```

This is possible because you can *overload* the *operators*. For instance,

```
// geom/overload.cpp  
Point operator*( float f ) {  
    return Point( x*f,y*f );  
}
```

2. Operator overloading

Syntax:

```
<returntype> operator<op>( <argument> ) { <definition> }
```

For instance:

Code:

```
1 // geom/pointscale.cpp
2 Point Point::operator*(double f) {
3     return Point(f*x,f*y);
4 };
5     /* ... */
6 cout << "p1 to origin "
7     << p1.dist_to_origin() <<
8     '\n';
9     Point scale2r = p1*2.;
10    cout << "scaled right: "
11        << scale2r.dist_to_origin()
12        << '\n';
13    // ILLEGAL Point scale2l = 2.*p1;
```

Output:

```
p1 to origin 2.23607
scaled right: 4.47214
```

Exercise 1

Define the plus operator between *Point* objects. The declaration is:

```
Point operator+(Point q);
```

You can base this off the file `overload.cpp` in the repository

Exercise 2

Revisit exercise ?? and replace the *add* and *scale* functions by overloaded operators.

Hint: for the *add* function you may need `'this'`.

3. Functor example

Simple example of overloading parentheses:

Code:

```
1 // object/functor.cpp
2 class IntPrintFunctor {
3 public:
4     void operator()(int x) {
5         cout << x << '\n';
6     }
7 };
8     /* ... */
9     IntPrintFunctor intprint;
10    intprint(5);
```

Output:

5

Exercise 3

Evaluate a linear function:

Using method:

```
// geom/overload.cpp
LinearFunction line(p1,p2);
cout << "Value at 4.0: "
      << line.evaluate_at(4.0)
      << '\n';
```

using operator:

```
// geom/overload.cpp
float y = line(4.0);
cout << y << '\n';
```

Write the appropriate overloaded operator.

You can base this off the file `overload.cpp` in the repository

Inherit from containers

4. Has-a std container

You could write

```
class namedvec {  
private:  
    std::string name;  
    std::vector<double> contents;  
public:  
    namedvec( std::string n,int s );  
    // ...  
};
```

The problem now is that for every vector method, *at*, *size*, *push_back*, you have to re-implement that for your *namedvec*.

5. Inherit from vector

Named vector inherits from standard vector:

```
// object/container.cpp
#include <vector>
#include <string>
class namedvector
    : public std::vector<int> {
private:
    std::string _name;
public:
    namedvector
        ( std::string n,int s )
        : _name(n)
        ,std::vector<int>(s) {};
    auto name() {
        return _name; };
};
```

```
// object/container.cpp
namedvector
    fivevec("five",5);
cout << fivevec.name()
    << ": "
    << fivevec.size()
    << '\n';
cout << "at zero: "
    << fivevec.at(0)
    << '\n';
```

Exercise 4

Extend the code from 11 to make *namedvector* templated.

```
// object/container.cpp
temptvector<int> fivetemp("five",5);
cout << fivetemp.name()
    << ": "
    << fivetemp.size() << '\n';
cout << "at zero: "
    << fivetemp.at(0) << '\n';
```

Exercise 5

Extend the code from 11 and 4 to make a namespaced class `geo::vector` that has the functionality of *namedvector*.

```
// object/container.cpp
using namespace geo;
geo::vector<int> fivegeo("five",5);
cout << fivegeo.name()
      << ": "
      << fivegeo.size() << '\n';
cout << "at zero: "
      << fivegeo.at(0) << '\n';
```

Internal access

6. Direct alteration of internals

Return a reference to a private member:

```
1 class Point {  
2 private:  
3     double x,y;  
4 public:  
5     double &x_component() { return x; };  
6 };  
7 int main() {  
8     Point v;  
9     v.x_component() = 3.1;  
10 }
```

Only define this if you need to be able to alter the internal entity.

7. Reference to internals

Returning a reference saves you on copying.

Prevent unwanted changes by using a 'const reference'.

```
1 class Grid {
2 private:
3     vector<Point> thepoints;
4 public:
5     const vector<Point> &points() const {
6         return thepoints; };
7 };
8 int main() {
9     Grid grid;
10    cout << grid.points()[0];
11    // grid.points()[0] = whatever ILLEGAL
12 }
```


8. Access gone wrong

We make a class for points on the unit circle

```
1 // object/unit.cpp
2 class UnitCirclePoint {
3 private:
4     float x,y;
5 public:
6     UnitCirclePoint(float x) {
7         setx(x); };
8     void setx(float newx) {
9         x = newx; y = sqrt(1-x*x);
10    };
```

You don't want to be able to change just one of x,y !
In general: enforce invariants on the members.

9. Const functions

A function can be marked as const:
it does not alter class data,
only changes are through return and parameters

10. 'this' pointer to the current object

```
1 class MyClass {  
2 private:  
3     int myint;  
4 public:  
5     MyClass(int myint) {  
6         this->myint = myint; // `this' redundant!  
7     };  
8 };
```

11. 'this' use

You don't often need the `this` pointer. Example: you need to call a function inside a method that needs the object as argument)

```
1 /* forward definition: */ class someclass;
2 void somefunction(const someclass &c) {
3     /* ... */ }
4 class someclass {
5     // method:
6     void somemethod() {
7         somefunction(*this);
8     };
```

(Rare use of dereference star)

Headers

12. C headers plusplus

You know how to use `.h` files in C.

Classes in C++ need some extra syntax.

13. Data members in proto

Data members, even private ones, need to be in the header file:

```
1 class something {  
2 private:  
3   int localvar;  
4 public:  
5   // declaration:  
6   double somedo(vector);  
7 };
```

Implementation file:

```
1 // definition  
2 double something::somedo(vector v) {  
3   .... something with v ....  
4   .... something with localvar ....  
5 };
```

14. Static class members

A static member acts as if it's shared between all objects.

(Note: C++17 syntax)

Code:

```
1 // link/static17.cpp
2 class myclass {
3 private:
4     static inline int count=0;
5 public:
6     myclass() { ++count; };
7     int create_count() {
8         return count; };
9 };
10 /* ... */
11 myclass obj1,obj2;
12 cout << "I have defined "
13     << obj1.create_count()
14     << " objects" << '\n';
```

Output:

I have defined 2 objects

15. Static class members, C++11 syntax

```
1 // link/static.cpp
2 class myclass {
3 private:
4     static int count;
5 public:
6     myclass() { ++count; };
7     int create_count() { return count; };
8 };
9     /* ... */
10 // in main program
11 int myclass::count=0;
```