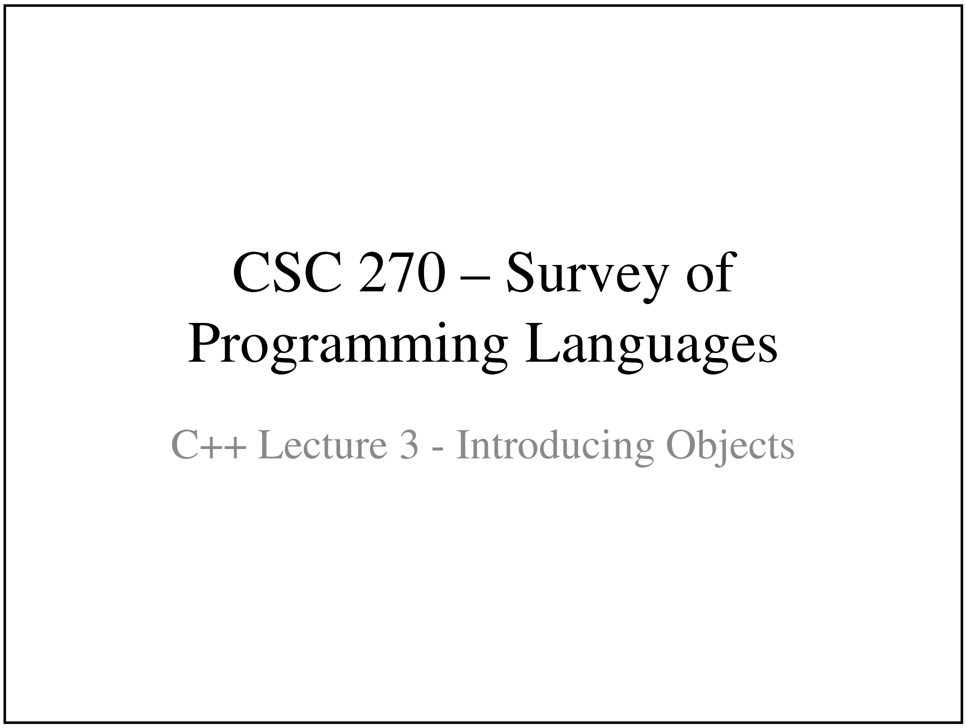
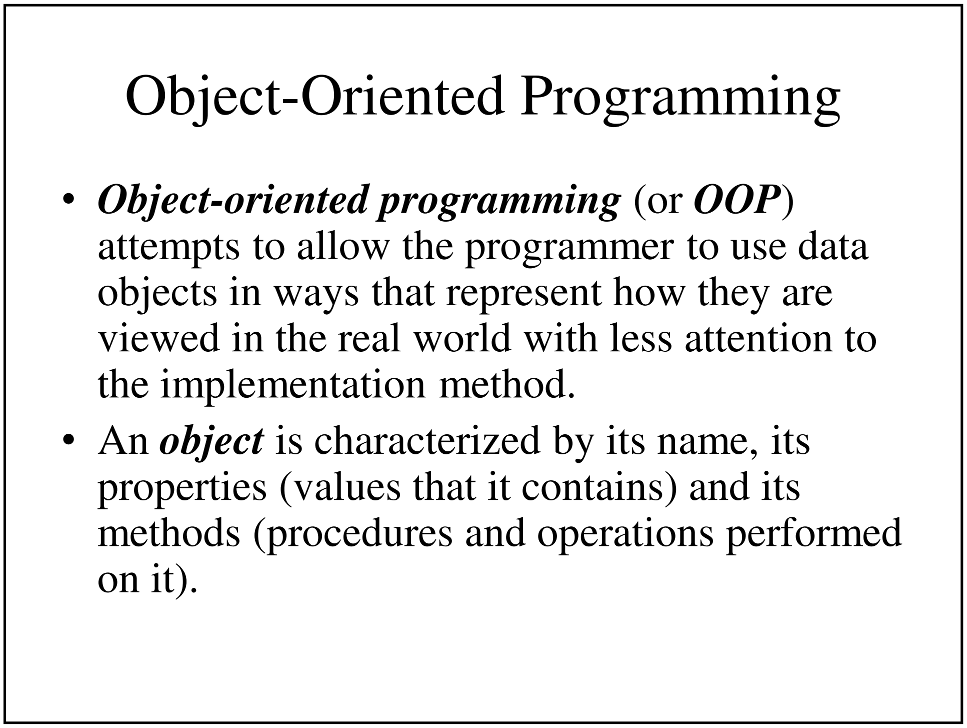


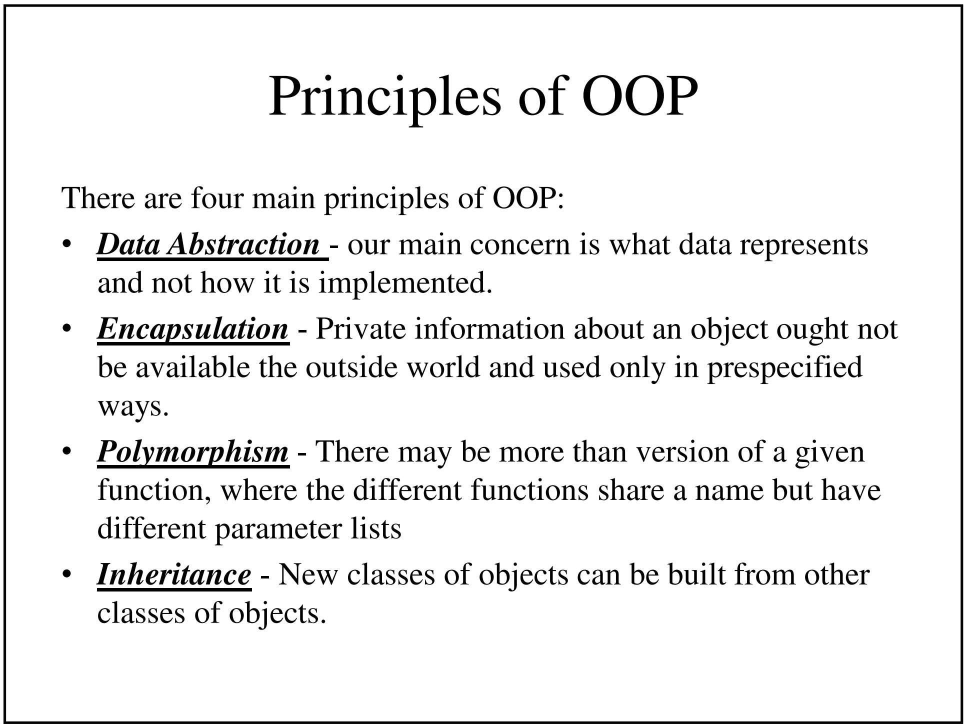
CSC 270 – Survey of Programming Languages

C++ Lecture 3 - Introducing Objects



Object-Oriented Programming

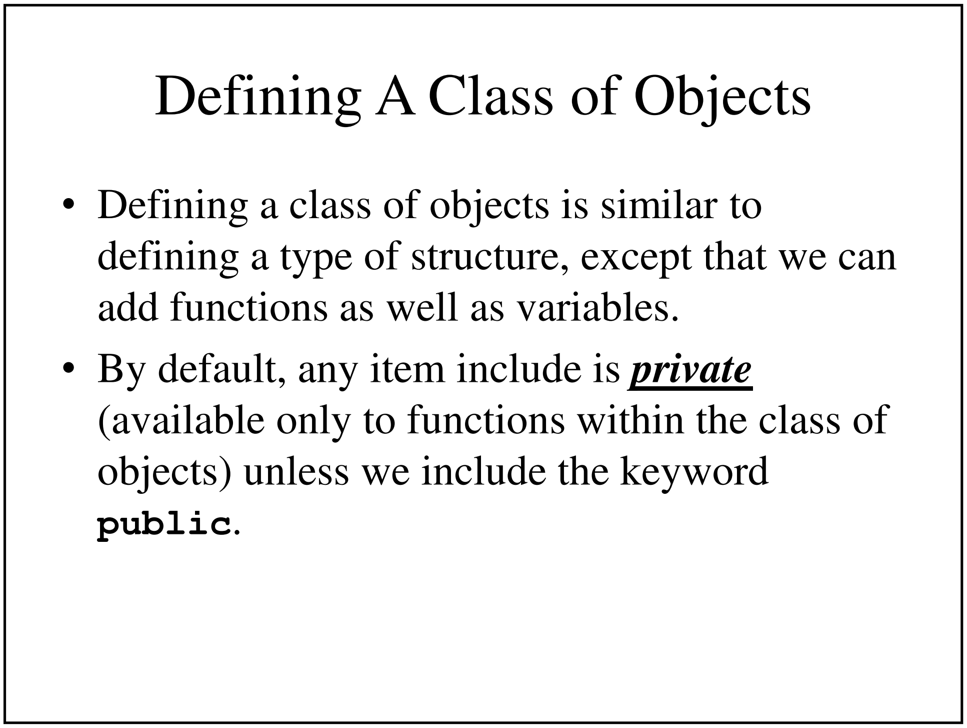
- ***Object-oriented programming*** (or ***OOP***) attempts to allow the programmer to use data objects in ways that represent how they are viewed in the real world with less attention to the implementation method.
- An ***object*** is characterized by its name, its properties (values that it contains) and its methods (procedures and operations performed on it).



Principles of OOP

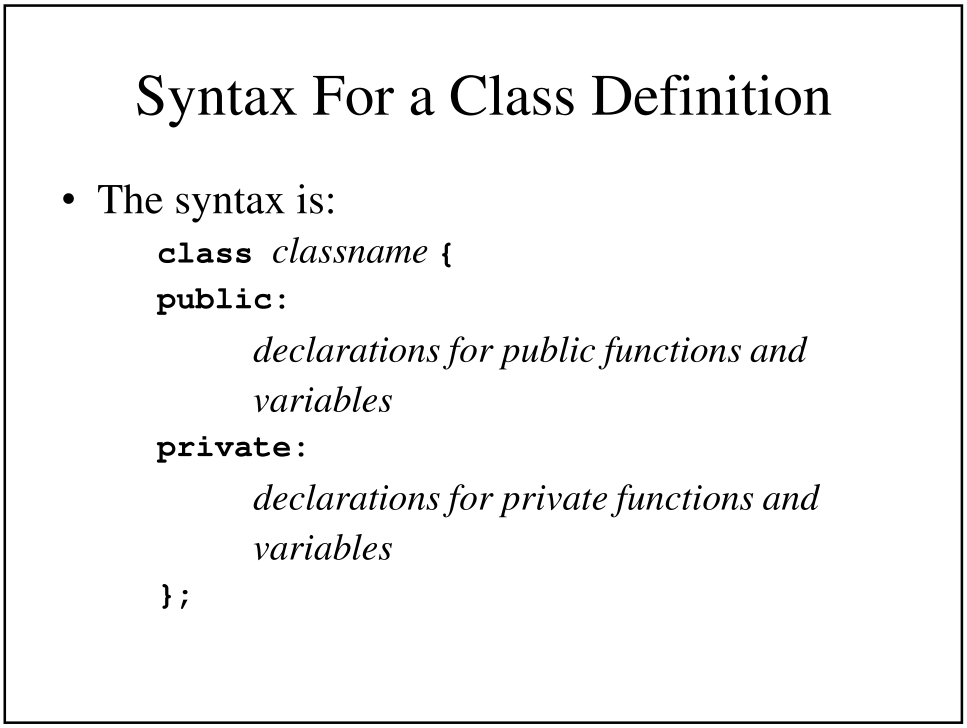
There are four main principles of OOP:

- ***Data Abstraction*** - our main concern is what data represents and not how it is implemented.
- ***Encapsulation*** - Private information about an object ought not be available the outside world and used only in prespecified ways.
- ***Polymorphism*** - There may be more than version of a given function, where the different functions share a name but have different parameter lists
- ***Inheritance*** - New classes of objects can be built from other classes of objects.



Defining A Class of Objects

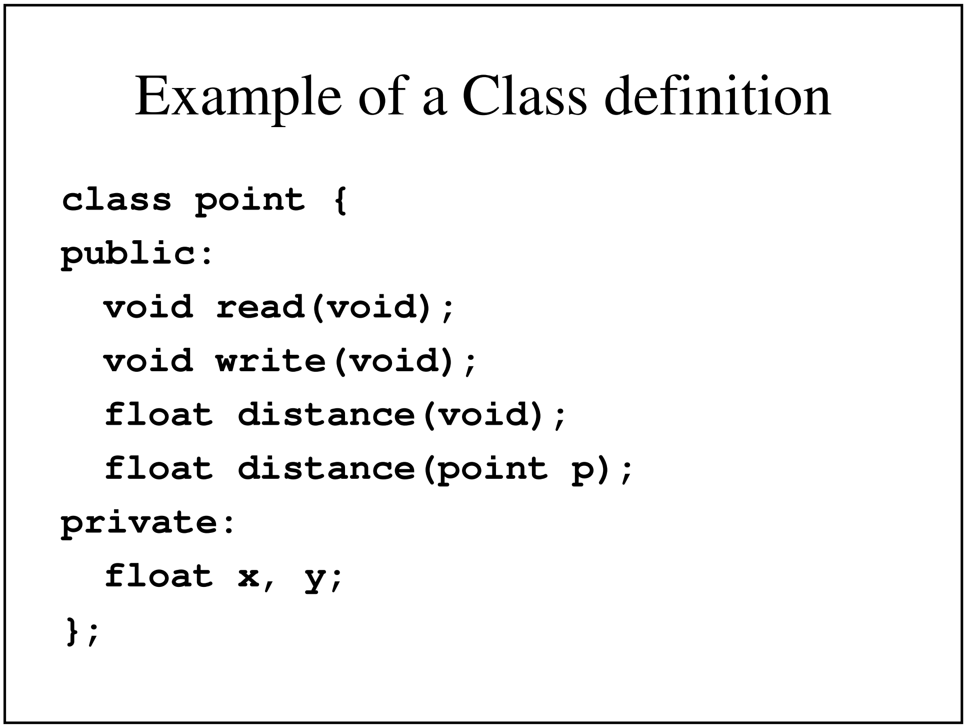
- Defining a class of objects is similar to defining a type of structure, except that we can add functions as well as variables.
- By default, any item include is ***private*** (available only to functions within the class of objects) unless we include the keyword **`public`**.



Syntax For a Class Definition

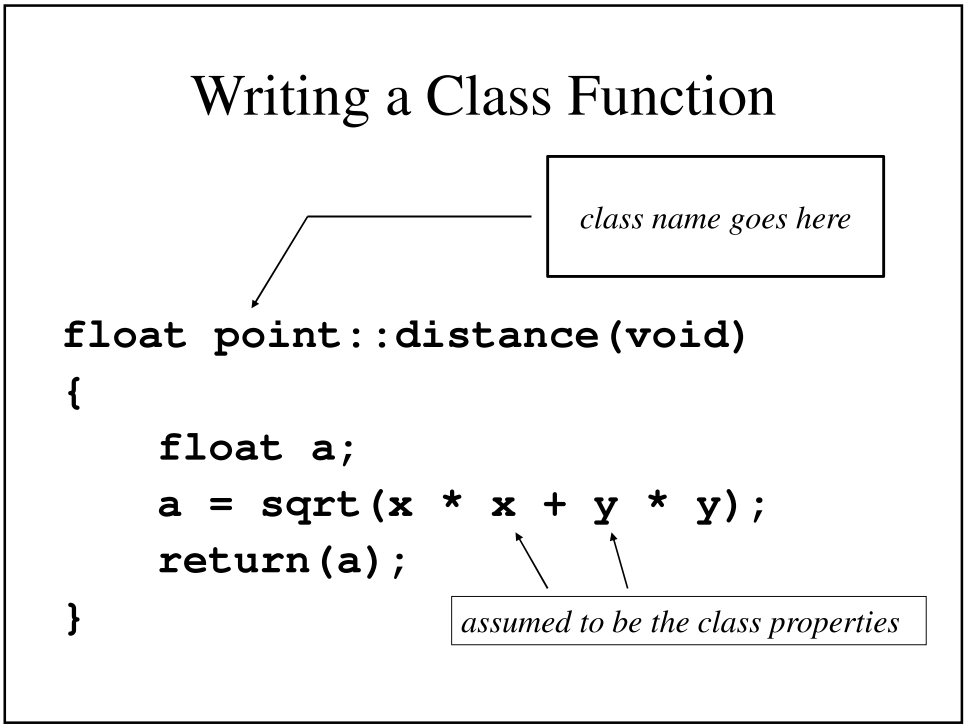
- The syntax is:

```
class classname {
public:
        declarations for public functions and
        variables
private:
        declarations for private functions and
        variables
};
```



Example of a Class definition

```
class point {
public:
  void read(void);
  void write(void);
  float distance(void);
  float distance(point p);
private:
  float x, y;
};
```

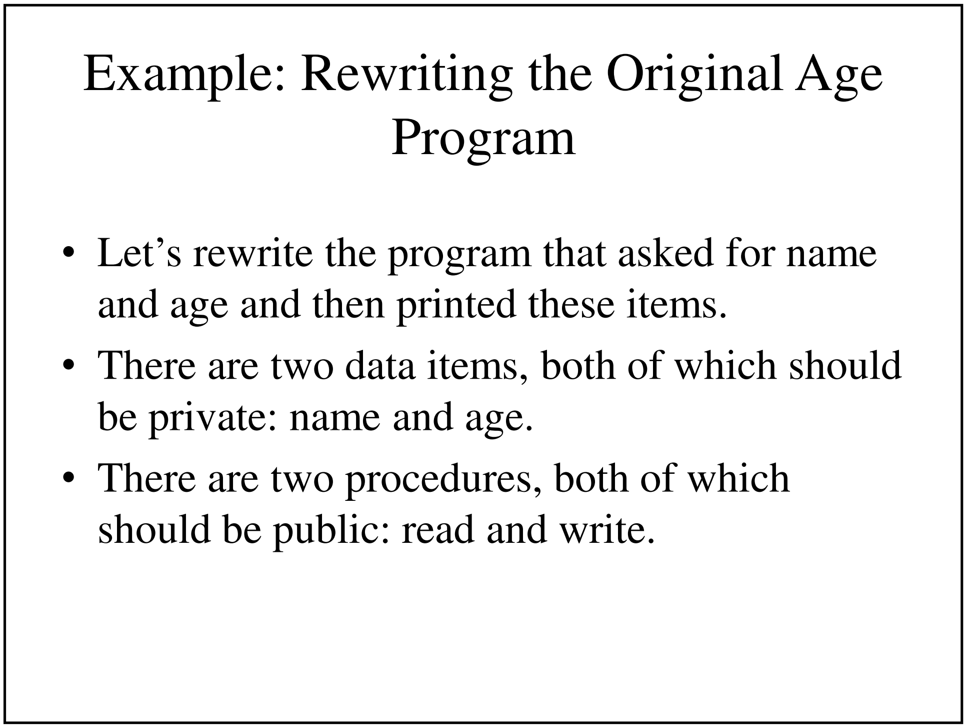


Writing a Class Function

class name goes here

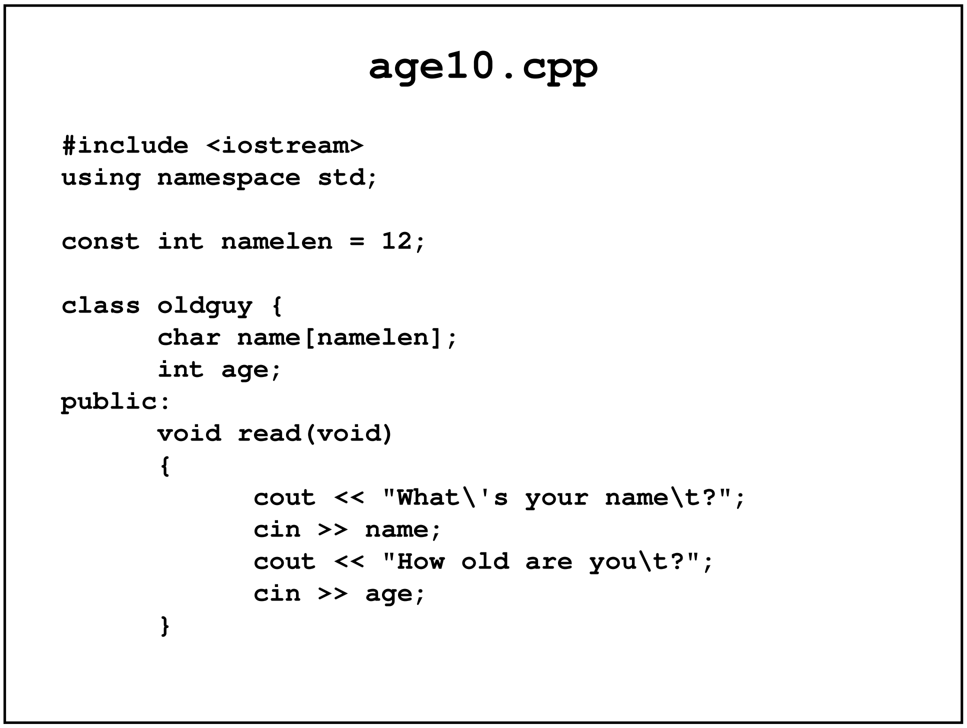
```
float point::distance(void)
{
    float a;
    a = sqrt(x * x + y * y);
    return(a);
}
```

assumed to be the class properties



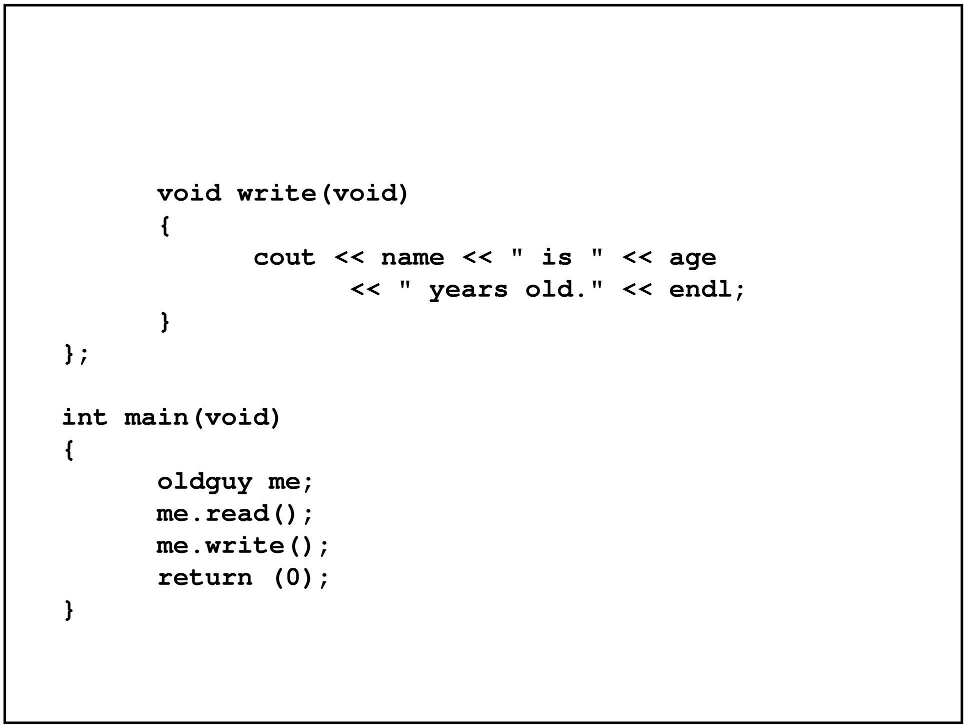
Example: Rewriting the Original Age Program

- Let’s rewrite the program that asked for name and age and then printed these items.
- There are two data items, both of which should be private: name and age.
- There are two procedures, both of which should be public: read and write.



age10.cpp

```
#include <iostream>
using namespace std;

const int namelen = 12;

class oldguy {
      char name[namelen];
      int age;
public:
      void read(void)
      {
            cout << "What\'s your name\t?";
            cin >> name;
            cout << "How old are you\t?";
            cin >> age;
      }
```



```
      void write(void)
      {
            cout << name << " is " << age
                  << " years old." << endl;
      }
};

int main(void)
{
      oldguy me;
      me.read();
      me.write();
      return (0);
}
```

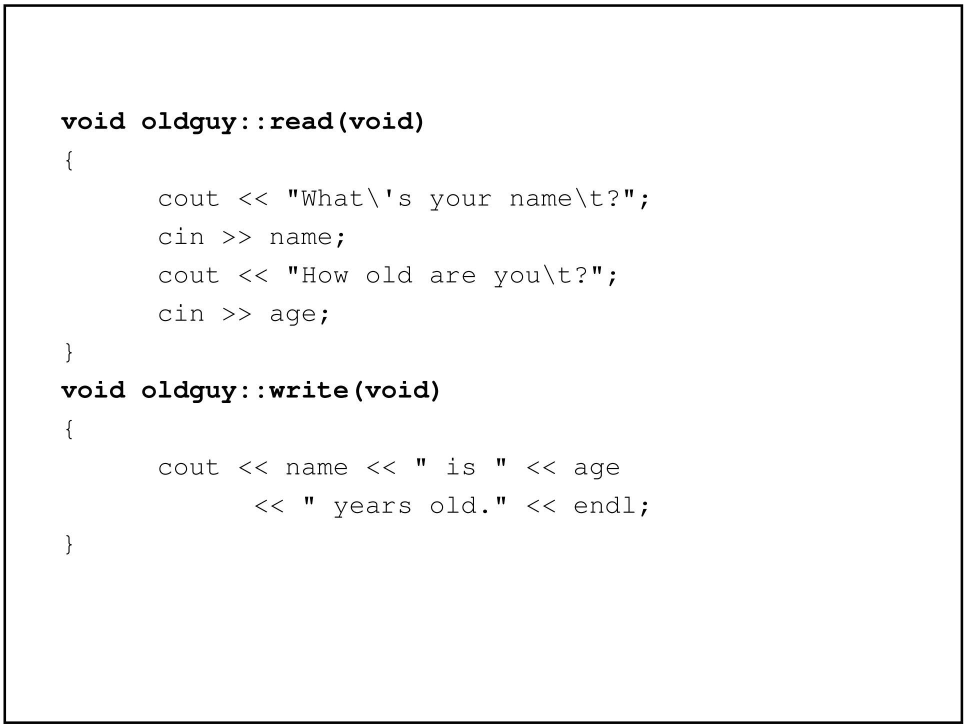
Putting **public** Before **private**

- It is better to place the public members of the class before the private member because these are the ones that we want programmers to think in term of.
- To ensure this, we place the keyword public at the top followed by the public members.
- Below the public members, we place the word private followed by the private members.
- We can write the body of the member function inside the declaration (if it’s short) or outside (where we must write

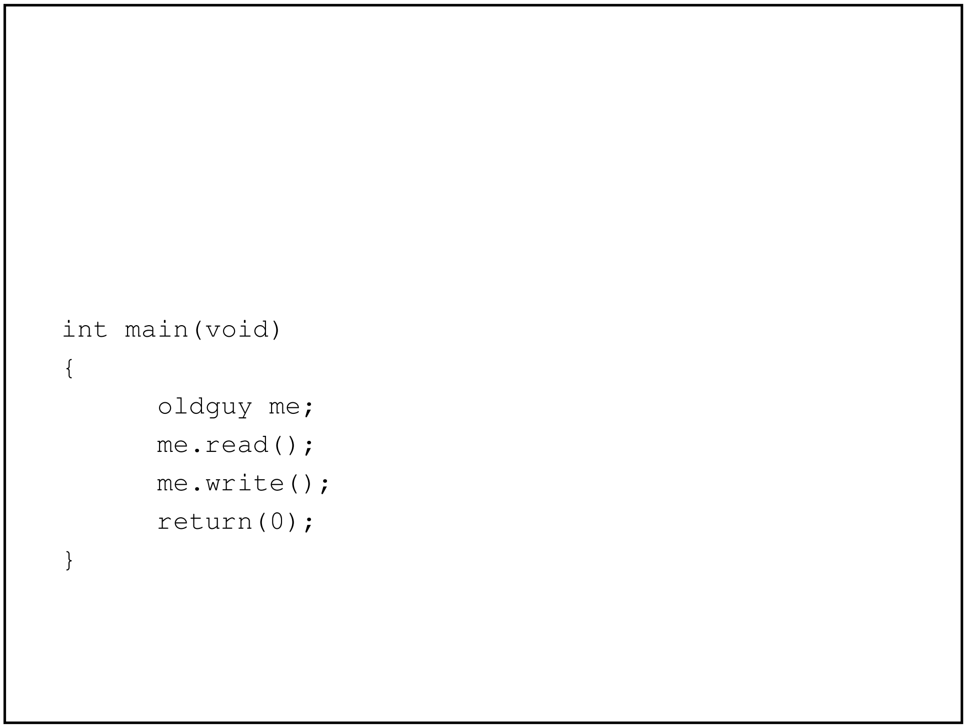
  `ClassName::` to indicate membership).

age11.cpp

```
#include <iostream>
using namespace std;

const int namelen = 12;

class oldguy {
public:
      void read(void);
      void write(void);
private:
      char name[namelen];
      int age;
};
```



```
void oldguy::read(void)
{
      cout << "What\'s your name\t?";
      cin >> name;
      cout << "How old are you\t?";
      cin >> age;
}
void oldguy::write(void)
{
      cout << name << " is " << age
            << " years old." << endl;
}
```



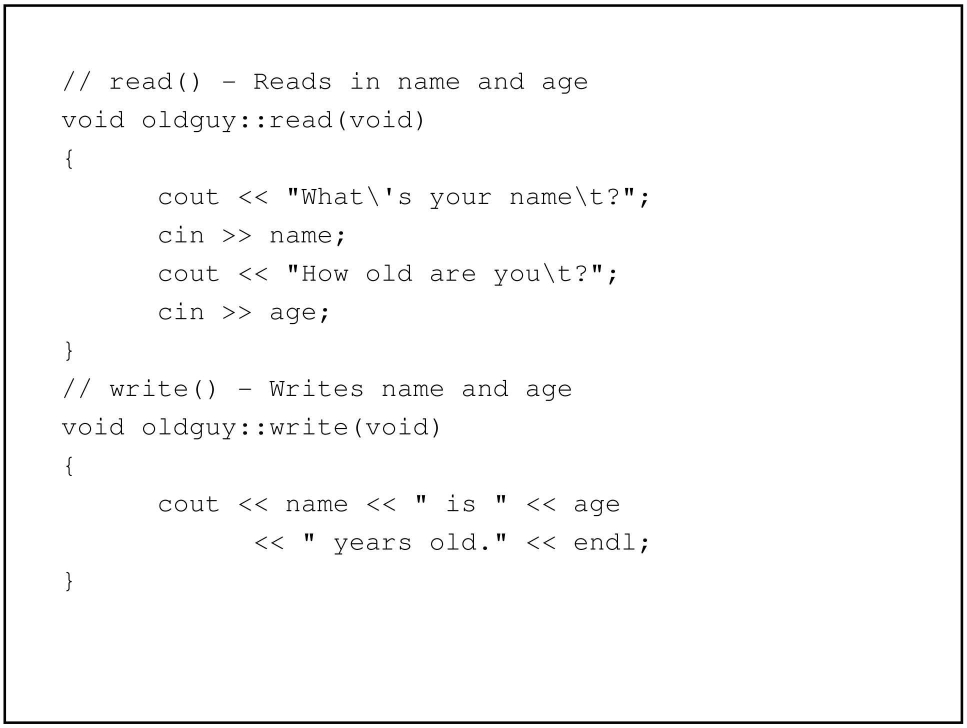
```
int main(void)
{
      oldguy me;
      me.read();
      me.write();
      return(0);
}
```

Member Functions and Parameters

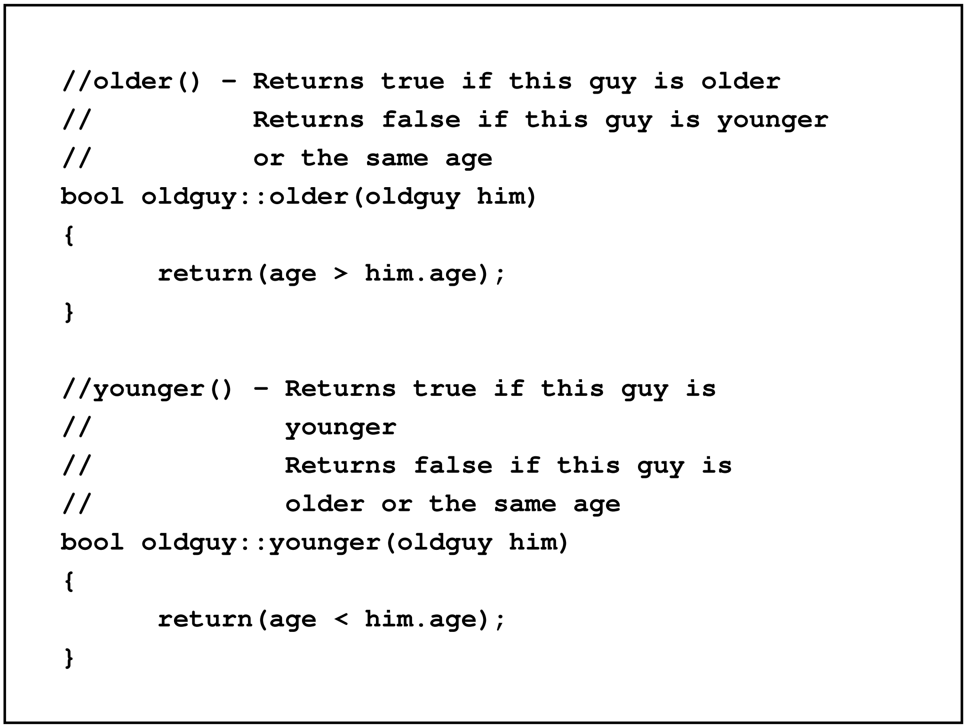
- Functions belonging to a class can have parameters, including other objects of the same class or different class.
- If you pass as a parameter an object of the same class, you must use the name of the object when specifying its members.
- E.g., **`y`** is an item in this object, **`q.y`** is an item in object **`q`**.

`age12.cpp`

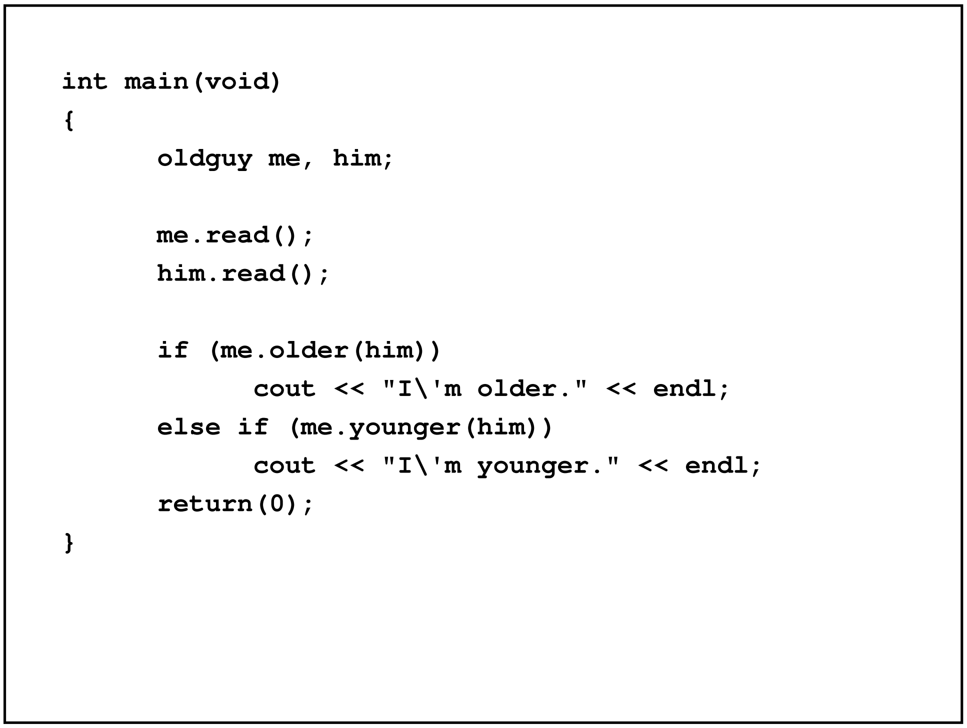
```
#include <iostream>
using namespace std;
const int namelen = 12;

// A class of object which contains name and age
class oldguy {
public:
      void read(void);
      void write(void);
      bool older(oldguy him);
      bool younger(oldguy him);
private:
      char name[namelen];
      int age;
};
```



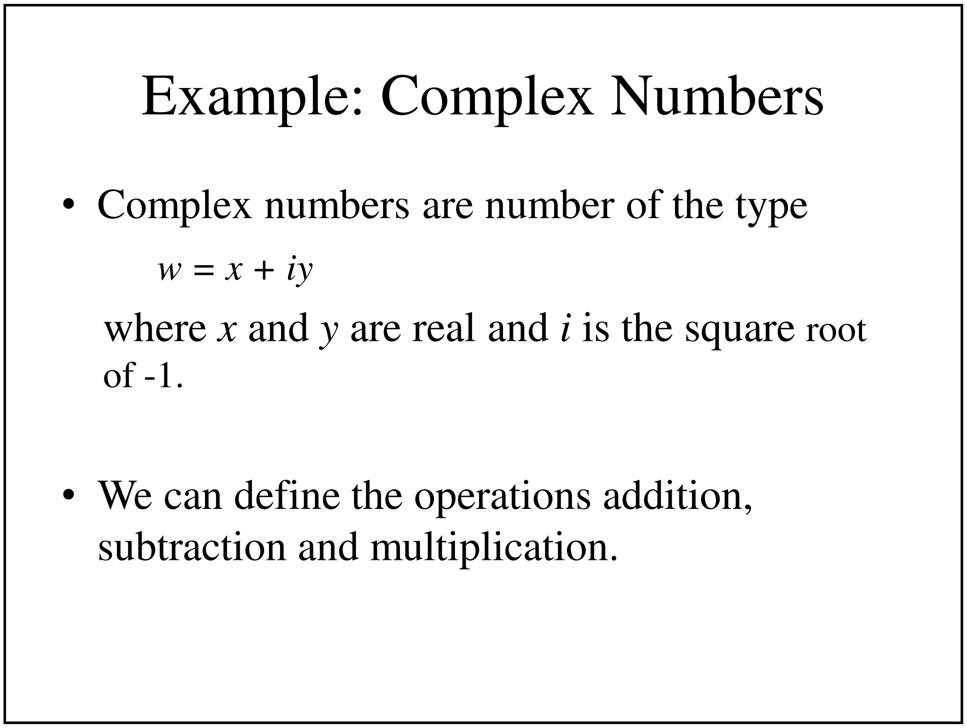
```
// read() - Reads in name and age
void oldguy::read(void)
{
      cout << "What\'s your name\t?";
      cin >> name;
      cout << "How old are you\t?";
      cin >> age;
}
// write() - Writes name and age
void oldguy::write(void)
{
      cout << name << " is " << age
            << " years old." << endl;
}
```



```
//older() - Returns true if this guy is older
//          Returns false if this guy is younger
//          or the same age
bool oldguy::older(oldguy him)
{
      return(age > him.age);
}

//younger() - Returns true if this guy is
//            younger
//            Returns false if this guy is
//            older or the same age
bool oldguy::younger(oldguy him)
{
      return(age < him.age);
}
```



```
int main(void)
{
      oldguy me, him;

      me.read();
      him.read();

      if (me.older(him))
            cout << "I\'m older." << endl;
      else if (me.younger(him))
            cout << "I\'m younger." << endl;
      return(0);
}
```



Example: Complex Numbers

- Complex numbers are number of the type

  $w = x + iy$

  where x and y are real and i is the square root of -1.

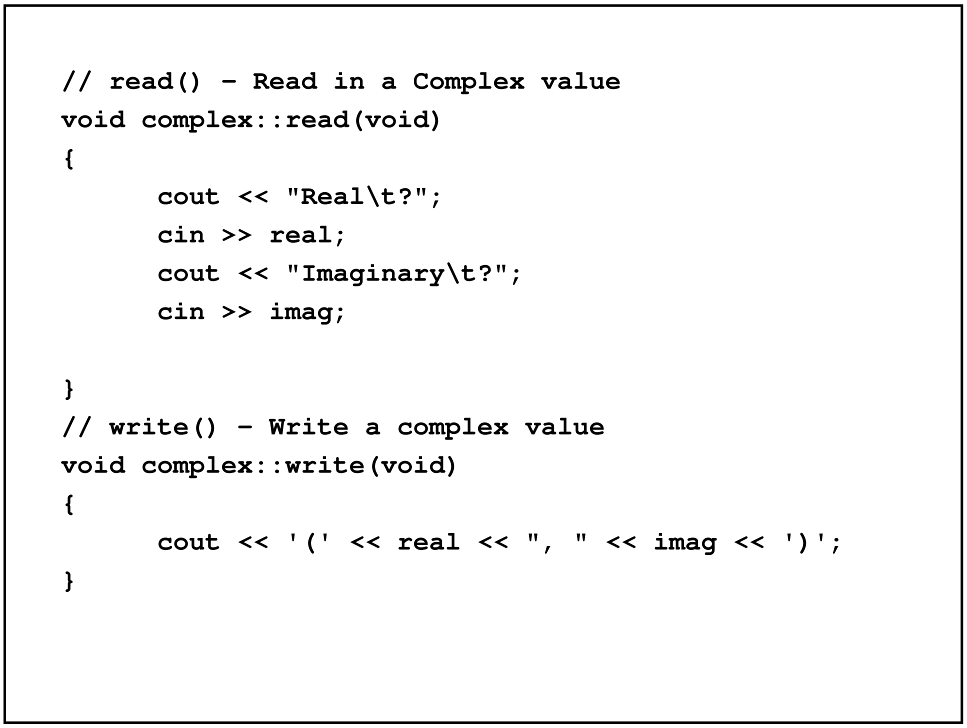
- We can define the operations addition, subtraction and multiplication.

Complex Number Operations

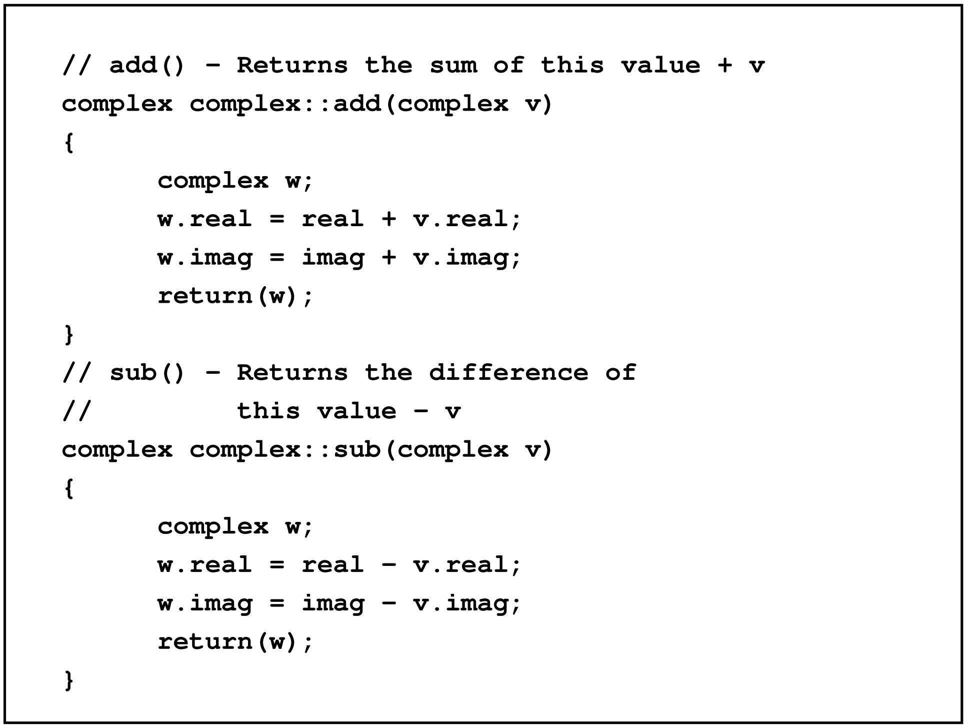
- If our two complex numbers are u and v:
  - *If* $w = u + v$
    - $Re\ w = Re\ u + Re\ v$
    - $Im\ W = Im\ u + Im\ v$
  - *If* $w = u - v$
    - $Re\ w = Re\ u - Re\ v$
    - $Im\ W = Im\ u - Im\ v$
  - *If* $w = u \cdot v$
    - $Re\ w = Re\ u \cdot Re\ v - Im\ u \cdot Im\ v$
    - $Im\ w = Re\ u \cdot Im\ v - Im\ u \cdot Re\ v$

`complx1.cpp`

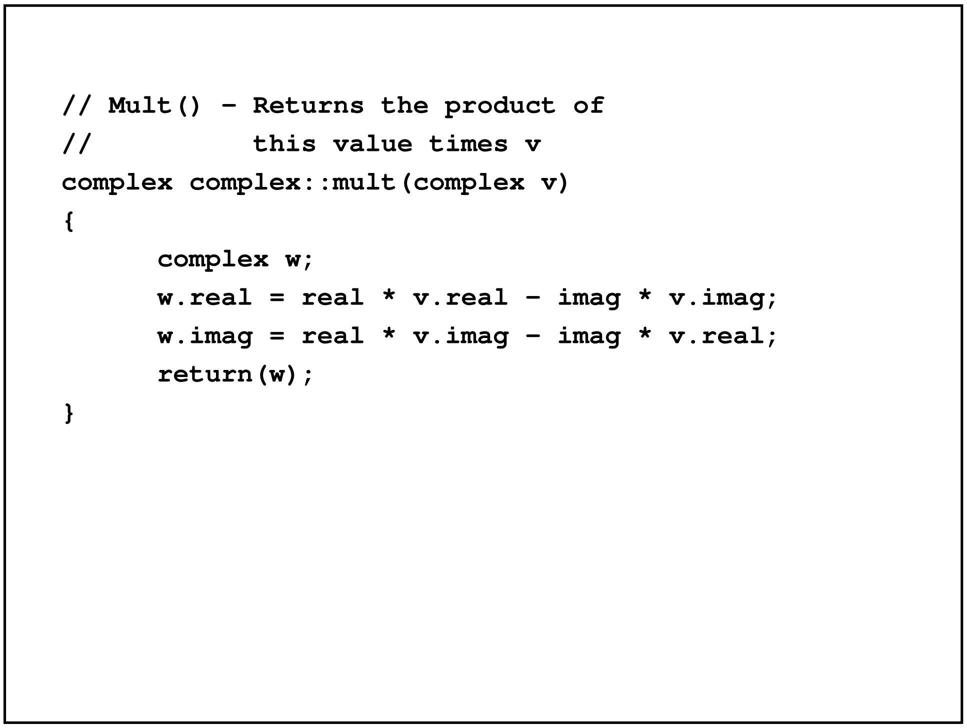
```
#include <iostream>
using namespace std;

class complex {
public:
      void read(void);
      void write(void);
      complex add(complex v);
      complex sub(complex v);
      complex mult(complex v);
private:
      float real;
      float imag;
};
```



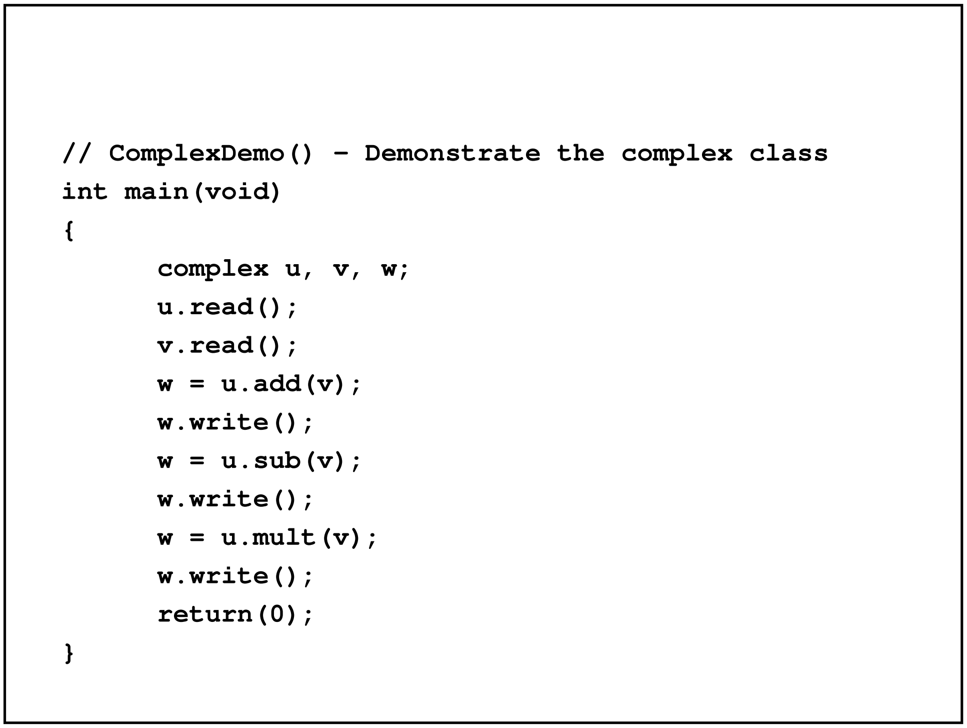
```
// read() – Read in a Complex value
void complex::read(void)
{
      cout << "Real\t?";
      cin >> real;
      cout << "Imaginary\t?";
      cin >> imag;

}
// write() – Write a complex value
void complex::write(void)
{
      cout << '(' << real << ", " << imag << ')';
}
```



```
// add() – Returns the sum of this value + v
complex complex::add(complex v)
{
      complex w;
      w.real = real + v.real;
      w.imag = imag + v.imag;
      return(w);
}
// sub() – Returns the difference of
//         this value – v
complex complex::sub(complex v)
{
      complex w;
      w.real = real – v.real;
      w.imag = imag – v.imag;
      return(w);
}
```



```
// Mult() - Returns the product of
//          this value times v
complex complex::mult(complex v)
{
      complex w;
      w.real = real * v.real - imag * v.imag;
      w.imag = real * v.imag - imag * v.real;
      return(w);
}
```



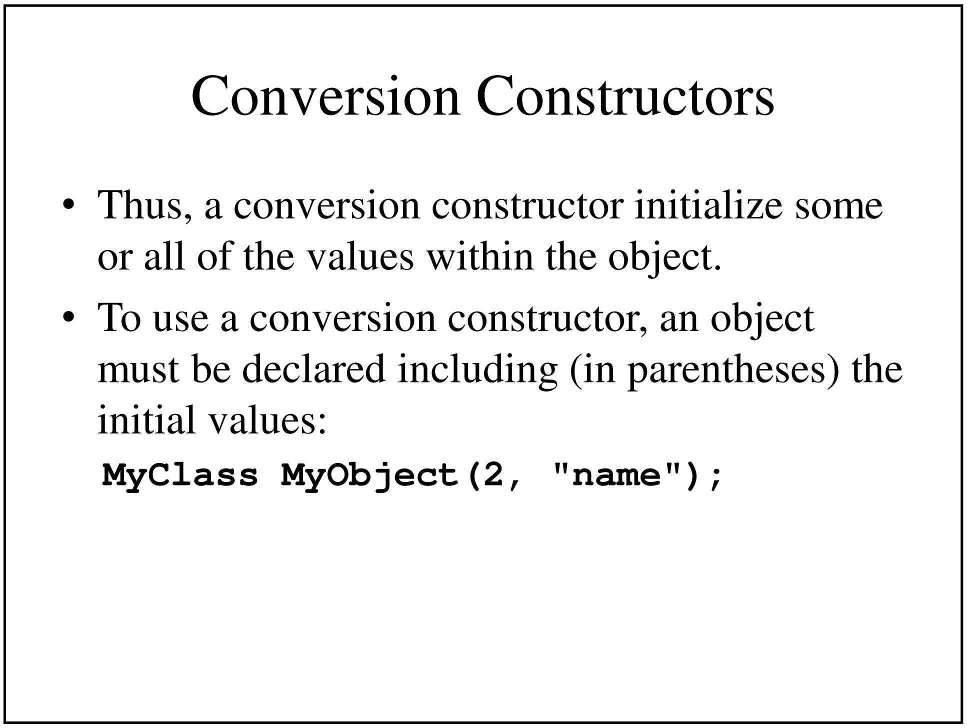
```
// ComplexDemo() - Demonstrate the complex class
int main(void)
{
      complex u, v, w;
      u.read();
      v.read();
      w = u.add(v);
      w.write();
      w = u.sub(v);
      w.write();
      w = u.mult(v);
      w.write();
      return(0);
}
```

Constructors

- Sometimes we need an object to have some initial values set when we define it. This can be done implicitly by writing a constructor.
- Constructors are called automatically when the program enters the function where the object is declared.
- Constructors share a name with the class and have no result type, not even void.

Default Constructors

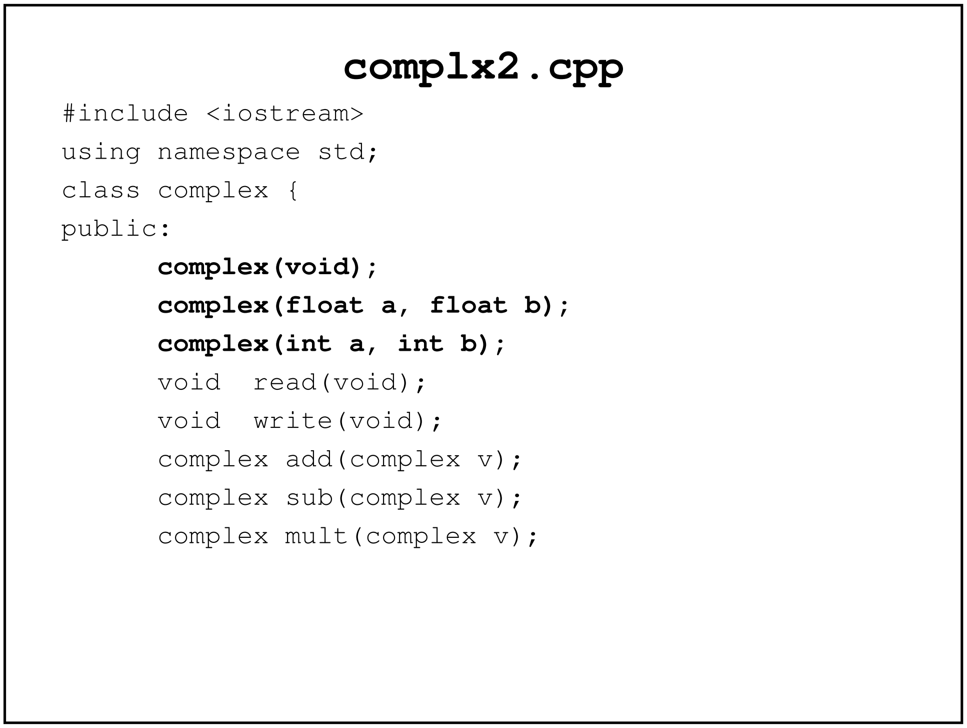
- If an object is declared without any parameters, the default constructor is called.
- A default constructor has no parameters.



Conversion Constructors

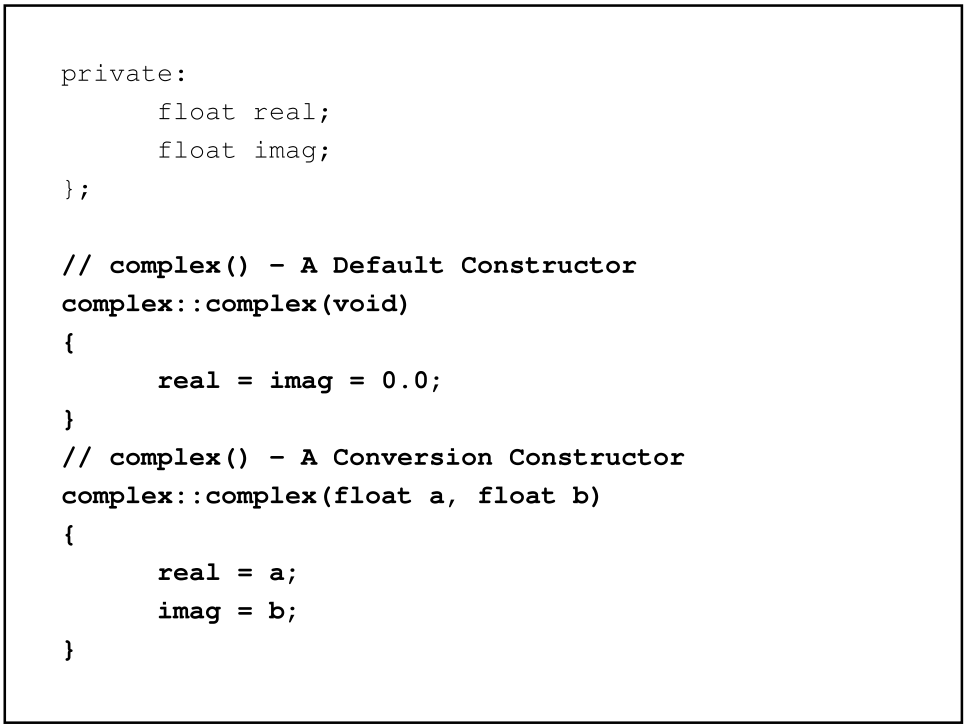
- Thus, a conversion constructor initialize some or all of the values within the object.
- To use a conversion constructor, an object must be declared including (in parentheses) the initial values:

```
MyClass MyObject(2, "name");
```

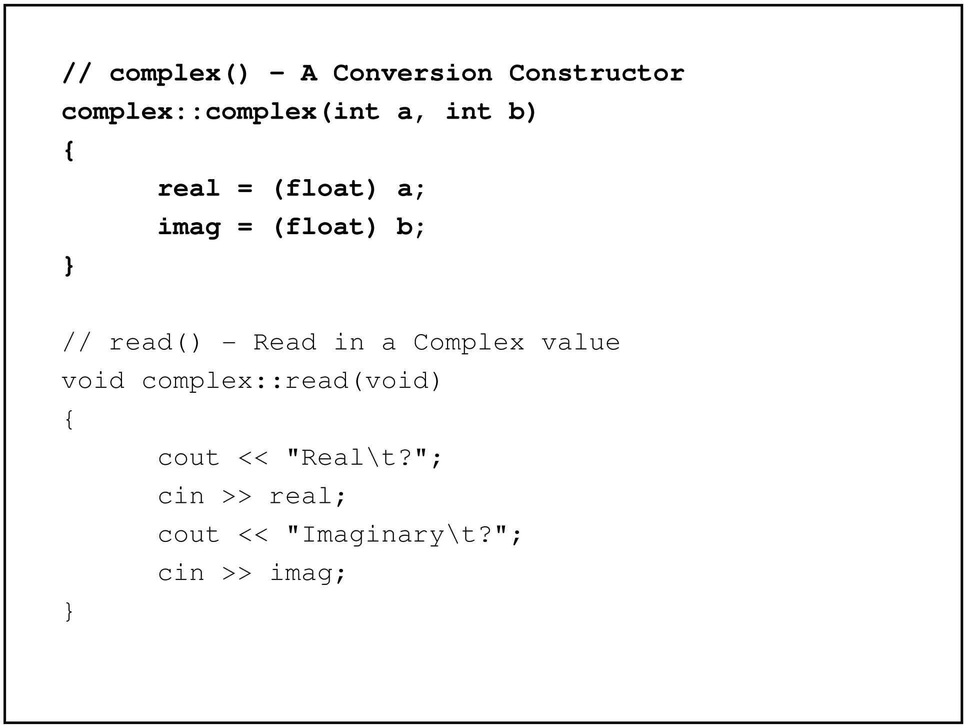


complx2.cpp

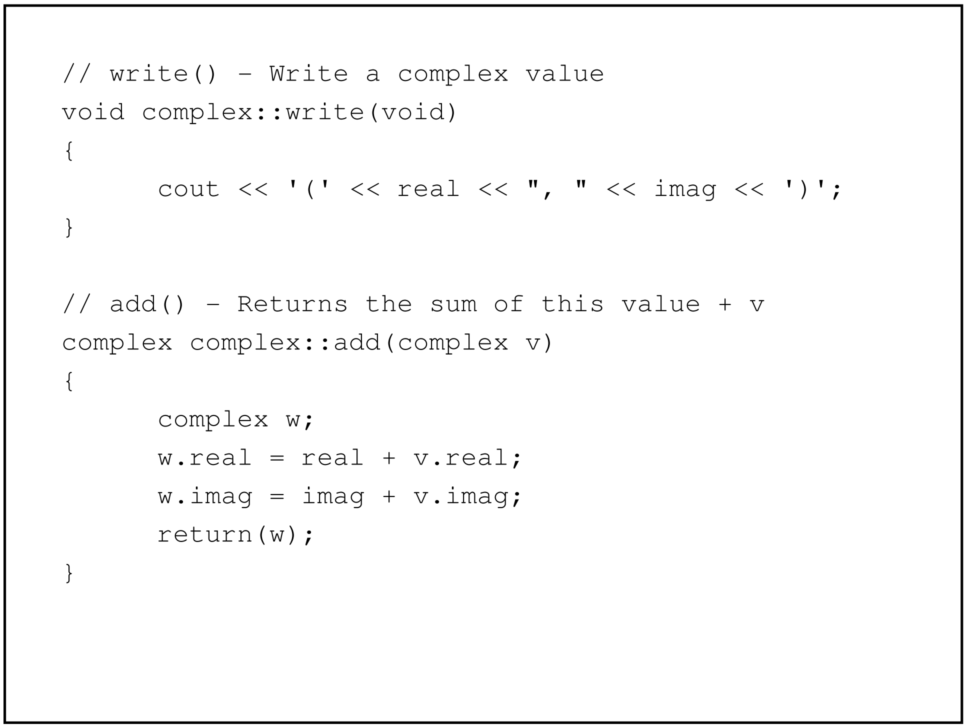
```
#include <iostream>
using namespace std;
class complex {
public:
      complex(void);
      complex(float a, float b);
      complex(int a, int b);
      void  read(void);
      void  write(void);
      complex add(complex v);
      complex sub(complex v);
      complex mult(complex v);
```



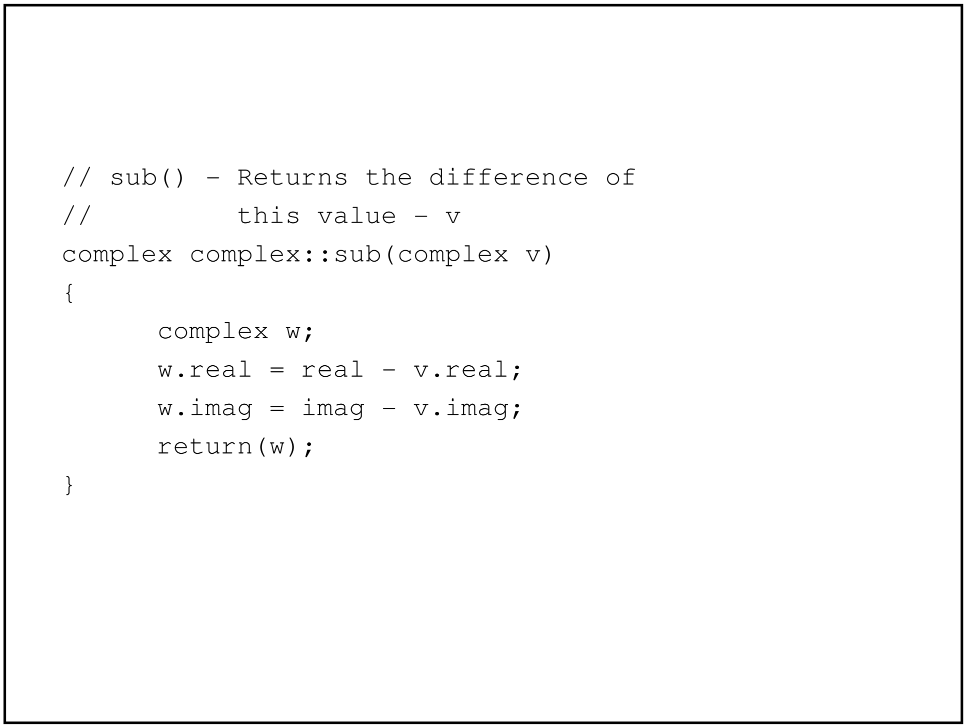
```
private:
      float real;
      float imag;
};

// complex() - A Default Constructor
complex::complex(void)
{
      real = imag = 0.0;
}
// complex() - A Conversion Constructor
complex::complex(float a, float b)
{
      real = a;
      imag = b;
}
```



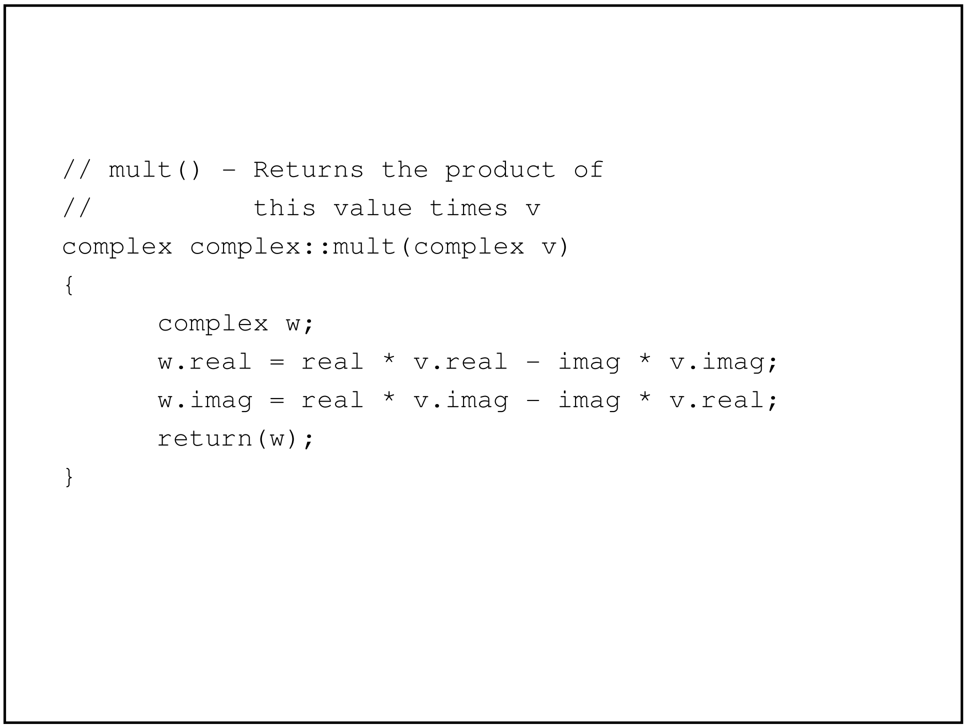
```
// complex() - A Conversion Constructor
complex::complex(int a, int b)
{
      real = (float) a;
      imag = (float) b;
}

// read() - Read in a Complex value
void complex::read(void)
{
      cout << "Real\t?";
      cin >> real;
      cout << "Imaginary\t?";
      cin >> imag;
}
```



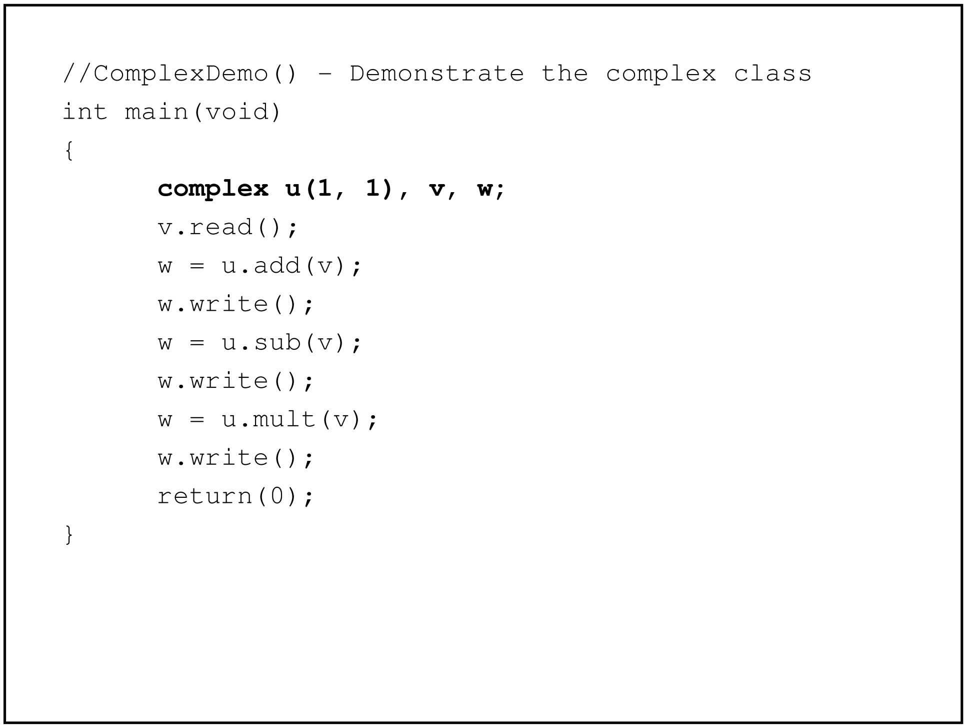
```
// write() - Write a complex value
void complex::write(void)
{
      cout << '(' << real << ", " << imag << ')';
}

// add() - Returns the sum of this value + v
complex complex::add(complex v)
{
      complex w;
      w.real = real + v.real;
      w.imag = imag + v.imag;
      return(w);
}
```



```
// sub() - Returns the difference of
//         this value - v
complex complex::sub(complex v)
{
      complex w;
      w.real = real - v.real;
      w.imag = imag - v.imag;
      return(w);
}
```



```
// mult() - Returns the product of
//          this value times v
complex complex::mult(complex v)
{
      complex w;
      w.real = real * v.real - imag * v.imag;
      w.imag = real * v.imag - imag * v.real;
      return(w);
}
```



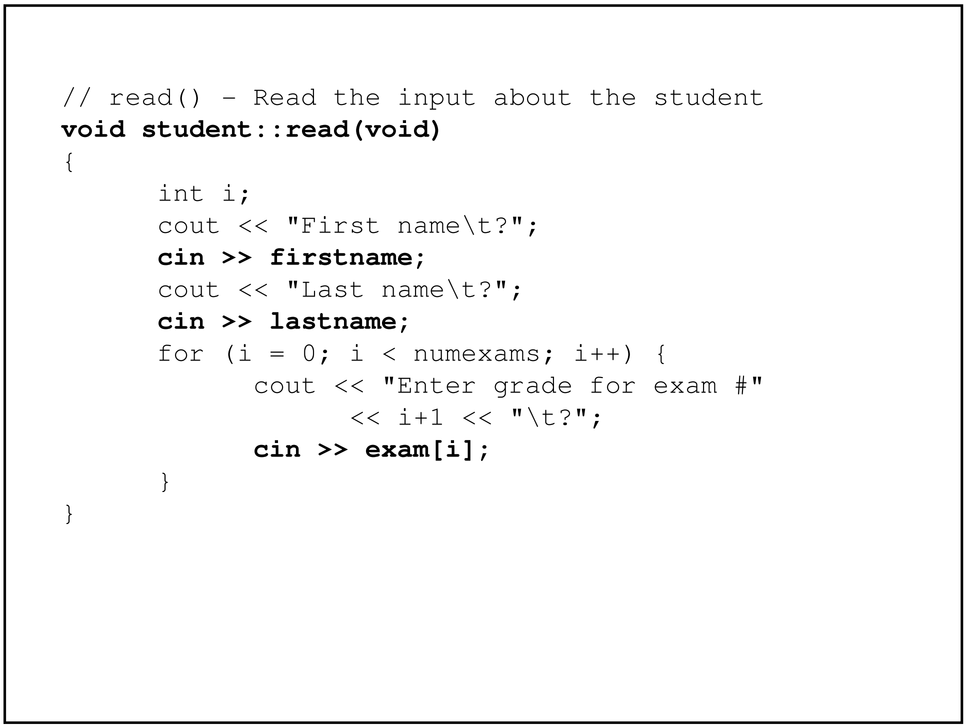
```
//ComplexDemo() - Demonstrate the complex class
int main(void)
{
      complex u(1, 1), v, w;
      v.read();
      w = u.add(v);
      w.write();
      w = u.sub(v);
      w.write();
      w = u.mult(v);
      w.write();
      return(0);
}
```

Rewriting **`average.cpp`**

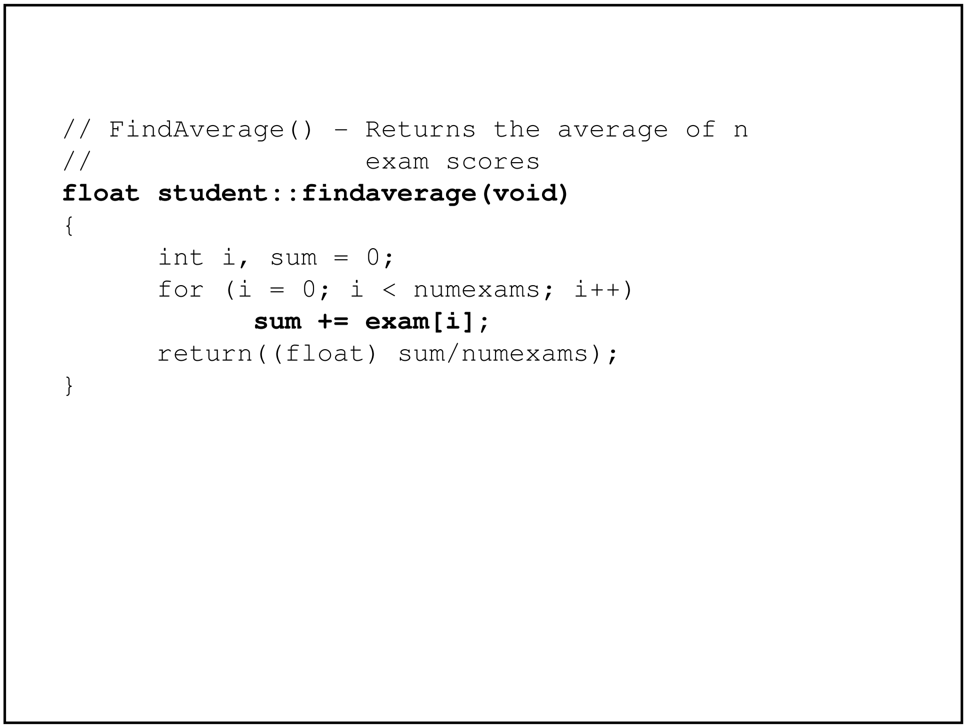
- Let’s rewrite average so that it is an object with the private data items (first and last name and four exam grades in an array) and three functions (**`read`**, **`write`** and **`findaverage`**).
- By writing two versions of write (one with the average, one without), we overload the function. It will choose the one matching the parameter list.

`avggrade.cpp`

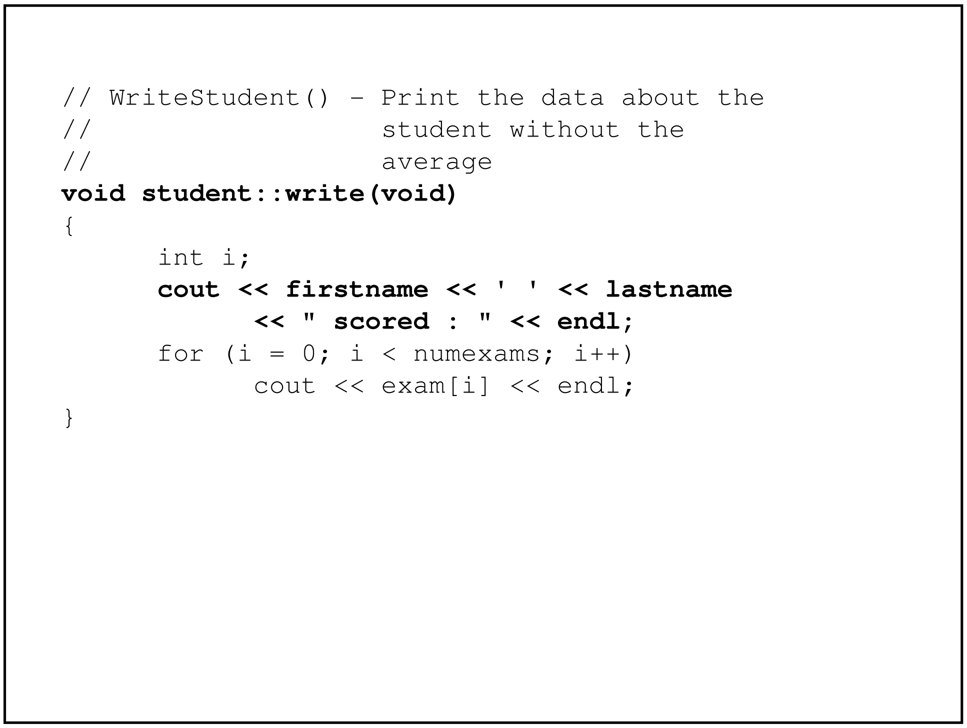
```
#include <iostream>

using namespace std;

const int namelen = 15, numexams = 4;

class student {
public:
      void read(void);
      void write(void);
      void write(float average);
      float findaverage();
private:
      char firstname[namelen],
            lastname[namelen];
      int exam[numexams];
};
```



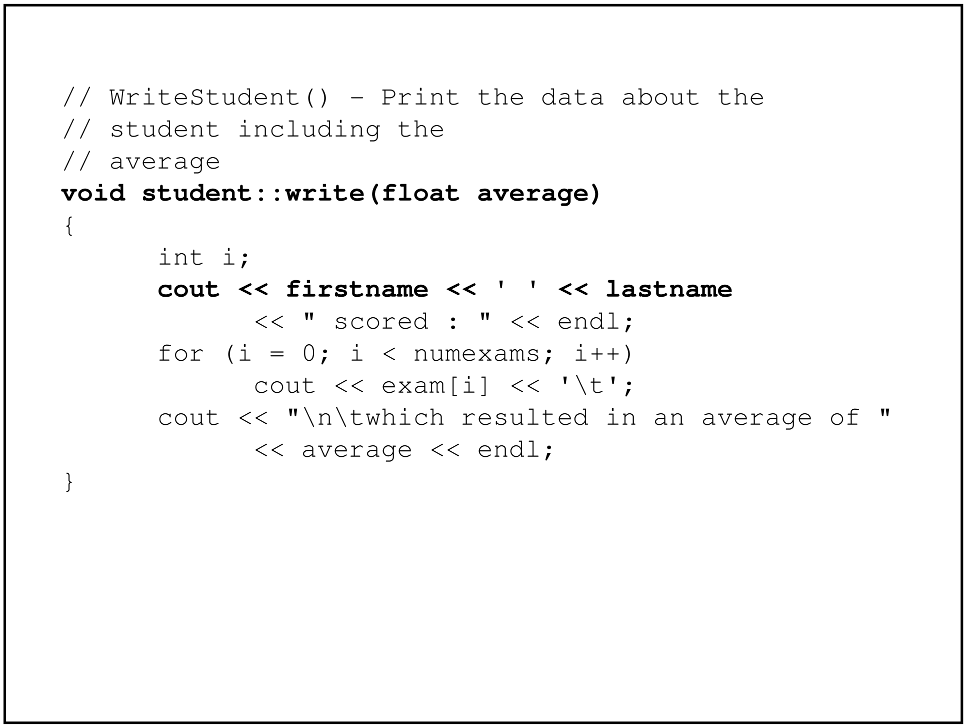
```
// read() - Read the input about the student
void student::read(void)
{
      int i;
      cout << "First name\t?";
      cin >> firstname;
      cout << "Last name\t?";
      cin >> lastname;
      for (i = 0; i < numexams; i++) {
            cout << "Enter grade for exam #"
                  << i+1 << "\t?";
            cin >> exam[i];
      }
}
```



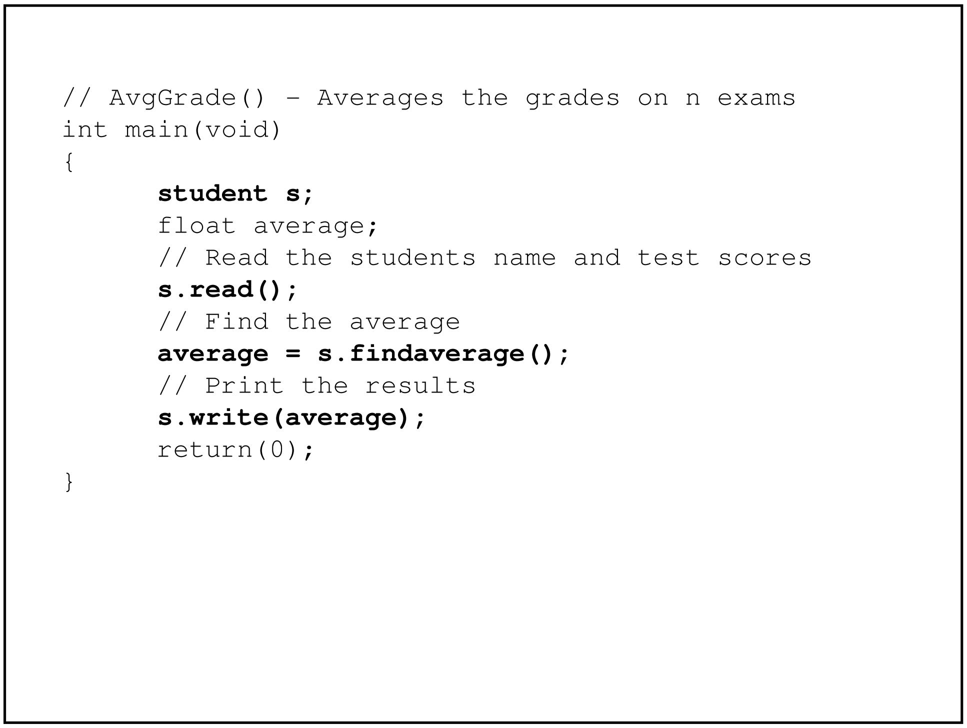
```
// FindAverage() - Returns the average of n
//                 exam scores
float student::findaverage(void)
{
      int i, sum = 0;
      for (i = 0; i < numexams; i++)
            sum += exam[i];
      return((float) sum/numexams);
}
```



```
// WriteStudent() - Print the data about the
//                  student without the
//                  average
void student::write(void)
{
      int i;
      cout << firstname << ' ' << lastname
            << " scored : " << endl;
      for (i = 0; i < numexams; i++)
            cout << exam[i] << endl;
}
```



```
// WriteStudent() - Print the data about the
// student including the
// average
void student::write(float average)
{
      int i;
      cout << firstname << ' ' << lastname
            << " scored : " << endl;
      for (i = 0; i < numexams; i++)
            cout << exam[i] << '\t';
      cout << "\n\twhich resulted in an average of "
            << average << endl;
}
```



```
// AvgGrade() - Averages the grades on n exams
int main(void)
{
      student s;
      float average;
      // Read the students name and test scores
      s.read();
      // Find the average
      average = s.findaverage();
      // Print the results
      s.write(average);
      return(0);
}
```