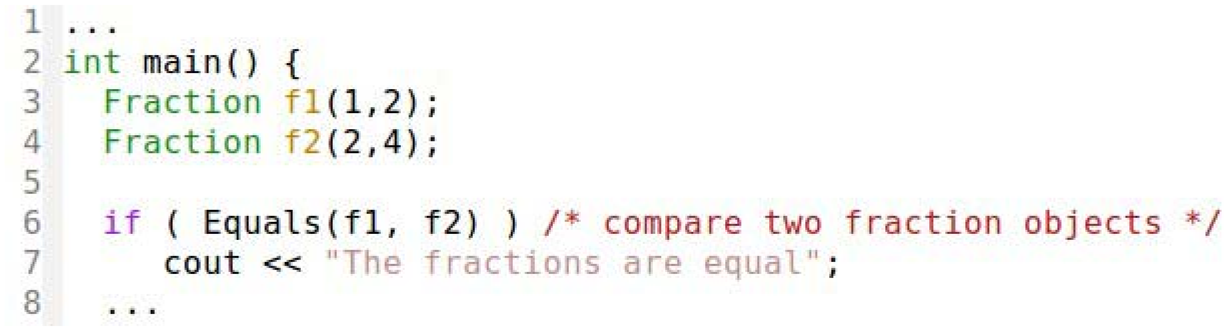
Review

- What are the protection levels in a class we talked about last time?
- Why do we use protection levels?
- Which part of program can access private data members? Which part of program cannot access private data? What happens when the program accesses private data illegally?
- Which part of program can access private functions? Which part of program cannot access private functions? What happens when the program accesses private functions illegally?
- What is a constructor?
- How can you tell if a function is a constructor in a class?
- What is a default constructor?
- How to pass arguments to a constructor?

More about classes: friend, conversion constructor, destructor

A Motivating Example

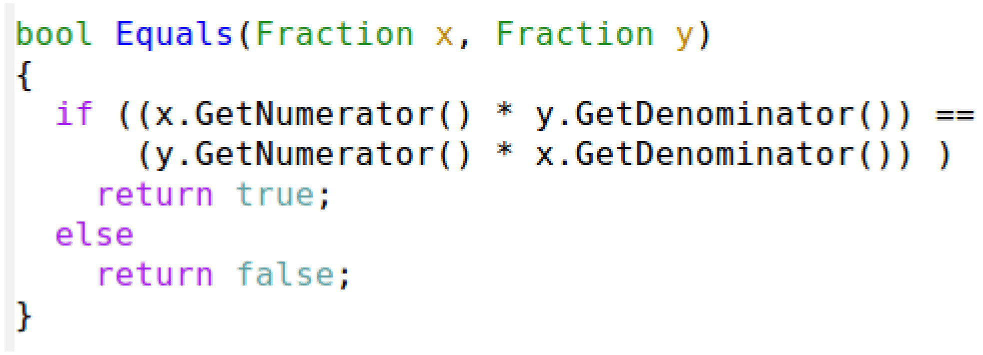
Suppose we want to write a function equals that compares 2 fraction objects and use it as follows



```
...
int main() {
  Fraction f1(1,2);
  Fraction f2(2,4);

  if ( Equals(f1, f2) ) /* compare two fraction objects */
     cout << "The fractions are equal";
  ...
```

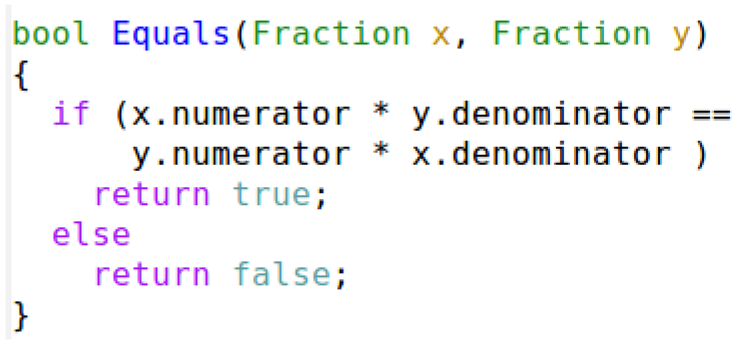
A possible definition for the function might be:



```
bool Equals(Fraction x, Fraction y)
{
  if ((x.GetNumerator() * y.GetDenominator()) ==
      (y.GetNumerator() * x.GetDenominator()) )
    return true;
  else
    return false;
}
```

A Motivating Example (continue)

What if we want to write the equals function as follows:



```
bool Equals(Fraction x, Fraction y)
{
  if (x.numerator * y.denominator ==
      y.numerator * x.denominator )
    return true;
  else
    return false;
}
```

Such functions are not member functions: can’t directly access the private functions.

Such functions (e.g. comparing two objects) needs to access private members frequently: we would like C++ to allow such access.

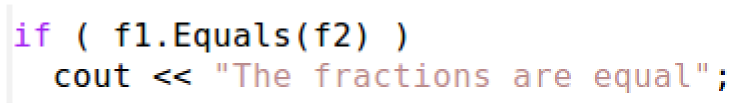
C++ solution: the ‘friend’ keyword.

The ‘friend’ keyword

- The friend keyword allows a class to grant full access to an outside entity
  - By "full access", we mean access to all the class' members, including the private section.
  - An outside entity can be a function, or even another class (we'll focus on functions for now).
- To grant friend status, declaration of the "friend" is made inside the class definition block, with the keyword friend in front of it.
  - A friend is neither public nor private, because by definition it is not a member of the class. Just a friend. So it does not matter where in the block it is placed.
  - A friend function to a class will have full access to the private members of the class. So, for example, the second definition of Equals() would be legal.
- Look at the friend_fraction example.
  - This example contains the Equals() function given above.
  - This example also defines an Add() function, as a friend, for adding two Fractions together and returning a result.
  - Includes a sample driver program that makes test calls to Equals() and Add().

Member function instead of a friend function

- When a function works on two objects, it's often convenient to pass both as parameters and make it a friend
  - Another option is to use a member function -- but one of the objects must be the **calling object**
  - Example: The Equals() function could have been set up as a member function, which would mean this kind of call:



```
if ( f1.Equals(f2) )
  cout << "The fractions are equal";
```

  - In the above example, **f1** is the **calling object** (ie. The object calling a member function) and **f2** is passed into f1's Equals function as an **argument**.
  - Look at member_fraction example.

Member vs. Friend functions

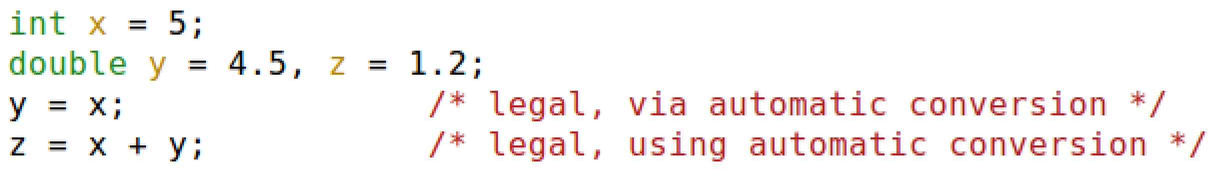
- Whether to make a function a friend or member of a class is usually a stylistic decision.
- Different programmers may have different preferences. Here's a comparison of the calls, side-by-side:

```
f3 = f1.Add(f2);  /* call to member function version */
f3 = Add(f1, f2); /* call to non-member function version */
```

- One thing to notice are that the member and friend versions above are not always equivalent
  - In the friend version of equals received copies of f1 and f2 (function cannot change original fractions).
  - What about the member version?

Conversion Constructors

- Some built-in types can perform automatic type conversion as such:



```
int x = 5;
double y = 4.5, z = 1.2;
y = x;                  /* legal, via automatic conversion */
z = x + y;              /* legal, using automatic conversion */
```

- We can also add this functionality to classes with a **conversion constructor**.

Conversion constructors continue

- A **conversion constructor** is a constructor with one parameter
  - Since a constructor creates/initializes a new object, we can use a conversion constructor to convert a variable of that parameter's type to a new object.
- An example of a conversion constructor:

```
Fraction(int n); /* can be used to convert int to Fraction
                    suppose it initializes to n/1       */
```

- The above constructor could be used to perform automatic type conversions as such:

```
Fraction f1, f2;
f1 = Fraction(4); /* explicit call to constructor. Fraction 4/1 is
                     created and assigned to f1                 */
f2 = 10;          /* implicit call to conversion constructor
                     equivalent to:  f2 = Fraction(10);         */
f1 = Add(f2, 5);  /* conversion constructor turns 5 into 5/1    */
```

Conversion constructors continue

- A constructor with multiple parameters may be a conversion constructor if all but one parameter is optional:

```
Fraction(int n, int d = 1);
```

- Automatic type conversion for constructors can be suppressed by using the keyword **explicit** in front of the declaration:

```
explicit Fraction(int n);
```

- The above constructor will not auto-convert integers to Fractions.
- See convert_fraction example.

Destructors

- In addition to the special constructor function, classes also have a special function called a **destructor**.
- The destructor looks like the default constructor (constructor with no parameters), but with a ~ in front.
- Destructors cannot have parameters, so there can only be one destructor for a class.

  Example: The destructor for the Fraction class would be: ~Fraction();

- Like the constructor, this function is called automatically (not explicitly)
- A destructor is called automatically right before an object is deallocated by the system, usually when it goes out of scope (is no longer accessible by the programmer).
- The destructor's typical job is to do any clean-up tasks (usually involving memory allocation) that are needed, before an object is deallocated.
- See destructor.cpp example.