Function Calls

- Additionally, using the & operator (instead of a *) will make that parameter call-by-reference.
  - It will hide the obtained address, but still work with and alter the same object/variable.

Call By Reference (2)

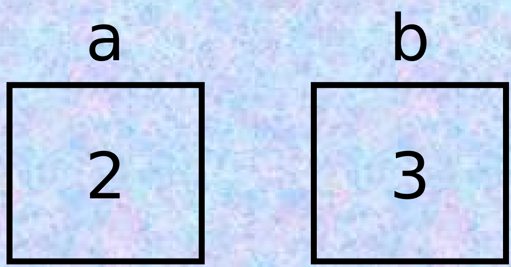
```
void swap(int &a,
  int &b)
{
    int temp = a;
    a = b;
    b = temp;
}
```

```
void main()
{
    int a = 2;
    int b = 3;

    swap(a, b);
}
```

Call By Reference (2)

```
void swap(int &a,
  int &b)
{
    int temp = a;
    a = b;
    b = temp;
}
```

```
void main()
{
    int a = 2;
    int b = 3;

    swap(a, b);
}
```



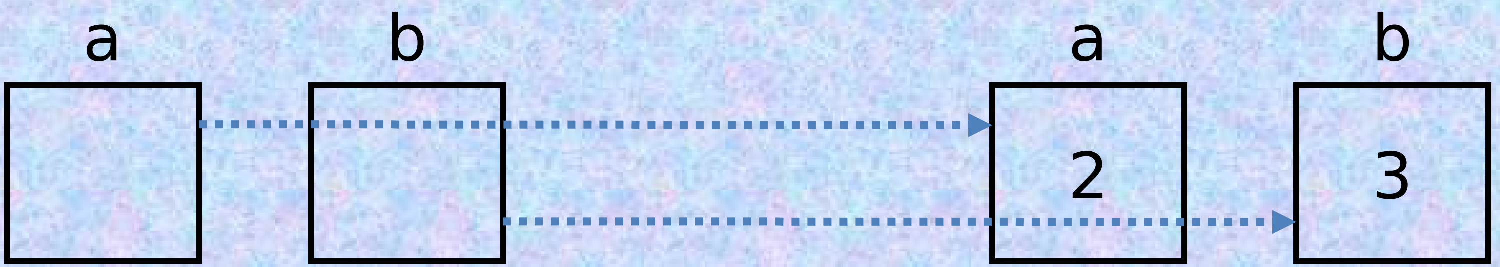
a b

2 3

Call By Reference (2)

```
void swap(int &a,
  int &b)
{
    int temp = a;
    a = b;
    b = temp;
}
```

```
void main()
{
    int a = 2;
    int b = 3;

    swap(a, b);
}
```



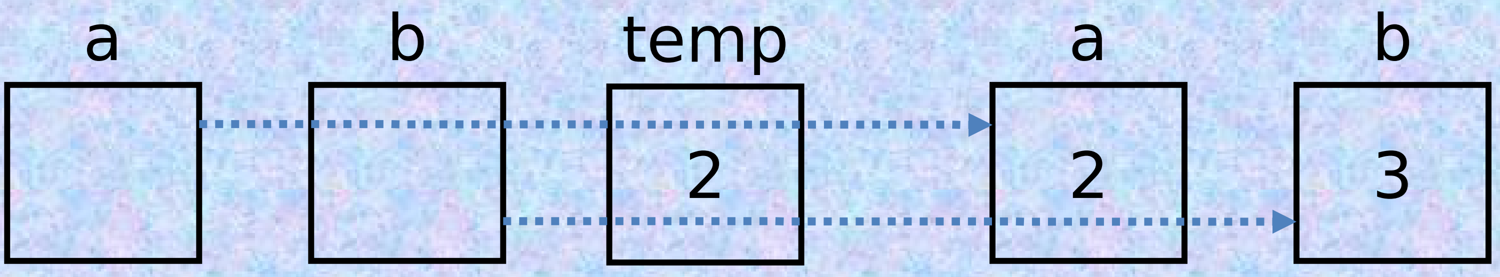
a b a b

2 3

Call By Reference (2)

```
void swap(int &a,
  int &b)
{
    int temp = a;
    a = b;
    b = temp;
}
```

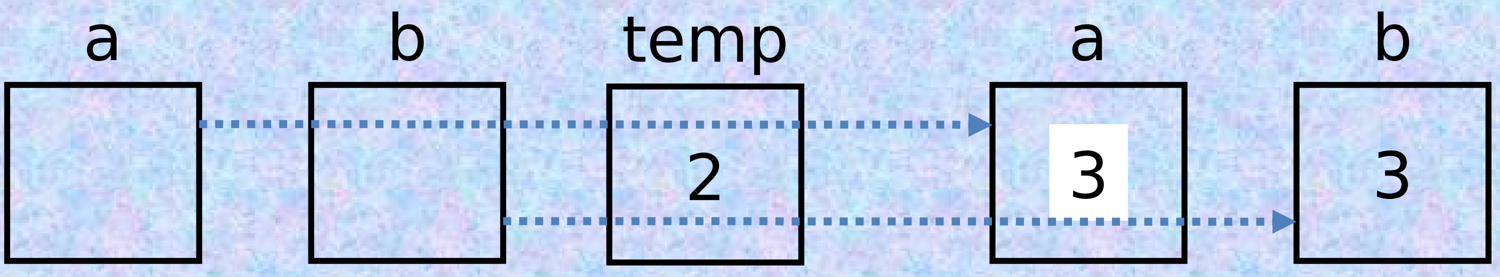
```
void main()
{
    int a = 2;
    int b = 3;

    swap(a, b);
}
```



Call By Reference (2)

```
void swap(int &a,
 int &b)
{
    int temp = a;
    a = b;
    b = temp;
}
```

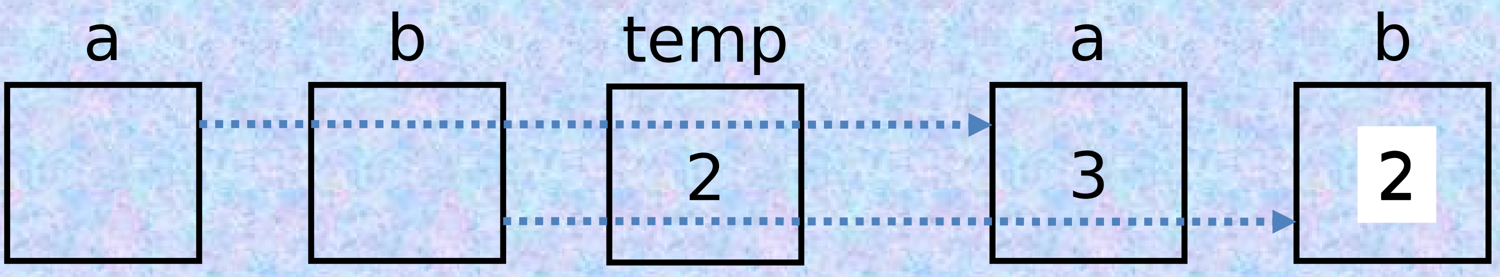
```
void main()
{
    int a = 2;
    int b = 3;

    swap(a, b);
}
```



Call By Reference (2)

```
void swap(int &a,
  int &b)
{
    int temp = a;
    a = b;
    b = temp;
}
```

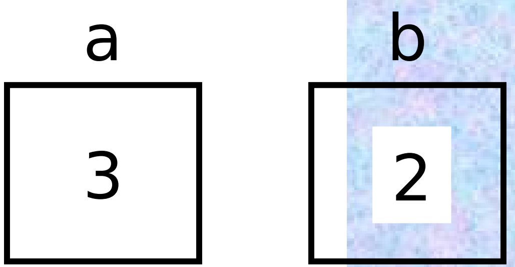
```
void main()
{
    int a = 2;
    int b = 3;

    swap(a, b);
}
```



Call By Reference (2)

```
void swap(int &a,
  int &b)
{
    int temp = a;
    a = b;
    b = temp;
}
```

```
void main()
{
    int a = 2;
    int b = 3;

    swap(a, b);
}
```



a

3

b

2

An Aside

- To some of you, we imagine that some of C++’s syntax and structure may be pretty foreign, to say the least.
  - In particular, some people have never worked (heavily) with OO before.
  - This is because there’s a whole different way of thinking about programming tasks in OO.

Object-Orientation

- Object-orientation is quite different.
  - As we’ve seen already, part of its design is to enforce the organization of data into logical, conceptual units within the system.
  - Each object keeps its data private (ideally) and seeks to enforce constraints to keep itself in a proper form.

Object-Orientation

- Object-orientation is quite different.
  - Work gets done by objects interacting with other objects.
    - As such, the exact flow of execution in the program may not be easy to track.
  - Object orientation aims to avoid making anything truly global.
    - Java doesn’t even *allow* “truly” global variables.
    - C++ allows them.

A Fraction Object

```
class Fraction
{
   private:
      int numerator;
      int denominator;

   public:
      Fraction add(Fraction &f);
}
```

A Fraction Object

```
public Fraction* Fraction::add(Fraction &f)
{
    int num = numerator * f.denominator;
    num += f.numerator * denominator;
    int dnm = f.denominator * denominator;

    return new Fraction(num, dnm);
}
```

Coding in OO

- First, let’s examine this line of code.

```
f1.add(f2); //Both are Fractions
```

- What is this setting up and modeling?
- Secondly, what is going on in `add()`?

Coding in OO

```
f1.add(f2); //Both are Fractions
```

- This line is basically saying “Call the “Fraction.add()” method from the perspective of f1.

A Fraction Object

So, that line of code has an implied reference to what was previously called “f1.”

```
public Fraction* Fraction::add(Fraction &f)
{
    int num = numerator * f.denominator;
    num += f.numerator * denominator;
    int dnm = f.denominator * denominator;

    return new Fraction(num, dnm);
}
```

A Fraction Object

This "implied reference" is known as **this** within C++. It's understood to be implied on any "unqualified" field names in the method below.

```
public Fraction* Fraction::add(Fraction &f)
{
    int num = numerator * f.denominator;
    num += f.numerator * denominator;
    int dnm = f.denominator * denominator;

    return new Fraction(num, dnm);
}
```

A Fraction Object

The use of “numerator” and “denominator”, when not preceded by “f.” here, are with respect to **this**.

```
public Fraction* Fraction::add(Fraction &f)
{
    int num = numerator * f.denominator;
    num += f.numerator * denominator;
    int dnm = f.denominator * denominator;

    return new Fraction(num, dnm);
}
```

A Fraction Object

What about when we *do* have “f.” preceding numerator and denominator?

```
public Fraction* Fraction::add(Fraction &f)
{
    int num = numerator * f.denominator;
    num += f.numerator * denominator;
    int dnm = f.denominator * denominator;

    return new Fraction(num, dnm);
}
```

A Fraction Object

In such cases, the perspective *shifts* to that of the object f, from which it then operates for the field or method after the “.”.

```
public Fraction* Fraction::add(Fraction &f)
{
    int num = numerator * f.denominator;
    num += f.numerator * denominator;
    int dnm = f.denominator * denominator;

    return new Fraction(num, dnm);
}
```

Coding in OO

```
f1.add(f2); //Both are Fractions
```

- Even though the add() method is operating with two different Fraction class instances, the code is able to keep track of which is **this** and which is the parameter f.

Documentation

- Documentation is the “plain” English text accompanying code that seeks to explain its structure and use.
  - Some of this documentation is typically in comments, directly in the code.
  - Other documentation may be in external documents.

Documentation

- For complex code, it can be very helpful to place inline comments on a “paragraph” level, explaining what purpose that block of code is accomplishing.
  - A line-by-line commentary may clarify *what* the code is doing, but rarely indicates *why*.
    - Note the purpose of your code – its goal.

Documentation

- We’ve already noted two different ways to comment within C++:

```
// This is a one-line comment.

/* This is a block comment,
   spanning multiple lines. */
```

Documentation

- In producing documentation for a method, it is wise to place some form of the “relationships” criterion within the description.
  - Generally, the conceptual purpose which a method, field, or class serves.

Documentation

- One should also include an explanation of the method’s *pre-conditions*, if it has any.
  - Pre-conditions: the limitations a particular method imposes on its inputs.
  - If a method is called with arguments that do not match its preconditions, its behavior is considered to be undefined.

Documentation

- As there exists a notion of *preconditions*, there also exist *post-conditions*.
  - Post-conditions: the effect a method has on its inputs (any unaffected/unlisted input should remain untouched), any generated exceptions, information about the return value, and effects on object state.

Benefits

- Documentation helps other programmers to understand the role of each accessible field and method for a given class.
- Documentation inside the code provides great reference material for future maintenance efforts.