Lecture 6: Encapsulation, Visibility Modifiers and Methods

CSC 1214: Object-Oriented Programming

Outline

- Encapsulation
- Visibility Modifiers
- Method Declarations

Outline

- Encapsulation
- Visibility Modifiers
- Method Declarations

Encapsulation

- **Encapsulation** is a mechanism that is used to restrict access to an object's data and methods. Also known as *information hiding*

- Until now we haven't been concerned about how object's data can be exposed to the external world. Consider our Car example below:

```
class Car {
      String numberPlate; // e.g. "UBC 080A"
      double speed = 0.0; // in kilometers per hour
      double maxSpeed; // in kilometers per hour
      int year;
      double oldCarSpeedLimit = 180.0;
}

class CarDriver {
  public static void main(String args[]){
   Car myCar = new Car();
   myCar.speed = 380.0;
  }
}
```

No encapsulation!

Encapsulation

- In object-oriented programming an object has two views:
  - **internal** - the details of the variables and methods of the class that defines it
  - **external** - the services that an object provides and how the object interacts with the rest of the system/ world
- From the external view, an object is an *encapsulated entity*, providing a set of specific services
- These services define the interface to the object

Encapsulation

- One object (called the *client*) may use another object for the services it provides

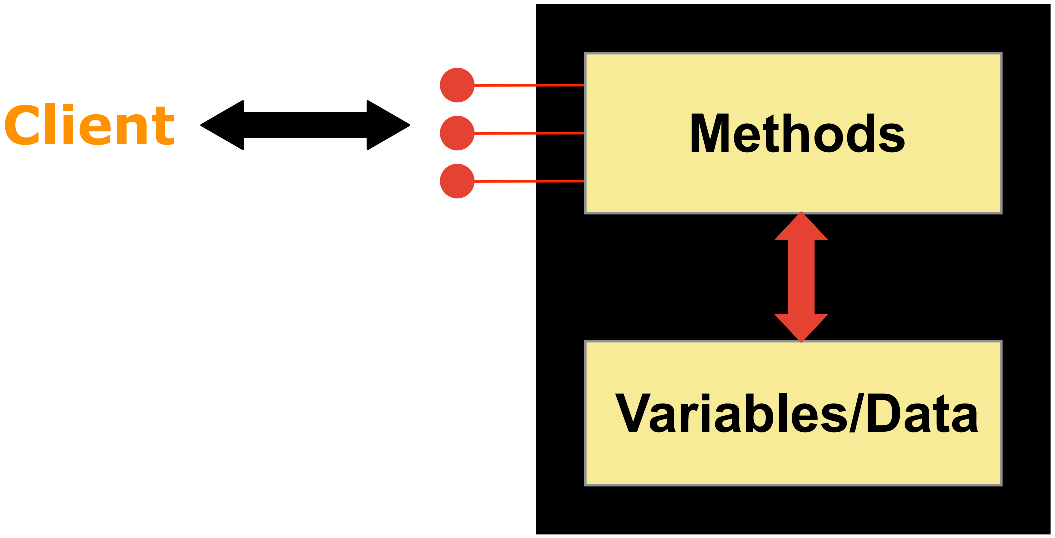
- The client of an object may request its services (call its methods), but it should not have to be aware of how those services are accomplished

- Any changes to the object's state (its variables) should be made by that object's methods

- We should make it difficult, if not impossible, for a client to access an object’s variables directly

Encapsulation

- An encapsulated object can be thought of as a black box -- its inner workings are hidden from the client
- The client invokes the interface methods of the object, which manages the instance data



Visibility Modifiers

- In Java, we accomplish encapsulation through the appropriate use of visibility modifiers

- A modifier is a Java reserved word that specifies particular characteristics of a method or data

- Java has three visibility modifiers: **public**, **protected**, and **private**

- The **protected** modifier involves inheritance, which we will discuss later

Visibility Modifiers

- Members of a class that are declared with **public visibility** can be *referenced anywhere.*

- A class may also be designated public, which means that any other class can use the class definition. The name of a public class must match the filename, thus a file can have only one public class.

- Members of a class that are declared with **private visibility** can be *referenced only within that class*

- Members declared without a visibility modifier have **default visibility** and can be *referenced by any class in the same package*. We will discuss packages in Java later.

Using Visibility Modifiers to Enforce Encapsulation

Private fields can only be referenced from within this class

```
class Car {
      private String numberPlate; // e.g. "UBC 080A"
      private double speed = 0.0; // in kilometers per hour
      private double maxSpeed; // in kilometers per hour
      private int year;
      private double oldCarSpeedLimit = 180.0;
}



class CarDriver {
  public static void main(String args[]) {
   Car myCar = new Car();
   myCar.speed = 380.0;
  }
}
```

Error!: The variable **speed** has private access in **Car**

Visibility Modifiers

- Public variables **violate encapsulation** because they allow the client to "reach in" and modify the values directly

- Therefore instance variables should not be declared with public visibility

- Though, it is acceptable to give a constant variable public visibility, which allows it to be used outside of the class

- Public constants do not violate encapsulation because, although the client can access it, its value cannot be changed

Visibility Modifiers

- Methods that provide the object's services are declared with public visibility so that they can be invoked by clients
- Public methods are also called **service methods**
- A method created simply to assist a service method is called a **support method**
- Since a support method is not intended to be called by a client, it should **not** be declared with public visibility

Visibility Modifiers

```
class Car {
  private String numberPlate; // e.g. "UBC 080A"
  private double speed = 0.0; // in kilometers per hour
  private double maxSpeed; // in kilometers per hour
  private int year;
  private double oldCarSpeedLimit = 180.0;

  public void setMaxSpeed (double newMaxSpeed){
    if(this.isBefore90s() && newMaxSpeed>oldCarSpeedLimit){
       System.out.println("Speed limit for cars older than 1990 is 180 KM/h");
     } else {
           this.maxSpeed = newMaxSpeed;
        }
  }

  public double getSpeed (){
     return this.speed;
  }

  private Boolean isBefore90s() {
     return year < 1990;
  }
}
```

Service Methods

Support Method. Private methods can only be accessed from within the class

Visibility Modifiers

	`public`	`private`
Variables	**Violate encapsulation**	**Enforce encapsulation**
Methods	**Provide services to clients**	**Support other methods in the class**

Accessors and Mutators

- Because instance data is private, a class usually provides services to access and modify data values

- An accessor method returns the current value of a variable

- A mutator method changes the value of a variable

- The names of accessor and mutator methods take the form getX and setX, respectively, where X is the name of the variable

- They are sometimes called “getters” and “setters”

Accessors and Mutators

```
class Car {
  private String numberPlate; // e.g. "UBC 080A"
  private double speed = 0.0; // in kilometers per hour
  private double maxSpeed; // in kilometers per hour
  private int year;
  private double oldCarSpeedLimit = 180.0;

  public void setMaxSpeed (double newMaxSpeed){
    if(this.isBefore90s() && newMaxSpeed>oldCarSpeedLimit){
       System.out.println("Speed limit for cars older than 1990 is 180 KM/h");
     } else {
          this.maxSpeed = newMaxSpeed;
       }
  }

  public double getSpeed (){
     return this.speed;
  }

  private Boolean isBefore90s() {
     return year < 1990;
  }
}
```

Mutator Method

Accessor Method

Accessors and Mutators

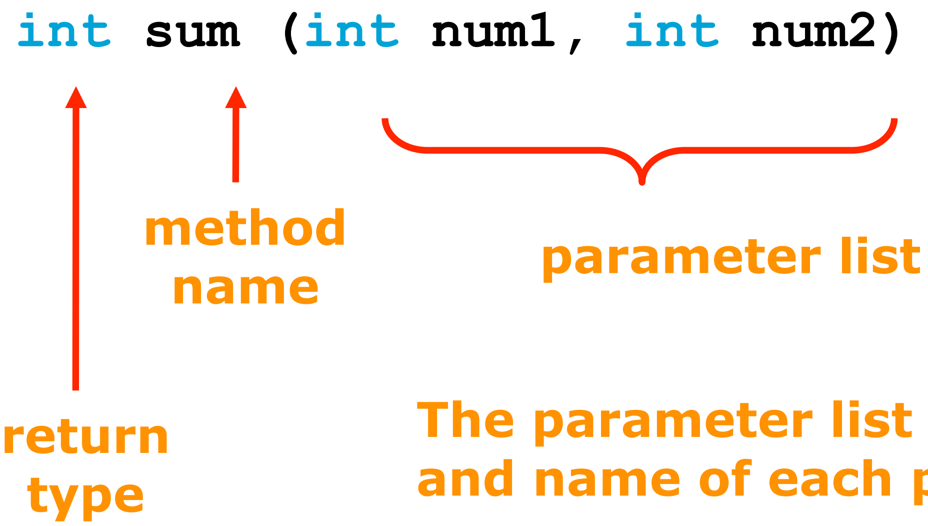
- The use of mutators gives the class designer the ability to restrict a client's options to modify an object's state
- A mutator is often designed so that the values of variables can be set only within particular limits
- For example, the setMaxSpeed of car should restrict the speed of cars older than 1990 to 180Km/hr.

Outline

- Encapsulation
- Visibility Modifiers
- Method Declarations

Method Declarations in Java

- A method declaration specifies the code that will be executed when the method is invoked (called)
- A method declaration begins with a method header



```
int sum (int num1, int num2)
```

method name

parameter list

return type

The parameter list specifies the type and name of each parameter

The name of a parameter in the method declaration is called a *formal parameter*

Method Body

- The method header is followed by the method body

```
int sum (int num1, int num2)
{
    int result = num1 + num2;
    return result;
}
```

The return expression must be consistent with the return type

`result` is local data

It is created each time the method is called, and is destroyed when it finishes executing

The Return Statement

- The return type of a method indicates the type of value that the method sends back to the calling location
- A method that does not return a value has a **`void`** return type

```
public void setMaxSpeed (double newMaxSpeed){...}
```

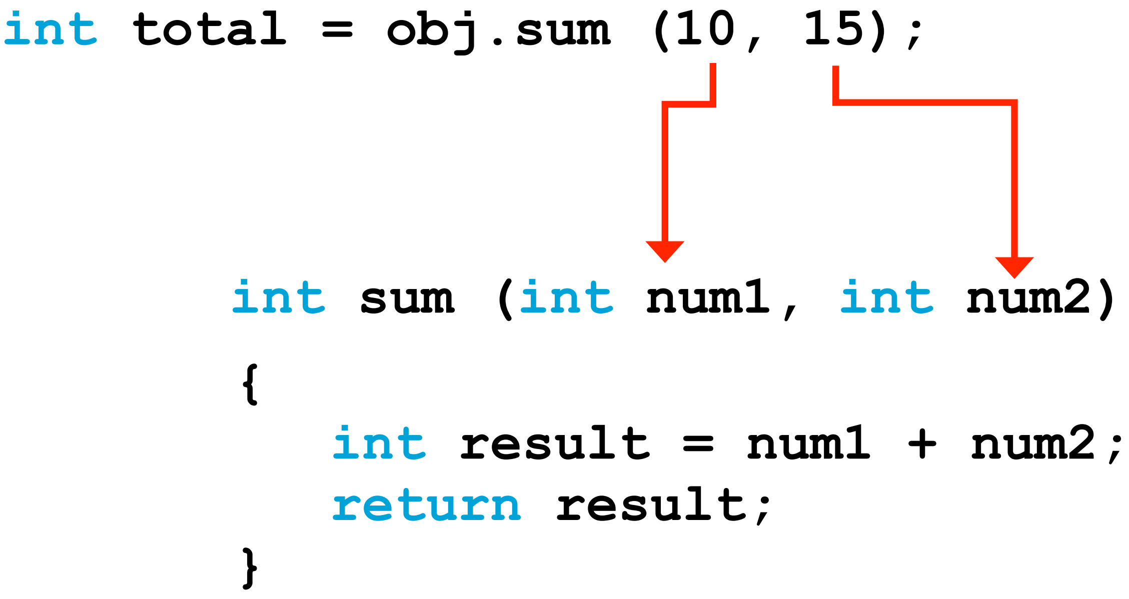
- A return statement specifies the value that will be returned

```
return expression;
```

- Its **`expression`** must conform to the return type

Method Invocation

- When a method is called, the actual parameters in the invocation are copied into (bound to) the formal parameters in the method header



```
int total = obj.sum (10, 15);




       int sum (int num1, int num2)
       {
          int result = num1 + num2;
          return result;
       }
```

Method Control Flow

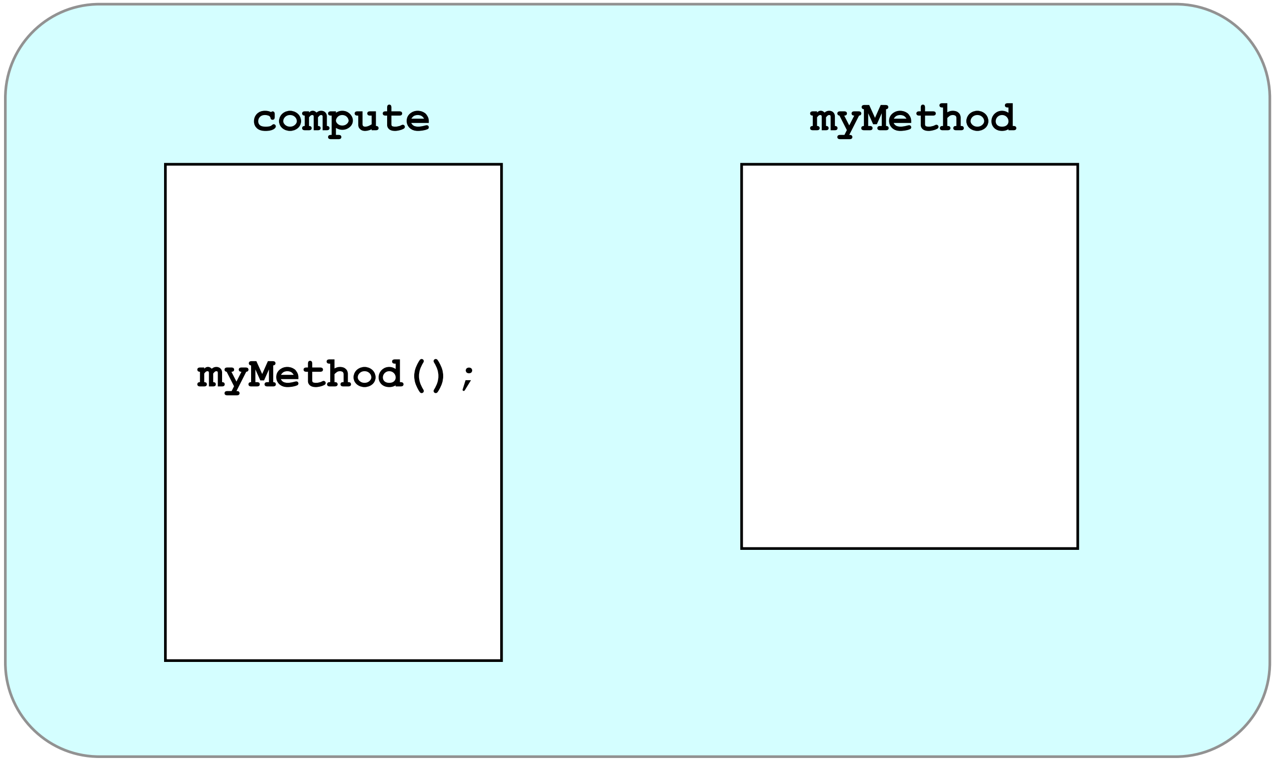
- When a method is invoked, the flow of control jumps to the method and executes its code
- When complete, the flow returns to the place where the method was called and continues
- The invocation may or may not return a value, depending on how the method is defined

Method Control Flow

Method Control Flow

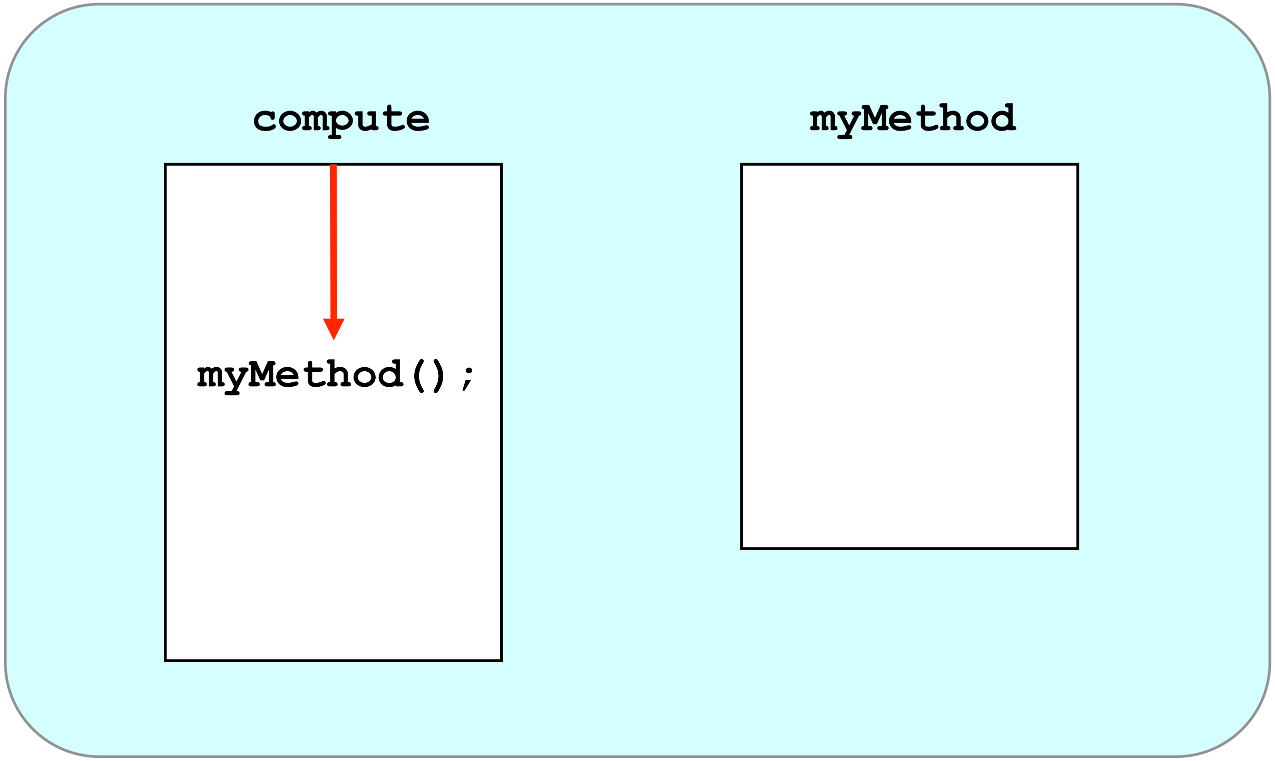
- If the called method is in the same class, only the method name is needed

Method Control Flow



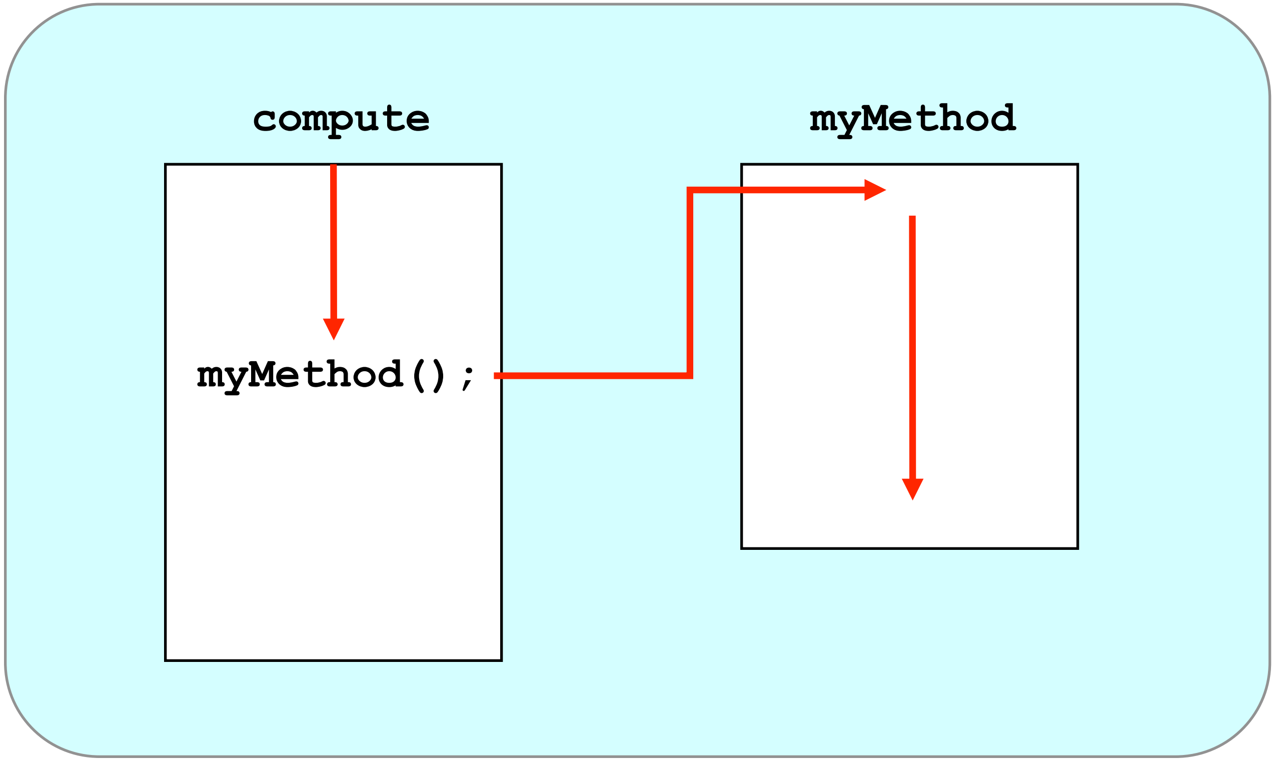
- If the called method is in the same class, only the method name is needed

Method Control Flow



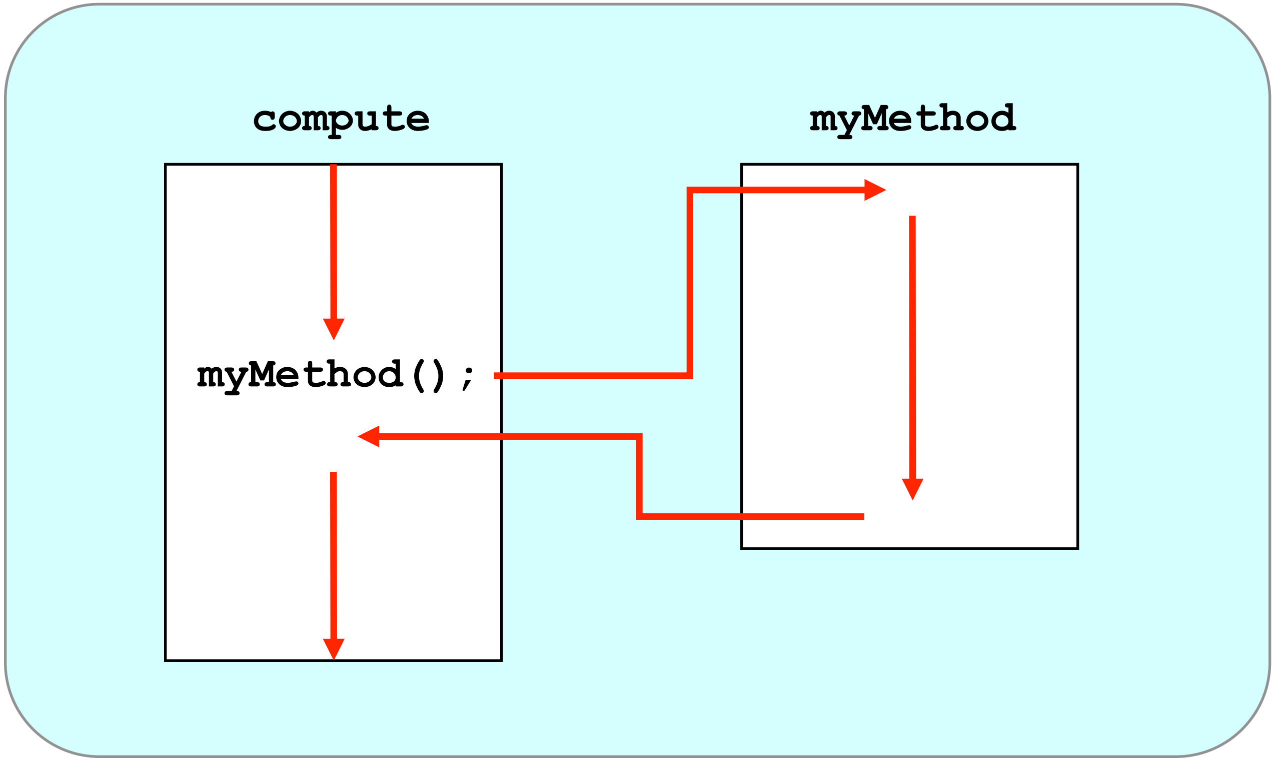
- If the called method is in the same class, only the method name is needed

Method Control Flow



- If the called method is in the same class, only the method name is needed

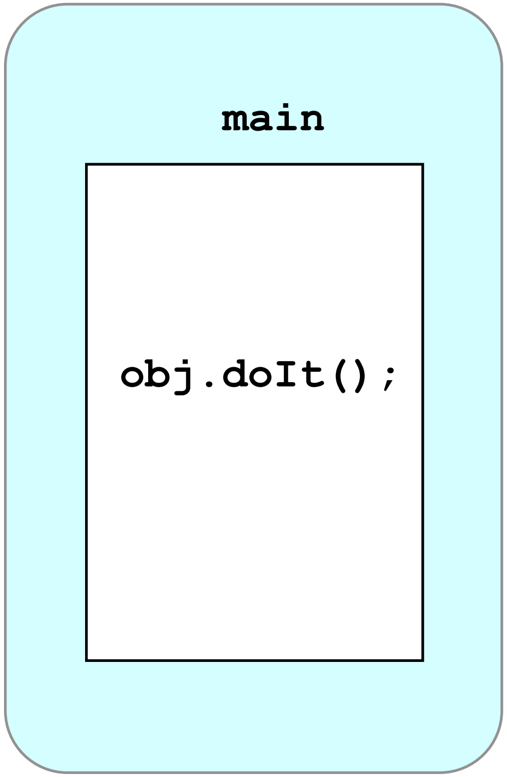
Method Control Flow



- If the called method is in the same class, only the method name is needed

Method Control Flow

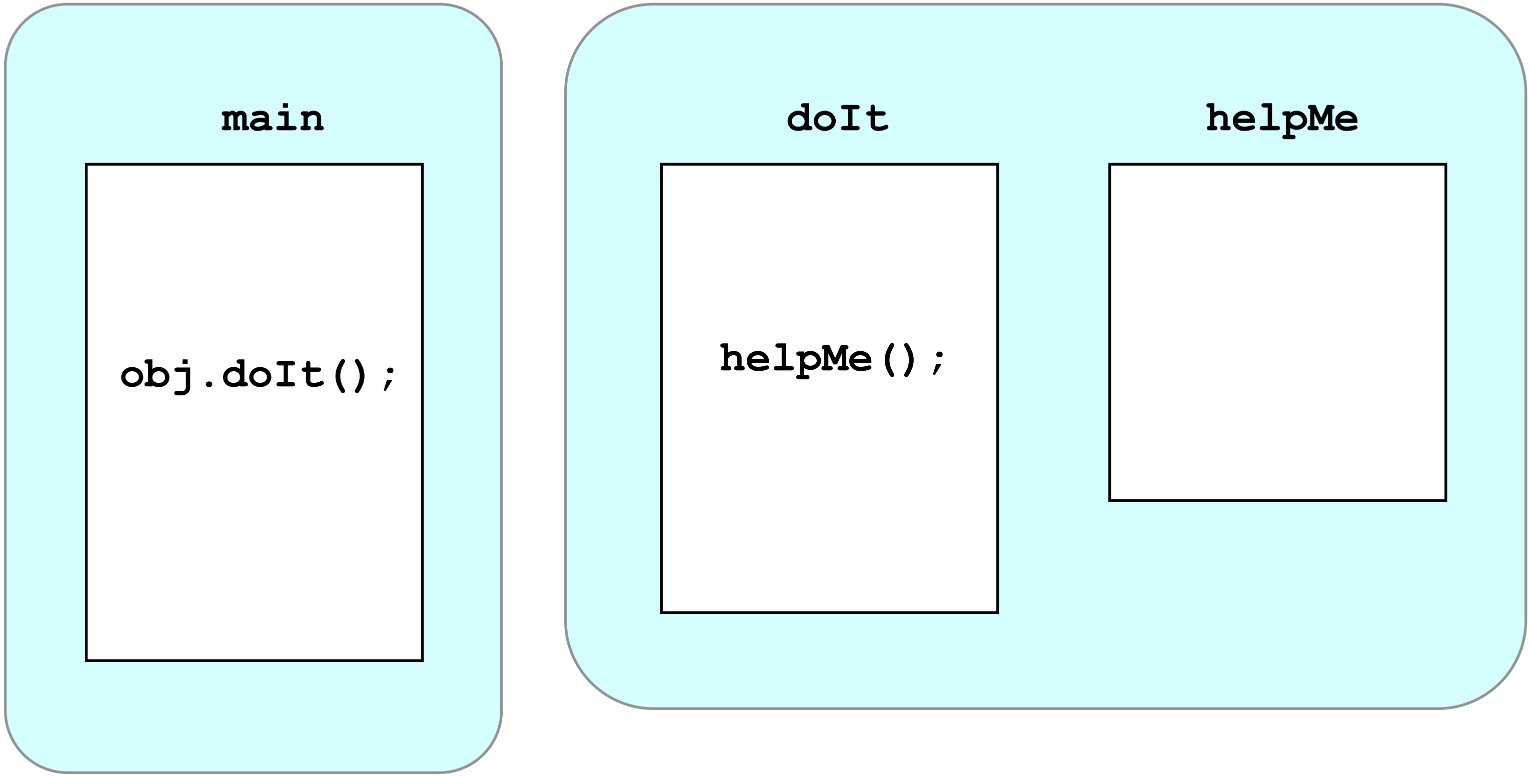
Method Control Flow



main

```
obj.doIt();
```

Method Control Flow



main

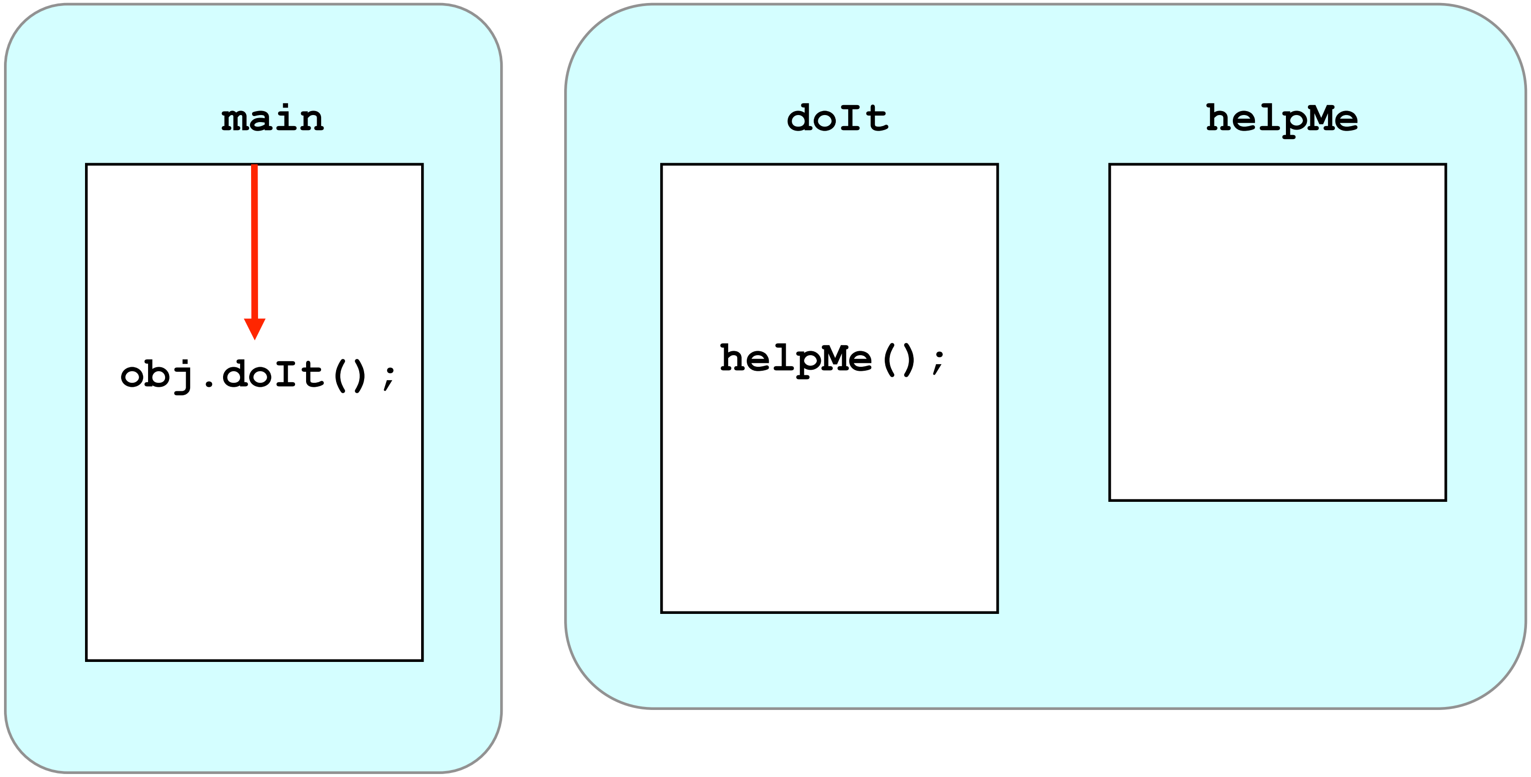
```
obj.doIt();
```

doIt

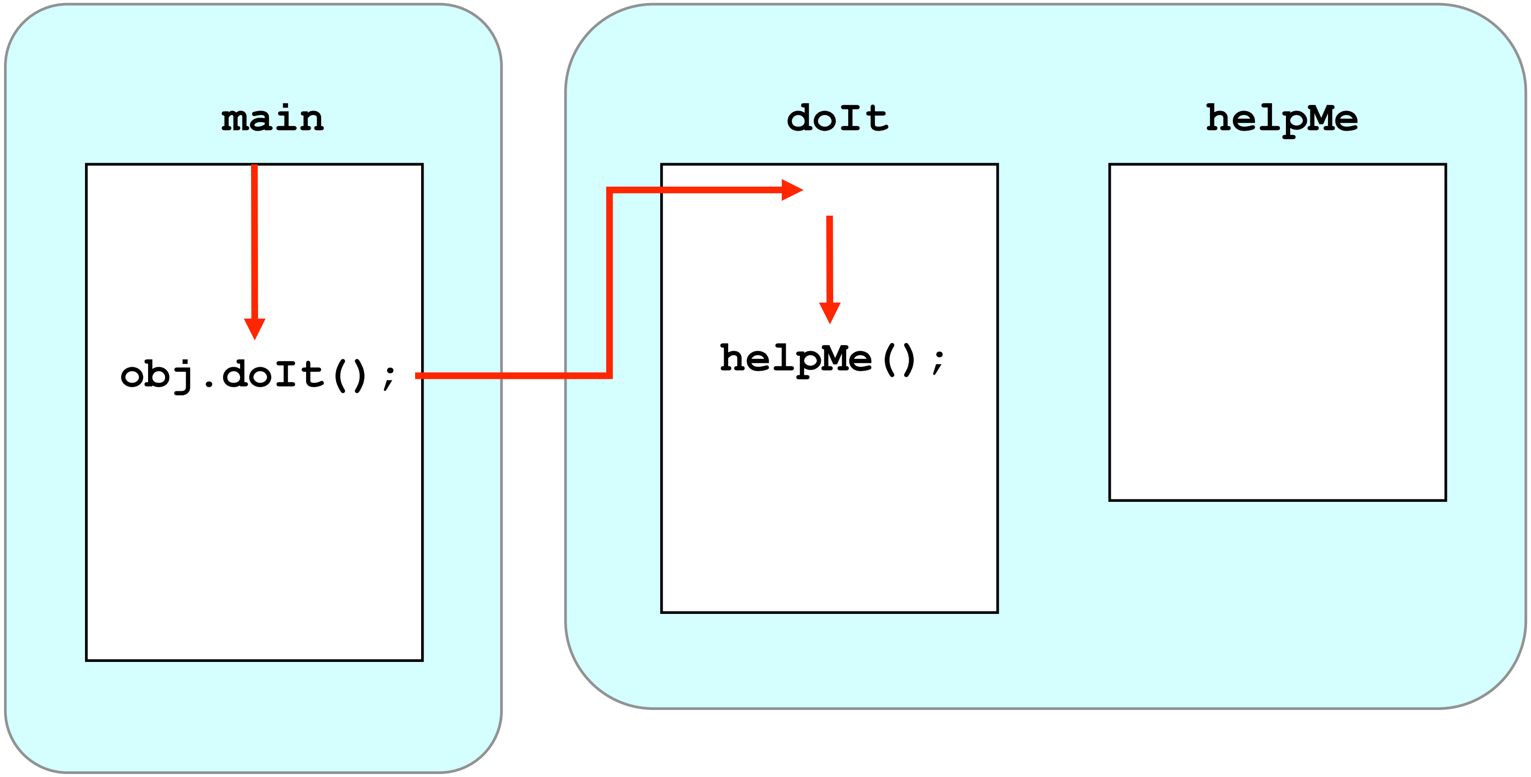
```
helpMe();
```

helpMe

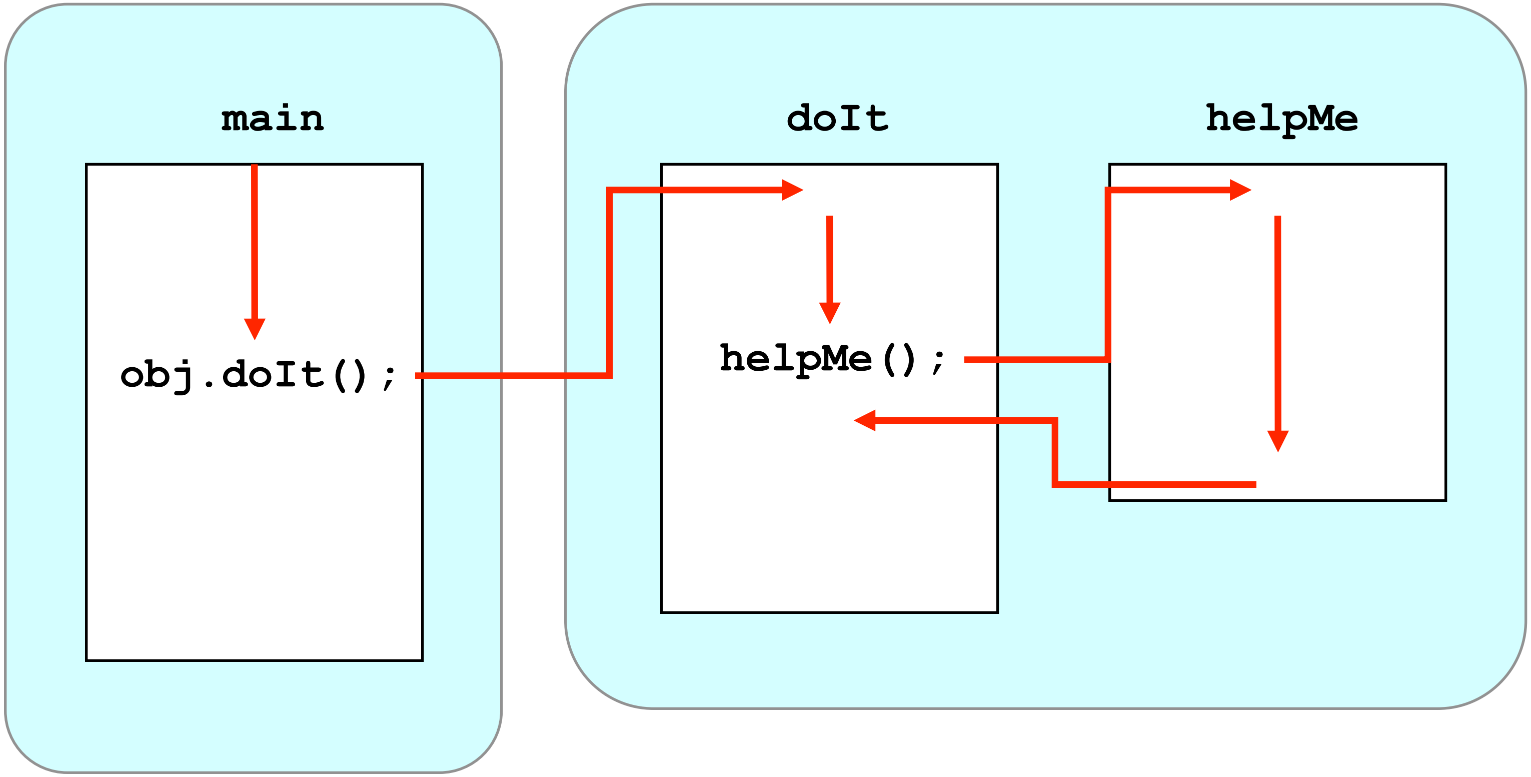
Method Control Flow



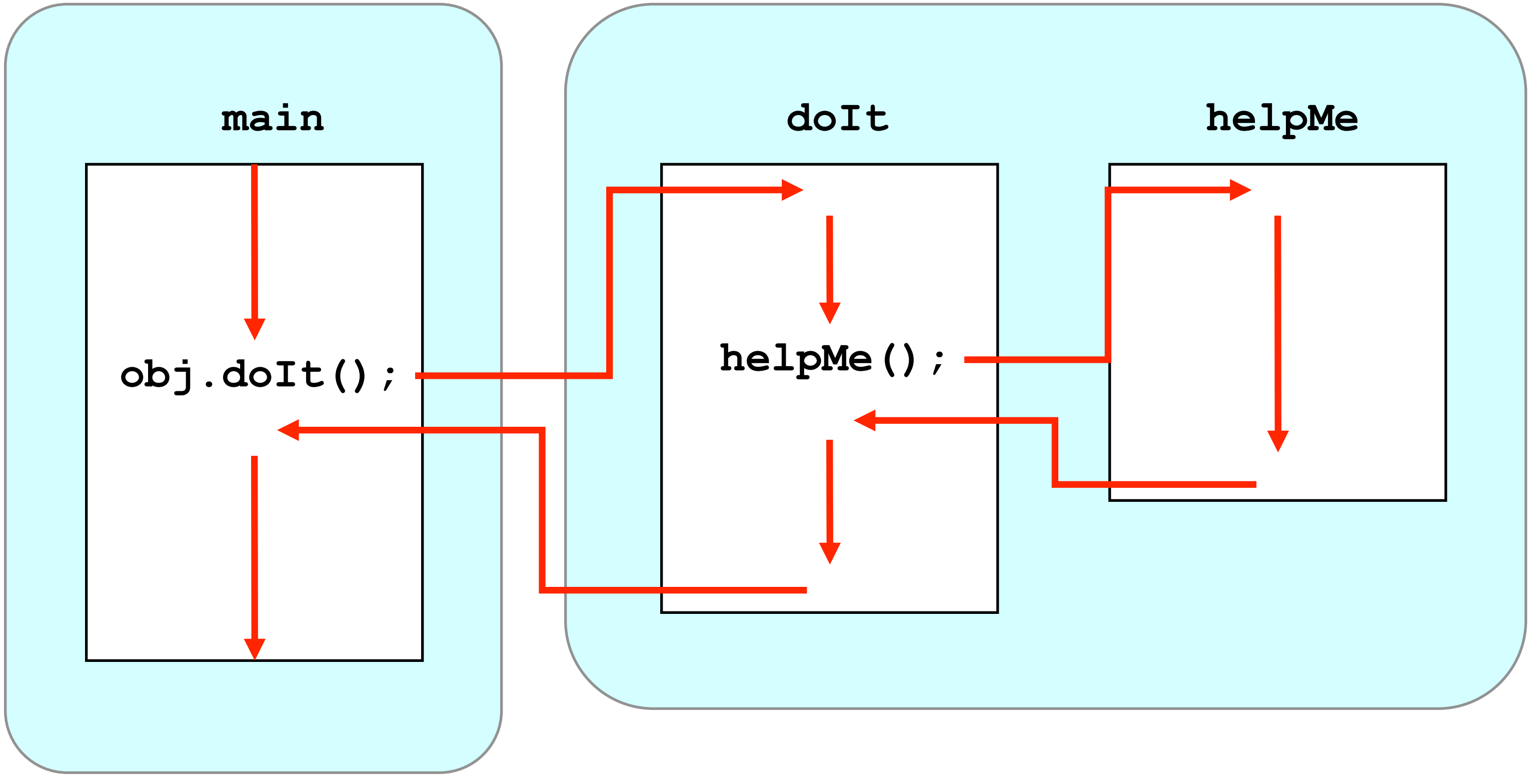
Method Control Flow



Method Control Flow



Method Control Flow



main

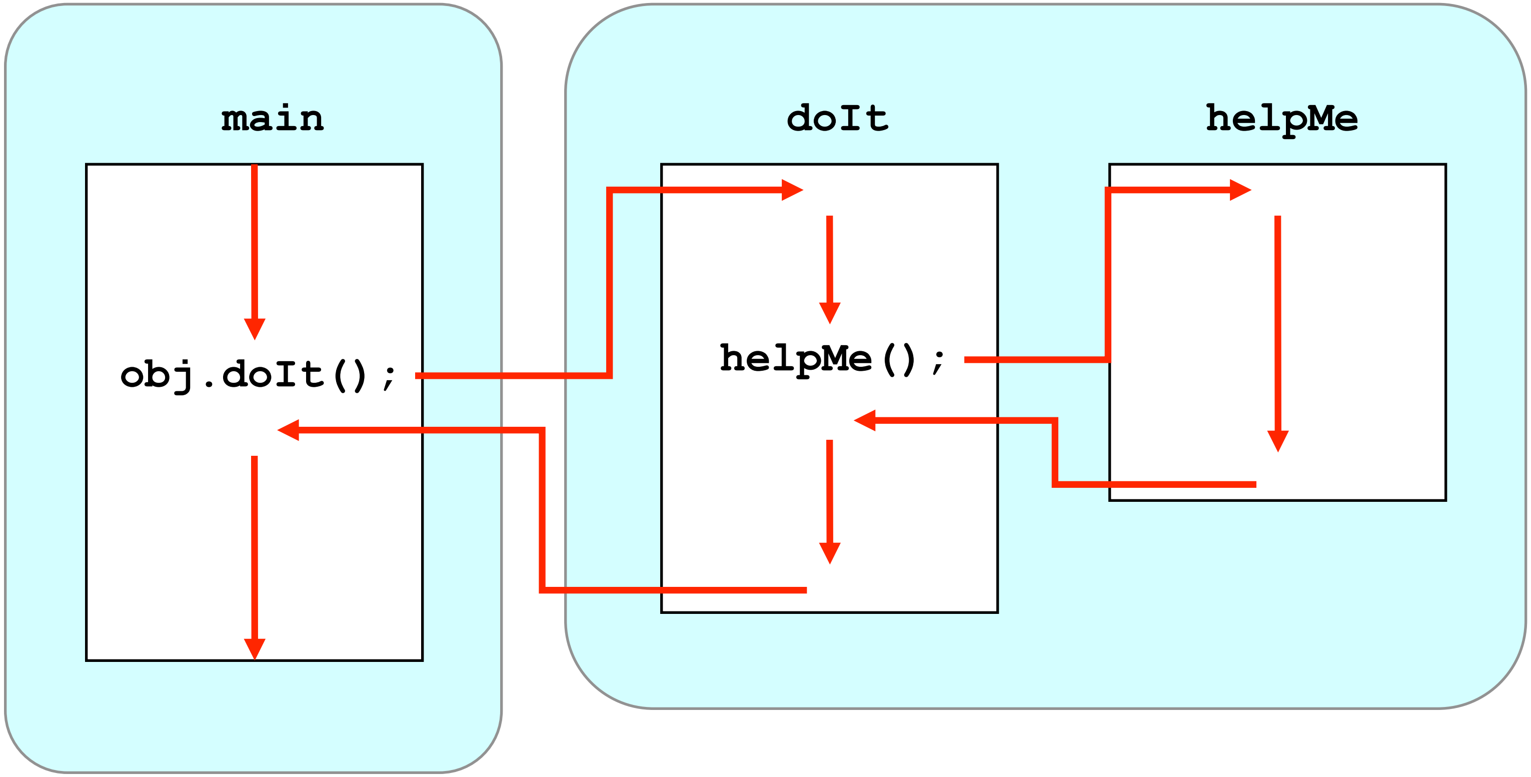
obj.doIt();

doIt

helpMe();

helpMe

Method Control Flow



- The called method is often part of another class or object. In that case the object or class name, dot operator, and the method are required.

Variadic Methods

- A variadic method is a method that takes a variable number of arguments.
- Until now all our methods take a fixed number of arguments. For instance, the **`sum`** method only takes to numbers as arguments.
- A more useful version of the **`sum`** method should be able to accept any number of arguments.e.g., **`sum(10,25)`**, **`sum( 10,25,50)`**, **`sum(1,2,3,4,5,6,7)`**, etc.

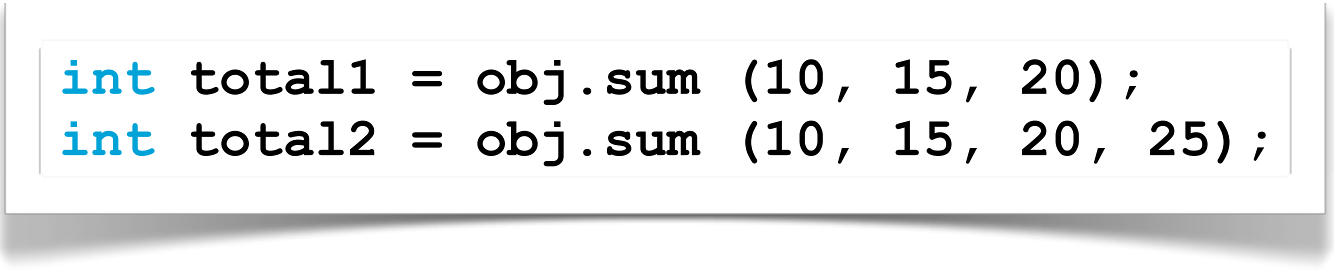
Variadic Methods in Java

The type of the last parameter is followed by an ellipsis (three dots, ...)

This feature is available as of Java 5.0

```
int sum (int... args){
   int total = 0;
   for(int index = 0; index < args.length; index++){
        total += args[index];
   }
   return total;
   }
}
```

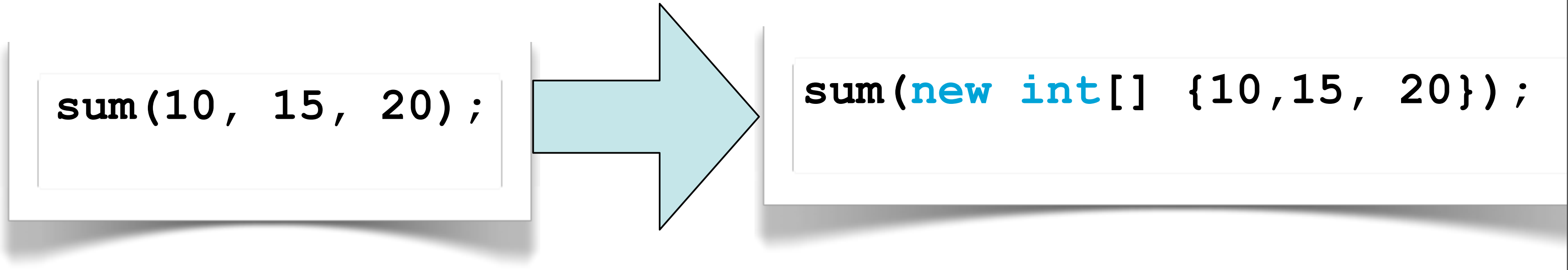
- Example:



```
int total1 = obj.sum (10, 15, 20);
int total2 = obj.sum (10, 15, 20, 25);
```

Variadic Methods in Java

- Behind the scenes: arguments passed to a variadic method are converted into an array of the same-typed values

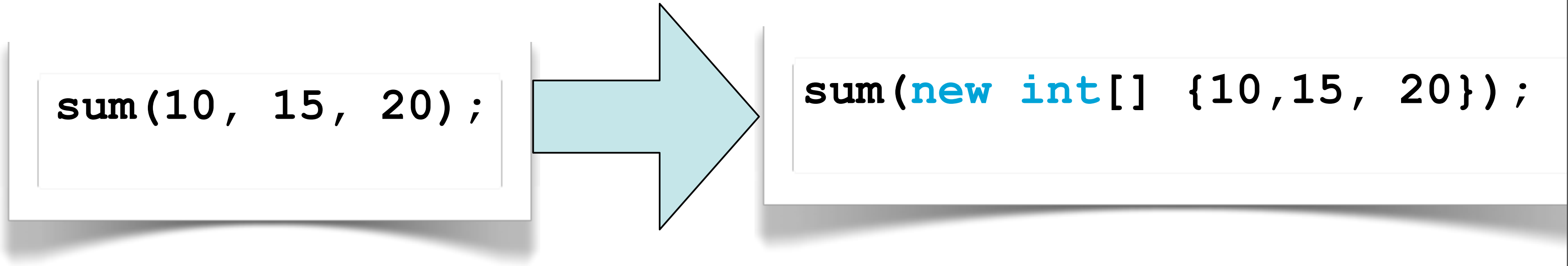


```
sum(10, 15, 20);
```

```
sum(new int[] {10,15, 20});
```

Variadic Methods in Java

- Behind the scenes: arguments passed to a variadic method are converted into an array of the same-typed values



```
sum(10, 15, 20);
```

```
sum(new int[] {10,15, 20});
```

```
int sum (int... args){
   int total = 0;
   for(int index = 0; index < args.length; index++){
        total += args[index];
   }
   return total;
   }
}
```

Hence **`args`** is an array