

# Methods

# Defining Methods

A method is a collection of statements that are grouped together to perform an operation.

Define a method

```
public static int max(int num1, int num2) {  
    int result;  
  
    if (num1 > num2)  
        result = num1;  
    else  
        result = num2;  
  
    return result;  
}
```

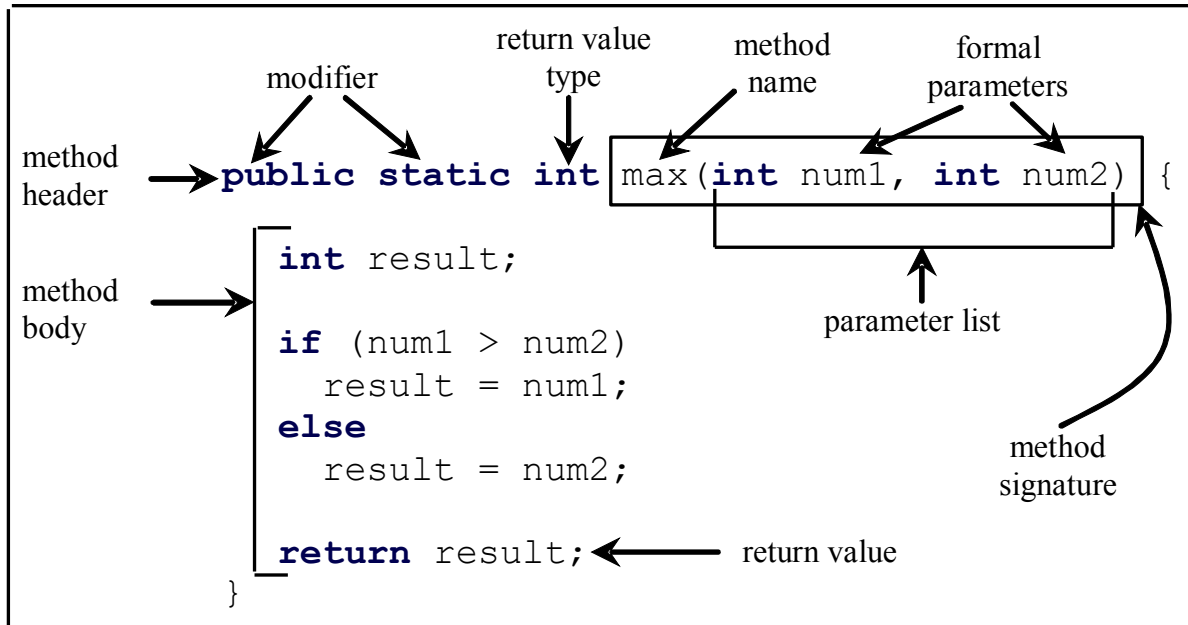
Invoke a method

```
int z = max(x, y);  
        ↑  ↑  
    actual parameters  
    (arguments)
```

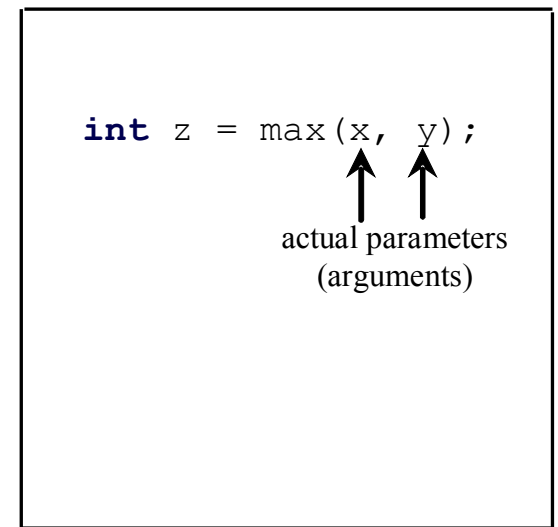
# Defining Methods

A method is a collection of statements that are grouped together to perform an operation.

Define a method



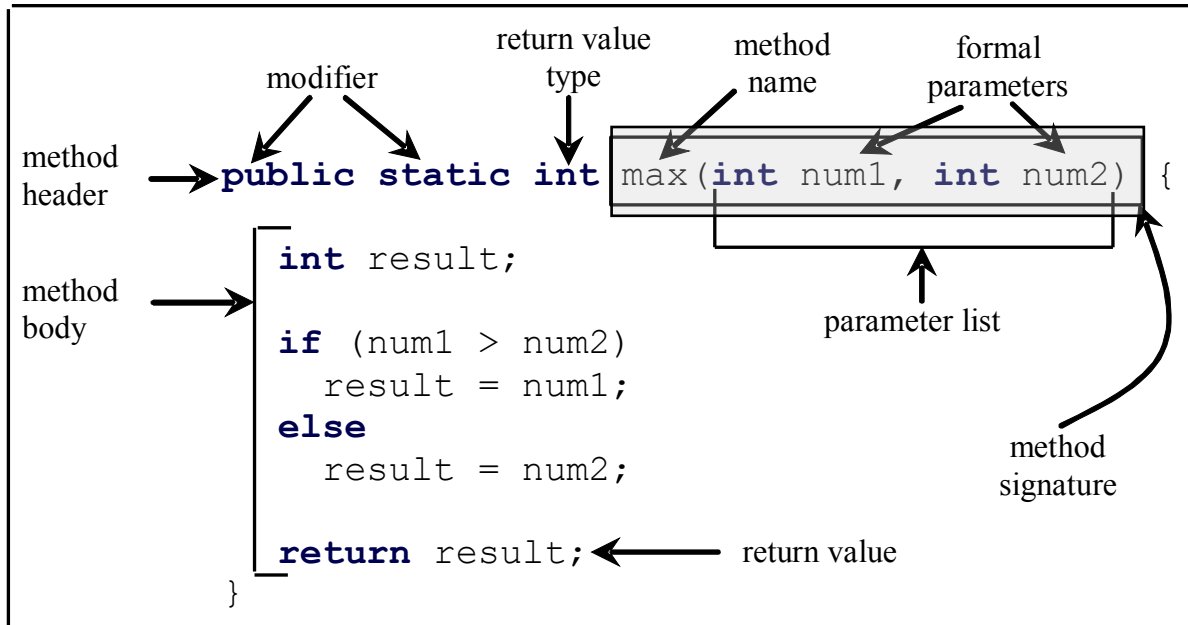
Invoke a method



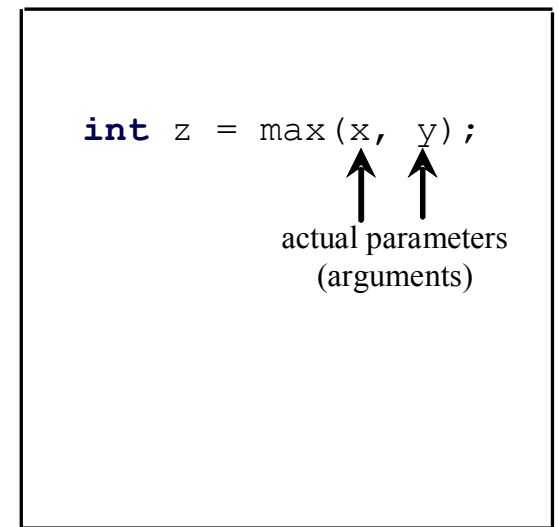
# Method Signature

*Method signature* is the combination of the method name and the parameter list.

Define a method



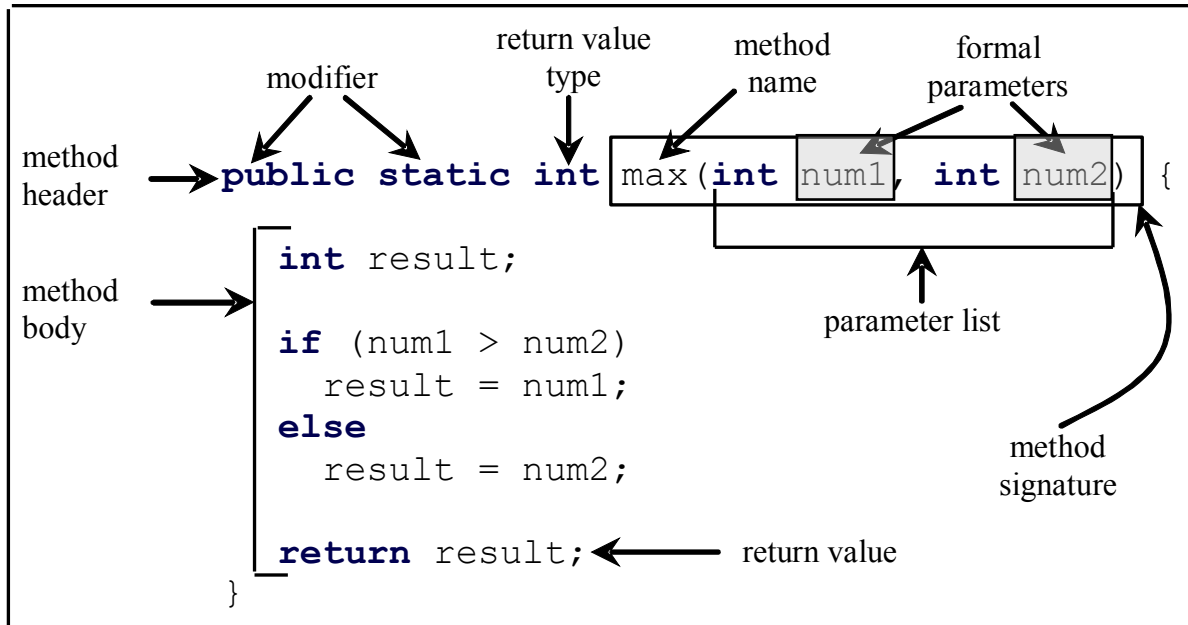
Invoke a method



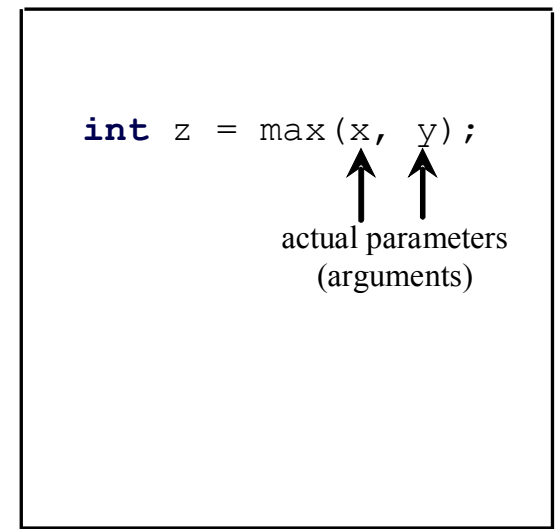
# Formal Parameters

The variables defined in the method header are known as *formal parameters*.

Define a method



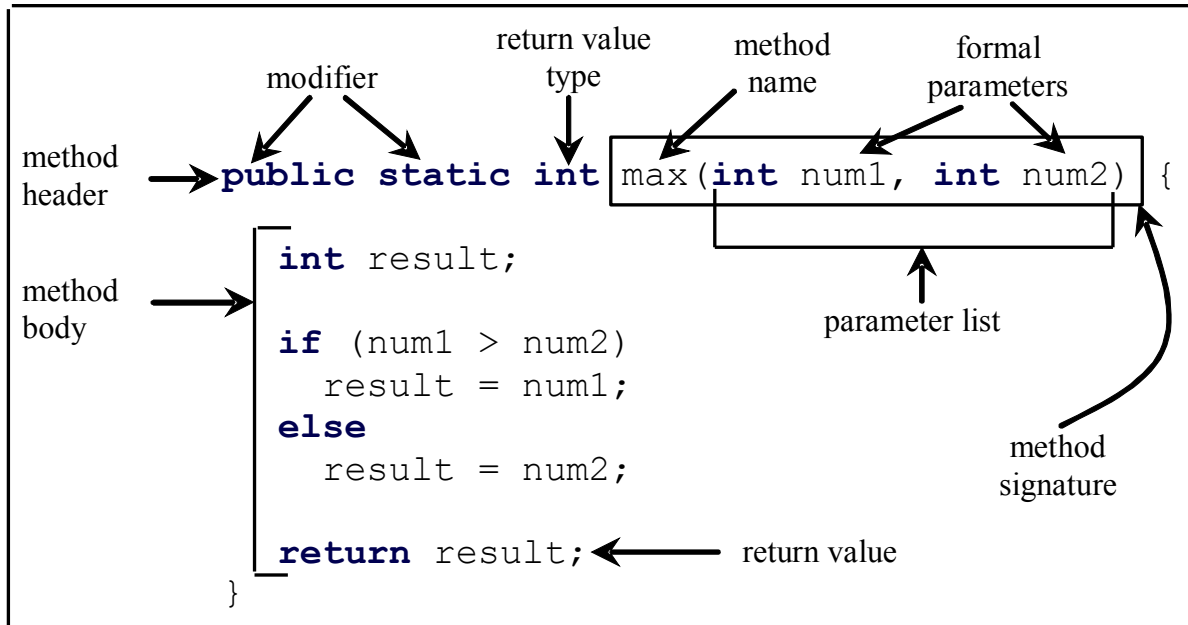
Invoke a method



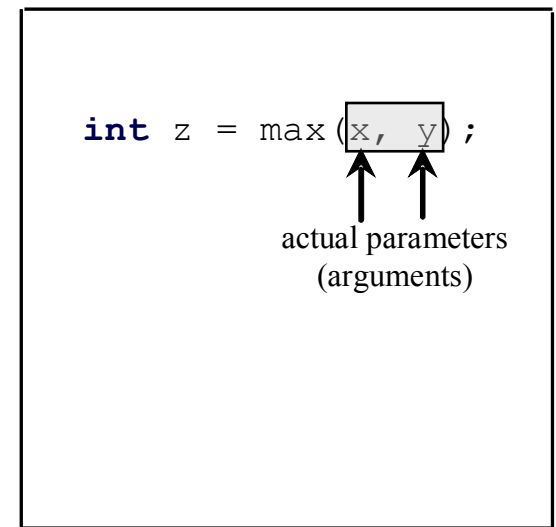
# Actual Parameters

When a method is invoked, you pass a value to the parameter. This value is referred to as *actual parameter* or *argument*.

Define a method



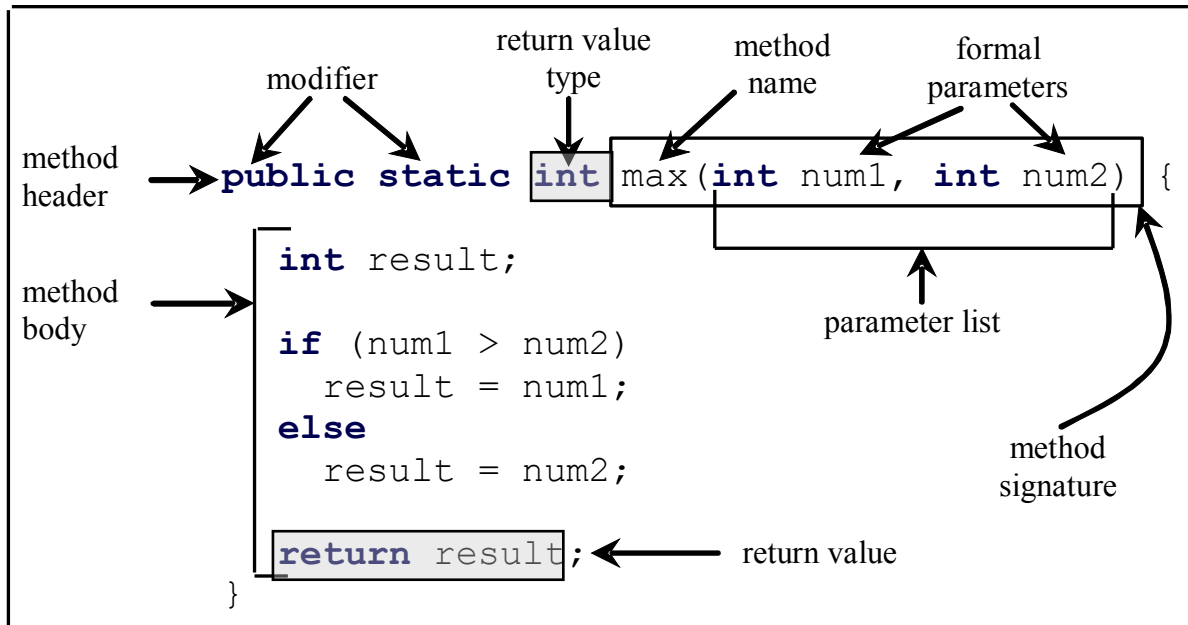
Invoke a method



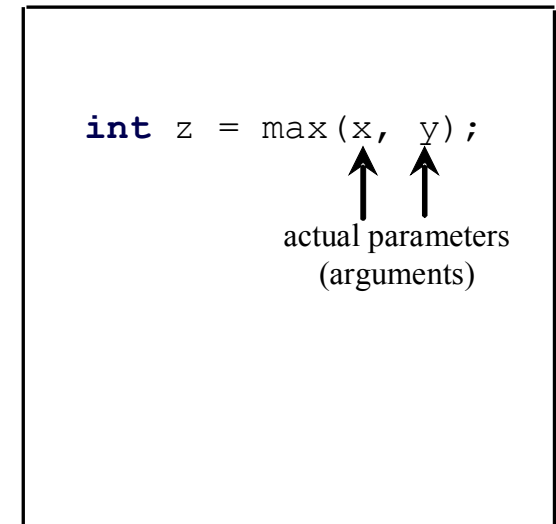
# Return Value Type

A method may return a value. The returnValueType is the data type of the value the method returns. If the method does not return a value, the returnValueType is the keyword void. For example, the returnValueType in the main method is void.

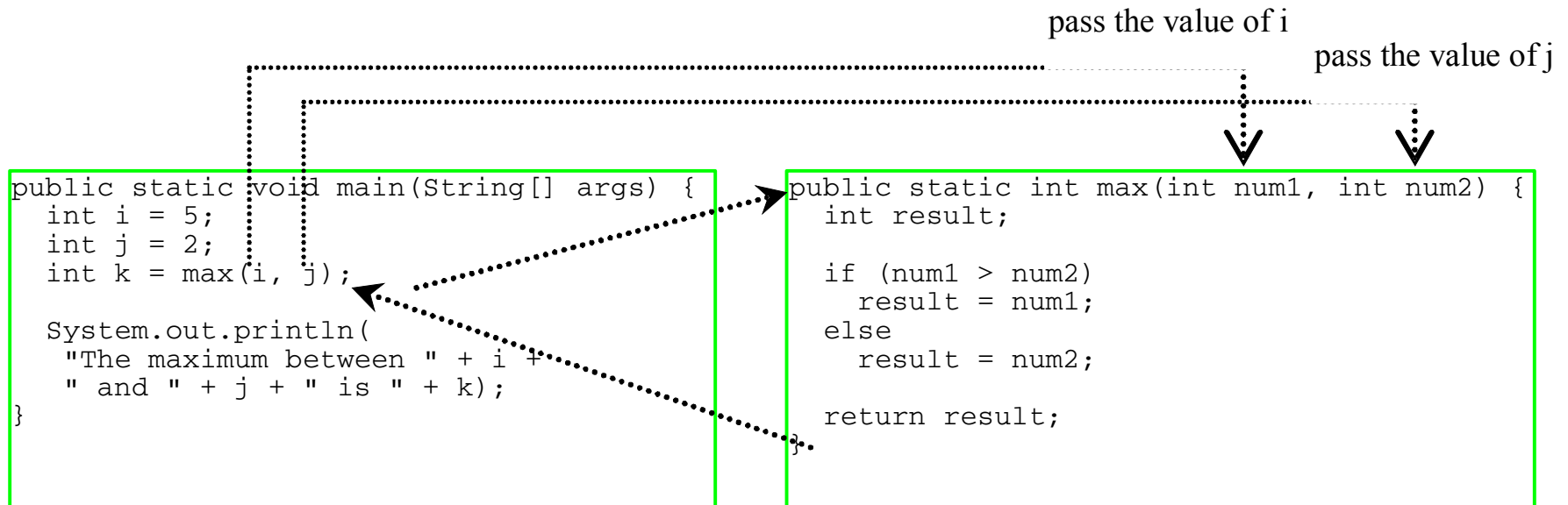
Define a method



Invoke a method



# Calling Methods





# Trace Method Invocation

i is now 5

```
public static void main(String[] args) {  
    int i = 5;  
    int j = 2;  
    int k = max(i, j);  
  
    System.out.println(  
        "The maximum between " + i +  
        " and " + j + " is " + k);  
}
```

```
public static int max(int num1, int num2) {  
    int result;  
  
    if (num1 > num2)  
        result = num1;  
    else  
        result = num2;  
  
    return result;  
}
```

# Trace Method Invocation

j is now 2

```
public static void main(String[] args) {  
    int i = 5;  
    int j = 2;  
    int k = max(i, j);  
  
    System.out.println(  
        "The maximum between " + i +  
        " and " + j + " is " + k);  
}
```

```
public static int max(int num1, int num2) {  
    int result;  
  
    if (num1 > num2)  
        result = num1;  
    else  
        result = num2;  
  
    return result;  
}
```

# Trace Method Invocation

invoke max(i, j)

```
public static void main(String[] args) {  
    int i = 5;  
    int j = 2;  
    int k = max(i, j);  
  
    System.out.println(  
        "The maximum between " + i +  
        " and " + j + " is " + k);  
}
```

```
public static int max(int num1, int num2) {  
    int result;  
  
    if (num1 > num2)  
        result = num1;  
    else  
        result = num2;  
  
    return result;  
}
```

# Trace Method Invocation

invoke max(i, j)  
Pass the value of i to num1  
Pass the value of j to num2

```
public static void main(String[] args) {  
    int i = 5;  
    int j = 2;  
    int k = max(i, j);  
  
    System.out.println(  
        "The maximum between " + i +  
        " and " + j + " is " + k);  
}
```

```
public static int max(int num1, int num2) {  
    int result;  
  
    if (num1 > num2)  
        result = num1;  
    else  
        result = num2;  
  
    return result;  
}
```

# Trace Method Invocation

declare variable result

```
public static void main(String[] args) {  
    int i = 5;  
    int j = 2;  
    int k = max(i, j);  
  
    System.out.println(  
        "The maximum between " + i +  
        " and " + j + " is " + k);  
}
```

```
public static int max(int num1, int num2) {  
    int result;  
  
    if (num1 > num2)  
        result = num1;  
    else  
        result = num2;  
  
    return result;  
}
```

# Trace Method Invocation

(num1 > num2) is true since num1 is 5  
and num2 is 2

```
public static void main(String[] args) {  
    int i = 5;  
    int j = 2;  
    int k = max(i, j);  
  
    System.out.println(  
        "The maximum between " + i +  
        " and " + j + " is " + k);  
}
```

```
public static int max(int num1, int num2) {  
    int result;  
  
    if (num1 > num2)  
        result = num1;  
    else  
        result = num2;  
  
    return result;  
}
```

# Trace Method Invocation

result is now 5

```
public static void main(String[] args) {  
    int i = 5;  
    int j = 2;  
    int k = max(i, j);  
  
    System.out.println(  
        "The maximum between " + i +  
        " and " + j + " is " + k);  
}
```

```
public static int max(int num1, int num2) {  
    int result;  
  
    if (num1 > num2)  
        result = num1;  
    else  
        result = num2;  
  
    return result;  
}
```

# Trace Method Invocation

return result, which is 5

```
public static void main(String[] args) {  
    int i = 5;  
    int j = 2;  
    int k = max(i, j);  
  
    System.out.println(  
        "The maximum between " + i +  
        " and " + j + " is " + k);  
}
```

```
public static int max(int num1, int num2) {  
    int result;  
  
    if (num1 > num2)  
        result = num1;  
    else  
        result = num2;  
  
    return result;  
}
```



# Trace Method Invocation

return max(i, j) and assign the  
return value to k

```
public static void main(String[] args) {  
    int i = 5;  
    int j = 2;  
    int k = max(i, j);  
  
    System.out.println(  
        "The maximum between " + i +  
        " and " + j + " is " + k);  
}
```

```
public static int max(int num1, int num2) {  
    int result;  
  
    if (num1 > num2)  
        result = num1;  
    else  
        result = num2;  
  
    return result;  
}
```

# Trace Method Invocation

Execute the print statement

```
public static void main(String[] args) {  
    int i = 5;  
    int j = 2;  
    int k = max(i, j);  
  
    System.out.println(  
        "The maximum between " + i +  
        " and " + j + " is " + k);  
}
```

```
public static int max(int num1, int num2) {  
    int result;  
  
    if (num1 > num2)  
        result = num1;  
    else  
        result = num2;  
  
    return result;  
}
```

# CAUTION

A return statement is required for a value-returning method. The method shown below in (a) is logically correct, but it has a compilation error because the Java compiler thinks it possible that this method does not return any value.

```
public static int sign(int n) {  
    if (n > 0)  
        return 1;  
    else if (n == 0)  
        return 0;  
    else if (n < 0)  
        return -1;  
}
```

(a)

Should be

```
public static int sign(int n) {  
    if (n > 0)  
        return 1;  
    else if (n == 0)  
        return 0;  
    else  
        return -1;  
}
```

(b)

To fix this problem, delete if ( $n < 0$ ) in (a), so that the compiler will see a return statement to be reached regardless of how the if statement is evaluated.

# Trace Call Stack

i is declared and initialized

```
public static void main(String[] args) {  
    int i = 5;  
    int j = 2;  
    int k = max(i, j);  
  
    System.out.println(  
        "The maximum between " + i +  
        " and " + j + " is " + k);  
}
```

```
public static int max(int num1, int num2) {  
    int result;  
  
    if (num1 > num2)  
        result = num1;  
    else  
        result = num2;  
  
    return result;  
}
```

i: 5

The main method  
is invoked.

# Trace Call Stack

j is declared and initialized

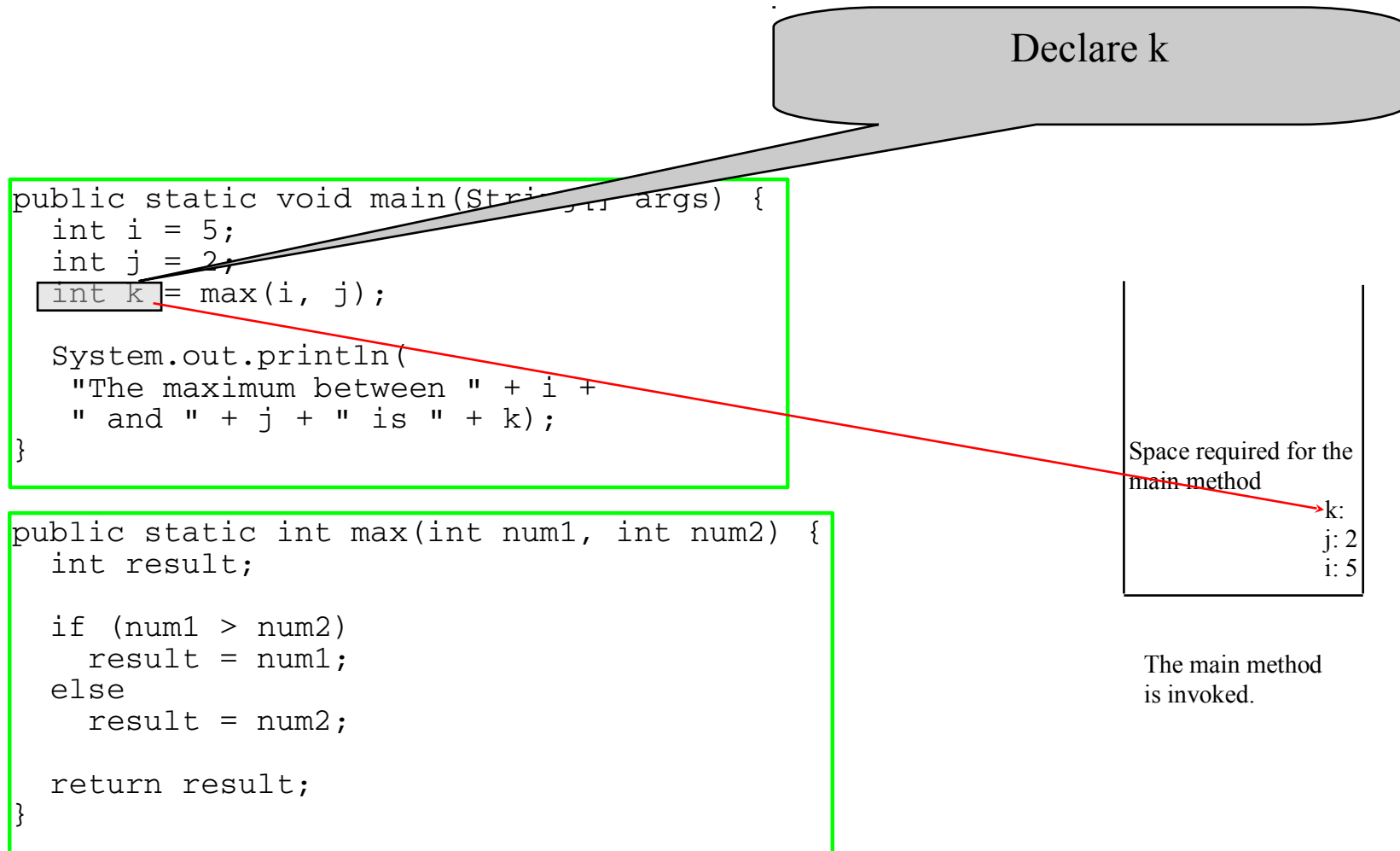
```
public static void main(String[] args) {  
    int i = 5;  
    int j = 2;  
    int k = max(i, j);  
  
    System.out.println(  
        "The maximum between " + i +  
        " and " + j + " is " + k);  
}
```

```
public static int max(int num1, int num2) {  
    int result;  
  
    if (num1 > num2)  
        result = num1;  
    else  
        result = num2;  
  
    return result;  
}
```

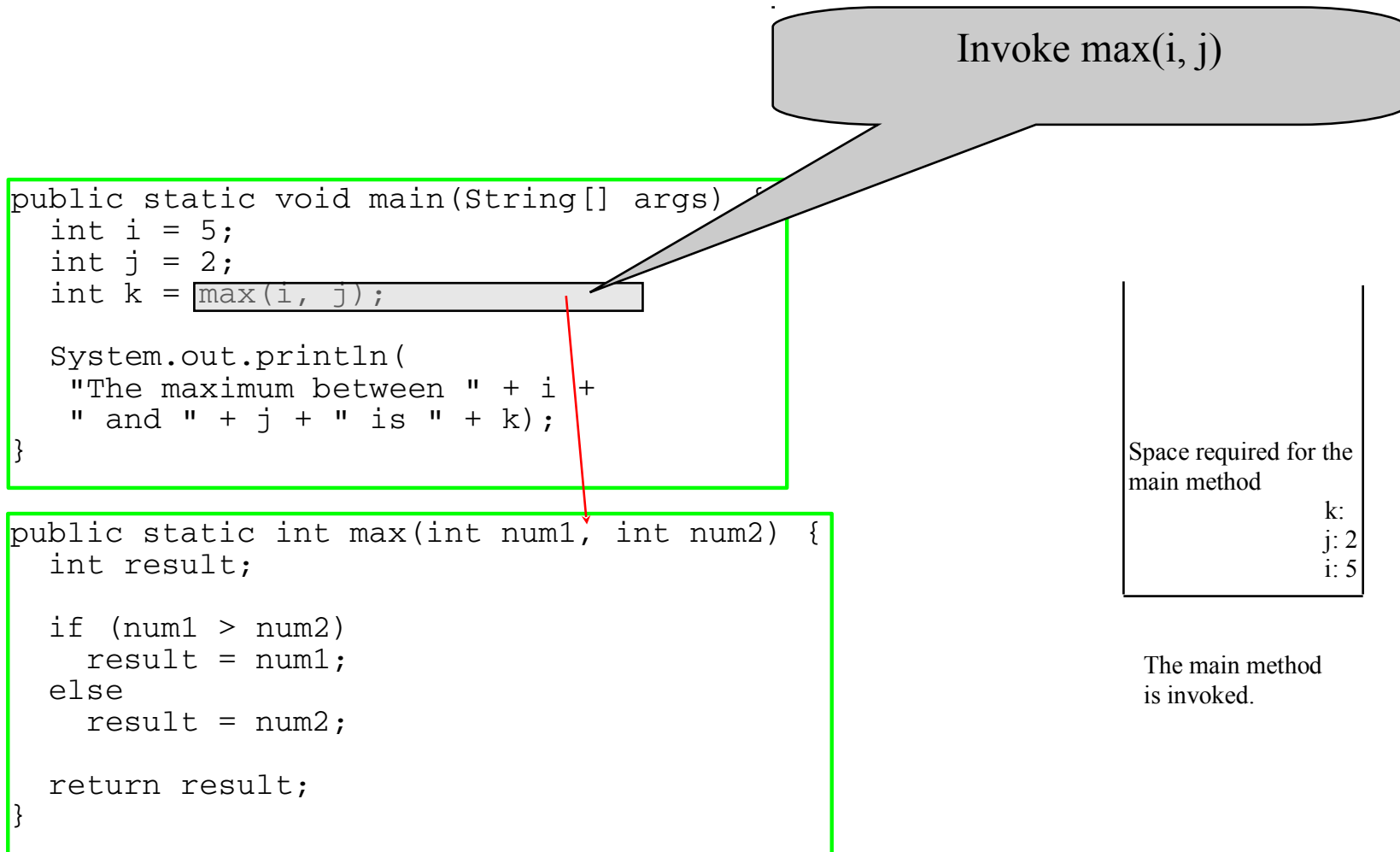
j: 2  
i: 5

The main method  
is invoked.

# Trace Call Stack



# Trace Call Stack

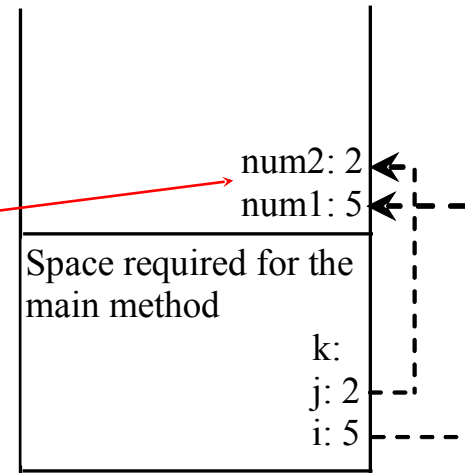


# Trace Call Stack

```
public static void main(String[] args) {  
    int i = 5;  
    int j = 2;  
    int k = max(i, j);  
  
    System.out.println(  
        "The maximum between " + i +  
        " and " + j + " is " + k);  
}
```

```
public static int max(int num1, int num2) {  
    int result;  
  
    if (num1 > num2)  
        result = num1;  
    else  
        result = num2;  
  
    return result;  
}
```

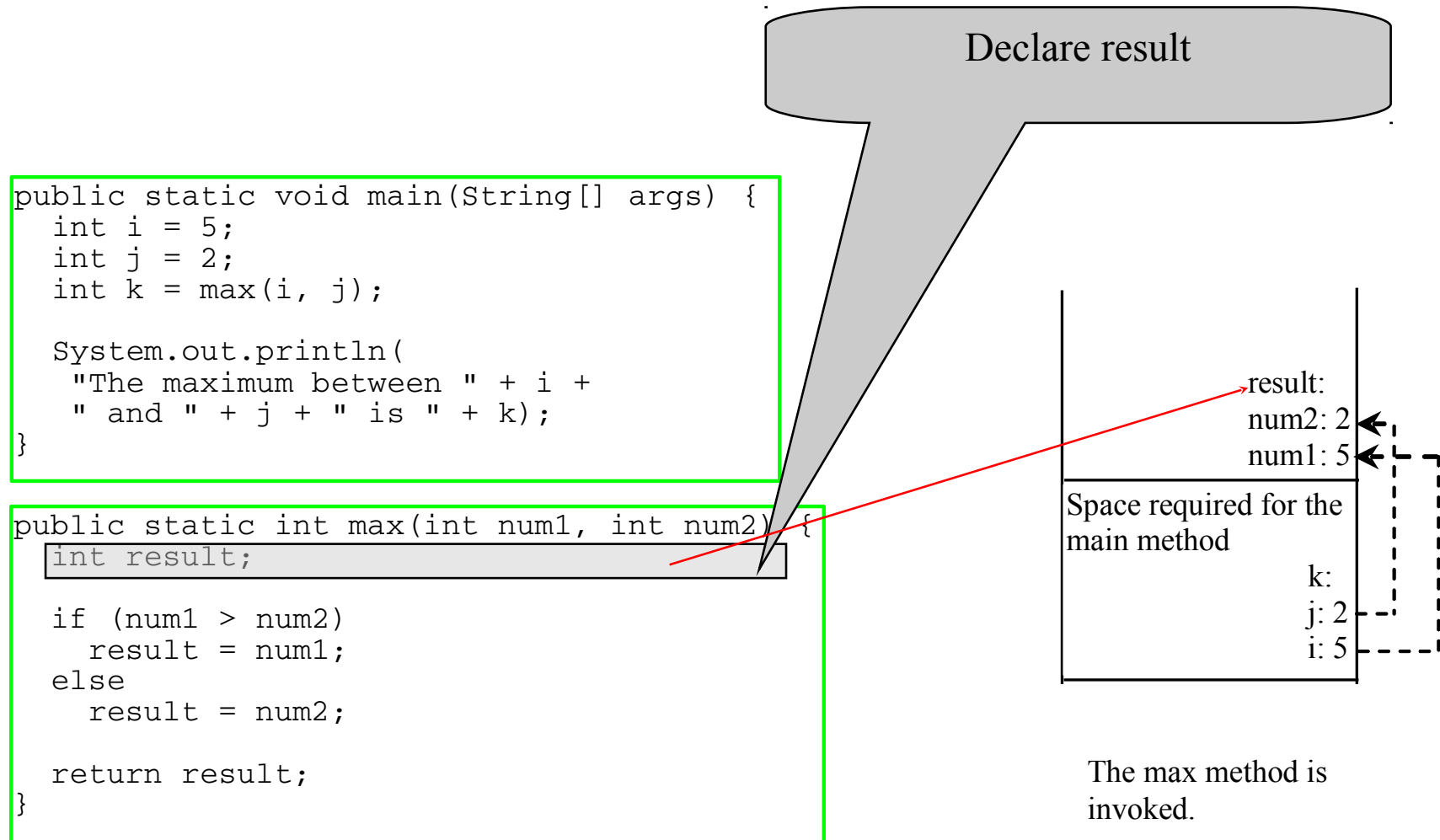
pass the values of i and j to num1  
and num2



The max method is  
invoked.



# Trace Call Stack

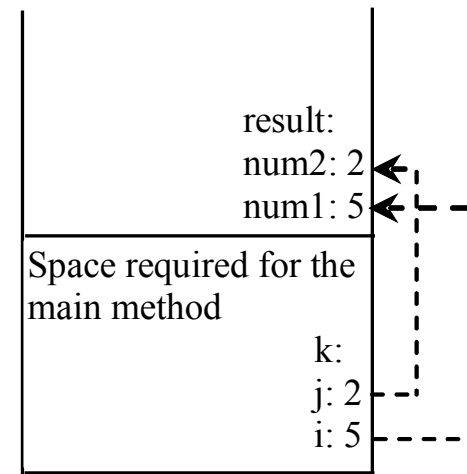


# Trace Call Stack

```
public static void main(String[] args) {  
    int i = 5;  
    int j = 2;  
    int k = max(i, j);  
  
    System.out.println(  
        "The maximum between " + i +  
        " and " + j + " is " + k);  
}
```

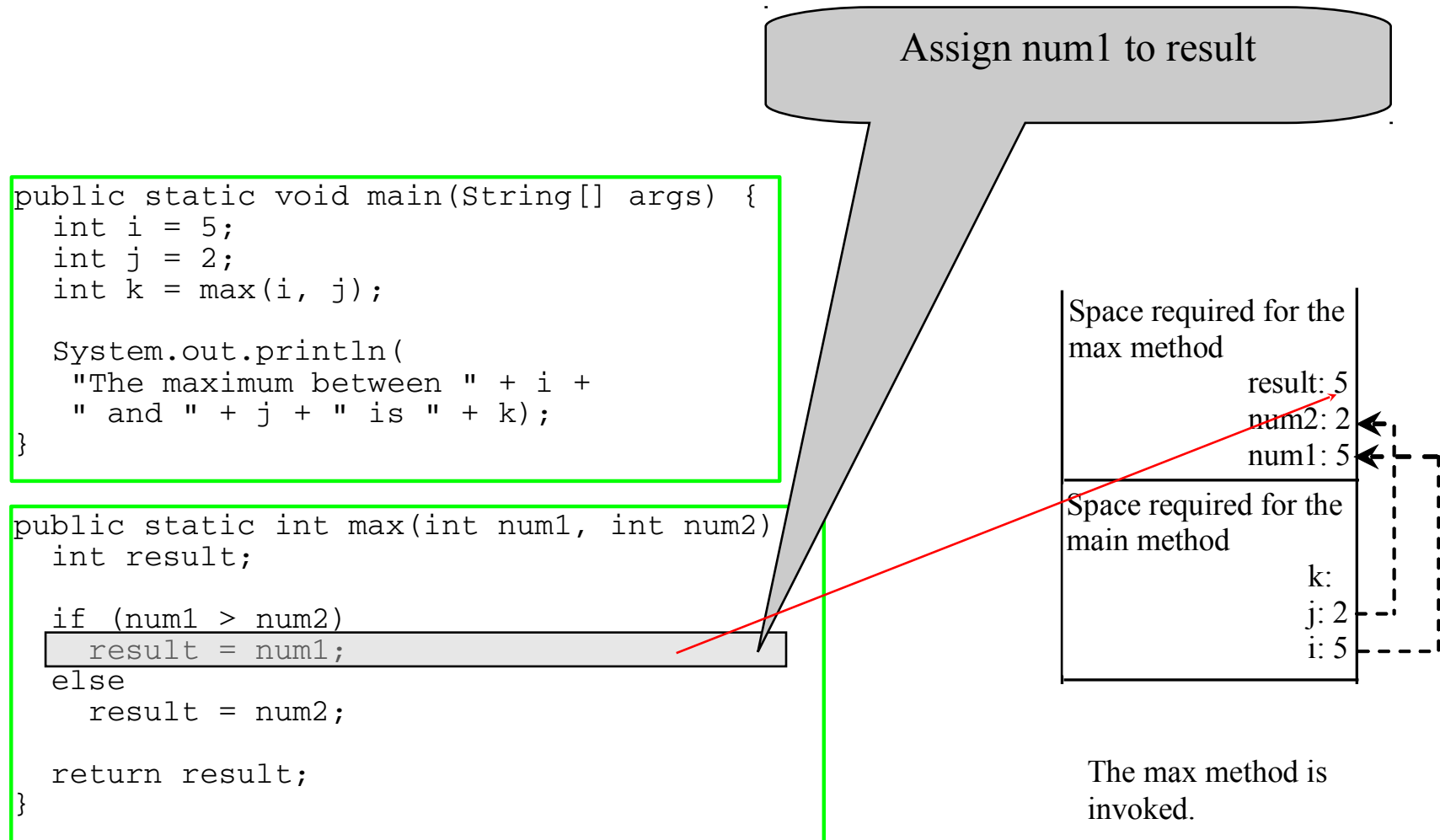
```
public static int max(int num1, int num2) {  
    int result;  
  
    if (num1 > num2)  
        result = num1;  
    else  
        result = num2;  
  
    return result;  
}
```

(num1 > num2) is true

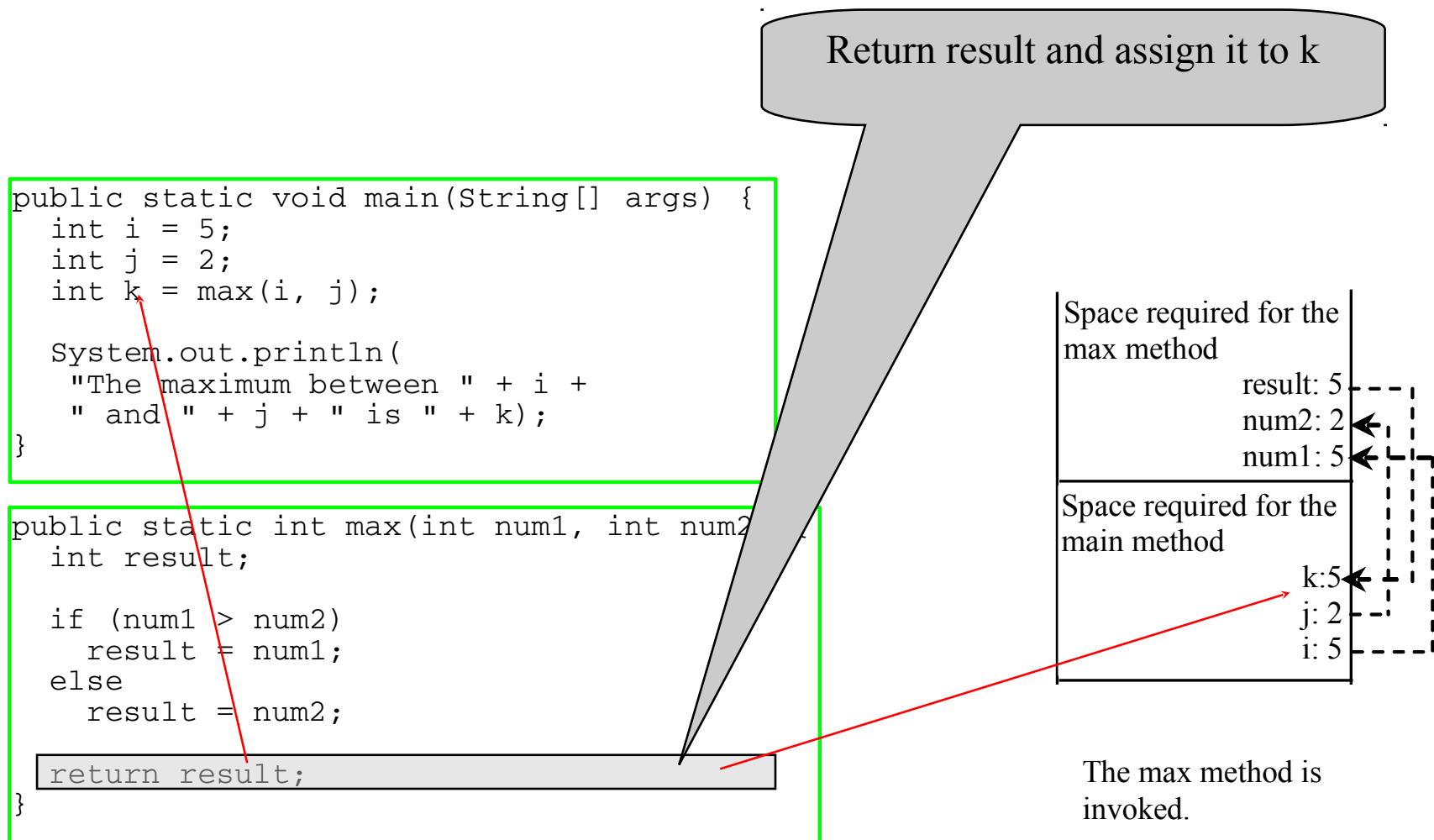


The max method is  
invoked.

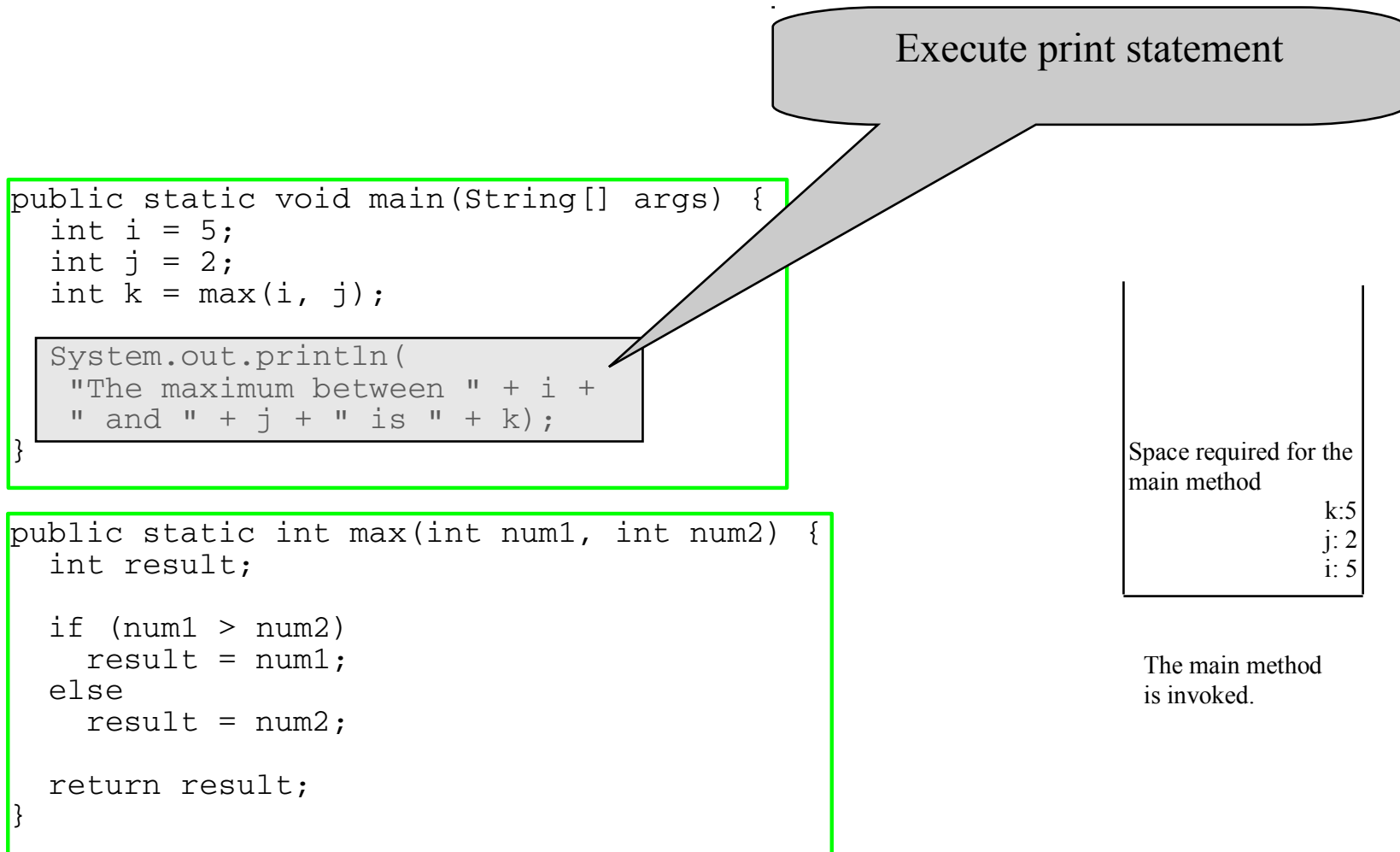
# Trace Call Stack



# Trace Call Stack



# Trace Call Stack



# Passing Parameters

```
public static void nPrintln(String message, int n) {  
    for (int i = 0; i < n; i++)  
        System.out.println(message) ;  
}
```

Suppose you invoke the method using

```
nPrintln("Welcome to Java", 5);
```

What is the output?

Suppose you invoke the method using

```
nPrintln("Computer Science", 15);
```

What is the output?

Can you invoke the method using

```
nPrintln(15, "Computer Science");
```

# Scope of Local Variables

A local variable: a variable defined inside a method.

Scope: the part of the program where the variable can be referenced.

The scope of a local variable starts from its declaration and continues to the end of the block that contains the variable. A local variable must be declared before it can be used.

# Scope of Local Variables, cont.

You can declare a local variable with the same name multiple times in different non-nesting blocks in a method, but you cannot declare a local variable twice in nested blocks.



# Scope of Local Variables, cont.

A variable declared in the initial action part of a for loop header has its scope in the entire loop. But a variable declared inside a for loop body has its scope limited in the loop body from its declaration and to the end of the block that contains the variable.

```
public static void method1() {  
    .  
    .  
    for (int i = 1; i < 10; i++) {  
        .  
        .  
        int j;  
        .  
        .  
        .  
    }  
}
```

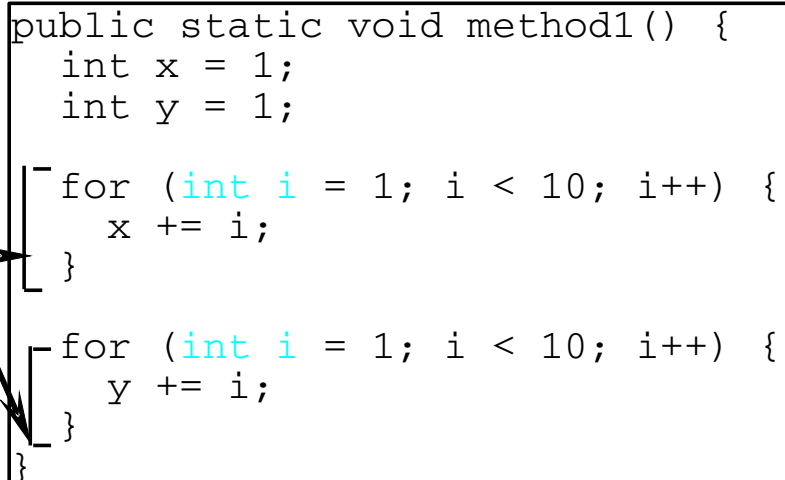
The scope of i →

The scope of j →

# Scope of Local Variables, cont.

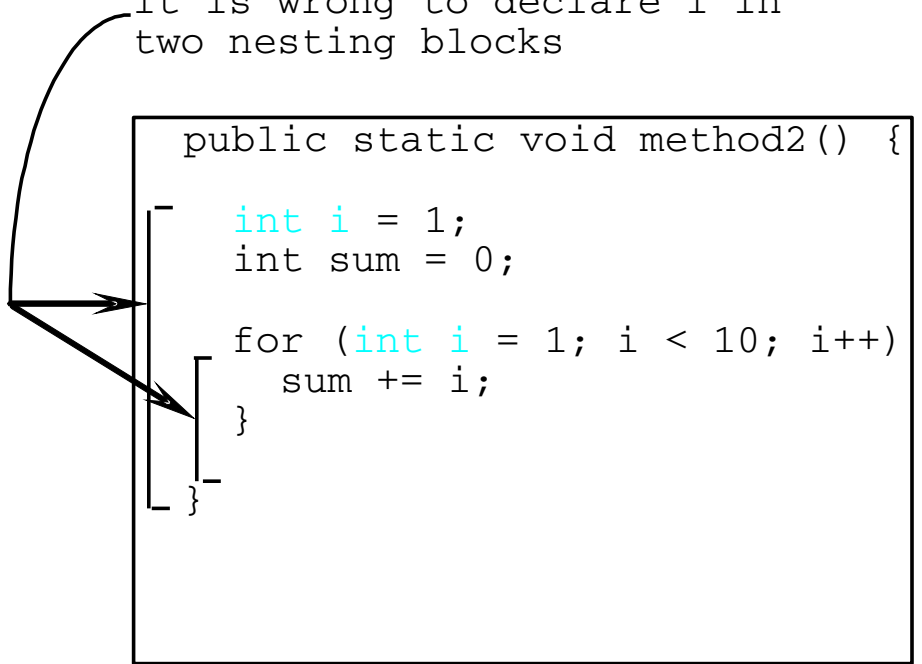
It is fine to declare `i` in two non-nesting blocks

```
public static void method1() {  
    int x = 1;  
    int y = 1;  
  
    for (int i = 1; i < 10; i++) {  
        x += i;  
    }  
  
    for (int i = 1; i < 10; i++) {  
        y += i;  
    }  
}
```



It is wrong to declare `i` in two nesting blocks

```
public static void method2() {  
    int i = 1;  
    int sum = 0;  
  
    for (int i = 1; i < 10; i++) {  
        sum += i;  
    }  
}
```



# Scope of Local Variables, cont.

```
// Fine with no errors
public static void correctMethod() {
    int x = 1;
    int y = 1;
    // i is declared
    for (int i = 1; i < 10; i++) {
        x += i;
    }
    // i is declared again
    for (int i = 1; i < 10; i++) {
        y += i;
    }
}
```

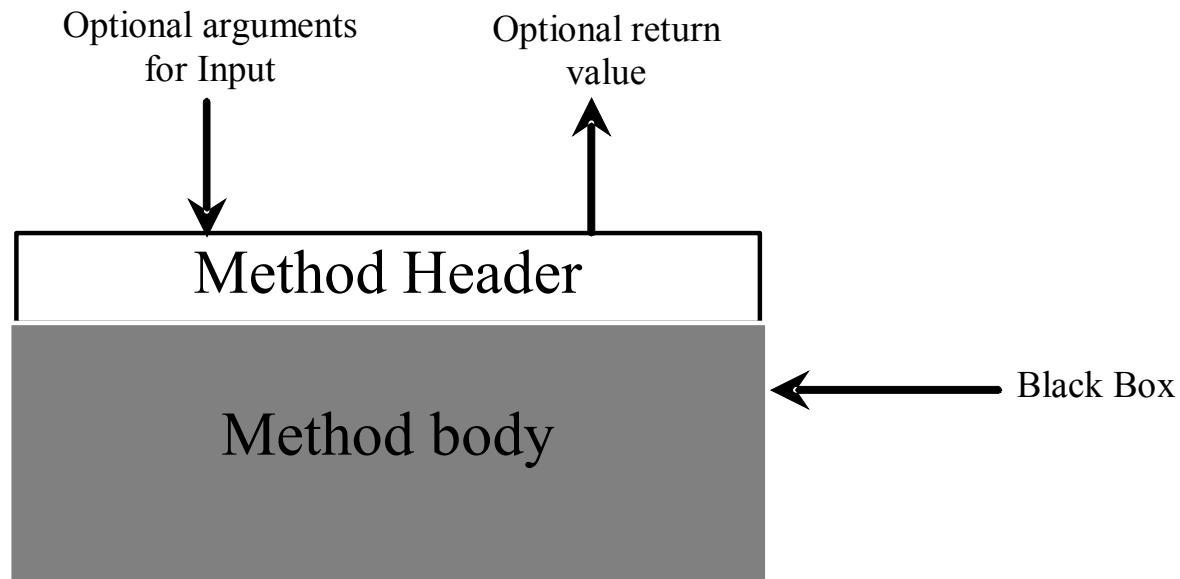
# Scope of Local Variables, cont.

// With errors

```
public static void incorrectMethod() {  
    int x = 1;  
    int y = 1;  
    for (int i = 1; i < 10; i++) {  
        int x = 0;  
        x += i;  
    }  
}
```

# Method Abstraction

You can think of the method body as a black box that contains the detailed implementation for the method.



# Benefits of Methods

- Write a method once and reuse it anywhere.
- Information hiding. Hide the implementation from the user.
- Reduce complexity.