Chapter 6
Methods
COSC1046

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Opening Problem

- Find the sum of integers from 1 to 10, from 20 to 30, and from 35 to 45, respectively.
- Compute the average points each student obtained during four years' study.

Opening Problem

```
int sum = 0;
for (int i = 1; i <= 10; i++)
  sum += i;
System.out.println("Sum from 1 to 10 is " + sum);

sum = 0;
for (int i = 20; i <= 37; i++)
  sum += i;
System.out.println("Sum from 20 to 37 is " + sum);

sum = 0;
for (int i = 35; i <= 49; i++)
  sum += i;
System.out.println("Sum from 35 to 49 is " + sum);
```

Use Method

```
public static int sum(int i1, int i2) {
  int result = 0;
  for (int i = i1; i <= i2; i++)
    result += i;

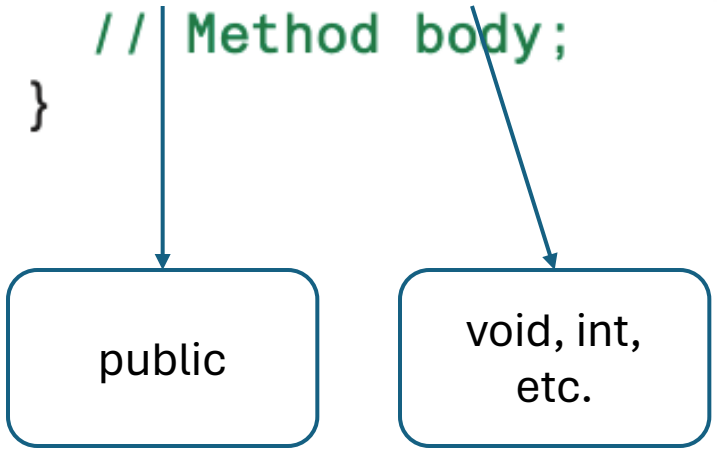
  return result;
}

public static void main(String[] args) {
  System.out.println("Sum from 1 to 10 is " + sum(1, 10));
  System.out.println("Sum from 20 to 37 is " + sum(20, 37));
  System.out.println("Sum from 35 to 49 is " + sum(35, 49));
}
```

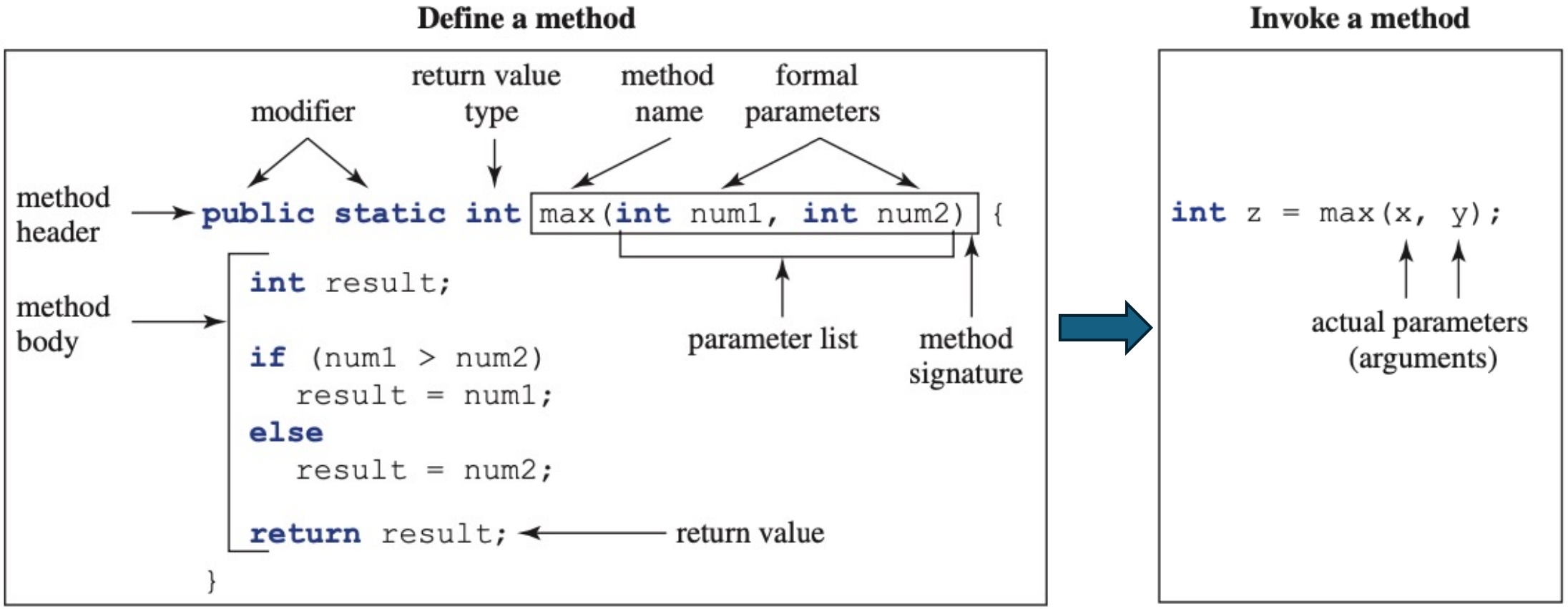
Define a Method

- The syntax for defining a method is as follows:

```
modifier returnValueType methodName(list of parameters) {
  // Method body;
}
```



Method



Method

- The static modifier is used for all the methods in this chapter. The reason for using it will be discussed in Chapter 9, Objects and Classes.
- The **returnValueType** is the data type of the value the method returns. Some methods perform desired operations without returning a value. In this case, the returnValueType is the keyword void.

Method

- A parameter is like a placeholder: when a method is invoked, you pass a value to the parameter
- Parameters are optional; that is, a method may contain no parameters. For example, the Math.random() method has no parameters.
- In the method header, you need to declare each parameter **separately**. For instance, max(int num1, int num2) is correct, but max(int num1, num2) is wrong.

Note

- We say “define a method” and “declare a variable.” We are making a subtle distinction here.
- A definition defines what the defined item is, but a declaration usually involves allocating memory to store data for the declared item.

Method Example

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

  /** Return the max of two numbers */
  public static int max(int num1, int num2) {
    int result;

    if (num1 > num2)
      result = num1;
    else
      result = num2;

    return result;
  }
}
```

Method Example

```
public class TestMax {
  /** Main method */
  public static void main(String[] args) {
    int i = 5;
    int j = 2;
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      result = num1;
    else
      result = num2;

    return result;
  }
}
```

Method Example

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public class TestMax {
  /** Main method */
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    int i = 5;
    int j = 2;
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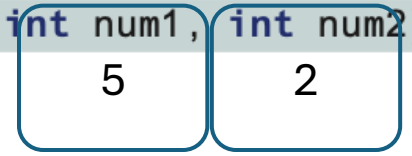
    System.out.println("The maximum of " + i +
      " and " + j + " is " + k);
  }

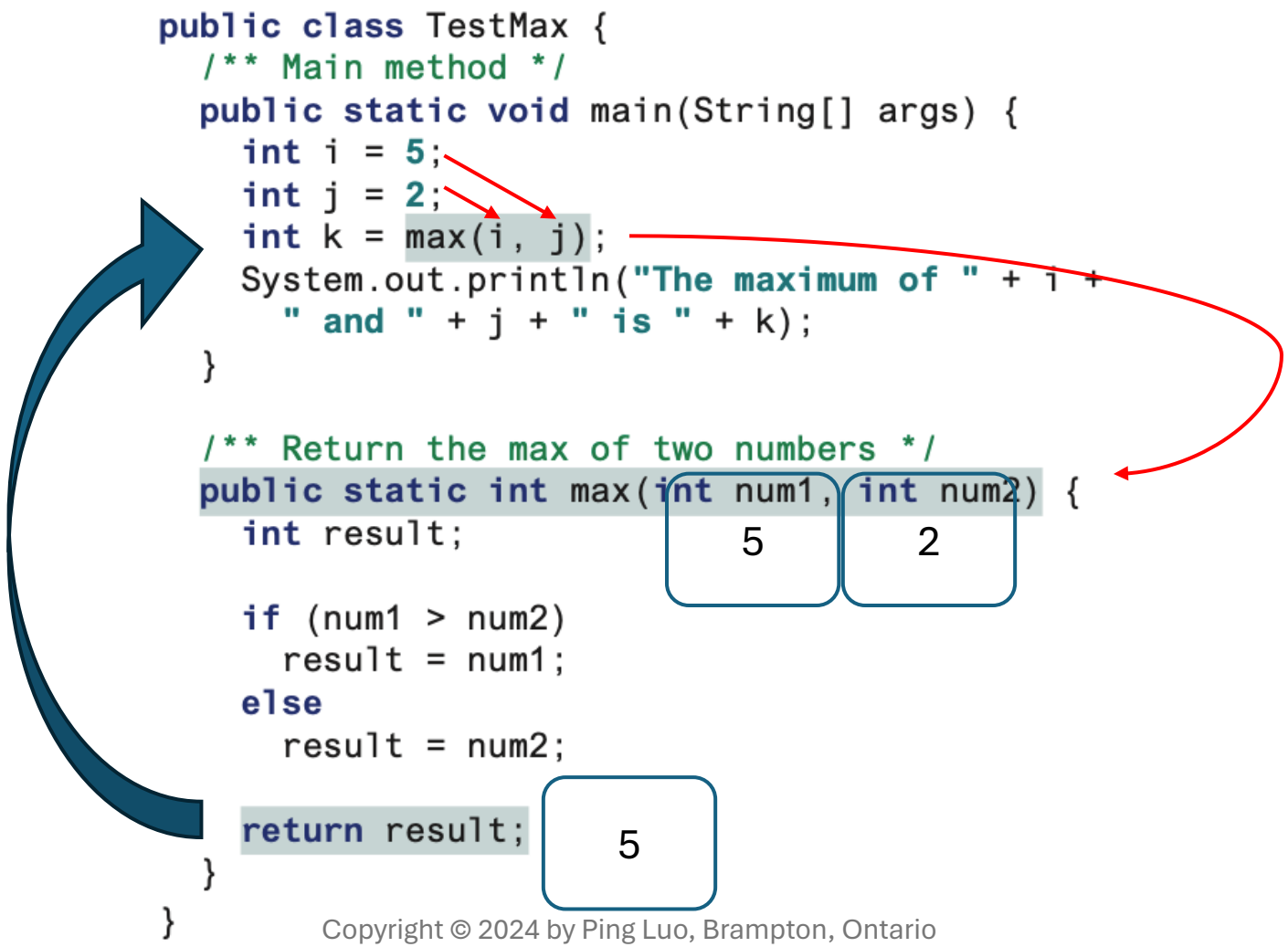
  /** Return the max of two numbers */
  public static int max(int num1, int num2) {
    int result;

    if (num1 > num2)
      result = num1;
    else
      result = num2;

    return result;
  }
}
```



Method Example



Caution

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

Caution

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

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

Case Study: Grade

```
if (score >= 90.0)
   grade = 'A';
else if (score >= 80.0)
   grade = 'B';
else if (score >= 70.0)
   grade = 'C';
else if (score >= 60.0)
    grade = 'D';
else
    grade = 'F';
```

input: score

getGrade(score)

output: grade

Example

```
public class TestReturnGradeMethod {
  public static void main(String[] args) {
    System.out.print("The grade is " + getGrade(78.5));
    System.out.print("\nThe grade is " + getGrade(59.5));
  }

  modifier returnType getGrade(parameter) {
    if (score >= 90.0)
      return 'A';
    else if (score >= 80.0)
      return 'B';
    else if (score >= 70.0)
      return 'C';
    else if (score >= 60.0)
      return 'D';
    else
      return 'F';
  }
}
```

Bonus!!!

Example

```
public class TestReturnGradeMethod {
  public static void main(String[] args) {
    System.out.print("The grade is " + getGrade(78.5));
    System.out.print("\nThe grade is " + getGrade(59.5));
  }

  modifier returnType getGrade(parameter) {
    if (score >= 90.0)
      return 'A';
    else if (score >= 80.0)
      return 'B';
    else if (score >= 70.0)
      return 'C';
    else if (score >= 60.0)
      return 'D';
    else
      return 'F';
  }
}
```

Bonus!!!

public static char getGrade(**double** score)

Caution

- The arguments must match the parameters in order, number, and compatible type, as defined in the method signature.

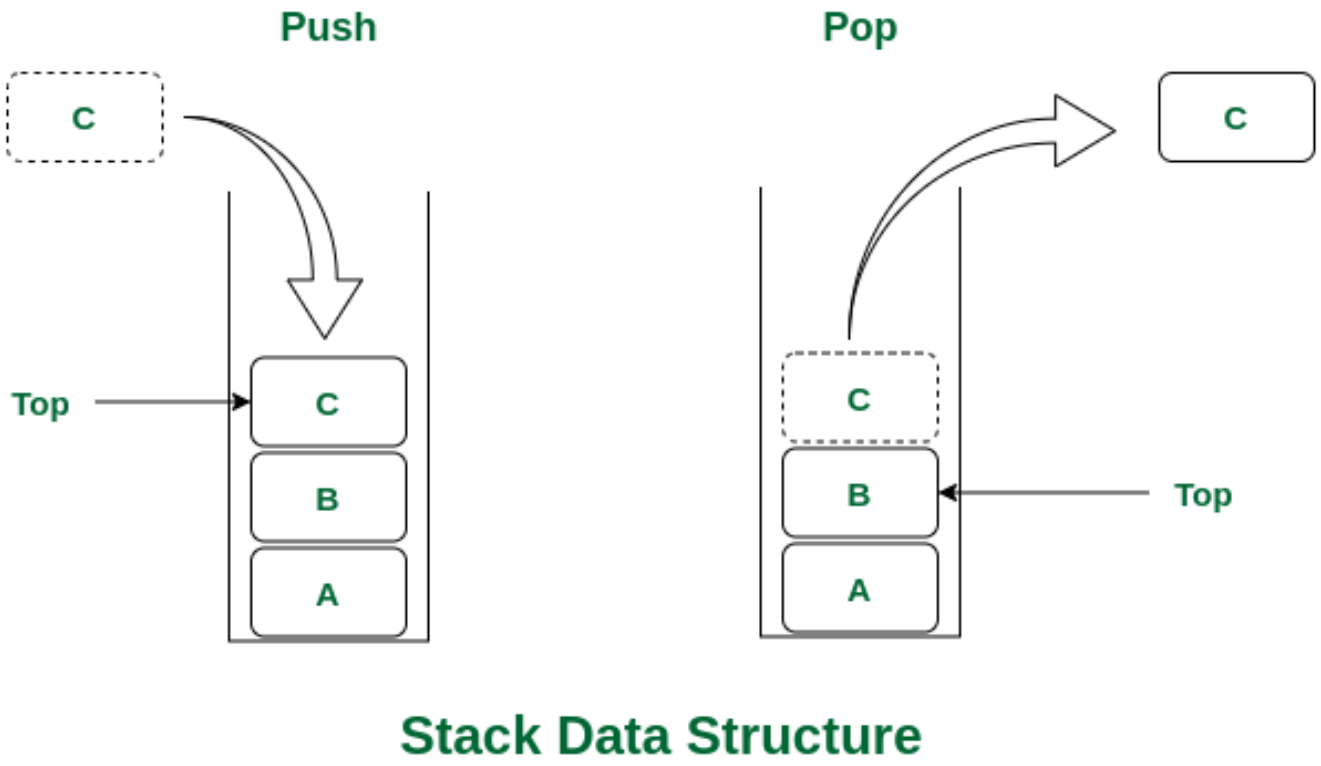
```
public static void nPrintln(String message, int n) {
  for (int i = 0; i < n; i++)
    System.out.println(message);
}
```

- nPrintln("Hello", 3) - correct
- nPrintln(3, "Hello") - wrong

Stack

- Each time a method is invoked, the system creates an activation record that stores parameters and variables for the method and places the activation record in an area of memory known as a call stack.
- A call stack is also known as an execution stack, runtime stack, or machine stack and it is often shortened to just “the stack.”
- A call stack stores the activation records in a last-in, first-out fashion.

Stack



Stack Data Structure

Stack Example

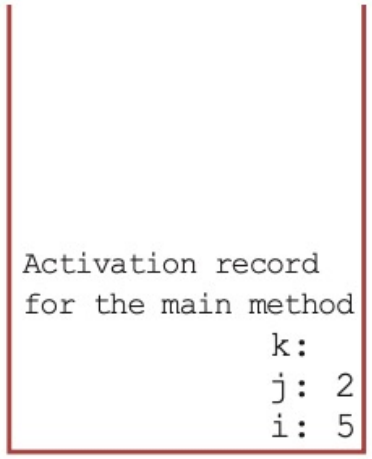
```
public class TestMax {
  /** Main method */
  public static void main(String[] args) {
    int i = 5;
    int j = 2;
    int k = max(i, j);
    System.out.println("The maximum of " + i +
      " and " + j + " is " + k);
  }

  /** Return the max of two numbers */
  public static int max(int num1, int num2) {
    int result;

    if (num1 > num2)
      result = num1;
    else
      result = num2;

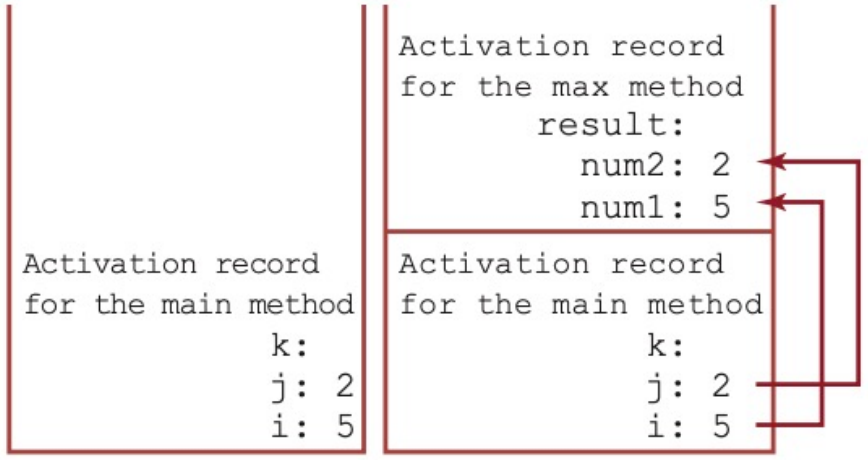
    return result;
  }
}
```

Stack



(1) The `main` method is invoked.

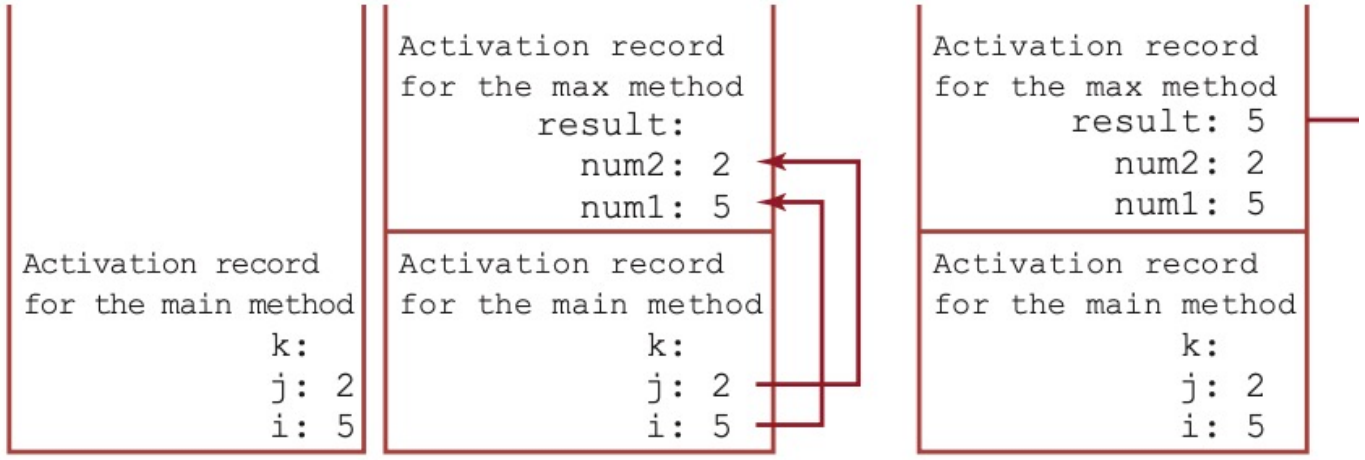
Stack



(1) The `main` method is invoked.

(2) The `max` method is invoked.

Stack

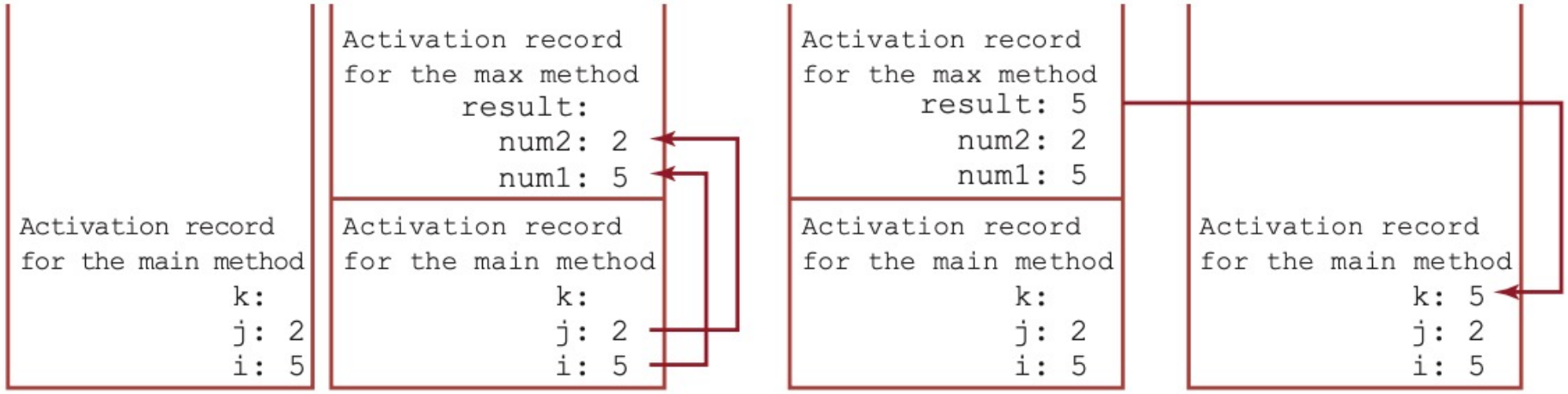


(1) The `main` method is invoked.

(2) The `max` method is invoked.

(3) The `max` method is being executed.

Stack



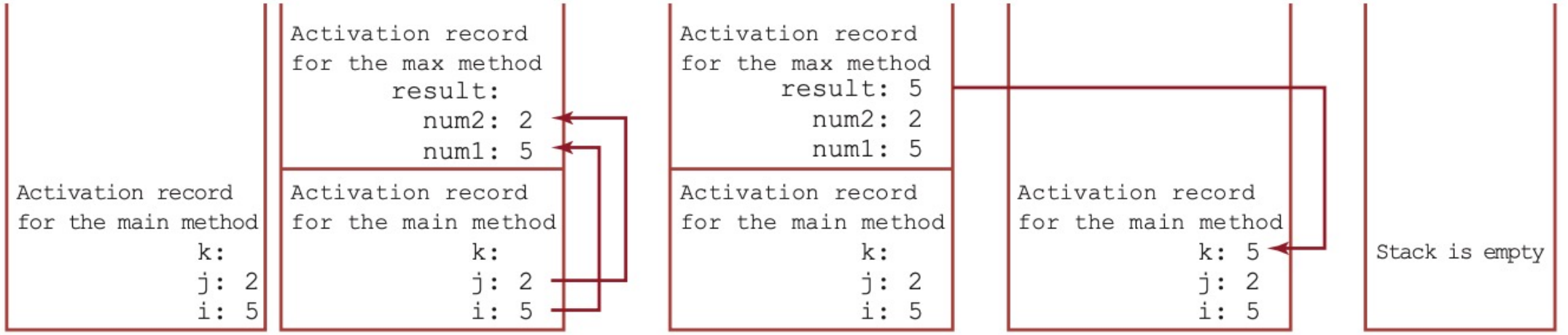
(1) The `main` method is invoked.

(2) The `max` method is invoked.

(3) The `max` method is being executed.

(4) The `max` method is finished and the return value is sent to `k`.

Stack



(1) The `main` method is invoked.

(2) The `max` method is invoked.

(3) The `max` method is being executed.

(4) The `max` method is finished and the return value is sent to `k`.

(5) The `main` method is finished.

Pass Values

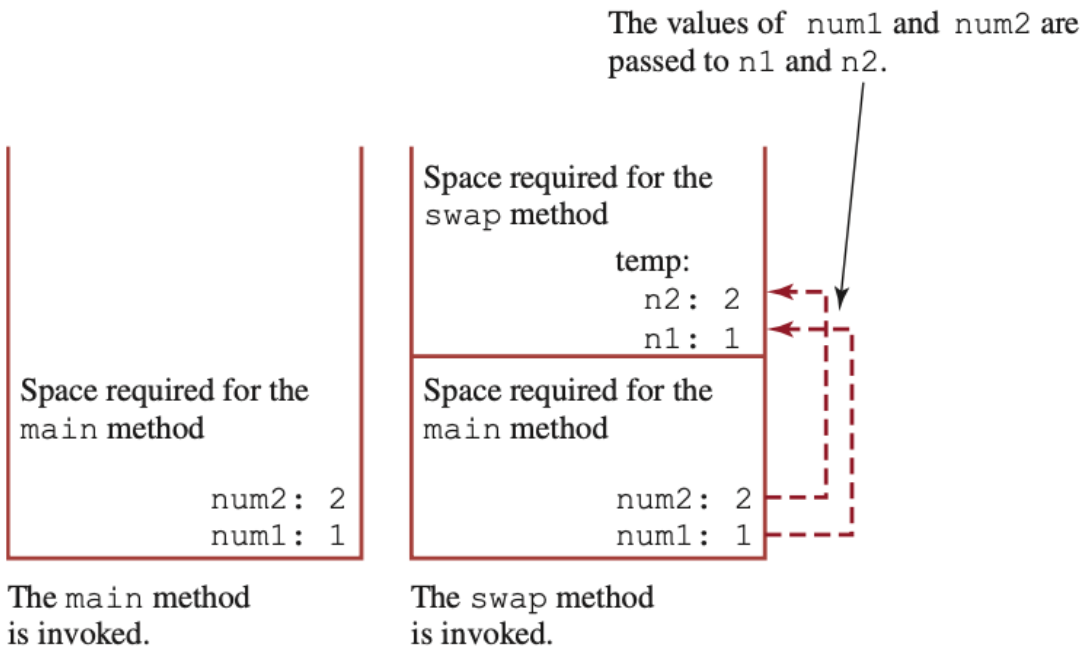
```
public class Increment {
    Run | Debug
    public static void main(String[] args) {
        int x = 1;
        System.out.println("Before the call, x is " + x);
        increment(x);
        System.out.println("After the call, x is " + x);
    }

    public static void increment(int n) {
        n++;
        System.out.println("n inside the method is " + n);
    }
}
```

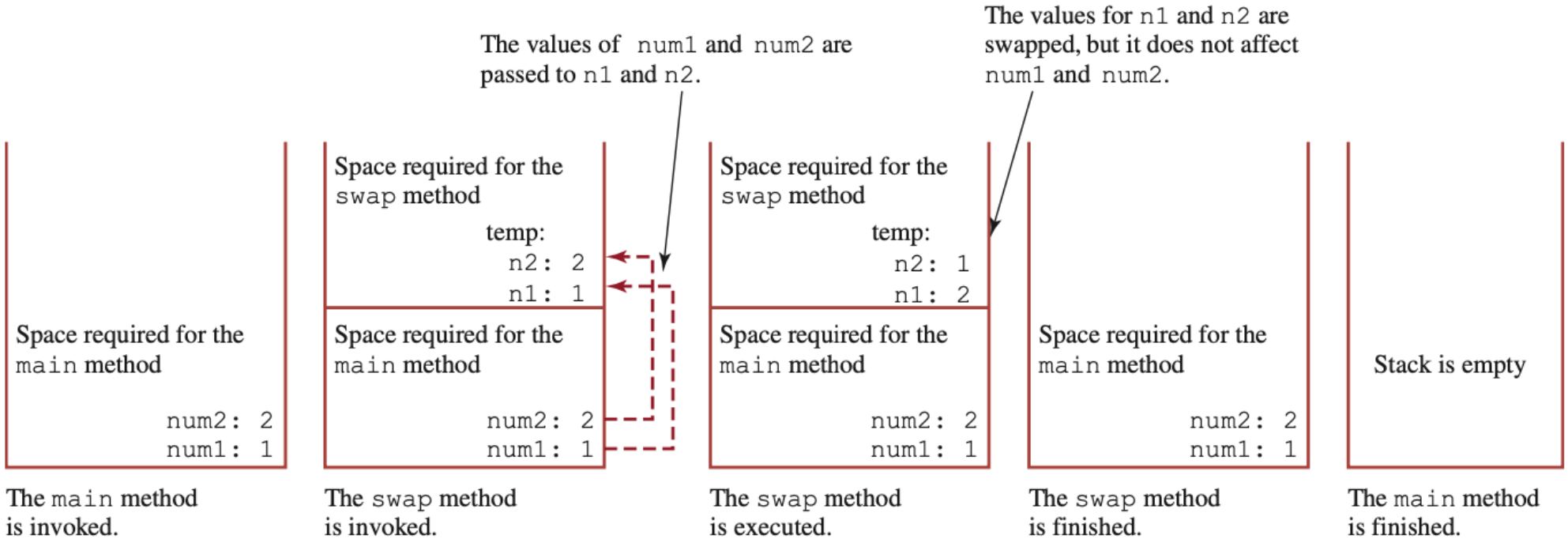
Caution

- When you invoke a method with an argument, the value of the argument is passed to the parameter. If the argument is a variable rather than a literal value, the value of the variable is passed to the parameter.
- https://liveexample.pearsoncmg.com/html/TestPassByValue.html

Stack

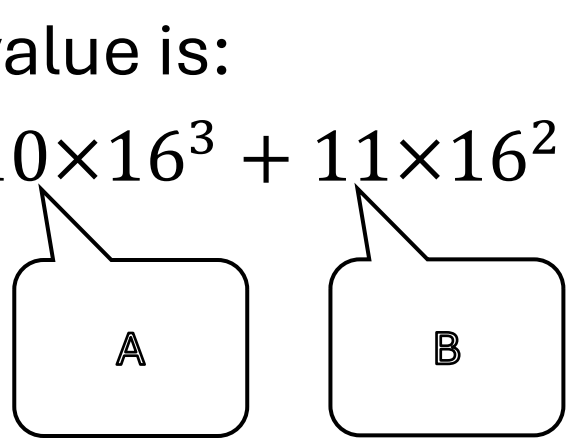


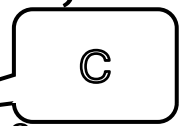
Stack



Case Study: Converting Hexadecimals to Decimals

- Given a hex number, for example, AB8C, its equivalent decimal value is:
- $10\times16^3 + 11\times16^2 + 8\times16^1 + 12\times16^0 = 43916$





```java
import java.util.Scanner;

public class Hex2Dec {
  /** Main method */
  Run | Debug
  public static void main(String[] args) {
    Scanner input = new Scanner(System.in);

    System.out.print(s:"Enter a hex number: ");
    String hex = input.nextLine();

    System.out.println("The decimal value for hex number "
      + hex + " is " + hexToDecimal(hex.toUpperCase()));
  }

  // finish the method here
  MODIFYER RETURNTYPE hexToDecimal() {
    int decimalValue = 0;

    return decimalValue;
  }

  public static int hexCharToDecimal(char ch) {
    if ('A' <= ch && ch <= 'F')
      return 10 + ch - 'A';
    else // ch is '0', '1', ..., or '9'
      return ch - '0';
  }
}
```

Mid-Term Exam

- Online Test on Moodle
- 8:30pm on Feb 27th to 8:30am on Feb 29th
- 50 single-choice questions, contributes 25 points toward the final grade
- You are expected to allocate approximately 40-60 minutes to complete the exam.
- Students who miss the Exam will receive a grade of 0.

10 Min Break

Method

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

Method

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

```java
public static int maxInt(int num1, int num2) {
    if (num1 > num2)
        return num1;
    else
        return num2;
}
```

```java
public static double maxDouble(double num1, double num2) {
    if (num1 > num2)
        return num1;
    else
        return num2;
}
```

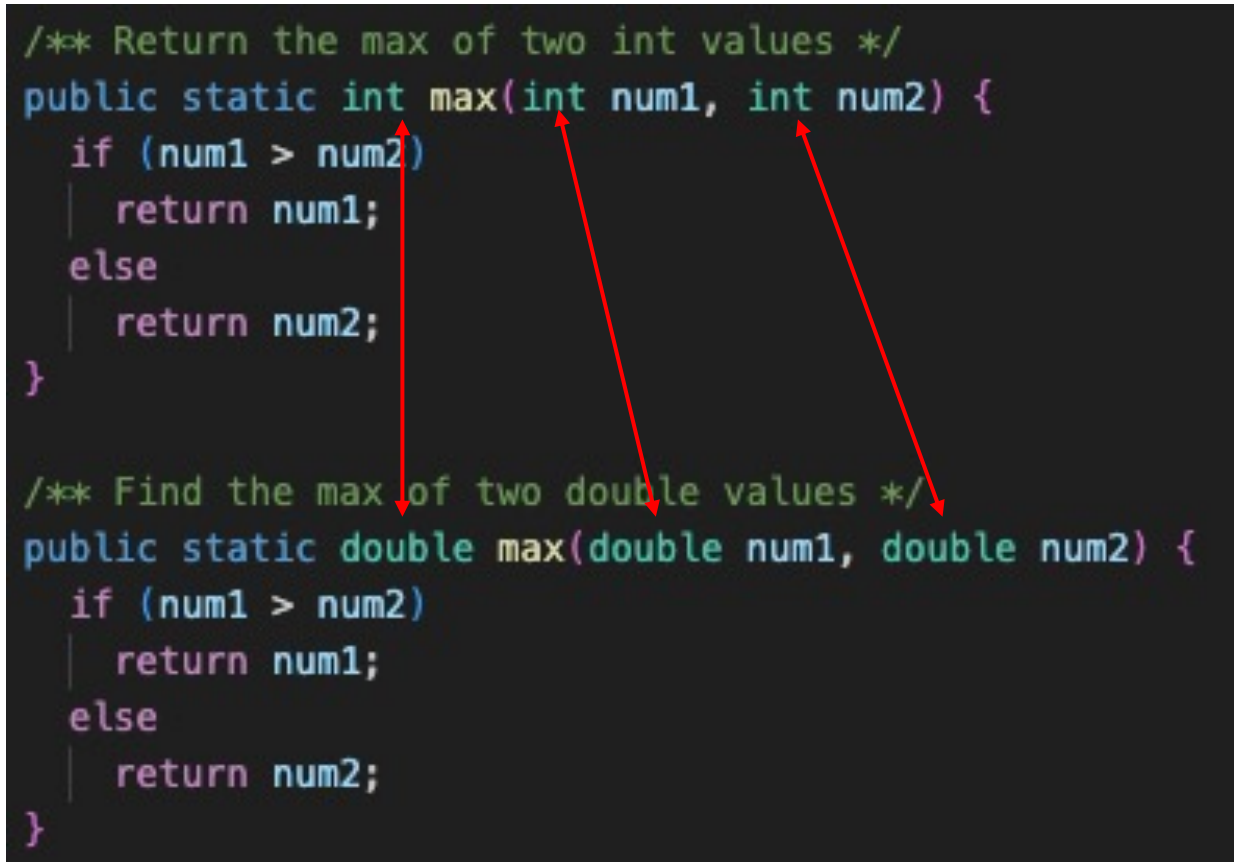
Overloading Method

- Overloading methods enable you to define the methods with the same name as long as their parameter lists are different.

```java
public static double max(double num1, double num2) {
    if (num1 > num2)
        return num1;
    else
        return num2;
}
```

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

Overloading Method



```java
/** Return the max of two int values */
public static int max(int num1, int num2) {
  if (num1 > num2)
    return num1;
  else
    return num2;
}

/** Find the max of two double values */
public static double max(double num1, double num2) {
  if (num1 > num2)
    return num1;
  else
    return num2;
}
```

Note

```java
public static void main(String[] args) {
  // Invoke the max method with int parameters
  System.out.println("The maximum of 3 and 4 is "
    + max(num1:3, num2:4));

  // Invoke the max method with the double parameters
  System.out.println("The maximum of 3.0 and 5.4 is "
    + max(num1:3.0, num2:5.4));

  // Invoke the max method with three double parameters
  System.out.println("The maximum of 3.0, 5.4, and 10.14 is "
    + max(num1:3.0, num2:5.4, num3:10.14));
}
```

?

```java
/** Return the max of two int values */
public static int max(int num1, int num2) {
  if (num1 > num2)
    return num1;
  else
    return num2;
}

/** Find the max of two double values */
public static double max(double num1, double num2) {
  if (num1 > num2)
    return num1;
  else
    return num2;
}
```

Note

```java
public static void main(String[] args) {
  // Invoke the max method with int parameters
  System.out.println("The maximum of 3 and 4 is "
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  // Invoke the max method with the double parameters
  System.out.println("The maximum of 3.0 and 5.4 is "
    + max(num1:3.0, num2:5.4));

  // Invoke the max method with three double parameters
  System.out.println("The maximum of 3.0, 5.4, and 10.14 is "
    + max(num1:3.0, num2:5.4, num3:10.14));
}
```

```java
/** Return the max of two int values */
public static int max(int num1, int num2) {
  if (num1 > num2)
    return num1;
  else
    return num2;
}

/** Find the max of two double values */
public static double max(double num1, double num2) {
  if (num1 > num2)
    return num1;
  else
    return num2;
}
```

```java
/** Return the max of three double values */
public static double max(double num1, double num2, double num3) {
  return max(max(num1, num2), num3);
}
```

Ambiguous Invocation

compile error!!!

```
public class AmbiguousOverloading {
  public static void main(String[] args) {
    System.out.println(max(1, 2));
  }

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

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

Case Study: Prime Number Method

- Write a program to print out the first **N** prime numbers.
- A prime number is a whole number greater than 1 whose only factors are 1 and itself.
- The smallest prime number is 2.

what do we need?

Case Study: Prime Number Method

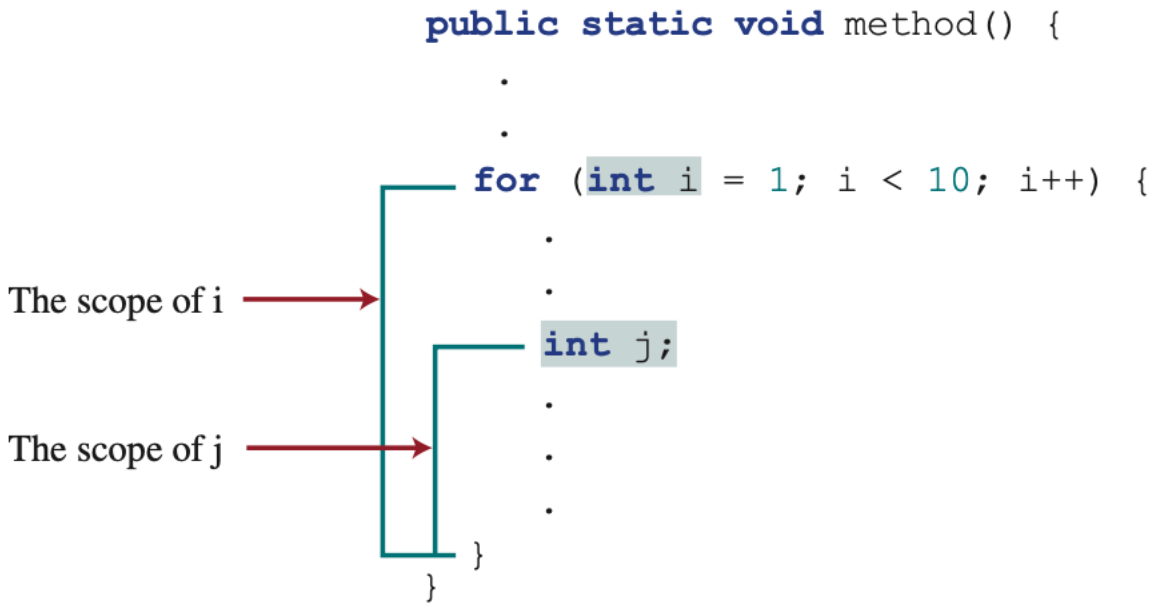
- Write a program to print out the first **N** prime numbers.
- A prime number is a whole number greater than 1 whose only factors are 1 and itself.
- The smallest prime number is 2.

what do we need?

1. count
2. while
3. function to determine if a number is prime number

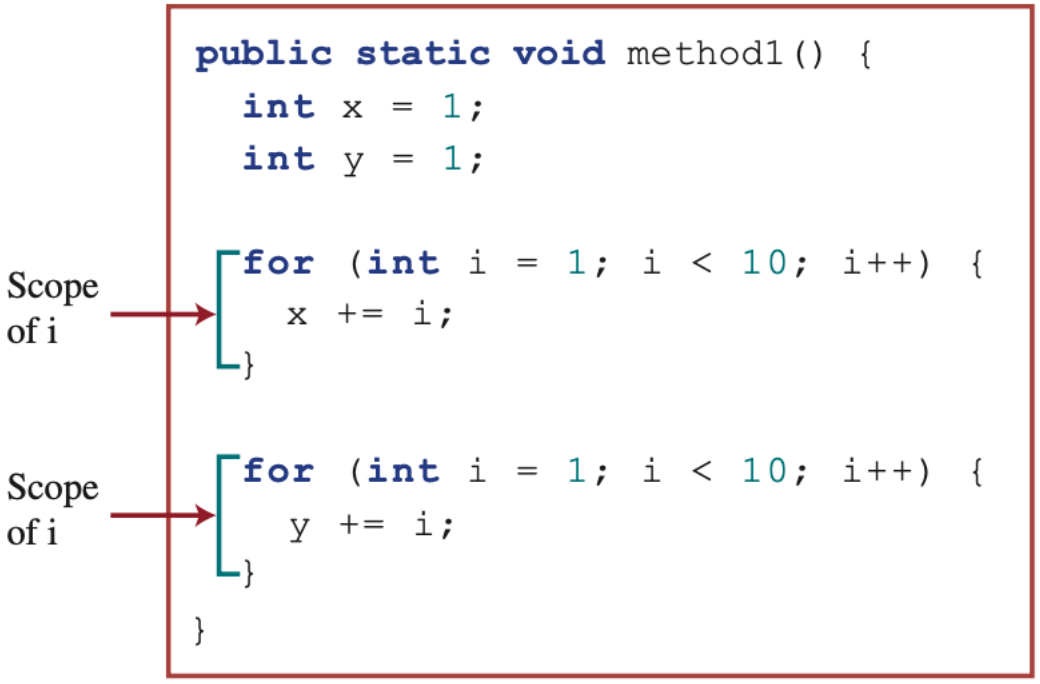
The Scope of Variables

- *The scope of a variable is the part of the program where the variable can be referenced.*

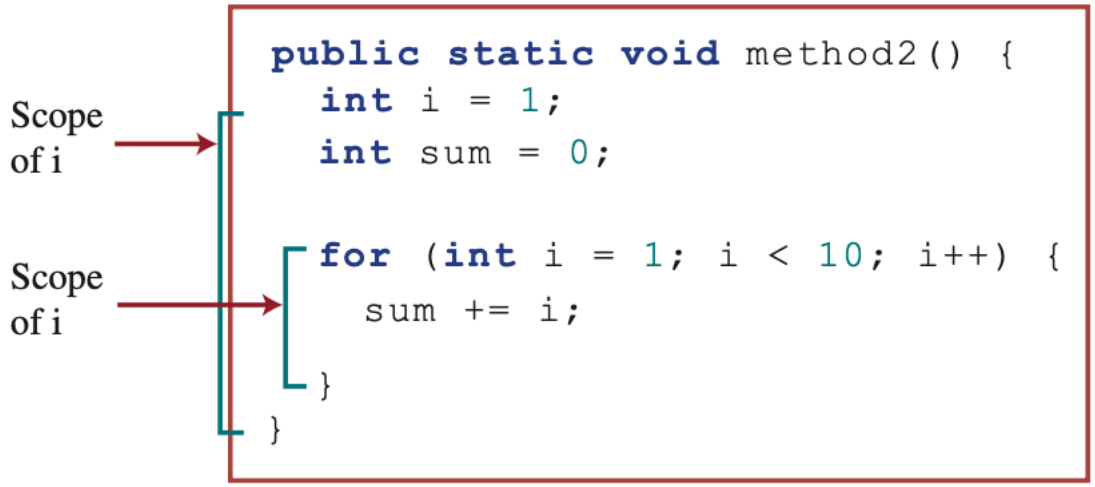


The Scope of Variables

```
for (int i = 0; i < 10; i++) {
}
System.out.println(i); // Causes a syntax error on i
```



right



wrong

The Scope of Variables

```java
public class Scope {

    Run | Debug
    public static void main(String args[]) {
        int i = 0;

        for (; i<10; i++) {
            System.out.println(x:"okay");
        }
        System.out.println(i);
    }
}
```

```
okay
okay
okay
okay
okay
okay
okay
okay
okay
okay
10
```

Study Week

- Feb 19 – 23, no lecture, no lab.

Feb 27 Lecture

1. Method II
2. Review for Chapters 1- 6
3. Exam start at 8:30pm

Q&A