CS 1027
Fundamentals of Computer Science II

Java Foundations: Overview

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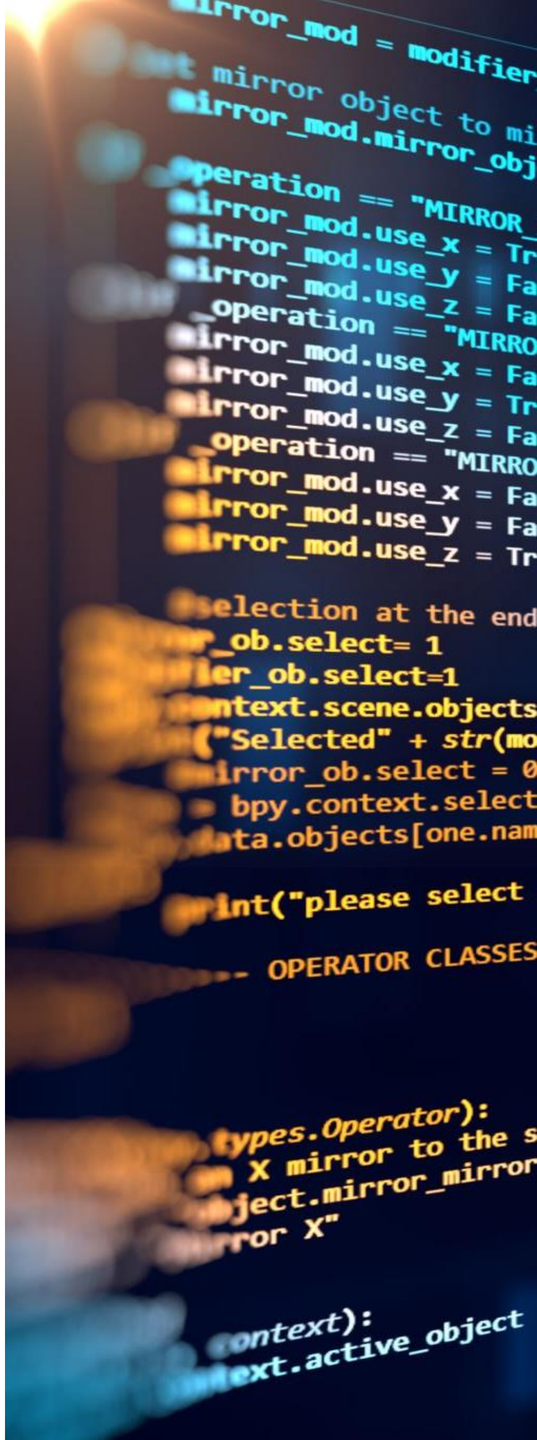
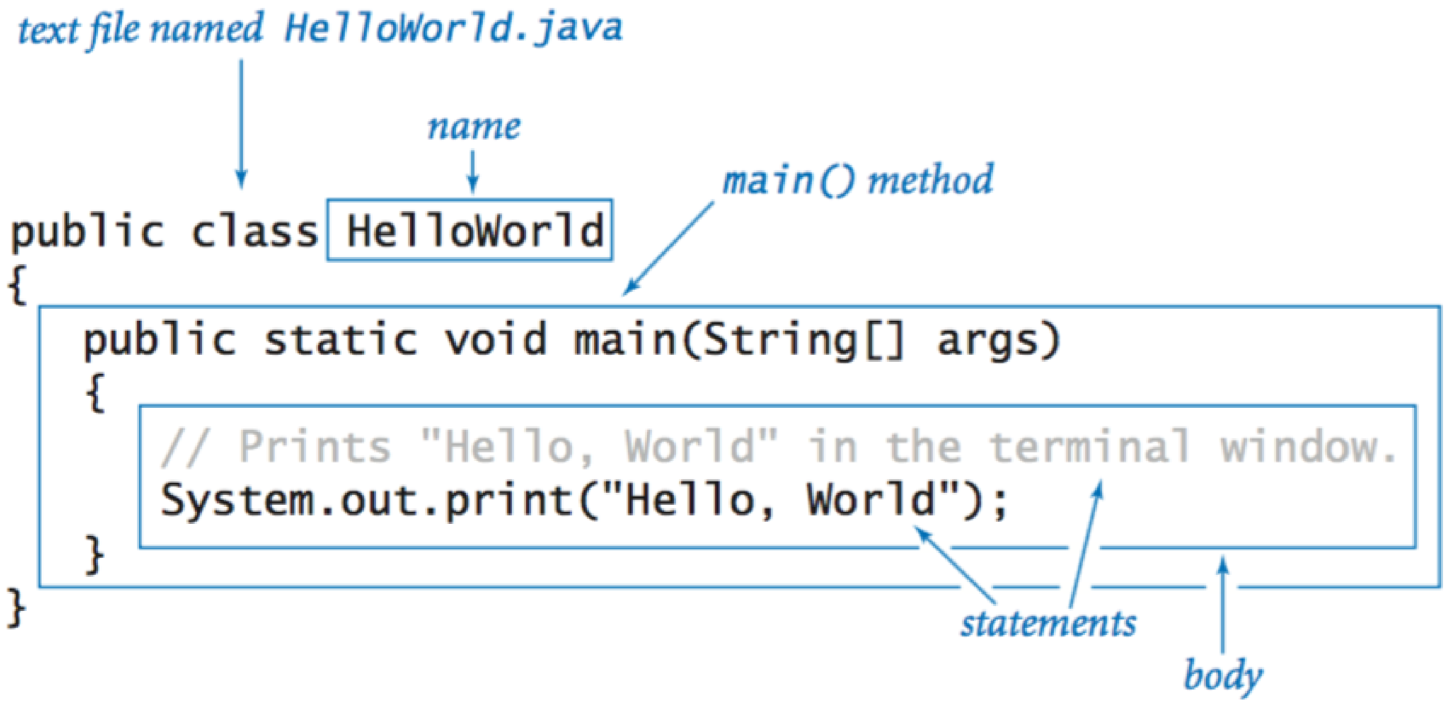


Agenda

- Java Program Anatomy
- Data Types and Variables
- Classes and Objects in Java
- Object-Oriented Programming (OOP) Basics
- Operators and Expressions
- Conditional Statements
- Arrays and Input/Output (I/O) Handling

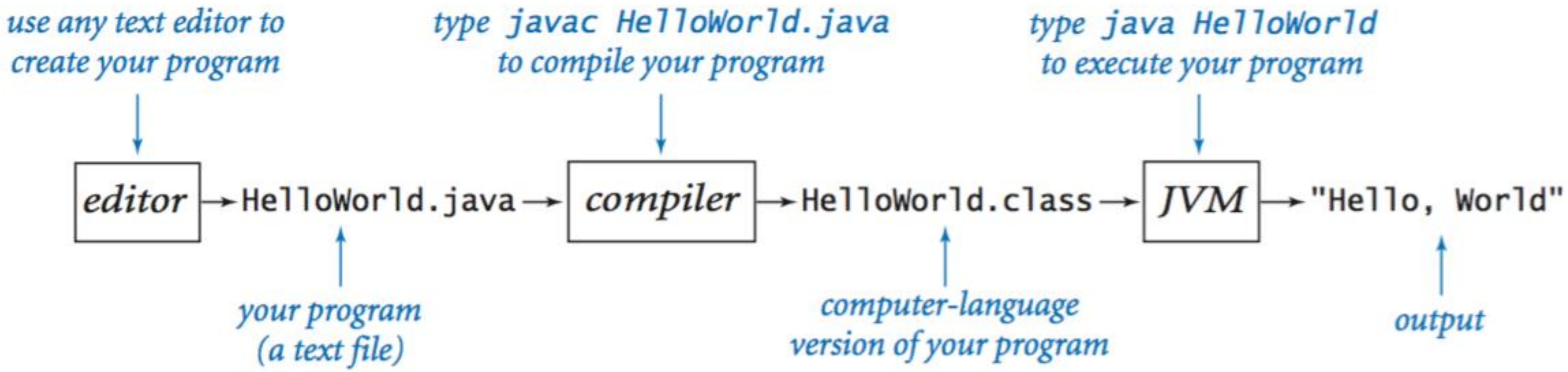
Java Program

- A Java program is a collection of classes.

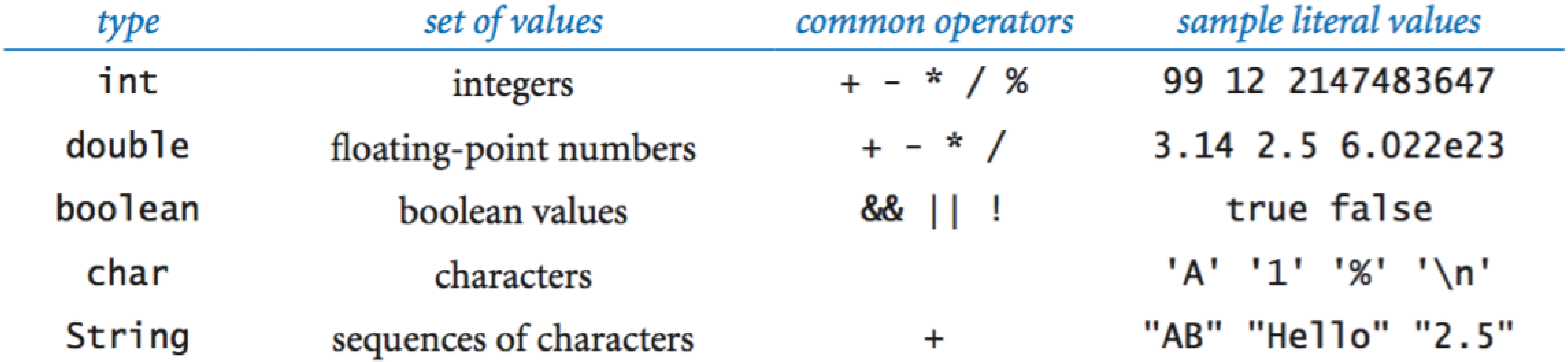


```
public class HelloWorld
{
   public static void main(String[] args)
   {
      // Prints "Hello, World" in the terminal window.
      System.out.print("Hello, World");
   }
}
```

Editing, Compiling, and Executing


use any text editor to create your program
type javac HelloWorld.java to compile your program
type java HelloWorld to execute your program
editor
HelloWorld.java
compiler
HelloWorld.class
JVM
"Hello, World"
your program (a text file)
computer-language version of your program
output

Data Types and Variables



type	*set of values*	*common operators*	*sample literal values*
`int`	integers	`+ - * / %`	`99 12 2147483647`
`double`	floating-point numbers	`+ - * /`	`3.14 2.5 6.022e23`
`boolean`	boolean values	`&& || !`	`true false`
`char`	characters		`'A' '1' '%' '\n'`
`String`	sequences of characters	`+`	`"AB" "Hello" "2.5"`

Question!

In Java, which of the following best describes the role of the main method in the context of object creation?

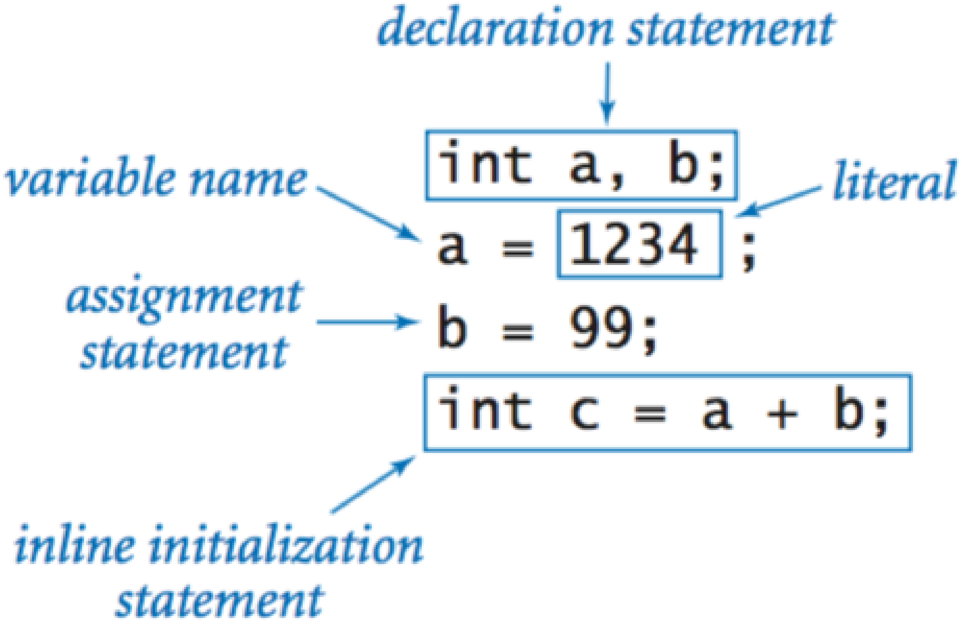
A) It serves as a constructor to initialize the object.

B) It is responsible for invoking other constructors in the program.

C) It serves as the entry point for program execution and can create and manipulate objects using constructors.

D) It can only invoke static methods and is not involved in object creation.

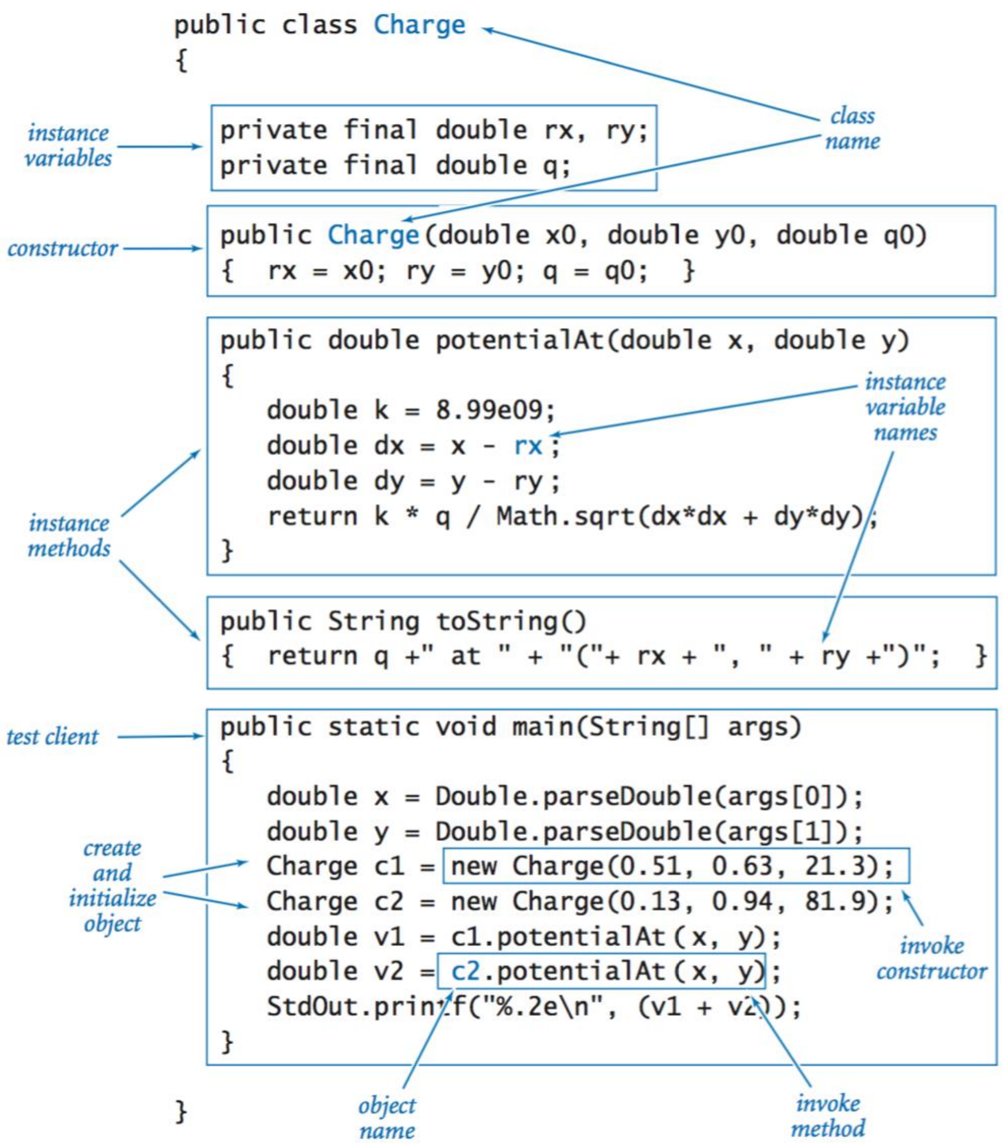
Declaration & Assignment Statements



```
int a, b;
a = 1234 ;
b = 99;
int c = a + b;
```

Class in Java

- The figure illustrates a Java class Charge with **constructors**, **instance variables**, **methods**, and a **test** client.

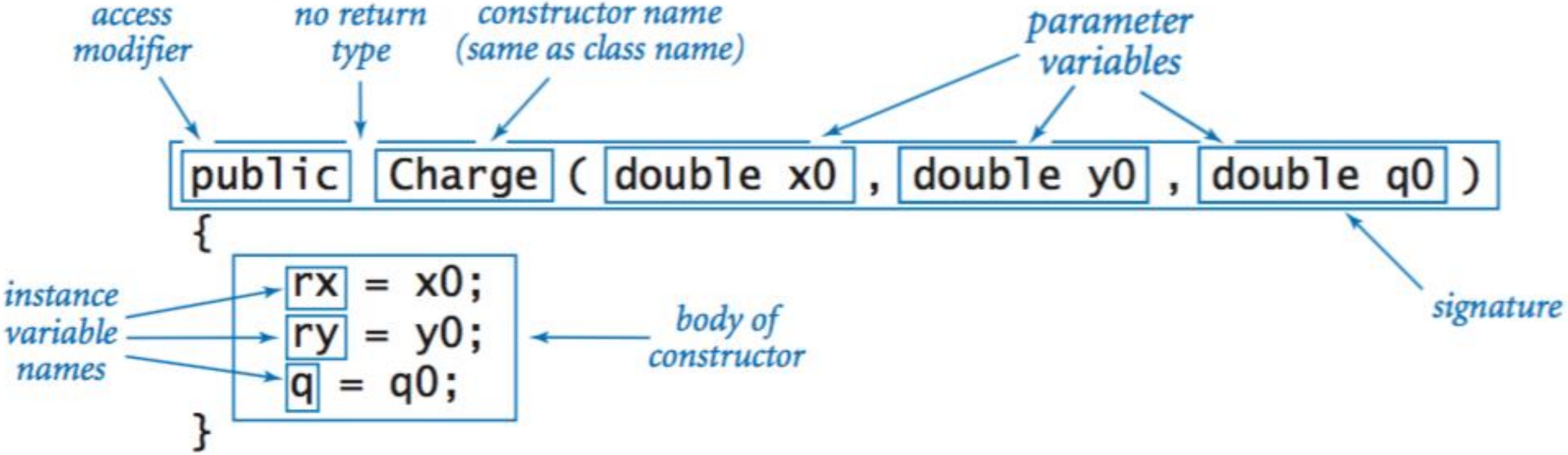


```
public class Charge
{
   private final double rx, ry;
   private final double q;

   public Charge(double x0, double y0, double q0)
   {  rx = x0; ry = y0; q = q0;  }

   public double potentialAt(double x, double y)
   {
      double k = 8.99e09;
      double dx = x - rx;
      double dy = y - ry;
      return k * q / Math.sqrt(dx*dx + dy*dy);
   }

   public String toString()
   {  return q +" at " + "("+ rx + ", " + ry +")";  }

   public static void main(String[] args)
   {
      double x = Double.parseDouble(args[0]);
      double y = Double.parseDouble(args[1]);
      Charge c1 = new Charge(0.51, 0.63, 21.3);
      Charge c2 = new Charge(0.13, 0.94, 81.9);
      double v1 = c1.potentialAt(x, y);
      double v2 = c2.potentialAt(x, y);
      StdOut.printf("%.2e\n", (v1 + v2));
   }

}
```

Constructor in Java

- The following illustrates a Java class **Charge** constructor.

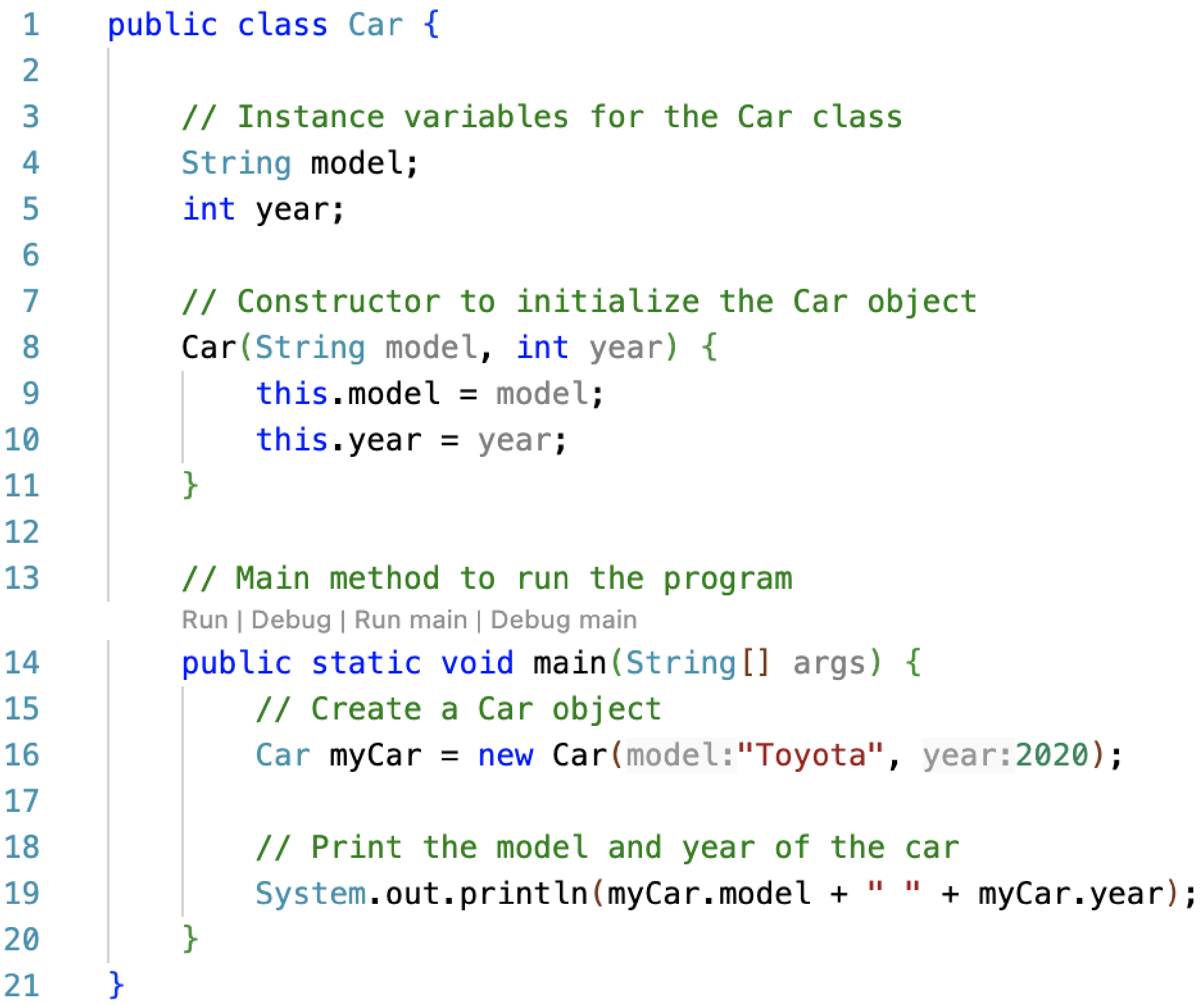
a Java class constructor **cannot** have a return value



```
public Charge ( double x0 , double y0 , double q0 )
{
    rx = x0;
    ry = y0;
    q = q0;
}
```

Java Class Example

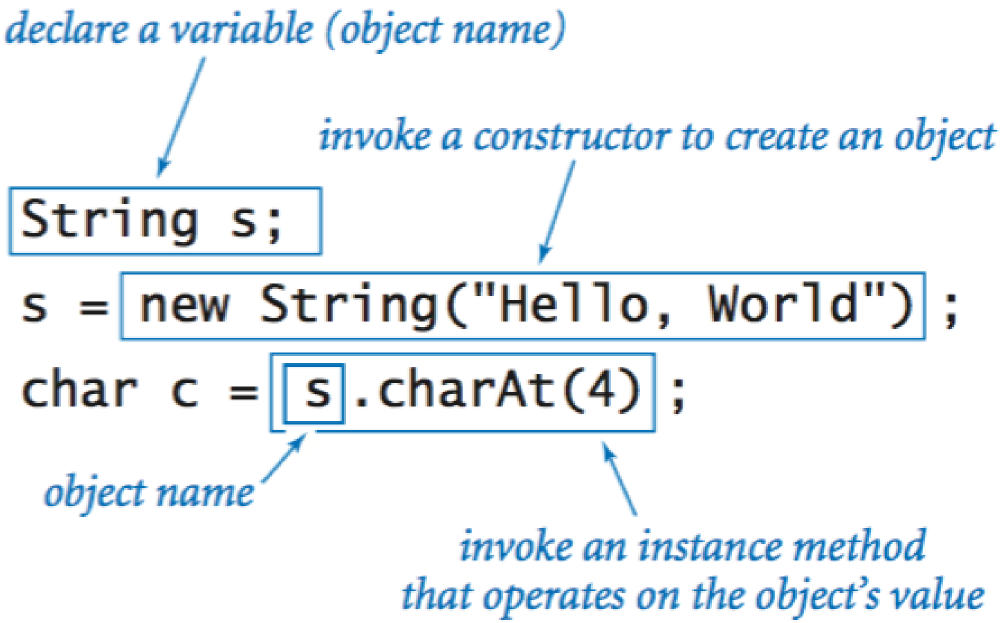
- The code snippet illustrates an example of a Java class (Car).
- It includes the following elements:
  - **Instance variables**: String model and int year;
  - **Constructor**: A method to initialize the model and year of a Car object.
  - **Main method**: Demonstrates the creation of a Car object (myCar) with the model "Toyota" and year 2020, followed by a System.out.println statement to print the car's model and year.



```java
public class Car {

    // Instance variables for the Car class
    String model;
    int year;

    // Constructor to initialize the Car object
    Car(String model, int year) {
        this.model = model;
        this.year = year;
    }

    // Main method to run the program
    Run | Debug | Run main | Debug main
    public static void main(String[] args) {
        // Create a Car object
        Car myCar = new Car(model:"Toyota", year:2020);

        // Print the model and year of the car
        System.out.println(myCar.model + " " + myCar.year);
    }
}
```

Object in Java

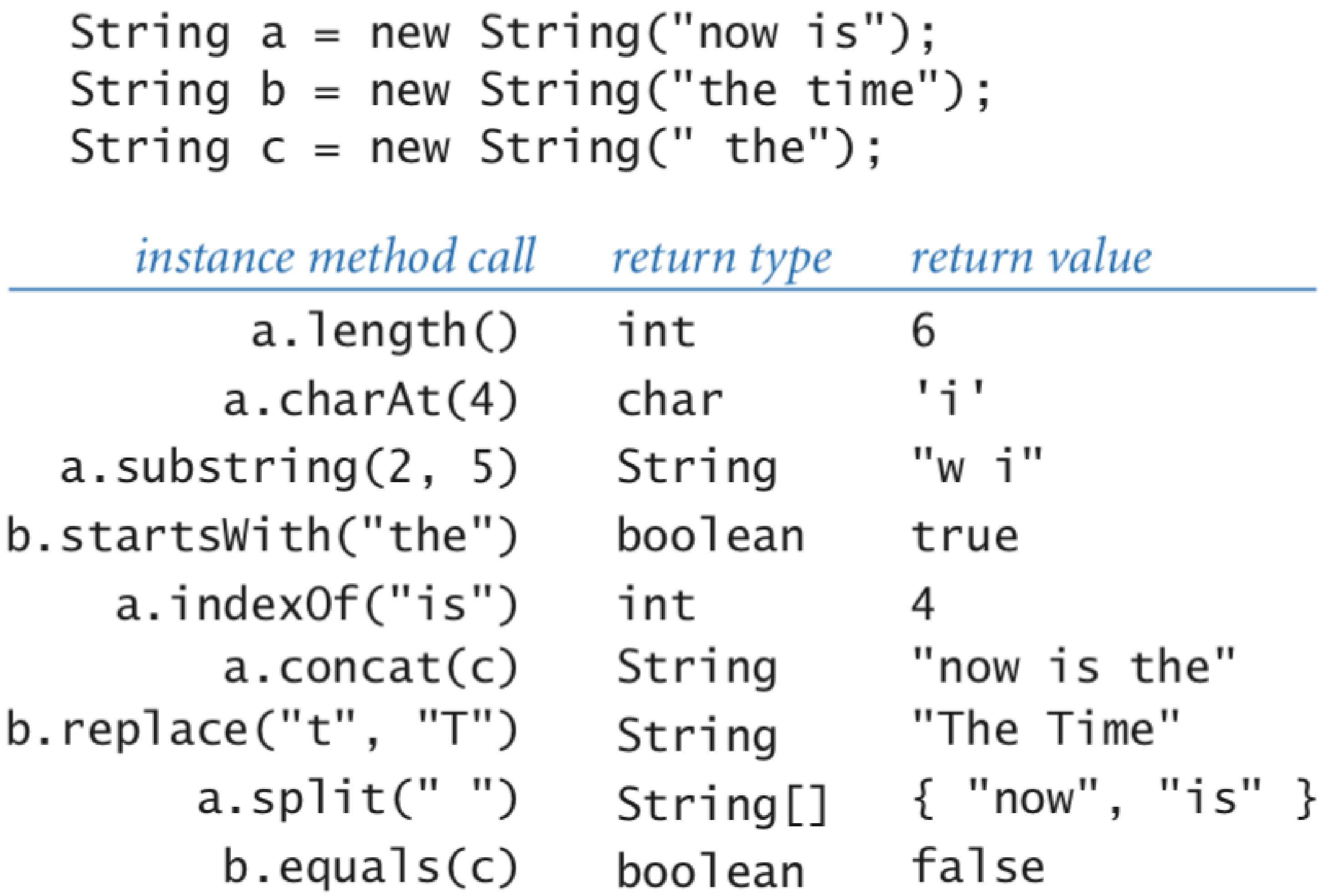
- **Declares a variable (object name)**: declares a variable **s** of type **String**, which will later reference a String object.
- **Invokes a constructor to create an object**: a new String object is created with the value "Hello, World", and the variable **s** is assigned to reference this object.



```
String s;
s = new String("Hello, World");
char c = s.charAt(4);
```

declare a variable (object name)
invoke a constructor to create an object
object name
invoke an instance method
that operates on the object's value

Strings

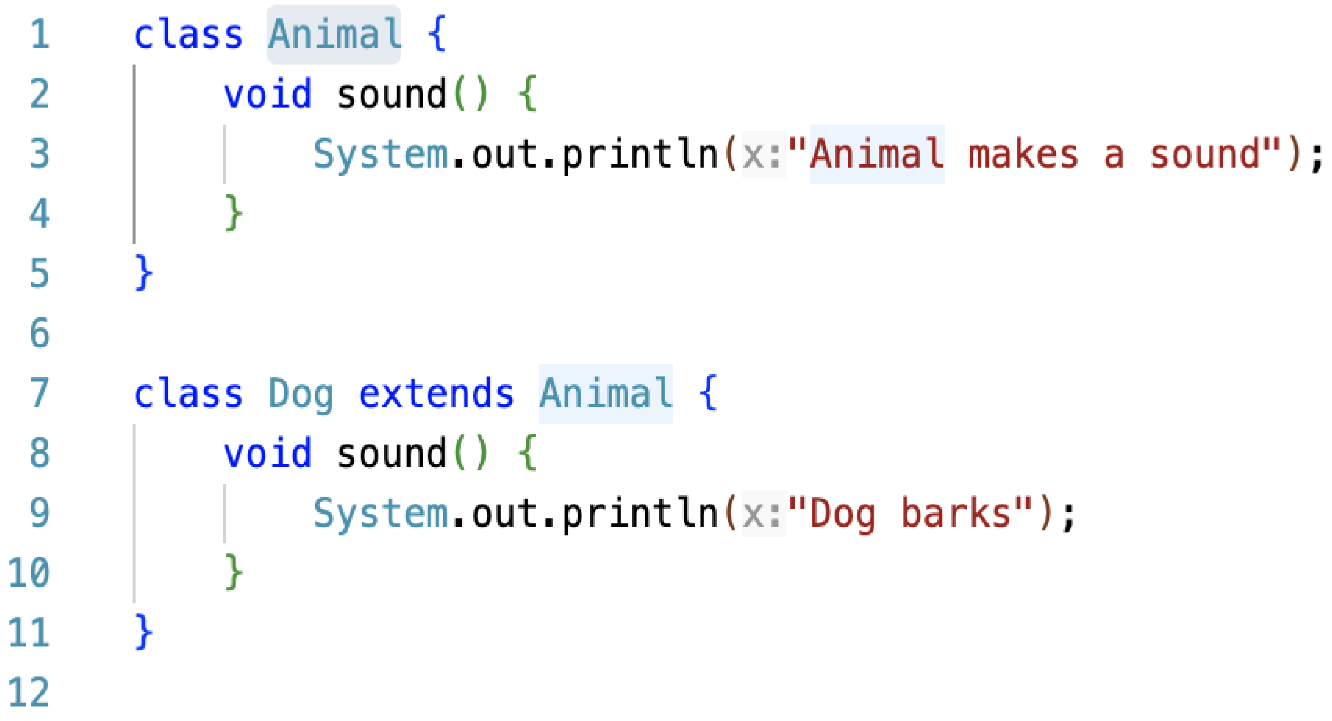


```
String a = new String("now is");
String b = new String("the time");
String c = new String(" the");
```

instance method call	*return type*	*return value*
`a.length()`	`int`	`6`
`a.charAt(4)`	`char`	`'i'`
`a.substring(2, 5)`	`String`	`"w i"`
`b.startsWith("the")`	`boolean`	`true`
`a.indexOf("is")`	`int`	`4`
`a.concat(c)`	`String`	`"now is the"`
`b.replace("t", "T")`	`String`	`"The Time"`
`a.split(" ")`	`String[]`	`{ "now", "is" }`
`b.equals(c)`	`boolean`	`false`

Inheritance & Polymorphism

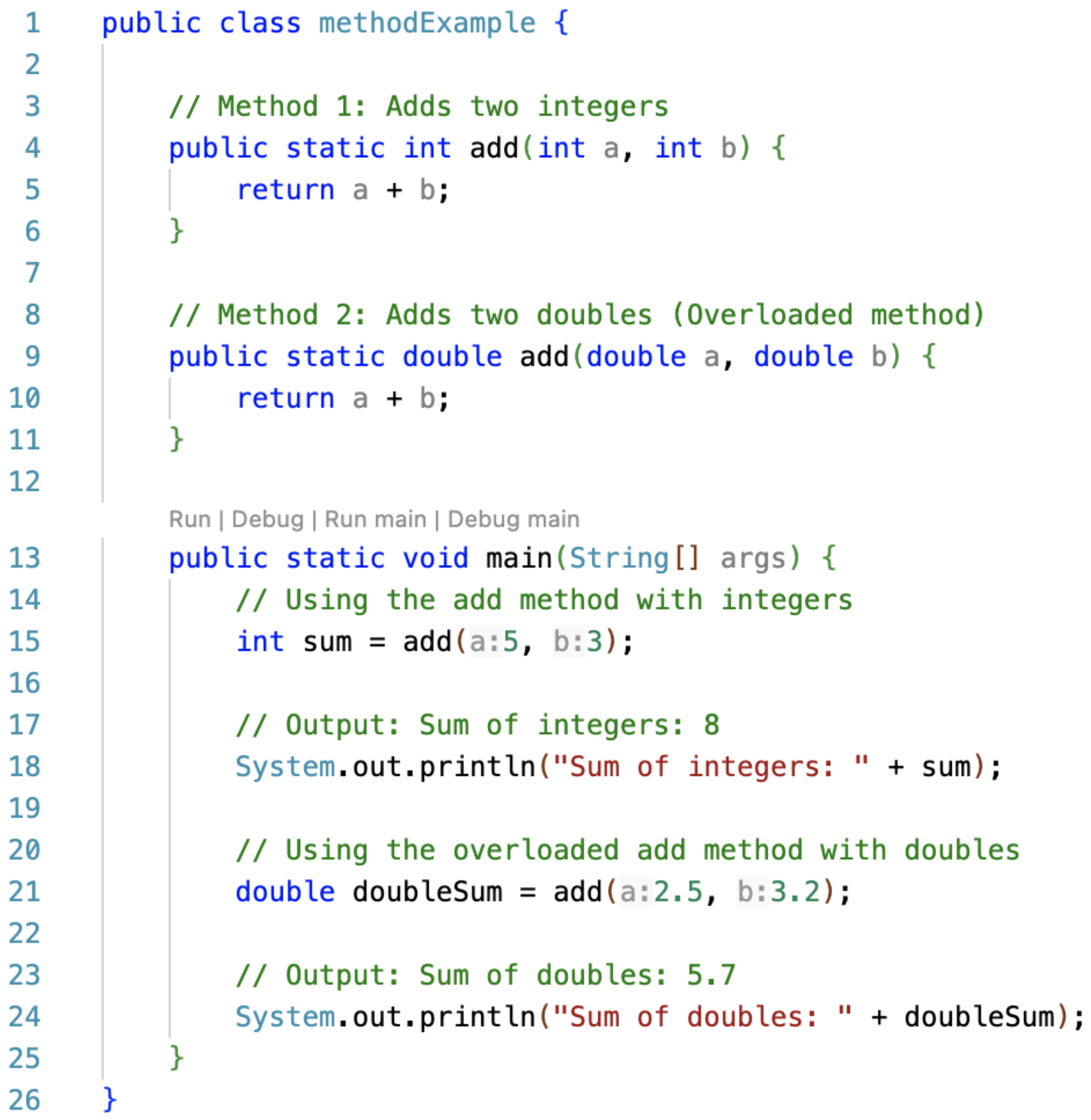
- **Inheritance**: The Dog class inherits properties and behaviors (methods) from the Animal class.
- **Method Overriding**: The Dog class redefines the sound() method to provide its specific behavior while maintaining the structure of the base class.



```java
class Animal {
    void sound() {
        System.out.println(x:"Animal makes a sound");
    }
}

class Dog extends Animal {
    void sound() {
        System.out.println(x:"Dog barks");
    }
}
```

Methods Overloading

- **Method Declaration and Return Types**:
  - The method add(int a, int b) returns an int.
  - The overloaded method add(double a, double b) returns a double.
- **Parameters and Arguments**:
  - The methods accept two parameters (int or double).
  - When calling the methods, we pass arguments such as 5, 3 and 2.5, 3.2.
- **Overloading Methods**:
  - There are two add methods: one works with int values and the other with double values.



```java
public class methodExample {

    // Method 1: Adds two integers
    public static int add(int a, int b) {
        return a + b;
    }

    // Method 2: Adds two doubles (Overloaded method)
    public static double add(double a, double b) {
        return a + b;
    }

    public static void main(String[] args) {
        // Using the add method with integers
        int sum = add(a:5, b:3);

        // Output: Sum of integers: 8
        System.out.println("Sum of integers: " + sum);

        // Using the overloaded add method with doubles
        double doubleSum = add(a:2.5, b:3.2);

        // Output: Sum of doubles: 5.7
        System.out.println("Sum of doubles: " + doubleSum);
    }
}
```

Question!

What will happen if a Java class has a constructor with no parameters and another constructor with parameters, but when an object of the class is instantiated, no arguments are provided?

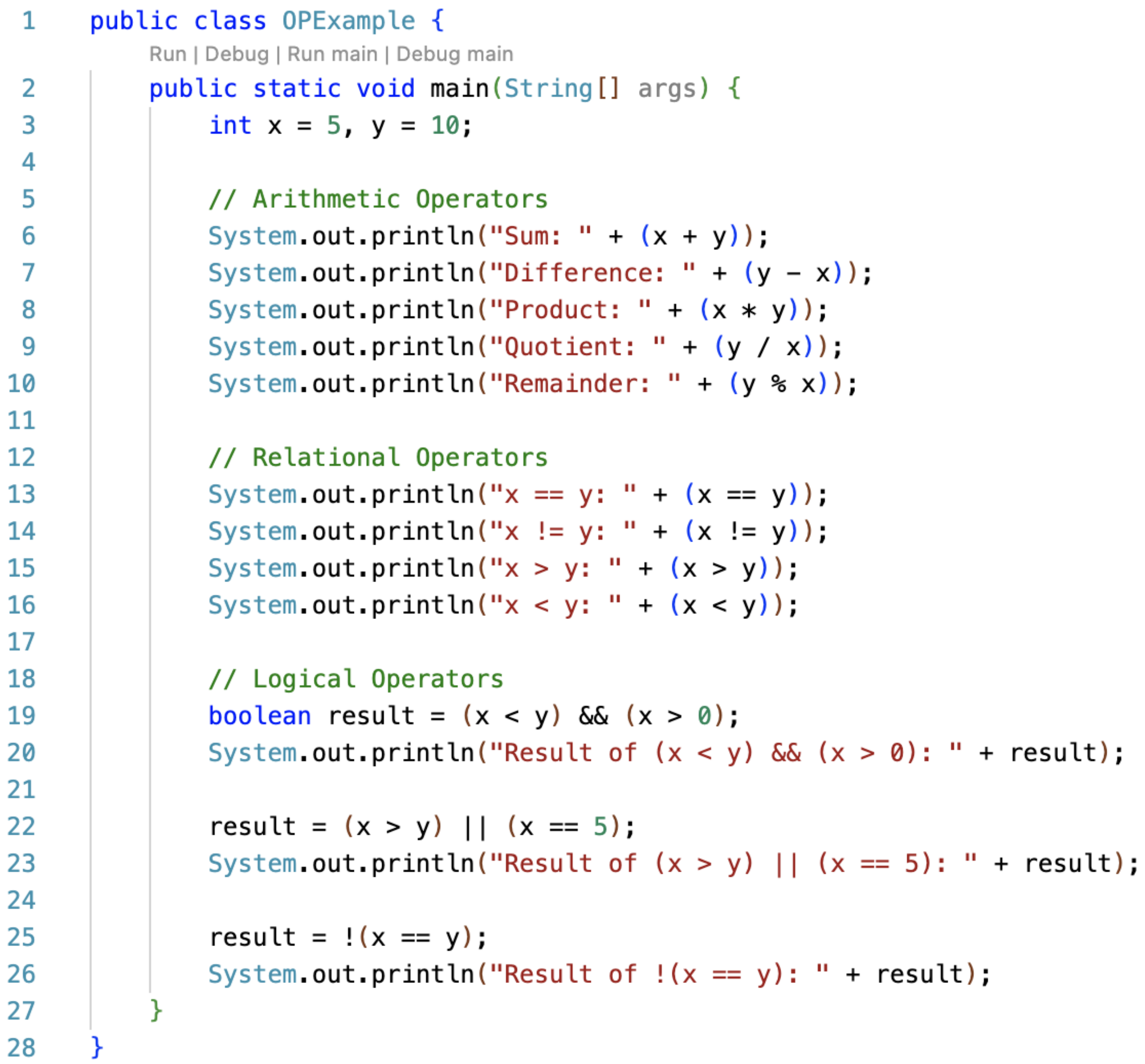
A) The object will not be created as there is a conflict in the constructor signatures.

B) Java will throw a compilation error because the no-argument constructor is not explicitly defined.

C) Java will call the no-argument constructor if it exists; otherwise, it will generate a default constructor.

D) The object will not be created because Java does not allow overloading constructors.

Operators & Expressions



```java
public class OPExample {
    public static void main(String[] args) {
        int x = 5, y = 10;

        // Arithmetic Operators
        System.out.println("Sum: " + (x + y));
        System.out.println("Difference: " + (y - x));
        System.out.println("Product: " + (x * y));
        System.out.println("Quotient: " + (y / x));
        System.out.println("Remainder: " + (y % x));

        // Relational Operators
        System.out.println("x == y: " + (x == y));
        System.out.println("x != y: " + (x != y));
        System.out.println("x > y: " + (x > y));
        System.out.println("x < y: " + (x < y));

        // Logical Operators
        boolean result = (x < y) && (x > 0);
        System.out.println("Result of (x < y) && (x > 0): " + result);

        result = (x > y) || (x == 5);
        System.out.println("Result of (x > y) || (x == 5): " + result);

        result = !(x == y);
        System.out.println("Result of !(x == y): " + result);
    }
}
```

Conditional Statements

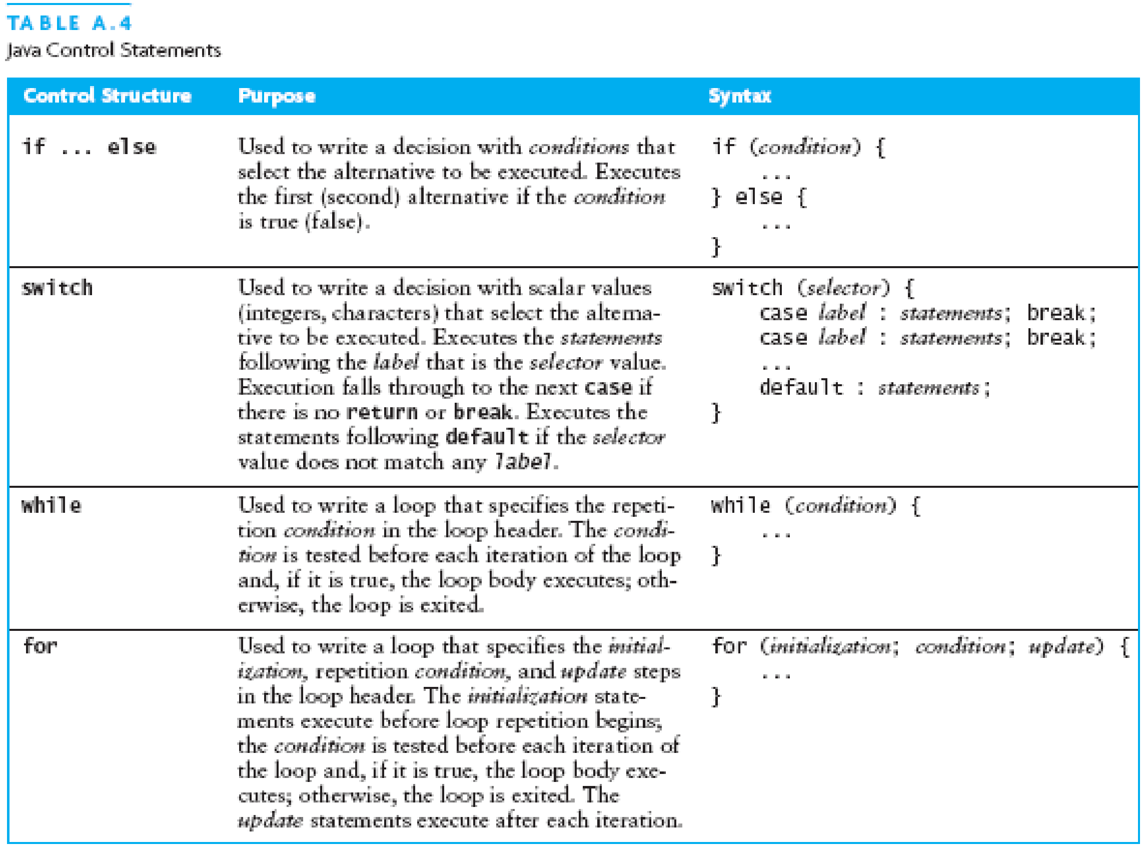


TABLE A.4

Java Control Statements

Control Structure	Purpose	Syntax

`if ... else`	Used to write a decision with *conditions* that select the alternative to be executed. Executes the first (second) alternative if the *condition* is true (false).	`if (`*condition*`) {`
		`    ...`
		`} else {`
		`    ...`
		`}`

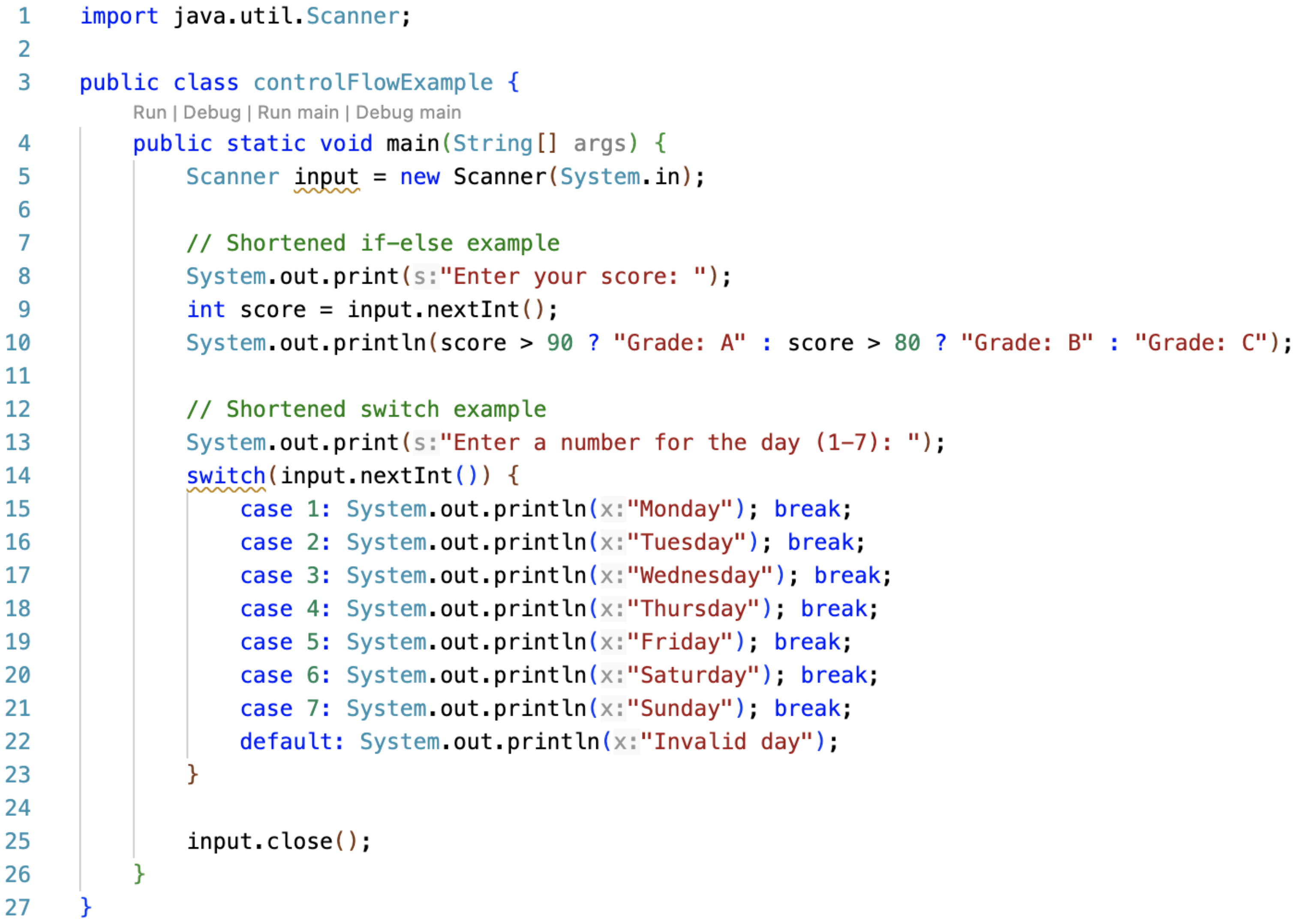
`switch`	Used to write a decision with scalar values (integers, characters) that select the alternative to be executed. Executes the *statements* following the *label* that is the *selector* value. Execution falls through to the next **`case`** if there is no **`return`** or **`break`**. Executes the statements following **`default`** if the *selector* value does not match any `label`.	`switch (`*selector*`) {`
		`    case `*label*` : `*statements*`; break;`
		`    case `*label*` : `*statements*`; break;`
		`    ...`
		`    default : `*statements*`;`
		`}`

`while`	Used to write a loop that specifies the repetition *condition* in the loop header. The *condition* is tested before each iteration of the loop and, if it is true, the loop body executes; otherwise, the loop is exited.	`while (`*condition*`) {`
		`    ...`
		`}`

`for`	Used to write a loop that specifies the *initialization*, repetition *condition*, and *update* steps in the loop header. The *initialization* statements execute before loop repetition begins; the *condition* is tested before each iteration of the loop and, if it is true, the loop body executes; otherwise, the loop is exited. The *update* statements execute after each iteration.	`for (`*initialization*`; `*condition*`; `*update*`) {`
		`    ...`
		`}`

Appendix A of Koffman, E. B., & Wolfgang, P. A. T. (2016). *Data structures: Abstraction and design using Java* (3nd ed.) Wiley.

Conditional Statements Example



```java
import java.util.Scanner;

public class controlFlowExample {
    Run | Debug | Run main | Debug main
    public static void main(String[] args) {
        Scanner input = new Scanner(System.in);

        // Shortened if-else example
        System.out.print(s:"Enter your score: ");
        int score = input.nextInt();
        System.out.println(score > 90 ? "Grade: A" : score > 80 ? "Grade: B" : "Grade: C");

        // Shortened switch example
        System.out.print(s:"Enter a number for the day (1-7): ");
        switch(input.nextInt()) {
            case 1: System.out.println(x:"Monday"); break;
            case 2: System.out.println(x:"Tuesday"); break;
            case 3: System.out.println(x:"Wednesday"); break;
            case 4: System.out.println(x:"Thursday"); break;
            case 5: System.out.println(x:"Friday"); break;
            case 6: System.out.println(x:"Saturday"); break;
            case 7: System.out.println(x:"Sunday"); break;
            default: System.out.println(x:"Invalid day");
        }

        input.close();
    }
}
```

Conditional Statements

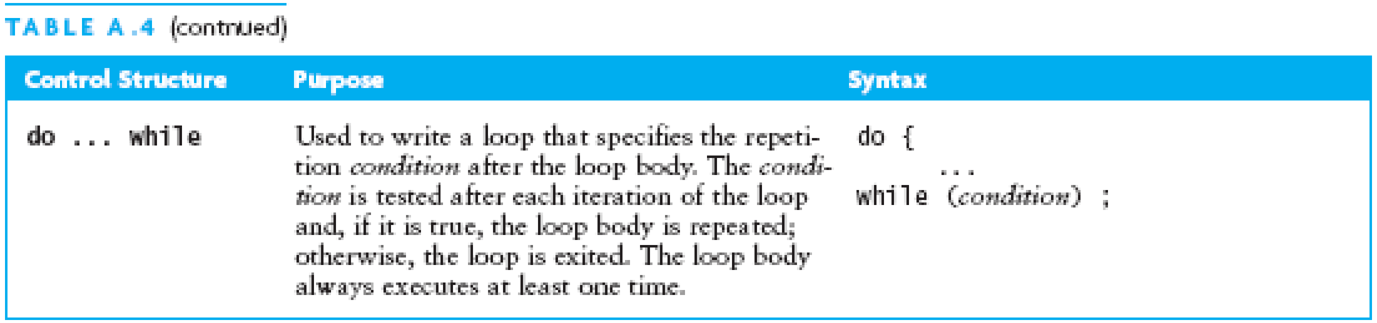


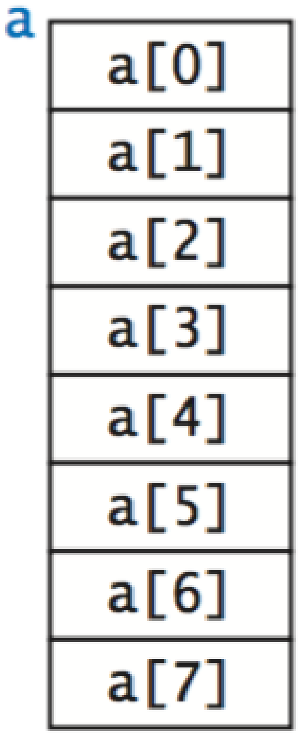
TABLE A.4 (contnued)

Control Structure	Purpose	Syntax

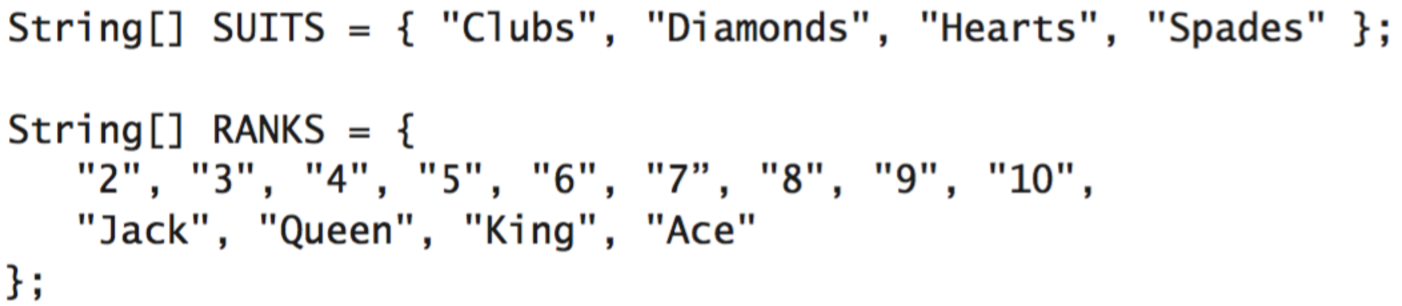
`do ... while`	Used to write a loop that specifies the repetition *condition* after the loop body. The *condition* is tested after each iteration of the loop and, if it is true, the loop body is repeated; otherwise, the loop is exited. The loop body always executes at least one time.	`do {`
		`    ...`
		`while (`*condition*`) ;`

Appendix A of Koffman, E. B., & Wolfgang, P. A. T. (2016). *Data structures: Abstraction and design using Java* (3nd ed.) Wiley.

Arrays

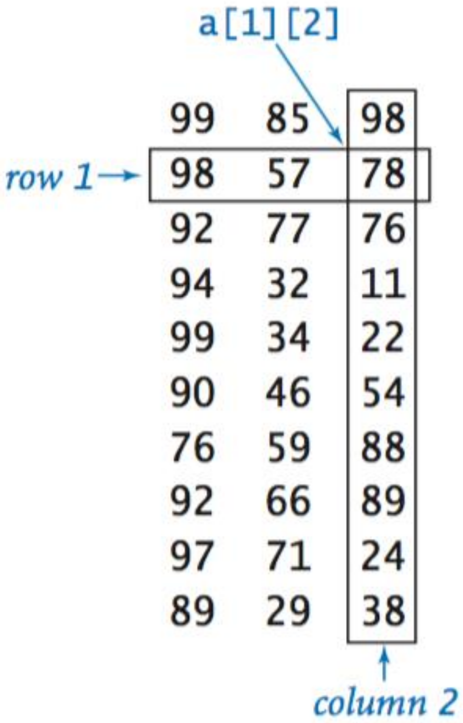


Inline array initialization

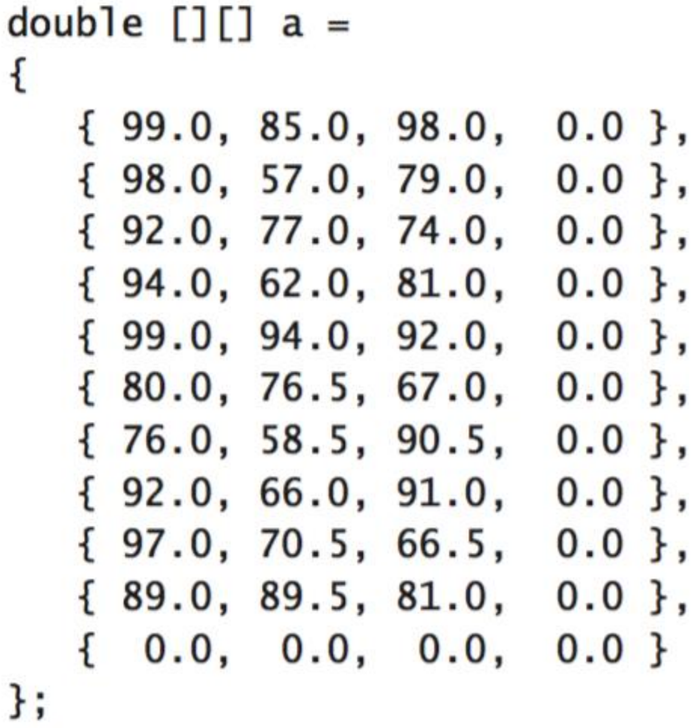


```
String[] SUITS = { "Clubs", "Diamonds", "Hearts", "Spades" };

String[] RANKS = {
   "2", "3", "4", "5", "6", "7”, "8", "9", "10",
   "Jack", "Queen", "King", "Ace"
};
```

2D Arrays



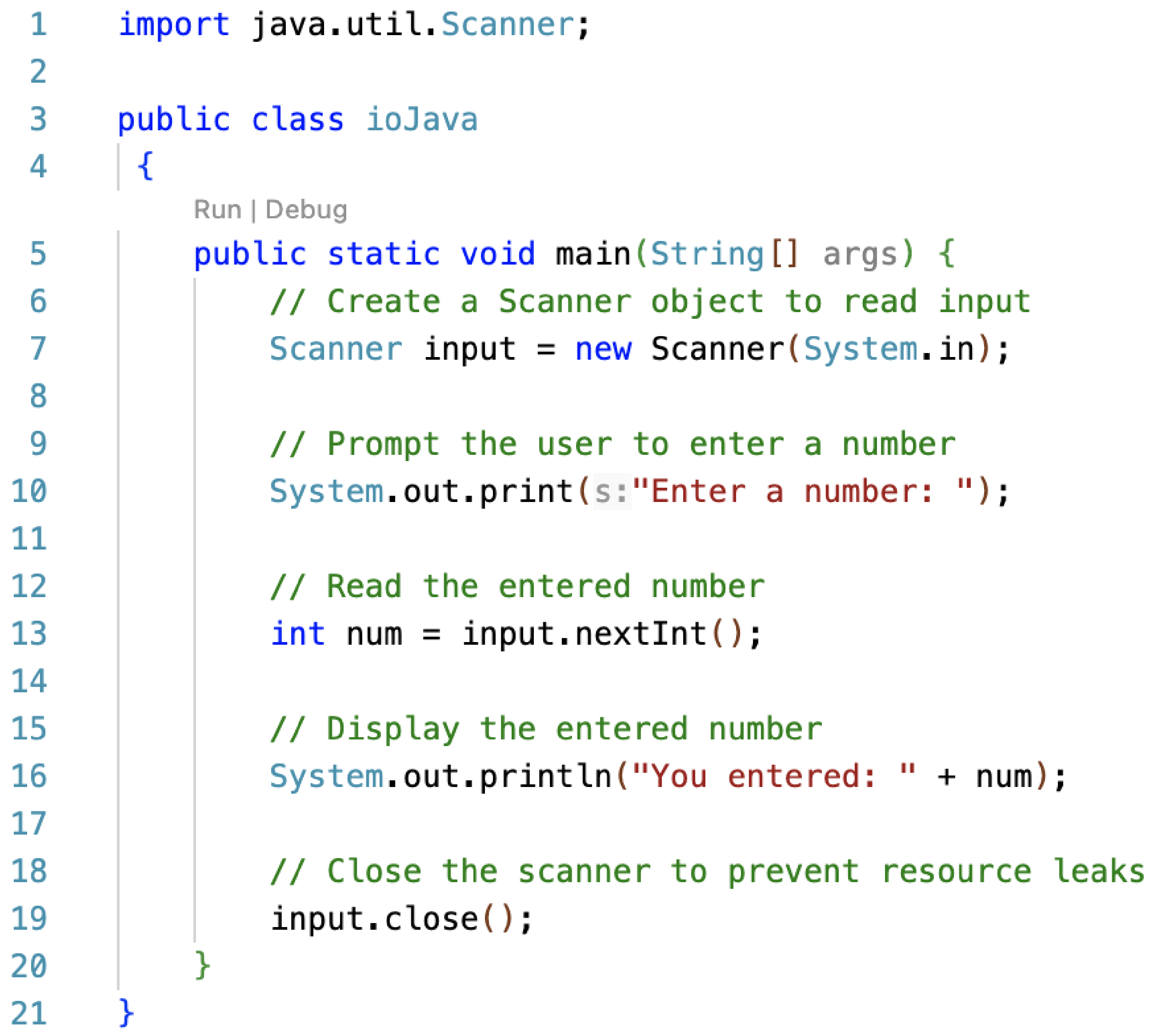
99	85	98
98	57	78
92	77	76
94	32	11
99	34	22
90	46	54
76	59	88
92	66	89
97	71	24
89	29	38



```
double [][] a =
{
    { 99.0, 85.0, 98.0,  0.0 },
    { 98.0, 57.0, 79.0,  0.0 },
    { 92.0, 77.0, 74.0,  0.0 },
    { 94.0, 62.0, 81.0,  0.0 },
    { 99.0, 94.0, 92.0,  0.0 },
    { 80.0, 76.5, 67.0,  0.0 },
    { 76.0, 58.5, 90.5,  0.0 },
    { 92.0, 66.0, 91.0,  0.0 },
    { 97.0, 70.5, 66.5,  0.0 },
    { 89.0, 89.5, 81.0,  0.0 },
    {  0.0,  0.0,  0.0,  0.0 }
};
```

Input/Output Handling

- Reading Input using Scanner
- Writing Output to Console



```java
import java.util.Scanner;

public class ioJava
{
    public static void main(String[] args) {
        // Create a Scanner object to read input
        Scanner input = new Scanner(System.in);

        // Prompt the user to enter a number
        System.out.print(s:"Enter a number: ");

        // Read the entered number
        int num = input.nextInt();

        // Display the entered number
        System.out.println("You entered: " + num);

        // Close the scanner to prevent resource leaks
        input.close();
    }
}
```

Best Practices and Coding Standards

- Use meaningful variable names
- Keep code DRY (Don’t Repeat Yourself)
- Commenting and documentation
- Follow Java naming conventions (e.g., camelCase, ClassName)

Takeaway Points

- A Java program is a collection of classes.
- The JVM approach enables a Java program written on one machine to execute on any other machine with a JVM.
- Java defines a set of primitive data types for representing numbers, characters, and Boolean data.
- The control structures of Java are similar to those found in other languages.
- You can declare your own Java classes and create objects of these classes using the new operator.
- A class has data fields and instance methods.

References

- The following references were used in the preparation of this presentation:
    - Appendix A of Koffman, E. B., & Wolfgang, P. A. T. (2016). Data structures: Abstraction and design using Java (3nd ed.) Wiley.
    - Princeton University. (n.d.). Java cheatsheet. https://introcs.cs.princeton.edu/java/11cheatsheet/