Java Unit - 1

Introduction to Java : History and Features of Java, Java program structure, Writing simple Java class and main() method, Command-line arguments, Understanding JDK, JRE and JVM

Data In the Cart : Using primitive data types, Type conversion, Keywords, Identifiers, Variables, Access modifiers, static keyword, Wrapper class

Operators : Working with Bit-wise, arithmetic, logical, and relational operators, Unary, assignment and Ternary operator, Operator precedence

Conditional Statements : Using if/else constructs and switch-case statements

Introduction to Java

What is Java?

Java is a **high-level, object-oriented, and platform-independent programming language** designed to build robust, secure, and scalable applications. It was developed by **James Gosling** and his team at Sun Microsystems (now part of Oracle) in **1995**. Java is widely used across various domains, including web development, mobile applications, enterprise software, and more.

History of Java

- **Origin and Development**:
  Java was developed by **James Gosling** and his team at **Sun Microsystems** in the early 1990s. Initially called **Oak**, it was renamed Java in 1995 due to trademark issues. The language was designed to address the challenges of building software for networked environments and to ensure platform independence.
- **Key Milestones**:
  - **1991**: Project started by the Green Team at Sun Microsystems.
  - **1995**: Java 1.0 was officially released, introducing the concept of "Write Once, Run Anywhere" (WORA).
  - **1997**: Java was standardized under the **Java Community Process (JCP)**.
  - **2006**: Java was open-sourced under the **GNU General Public License (GPL)**.
  - **2010**: Oracle Corporation acquired Sun Microsystems and took over Java development.

Java Language Used For:

1. Web development - Spring, hibernate

2. Mobile App
3. ERP
4. Desktop app - JavaFX, Applet
5. IOT devices
6. Game development - LWJGl
7. Banking Application - Paytm, CRED
8. Networking App - chat application (net package)

Key Features of Java OR What Makes Java Unique and Why It's a Powerful Language

Java has been a cornerstone of the programming world since its inception in the mid-1990s. Let's dive into the key aspects that make Java unique and powerful:

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1. Platform Independence

- **"Write Once, Run Anywhere (WORA)"**:
  Java programs are compiled into an intermediate form called **bytecode**. This bytecode is platform-independent and runs on any device equipped with the **Java Virtual Machine (JVM)**.
  - Example: A program written and compiled on Windows can run seamlessly on Linux or macOS without any changes.
- This feature is a game-changer, especially for large-scale software systems that need to operate across diverse environments.

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2. Object-Oriented Programming (OOP)

- Java is built around the principles of **Object-Oriented Programming**, which promotes reusability, scalability, and maintainability.
  - **Key OOP Concepts in Java:**
    1. **Encapsulation**: Wrapping data (fields) and methods in a single unit (class).
    2. **Inheritance**: Reusing existing code to create new functionality.
    3. **Polymorphism**: The ability to process objects differently based on their data type or class.
    4. **Abstraction**: Hiding complex implementation details and exposing only essential features.

- This makes Java suitable for modeling real-world problems and building robust applications.

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3. Robustness and Reliability

- Java is known for its emphasis on **error-checking** and **runtime exception handling**.
- Features like **automatic memory management (Garbage Collection)** reduce memory leaks and improve program stability.
- Strong type-checking during compilation helps catch potential bugs early.

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4. Secure Programming Environment

- Java was designed with security in mind:
    - The JVM isolates Java programs, preventing unauthorized access to system resources.
    - The Java security model includes features like **bytecode verification**, **sandboxing**, and built-in cryptographic algorithms.
- These features make Java a preferred choice for applications that prioritize data security, such as banking and e-commerce platforms.

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5. Multithreading Support

- Java simplifies the creation of programs that can perform multiple tasks simultaneously using **threads**.
    - Example: A Java program can download a file, process data, and update the user interface at the same time.
- This makes Java ideal for developing high-performance applications like games and multimedia software.

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6. Rich Standard Library (Java API)

- Java comes with an extensive library of pre-built classes and methods, called the **Java Standard Library** or **Java API**.
    - Examples:

        - **java.util**: Collections, date-time handling, and utility classes.
        - **java.io**: Input and output stream handling.
        - **java.net**: Networking functionalities.
- These libraries reduce development time and ensure developers don't have to "reinvent the wheel."

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7. Community Support and Ecosystem

- Java has one of the largest and most active developer communities.
- A vast ecosystem of frameworks and tools is built around Java:
    - **Spring** and **Hibernate** for backend development.
    - **Apache Spark** for big data.
    - **Android SDK** for mobile app development.

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8. Performance and Scalability

- Java's Just-In-Time (JIT) Compiler optimizes bytecode execution at runtime, improving performance.
- Java applications scale efficiently, making them ideal for enterprise-level solutions and cloud computing.

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9. Versatility Across Domains

- Java is a general-purpose language, which means it can be used in multiple domains:
    - **Web Applications**: Using frameworks like Spring or Struts.
    - **Mobile Development**: Primary language for Android development.
    - **Enterprise Systems**: Banking, ERP, and CRM solutions.
    - **IoT**: Lightweight Java libraries power embedded devices.

Java Program Structure:

Java programs are organized in a specific structure that makes them easy to read, maintain, and execute. Below is a detailed step-by-step explanation of the components that form the structure of a typical Java program.

Note:

1. Always ensure that if a class is declared `public`, its name matches the file name.
2. If no class in the file is `public`, you can name the file anything you like, as long as it compiles correctly.
3. For clarity and maintainability, it's a good practice to keep the file name the same as the main class name, even if it isn't required.

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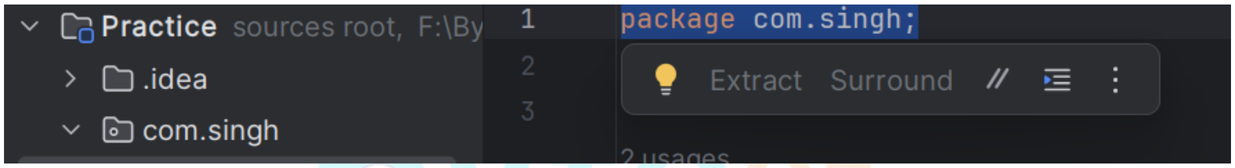
1. Package Declaration (Optional)

The package declaration specifies the namespace in which the classes are defined. This helps to organize classes and avoid name conflicts.



```
package com.singh;
```

- **Purpose**: Groups related classes together.
- **Optional**: Not required if the program doesn't use custom packages.

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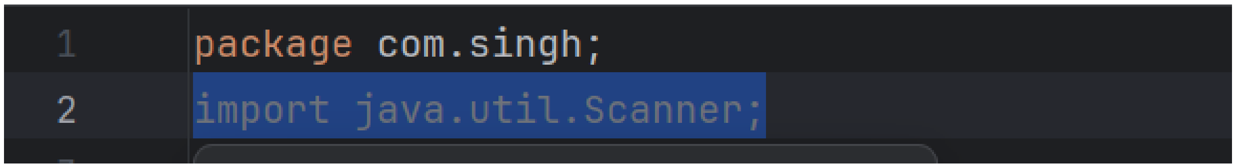
2. Import Statements (Optional)

Import statements allow the program to include predefined or user-defined classes from other packages.



```
package com.singh;
import java.util.Scanner;
```

- **Purpose**: Provides access to classes and methods from libraries or other packages.
- **Optional**: Not required if fully qualified names are used.

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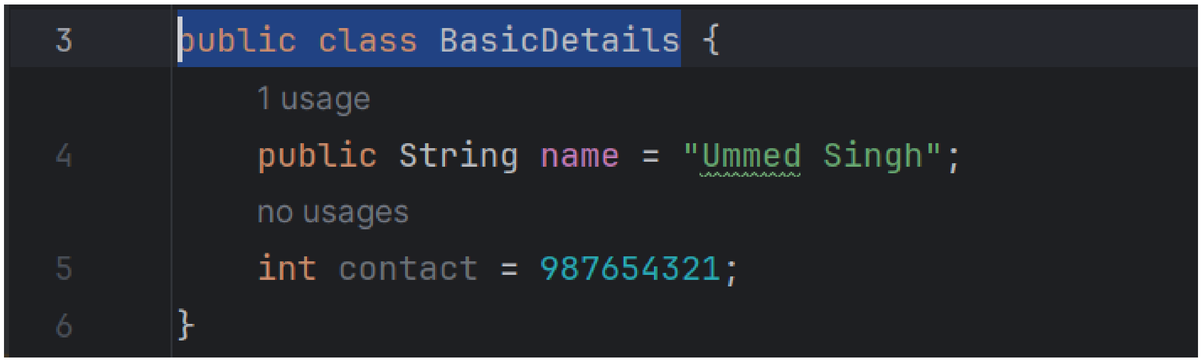
3. Class Declaration

A Java program must have at least one class definition. The class name should match the filename if it is declared `public`.



```java
public class BasicDetails {
    1 usage
    public String name = "Ummed Singh";
    no usages
    int contact = 987654321;
}
```

- **Purpose**: Defines the blueprint of objects, methods, and variables.
- **Mandatory**: Every Java program must have at least one class.

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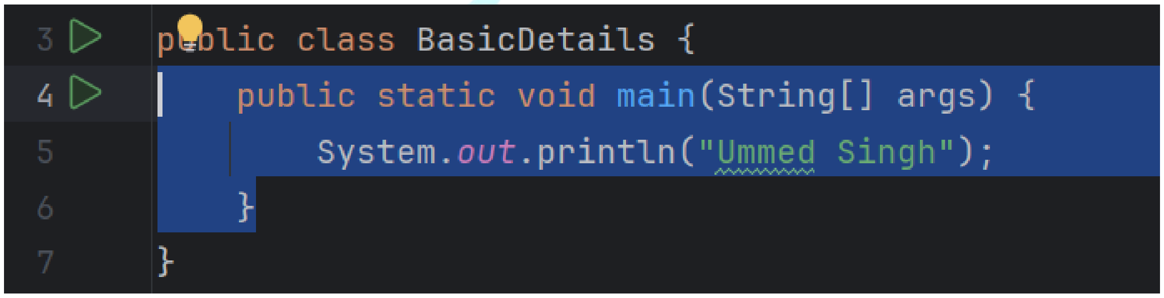
4. Main Method

The `main` method is the entry point of any Java program. The Java Virtual Machine (JVM) starts program execution from here.



```java
public class BasicDetails {
    public static void main(String[] args) {
        System.out.println("Ummed Singh");
    }
}
```

Purpose: Acts as the starting point of the program.

- **Structure**:
    - `public`: Makes the method accessible to the JVM.
    - `static`: Allows the method to be executed without creating an instance of the class.
    - `void`: Indicates the method doesn't return a value.
    - `String[] args`: Accepts command-line arguments as an array of strings.

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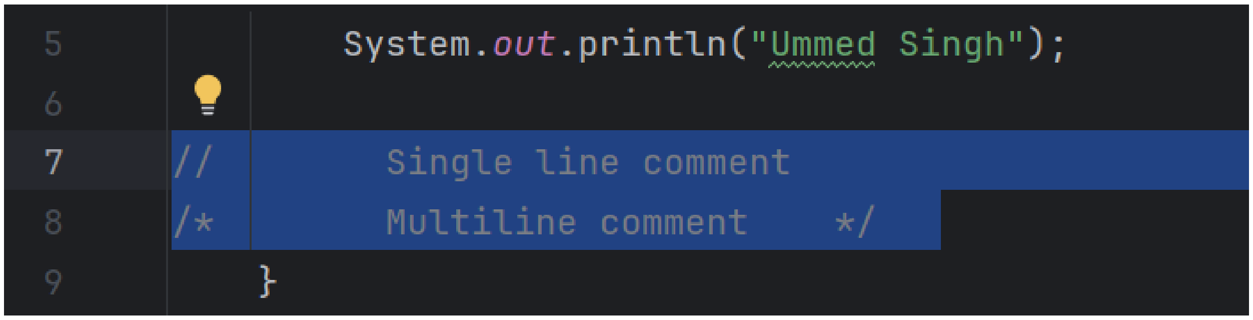
5. Comments (Optional)

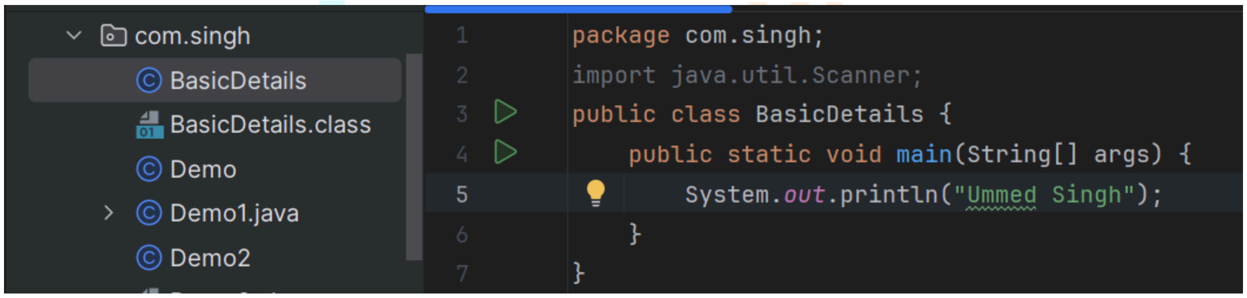
Comments enhance readability and provide information about the code. They are ignored by the compiler.



```
        System.out.println("Ummed Singh");

//      Single line comment
/*      Multiline comment    */
    }
```

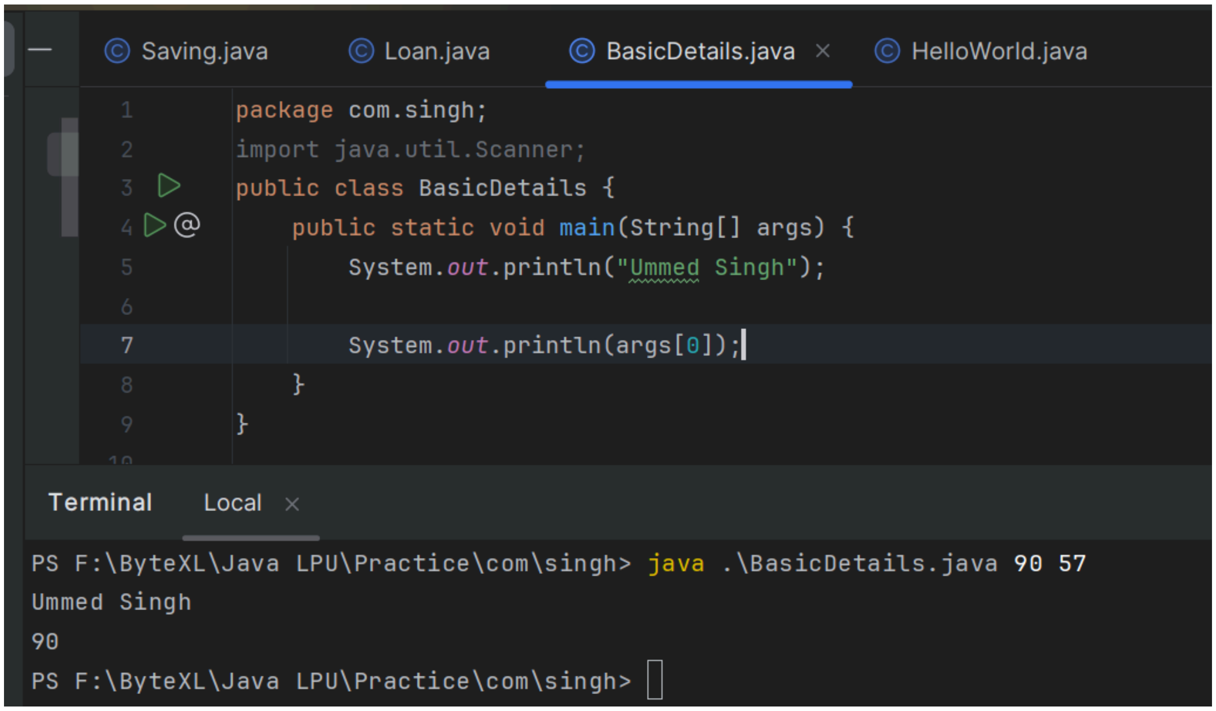
- **Purpose**: Improves code maintainability.

Writing simple java class and main() method:



```
package com.singh;
import java.util.Scanner;
public class BasicDetails {
    public static void main(String[] args) {
        System.out.println("Ummed Singh");
    }
}
```

Command line arguments:



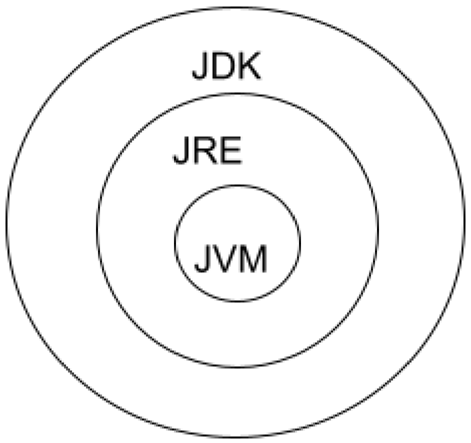
```java
package com.singh;
import java.util.Scanner;
public class BasicDetails {
    public static void main(String[] args) {
        System.out.println("Ummed Singh");

        System.out.println(args[0]);
    }
}
```

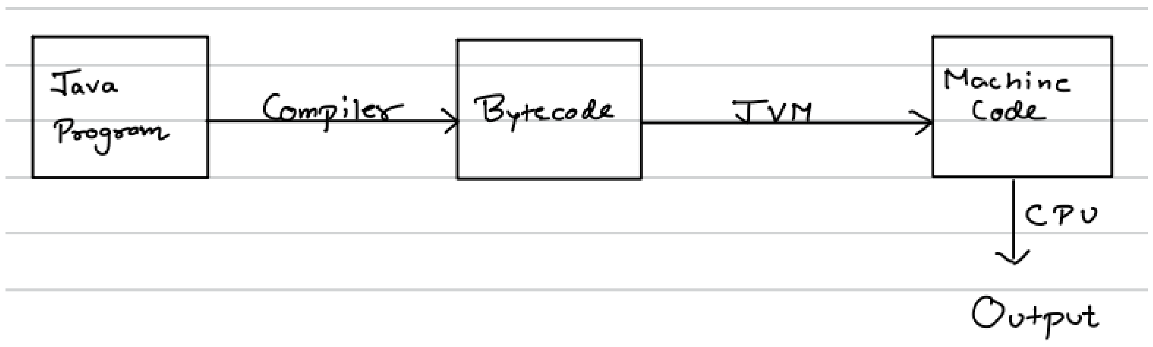
```
PS F:\ByteXL\Java LPU\Practice\com\singh> java .\BasicDetails.java 90 57
Ummed Singh
90
PS F:\ByteXL\Java LPU\Practice\com\singh>
```

Understanding JDK, JRE, JVM:

Java is a platform-independent programming language that relies on an ecosystem of tools and components. Three critical components in this ecosystem are **JDK**, **JRE**, and **JVM**.

1. **JVM**

- 

- The Java Virtual Machine (JVM) is a crucial part of the Java ecosystem that allows Java programs to run on any device or operating system. Understanding the JVM is essential for grasping how Java code is executed, optimized, and managed.
- It's just an abstract machine that doesn't exist physically
- It is responsible for converting compiled Java code into machine language that the host system's CPU can understand and execute.
- 

- JVM is platform dependent
- So we need to install a JVM based on the platform, i.e., macOS, Linux, or Windows. The input for JVM is bytecode, and the output is machine code. Now, since bytecode can be run by any JVM, it makes a Java program platform-independent.
- JVM has JIT (Just In Time) compilers, which take bytecode and convert it into machine code.
- It handles everything: loading code, executing it, managing memory, and cleaning up.

Why is JVM Important?

- **Runs Everywhere:** It lets Java run on any device or OS.
- **Manages Memory:** It automatically takes care of memory, so you don't have to worry about freeing up space manually.
- **Optimizes Performance:** Uses techniques to make your program run faster.

2. JRE (Java Runtime Environment)

The JRE is a software package that provides the necessary environment to run Java programs.

- **Purpose**: Provides libraries and tools to execute Java applications.
- **Components**:
    - **JVM**:
        - The core of JRE, which runs Java programs.
    - **Core Libraries**:
        - Predefined classes and methods (e.g., `java.util`, `java.lang`).
    - **Supporting Files**:
        - Configuration files and resources required for execution.
- **What It Does Not Include**:
    - Development tools like the compiler (`javac`) or debugger.

Key Point: If you only want to run Java programs and not develop them, you only need the JRE.

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3. JDK (Java Development Kit)

The JDK is a complete development environment for building Java applications.

- **Purpose**: Provides tools for developing, debugging, and monitoring Java programs.
- **Components**:
    1. **JRE**:
        - The JDK includes the JRE for running Java programs.
    2. **Development Tools**:
        - **Compiler (`javac`)**: Converts Java source code into bytecode.
        - **Debugger (`jdb`)**: Helps debug Java programs.
        - **JavaDoc**: Generates documentation from comments in the source code.
        - **JavaFX**: Tools for building graphical applications.
    3. **Other Utilities**:
        - `jar` (Java Archive tool), `jconsole` (monitoring tool), etc.

Key Point: If you want to write, compile, and debug Java programs, you need the JDK.

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4. Relationship Between JDK, JRE, and JVM

- **JVM** is the foundation that runs Java programs.
- **JRE** includes the JVM and additional libraries to provide a runtime environment.
- **JDK** is a superset of JRE that also includes development tools.

JDK = JRE + Development Tools

JRE = JVM + Libraries

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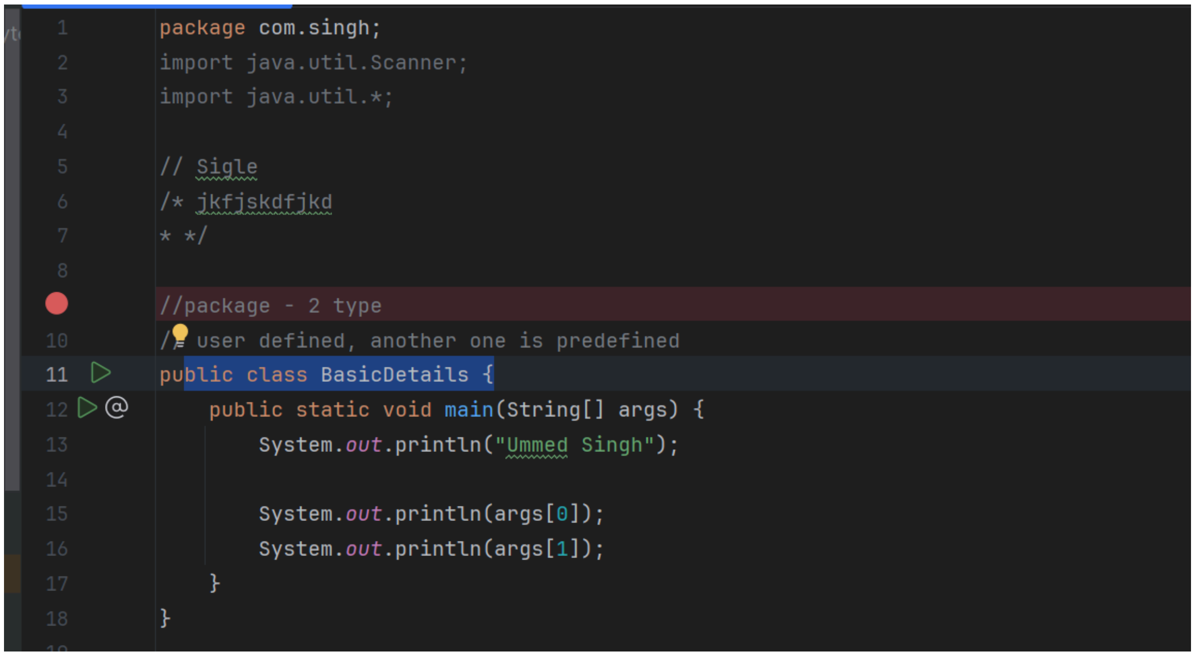
5. Example Workflow

1. **Write Code**: Use a text editor or IDE to write `.java` files (requires JDK).
2. **Compile Code**: Use `javac` (Java compiler) to convert `.java` files into `.class` files (requires JDK).
3. **Run Code**: Use the `java` command to execute the `.class` files (requires JRE).



```java
package com.singh;
import java.util.Scanner;
import java.util.*;

// Sigle
/* jkfjskdfjkd
* */

//package - 2 type
// user defined, another one is predefined
public class BasicDetails {
    public static void main(String[] args) {
        System.out.println("Ummed Singh");

        System.out.println(args[0]);
        System.out.println(args[1]);
    }
}
```

- **Compilation**: `javac HelloWorld.java` ➔ Generates `HelloWorld.class`.
- **Execution**: `java HelloWorld` ➔ Runs the program using JVM.

Data In the cart

Data Types in Java

Data types specify the type of data that a variable can hold. Java is a strongly typed language, which means every variable must be declared with a data type before it can be used.

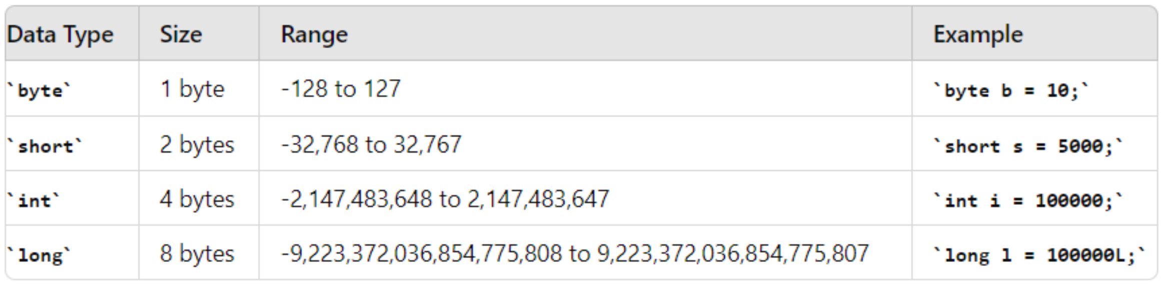
Categories of Data Types

1. **Primitive Data Types:**

    - The basic data types that are predefined by Java. They represent simple values and are not objects.
    - **Types:** `byte`, `short`, `int`, `long`, `float`, `double`, `char`, `boolean`.
2. **Non-Primitive (Reference) Data Types:**
    - These are not predefined; they are created by the programmer. They refer to objects and can hold multiple values.
    - **Examples:** `String`, `Arrays`, `Classes`, `Interfaces`.

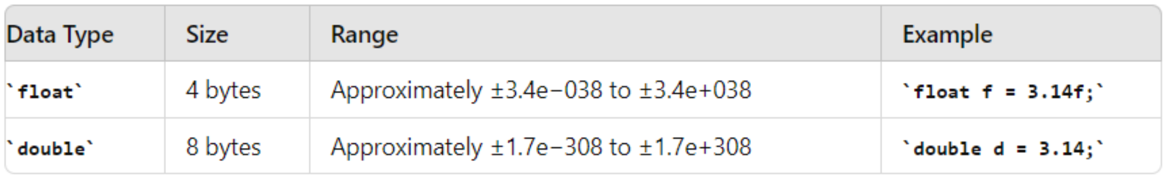
Detailed Breakdown of Primitive Data Types

1. **Integer Types:** Used to store whole numbers (no decimal).



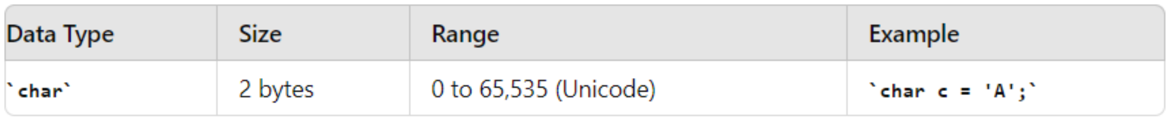
Data Type	Size	Range	Example
`byte`	1 byte	-128 to 127	`byte b = 10;`
`short`	2 bytes	-32,768 to 32,767	`short s = 5000;`
`int`	4 bytes	-2,147,483,648 to 2,147,483,647	`int i = 100000;`
`long`	8 bytes	-9,223,372,036,854,775,808 to 9,223,372,036,854,775,807	`long l = 100000L;`

2. **Floating-Point Types:** Used to store numbers with fractional parts (decimals)



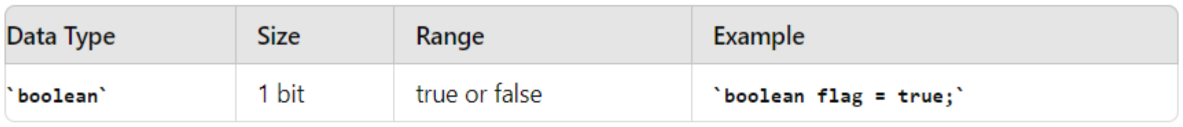
Data Type	Size	Range	Example
`float`	4 bytes	Approximately ±3.4e−038 to ±3.4e+038	`float f = 3.14f;`
`double`	8 bytes	Approximately ±1.7e−308 to ±1.7e+308	`double d = 3.14;`

3. **Character Type:**Stores a single 16-bit Unicode character



Data Type	Size	Range	Example
`char`	2 bytes	0 to 65,535 (Unicode)	`char c = 'A';`

4. **Boolean Type:**Stores one of two values: `true` or `false`



Data Type	Size	Range	Example
`boolean`	1 bit	true or false	`boolean flag = true;`

Non-Primitive Data Types

1. **Strings:** A sequence of characters used for text. Strings are objects in Java, and they have built-in methods for manipulation.
2. **Arrays:** A collection of variables of the same type stored in contiguous memory locations.
3. **Classes and Objects:** Classes are blueprints for creating objects. Objects are instances of classes and represent entities with attributes and behaviors.

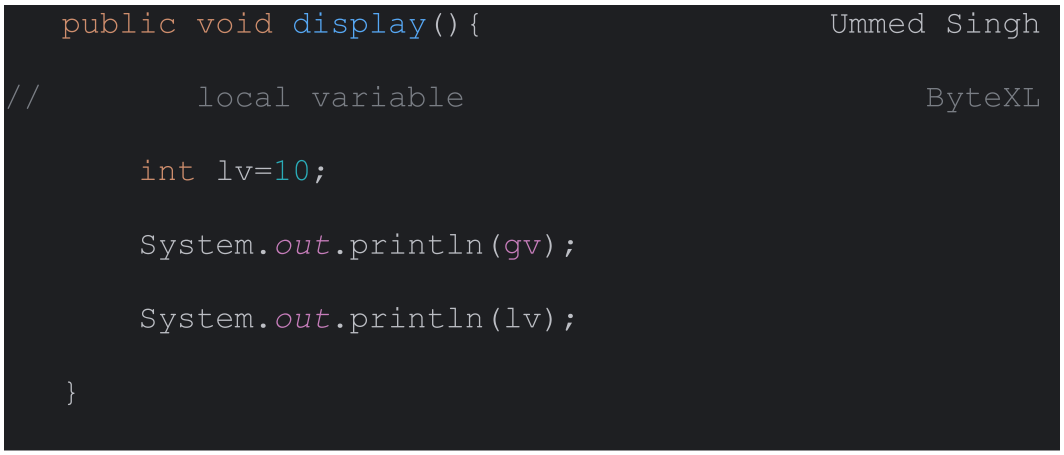
```java
public class DataTypesDemo {                                    ByteXL

   public static void main(String[] args) {

// Primitive data types

       byte b = 127;  // 1 byte = 8 bit

       int age = 24;

       float f = 23.45f;

       double salary = 200000.12;

       char hindiChar = 'उ';

       boolean isEmployed = true;

// Non-primitive data type

       String name = "Ummed Singh";

       int[] arr  = {10, 20, 30};

// Output the values

       System.out.println("Name: "+ name);

       System.out.println("Age: "+ age);

       System.out.println("Salary: "+ salary);

       System.out.println("HindiChar: "+ hindiChar);

       System.out.println("Employed: "+ isEmployed);

   }

}
```

Variables in Java

Variables are containers for storing data values. In Java, variables must be declared with a specific type, defining the kind of data they can hold. Variables are essential as they allow programs to store and manipulate data.

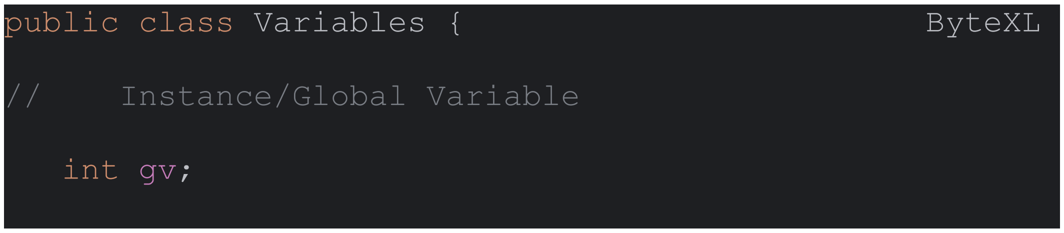
Types of Variables in Java

1. **Local Variables:**
   - **Definition:** Declared inside a method, constructor, or block and only accessible within that scope.
   - **Scope:** Limited to the method or block in which they are defined.
   - **Initialization:** Must be initialized before use.



```
    public void display(){
//          local variable
        int lv=10;
        System.out.println(gv);
        System.out.println(lv);
    }
```

2. **Instance Variables:**
   - **Definition:** Declared inside a class but outside any method, they represent the properties of an object.
   - **Scope:** Accessible throughout the class and with each object having its own copy.
   - **Initialization:** Automatically initialized to default values (0, null, false, etc.) if not explicitly initialized.



```
public class Variables {
//      Instance/Global Variable
    int gv;
```

3. **Static (Class) Variables:**
   - **Definition:** Declared with the `static` keyword inside a class but outside methods. Shared among all instances of the class.
   - **Scope:** Accessible throughout the class and shared across all objects.
   - **Initialization:** Automatically initialized to default values.

```
public class Variables {                          Ummed Singh

   //    static variable

   static int count = 0;

}
```

Variable Declaration and Initialization

- **Declaration:** Defines the variable type and name.
  - Syntax: `dataType variableName;`
  - Example: `int age;`
- **Initialization:** Assigns a value to the declared variable.
  - Syntax: `variableName = value;`
  - Example: `age = 25;`
- **Combined Declaration and Initialization:**
  - Syntax: `dataType variableName = value;`
  - Example: `int age = 25;`

Naming Conventions for Variables

1. **Start with a Letter:** Variable names must start with a letter, underscore (_), or dollar sign ($), but not a number.
2. **Case Sensitivity:** Java is case-sensitive; `Age` and `age` are different variables.
3. **Descriptive Names:** Use meaningful names that describe the variable's purpose, like `studentAge` instead of `x`.

Variable Scope and Lifetime

- **Scope:** Refers to the part of the program where the variable can be accessed.
- **Lifetime:** Refers to how long the variable exists in memory. Local variables last until the method exits, instance variables last as long as the object exists, and static variables last for the program's lifetime.

```
public class Variables {                                      ByteXL
```

```
    // Instance variable

    String name = "Ummed Singh";

    // Static variable

    static int count = 0;

    public void display() {

// Local variable

        int age = 25;

        count++; // Increment static variable

        System.out.println("Name: " + name);

        System.out.println("Age: " + age);

        System.out.println("Count: " + count);

    }

    public static void main(String[] args) {

        Variables demo1 = new Variables();

        demo1.display();

        Variables demo2 = new Variables();

        demo2.display();

    }

}
```

Type Casting/conversion in Java

Type casting is converting a variable from one data type to another. There are two types of casting:

1. Implicit (Widening) Casting

- Automatically done by the compiler when converting a smaller type to a larger type.
- No data loss occurs.

```
byte b = 10;

int i = b;

long l = i;

System.out.println(l);
```

a. byte to short, int, long, float, and double
b. char to int, long, float, and double
c. int to long, float, and double
d. long to float and double
e. float to double

2. Explicit (Narrowing) Casting

- Must be done manually when converting a larger type to a smaller type.
- Risk of data loss.
- Use parentheses to specify the type.
- Example:

```
int a = 129;

byte b = (byte) a;       // -128, -127.....0, 1,....127

System.out.println(b); //   a - b => 129 - 127 = 7

//         OUTPUT => -127
```

a. double to float, long, int, short, byte, and char
b. float to long, int, short, byte, and char
c. long to int, short, and byte
d. int to short, byte, and char
e. short to byte

Automatic Type Promotions in Expressions

Automatic type promotion in expressions is a concept in Java where smaller data types are automatically promoted to larger data types during arithmetic operations. This ensures that calculations are done accurately without data loss or errors.

Java promotes smaller data types to larger ones when evaluating expressions. The promotion rules are applied automatically based on the hierarchy of data types.

1. Type Promotion Rules

1. **Byte, Short, and Char Promotion:**
   - `byte`, `short`, and `char` are automatically promoted to `int` when used in arithmetic operations.
2. **Promotion to Larger Types:**
   - If one operand is `long`, the whole expression is promoted to `long`.
   - If one operand is `float`, the whole expression is promoted to `float`.
   - If one operand is `double`, the whole expression is promoted to `double`.
3. **Mixed-Type Expressions:**
   - The promotion follows the hierarchy: `byte` → `short` → `int` → `long` → `float` → `double`.

2. Examples of Automatic Type Promotion

1. **Promotion of `byte`, `short`, and `char` to `int`**

```
byte b1 = 10;

byte b2 = 20;

// Both b1 and b2 are promoted to int before addition

int result = b1 + b2;

System.out.println("byte to int: "+ result); // Output: 30
```

2. **Mixed Data Types in Expressions**

```
int i = 10;

long 1 = 20L;

// i is promoted to long, and result is long
```

```java
long result = i + 1 ;
System.out.println("int to long: "+ result); // Output: 30
```

3. Promotion to `float`

```java
int i = 10;
float f = 3.14f;
float result = i + f; // i is promoted to float, and result is float
System.out.println("int to float: "+ result); // Output: 13.14
```

4. Promotion to `double`

```java
float f = 2.5f;
double d = 4.5;
double result = f + d; // f is promoted to double, and result is double
System.out.println("float to double: " + result); // Output: 7.0
```

5. `char` Promotion in Expressions

```java
char c1 = 'A'; // Unicode value is 65
char c2 = 'B'; // Unicode value is 66
int result = c1 + c2; // Both c1 and c2 are promoted to int
System.out.println("char to int: " + result); // Output: 131
```

6. Complex Expression with Multiple Promotions

```
byte b = 50;

char c = 'C'; // Unicode value is 67

int i = 1000;

long l = 1500001;

float f = 5.67f;

double d = 0.1234;

// Promotion hierarchy in this expression:

// b> int, c> int, int> long, long -> float, float ->
double

double result = (f*b) + (i/c) - (d* l);

System.out.println("Complex promotion: "+ result);

// Output: 283.47660000000003 (may vary slightly due to
floating-point arithmetic)
```

3. Keywords

Java keywords are reserved words that have predefined meanings in the language. They serve specific purposes and are an integral part of the syntax. Examples include:

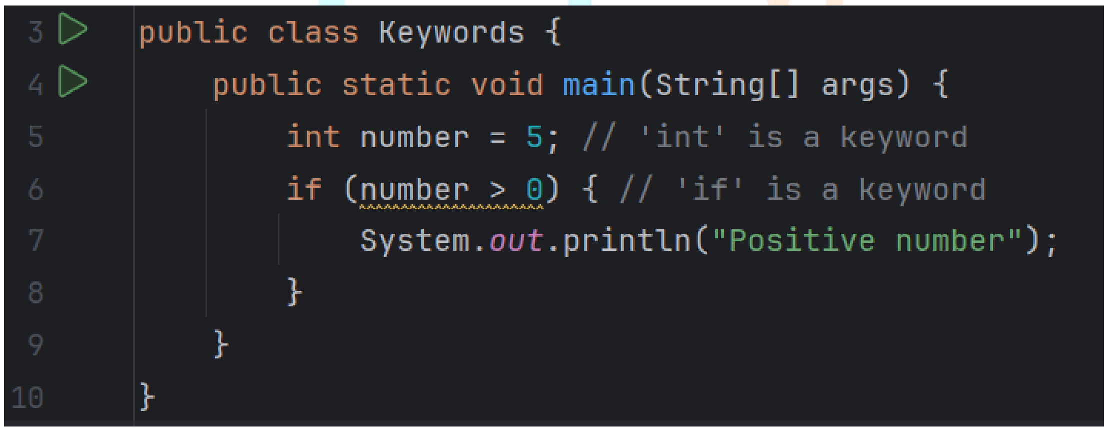
Keyword	Purpose
`class`	Declares a class
`public`	Access modifier for public visibility
`static`	Indicates a static method or variable
`return`	Exits a method and optionally returns a value
`void`	Specifies a method with no return value

`if`	Begins a conditional branch
`else`	Defines an alternate path in a conditional
`while`	Starts a loop that runs while a condition is true
`for`	Starts a loop with an iterator
`try`	Begins a block to test for exceptions
`catch`	Handles exceptions raised in a `try` block

Key Characteristics of Keywords

- There are over 50 reserved keywords in Java.
- They are case-sensitive.
- They cannot be used as identifiers for variables, methods, or classes.

Example of usage:



```java
public class Keywords {
    public static void main(String[] args) {
        int number = 5; // 'int' is a keyword
        if (number > 0) { // 'if' is a keyword
            System.out.println("Positive number");
        }
    }
}
```

4. Identifiers

Identifiers are names used to identify variables, methods, classes, or other entities in Java. They are essential for naming and organizing elements in a program. Below are the key rules and additional details for identifiers:

Rules for Identifiers:

1. **Start Character:**
   - Must begin with a letter (A-Z or a-z), underscore (`_`), or dollar sign (`$`).
   - Cannot start with a digit (0-9).
2. **Subsequent Characters:**

    - Can include letters, digits, underscores, and dollar signs.
    - Spaces are not allowed within an identifier.
3. **Reserved Words:**
    - Cannot use Java keywords or reserved words as identifiers (e.g., `class`, `int`, `public`).
4. **Case Sensitivity:**
    - Identifiers are case-sensitive. For example, `Variable` and `variable` are considered different identifiers.
5. **Length and Readability:**
    - While there is no strict limit on length, it is recommended to use meaningful and concise names for better readability.

Best Practices for Identifiers:

- Use **camelCase** for variable and method names (e.g., `studentAge`, `calculateSum`).
- Use **PascalCase** for class names (e.g., `StudentDetails`, `InvoiceProcessor`).
- Avoid using single-character names except for loop counters or temporary variables.
- Use underscores sparingly, primarily in constants (e.g., `MAX_SPEED`).

Examples:

Valid Identifiers:

```
public class Identifiers {                        // ByteXL

   int age = 25;            // 'age' is a valid identifier

   String $name = "Ummed Singh"; // '$name' is valid

   float _price = 19.99f;   // '_price' is valid

}
```

Invalid Identifiers:

```
int 2ndNumber = 5;       // Invalid: Cannot start with a digit

String class = "Test"; // Invalid: 'class' is a reserved word

int first name = 10;     // Invalid: Spaces are not allowed
```

By following these rules and best practices, you can create identifiers that are both functional and maintainable, ensuring code clarity and consistency.

Access Modifiers

Access modifiers in Java control the visibility and accessibility of classes, methods, and variables. They play a crucial role in defining the boundaries of an object-oriented program and ensuring encapsulation. Java provides four types of access modifiers:

Types of Access Modifiers

1. Public

- **Visibility:** Accessible from any other class, regardless of the package.
- **Use Case:** When methods, variables, or classes need to be universally accessible.

Example:

```java
public class AccessModifiers {

   public int a = 10;      // public

   public void display() {

       System.out.println(a);

   }

}
```

2. Private

- **Visibility:** Accessible only within the same class.
- **Use Case:** Used to enforce strict encapsulation and prevent access to sensitive data or methods from outside the class.

Example:

```java
public class AccessModifiers {

   private int a = 10;      // private
```

```
    public void display() {

        System.out.println(a);

    }

}
```

3. Protected

- **Visibility:** Accessible within the same package and subclasses (even in different packages).
- **Use Case:** Useful when sharing data with subclasses while restricting access to the rest of the program.

Example:

```
public class AccessModifiers {

    protected int value = 10;       // protected

}

class Subclass extends AccessModifiers {

    void display() {

        System.out.println("Value: " + value);

    }

}
```

4. Default (Package-Private)

- **Visibility:** Accessible only within the same package.
- **Use Case:** Ideal for package-level access where classes or members should not be exposed outside the package.

Example:

```java
public class AccessModifiers {

   int a = 10;       // default

   public void display() {

       System.out.println(a);

   }

}
```

Summary of Access Levels

Modifier	Same Class	Same Package	Subclass (Different Package)	Other Packages
`public`	Yes	Yes	Yes	Yes
`protected`	Yes	Yes	Yes	No
`default`	Yes	Yes	No	No
`private`	Yes	No	No	No

Best Practices

- Use `private` by default for member variables and provide controlled access through getter and setter methods.
- Use `protected` when designing classes for inheritance.

- Use public only when methods or variables are intended to be universally accessible.
- Avoid using the default modifier unless package-level access is explicitly required.

The static Keyword in Java

The static keyword in Java is used to define class-level variables, methods, or blocks that can be accessed without creating an instance of the class. It is widely used for defining shared resources or utilities.

Features of the static Keyword

1. **Class-Level Association:**
   - static members belong to the class rather than any specific instance.
2. **Memory Management:**
   - static members are created once and shared among all instances, reducing memory usage.
3. **Direct Access:**
   - static members can be accessed using the class name directly.

Usage of the static Keyword

1. Static Variables

- Used to define variables shared among all instances of a class.
- Useful for constants or counters.

Example:

```
public class Counter {    // cntNmb

   static int cntNmb = 0;

   int a;

   public void countNumber(){

       cntNmb++;

       int b = 10;
```

```
        System.out.println(cntNmb);

    }

}
```

```
public class BasicDetails {

    public static void main(String[] args) {

        Counter obj = new Counter(); //

        obj.countNumber();

        Counter obj1 = new Counter();

        obj1.countNumber();

    }

}
```

2. Static Methods

- Used to define utility or helper methods that do not depend on instance variables.

Example:

```
AccessModifiers accObj = new AccessModifiers();

System.out.println(AccessModifiers.a);
```

3. Static Blocks

- Executed when the class is loaded.
- Typically used for initializing static variables.

Example:

```java
class StaticBlockExample {
   static int number;
   static {
       number = 10;
       System.out.println("Static block executed.");
   }
   public static void main(String[] args) {
       System.out.println("Number: " + number);
   }
}
/* OUTPUT
   Static block executed.
   Number: 10
*/
```

4. Static Classes

- Inner classes can be declared as `static`, allowing them to be accessed without an outer class instance.

Example:

```java
class OuterClass {
   static class StaticInnerClass {
       void display() {
         System.out.println("Static Inner Class called.");
       }
```

```
    }

}

public class Test {

    public static void main(String[] args) {

        OuterClass.StaticInnerClass inner = new
OuterClass.StaticInnerClass();

        inner.display();

    }

}
```

Key Points

- A `static` method cannot access non-static variables or methods directly.
- `this` and `super` cannot be used in static contexts.
- Static members are initialized once and persist throughout the program's lifetime.
-

Wrapper Classes in Java

1. What are Wrapper Classes?

Wrapper classes in Java provide a way to use primitive data types (like `int`, `double`, `boolean`) as objects. These classes are part of the `java.lang` package and are essential for converting primitive types into objects and vice versa. Each primitive type has a corresponding wrapper class:

Primitive Type	Wrapper Class
`byte`	`Byte`

`short`	`Short`
`int`	`Integer`
`long`	`Long`
`float`	`Float`
`double`	`Double`
`char`	`Character`
`boolean`	`Boolean`

---

2. Why Use Wrapper Classes?

- **Object-Oriented Programming**: Collections in Java (like `ArrayList`, `HashMap`) work with objects, not primitives.
- **Utility Methods**: Wrapper classes provide methods to manipulate and perform operations on primitive types (e.g., parsing strings to numbers).
- Ex: int a = 10 -> “10”
- **Autoboxing and Unboxing**: These features simplify the conversion between primitives and their corresponding wrapper classes.

---

3. Features of Wrapper Classes

- **Immutability**: Wrapper objects are immutable, meaning their values cannot be changed once created.

- **Caching**: Certain wrapper classes (e.g., `Integer`) cache frequently used values for better performance.
- **Interoperability**: Convert between data types and parse data from strings (e.g., `Integer.parseInt()`).

---

4. Examples

a. Autoboxing and Unboxing

```java
public class WrapperDemo {
   public static void main(String[] args) {
       // Autoboxing: Primitive to Wrapper
       int primitive = 10;
       Integer wrapped = primitive;
       // Unboxing: Wrapper to Primitive
       Integer wrappedValue = 20;
       int primitiveValue = wrappedValue;
       System.out.println("Primitive: " + primitive + ", 
Wrapped: " + wrapped);
       System.out.println("Wrapped: " + wrappedValue + ", 
Primitive: " + primitiveValue);
   }
}
```

b. Using Utility Methods

```java
public class UtilityMethodDemo {
   public static void main(String[] args) {
       String number = "123";
```

```java
        // Convert String to Integer
        int num = Integer.parseInt(number);
        // Convert Integer to String
        String numStr = Integer.toString(num);
        System.out.println("String to Integer: " + num);
        System.out.println("Integer to String: " + numStr);
    }
}
```

c. Wrapper Classes in Collections

```java
public class WrapperInCollections {
    public static void main(String[] args) {
        ArrayList<Integer> list = new ArrayList<>();
        // Adding elements (Autoboxing)
        list.add(10);
        list.add(20);
        // Retrieving elements (Unboxing)
        int first = list.get(0);
        System.out.println("List: " + list);
        System.out.println("First Element: " + first);
    }
}
```

---

5. Key Methods of Wrapper Classes

Each wrapper class provides several methods. Here are some examples:

Wrapper Class	Common Methods	Description
`Integer`	`parseInt(String s)`	Converts a string to an integer.
	`valueOf(String s)`	Returns an `Integer` object representing the value.
`Double`	`parseDouble(String s)`	Converts a string to a double.
	`doubleValue()`	Returns the value as a primitive double.
`Boolean`	`parseBoolean(String s)`	Parses a string to a boolean.
	`booleanValue()`	Returns the value as a primitive boolean.
`Character`	`isDigit(char ch)`	Checks if the character is a digit.
	`isLetter(char ch)`	Checks if the character is a letter.

6. Common Use Cases

1. **Data Structures**: Using wrapper classes in `ArrayList`, `HashMap`, etc.

2. **Parsing Data**: Converting user input (String) to primitive types.
3. **Default Values**: Using null for uninitialized objects.

---

7. Performance Considerations

- **Memory Usage**: Wrapper classes consume more memory than primitives.
- **Autoboxing/Unboxing Overhead**: May lead to performance issues in critical applications if overused.

Operators

Operators are special symbols that perform operations on variables and values.

Detailed Explanation of Each Operator

1. Arithmetic Operators: Arithmetic operators are used to perform basic mathematical operations.

- **Operators:** + (Addition), - (Subtraction), * (Multiplication), / (Division), % (Modulus)

```
    int a = 10;

    int b = 5;

    System.out.println("Addition: "+ (a + b)); // 15

    System.out.println("Subtraction: "+ (a - b)); // 5

    System.out.println("Multiplication: "+ (a* b)); // 50

    System.out.println("Division: " + (a/b)); // 2

    System.out.println("Modulus: "+ (a%b)); // 0

}
```

2. Relational Operators: Relational operators compare two values and return a boolean result (`true` or `false`).

- **Operators:** == (Equal to), != (Not equal to), > (Greater than), < (Less than), >= (Greater than or equal to), <= (Less than or equal to)

```
int a = 10;
int b = 20;
System.out.println(a == b); // false
System.out.println(a != b); // true
System.out.println(a > b); // false
System.out.println(a < b); // true
```

3. Logical Operators: Logical operators are used to combine multiple conditions.

- **Operators:** && (Logical AND), || (Logical OR), ! (Logical NOT)

```
boolean a = true;
boolean b = false;
System.out.println(a && b); // false
System.out.println(a || b); // true
System.out.println(!a); // false
```

4. Bitwise Operators Bitwise operators work on bits and perform bit-level operations.

- **Operators:** & (Bitwise AND), | (Bitwise OR), ^ (Bitwise XOR), ~ (Bitwise Complement), << (Left shift), >> (Right shift), >>> (Unsigned right shift)

```
public class BitwiseOperatorsDemo {
    public static void main(String[] args) {
        // Define two numbers
        int a = 5;  // Binary: 0101
        int b = 3;  // Binary: 0011
```

```java
        System.out.println("Bitwise Operators in Java\n");

        // Bitwise AND (&)
        int andResult = a & b; // 0101 & 0011 = 0001 (Decimal 1)
        System.out.println("a & b = " + andResult);

        // Bitwise OR (|)
        int orResult = a | b; // 0101 | 0011 = 0111 (Decimal 7)
        System.out.println("a | b = " + orResult);

        // Bitwise XOR (^)
        int xorResult = a ^ b; // 0101 ^ 0011 = 0110 (Decimal 6)
        System.out.println("a ^ b = " + xorResult);

        // Bitwise Complement (~)
        int notResult = ~a; // ~0101 = 1010 (Two's complement: -6 in Decimal)
        System.out.println("~a = " + notResult);

        // Left Shift (<<)
        int leftShift = a << 1; // 0101 << 1 = 1010 (Decimal 10)
        System.out.println("a << 1 = " + leftShift);

        // Right Shift (>>)
        int rightShift = a >> 1; // 0101 >> 1 = 0010 (Decimal 2)
        System.out.println("a >> 1 = " + rightShift);


        // Unsigned Right Shift (>>>)

        int unsignedRightShift = -5 >>> 1;

        // -5 = 11111111 11111111 11111111 11111011 (32-bit)

        // Shifted: 01111111 11111111 11111111 11111101 (Decimal
2147483645)

        System.out.println("-5 >>> 1 = " + unsignedRightShift);


        // Explanation of binary representation

        System.out.println("\nBinary Representations:");

        System.out.println("a (5) in binary: " +
Integer.toBinaryString(a));

        System.out.println("b (3) in binary: " +
Integer.toBinaryString(b));

        System.out.println("-5 in binary: " + Integer.toBinaryString(-5));

    }

}
```

5. Assignment Operators: Assignment operators assign values to variables.

- **Operators:** `=`, `+=`, `-=`, `*=`, `/=`, `%=`

```
int c = 10;

c += 5; // c = c + 5

System.out.println(c); // 15
```

6. Unary Operators: Unary operators work with a single operand.

- **Operators:** + (Unary plus), - (Unary minus), ++ (Increment), -- (Decrement), ! (Logical NOT)

```
int d = 5;

System.out.println(++d); // 6


System.out.println(d--); // 6

System.out.println(-d); // -5
```

7. Ternary Operator: The ternary operator is a shorthand for an `if-else` statement.

- **Syntax:** `condition ? if-true : if-false`

```
int e = 10;

int f = (e > 5) ? 100 : 200;

System.out.println(f);
```

Practical Activities

- **Activity 1:** Create a calculator program using arithmetic operators.
- **Activity 2:** Write a program to determine the largest of three numbers using relational and logical operators.
- **Activity 3:** Implement a simple grading system using the ternary operator.

Operator Precedence in Java

Operator precedence determines the order in which operators are evaluated in an expression. Operators with higher precedence are evaluated before those with lower precedence.

Why is Operator Precedence Important?

Understanding operator precedence helps in predicting how an expression will be evaluated and allows writing expressions that produce the intended results.

Hierarchy of Operator Precedence

Below is the list of Java operators arranged in decreasing order of precedence:

1. **Parentheses:** `()`, `[]`
2. **Postfix Operators**: `expr++`, `expr−`
3. **Unary Operators**: `++expr`, `--expr`, `+`, `-`, `~`, `!`
4. **Multiplicative Operators**: `*`, `/`, `%`
5. **Additive Operators**: `+`, `-`
6. **Shift Operators**: `<<`, `>>`, `>>>`
7. **Relational Operators**: `<`, `>`, `<=`, `>=`, `instanceof`
8. **Equality Operators**: `==`, `!=`
9. **Bitwise AND**: `&`
10. **Bitwise XOR**: `^`
11. **Bitwise OR**: `|`
12. **Logical AND**: `&&`
13. **Logical OR**: `||`
14. **Ternary Operator**: `? :`
15. **Assignment Operators**: `=`, `+=`, `-=`, `*=`, `/=`, `%=`, `&=`, `^=`, `|=`, `<<=`, `>>=`, `>>>=`

```java
int x = 5+2 * 3; // Multiplication has higher precedence than addition

System.out.println(x);
```

```java
int y = (5+2) * 3; // Parentheses change the order of operations

System.out.println(y); // 21
```

Selection Statements in Java

Selection statements control the flow of execution based on certain conditions. They allow the program to make decisions and execute different code paths.

Types of Selection Statements in Java

1. **`if` Statement**
2. **`if-else` Statement**

3. `if-else-if` **Ladder**
4. `switch` **Statement**

Detailed Explanation with Examples

1. `if` Statement

The `if` statement evaluates a condition and executes a block of code if the condition is `true`.

```
if (condition){

   // Code to execute if the condition is true

}

int number  = 10;

if(number > 5){

   System.out.println("The number is greater than 5.");

}
```

2. `if-else` Statement

The `if-else` statement provides an alternative path if the condition is `false`.

```
if (condition){
   // Code to execute if the condition is true
}else {
   // Code to execute if the condition is false
}

int number = 3;
if (number % 2 ==0){
   System.out.println("The number is even.");

}else {
   System.out.println("The number is odd");
}
```

3. `if-else-if` Ladder

The `if-else-if` ladder is used when there are multiple conditions to test.

Syntax:

```
if (condition1) {                                              Ummed Singh
   // Code if condition1 is true                                    ByteXL
} else if (condition2) {
   // Code if condition2 is true
} else {
   // Code if all conditions are false
}
```

Example:

```
int marks = 85;
if (marks >= 90) {                                             Ummed Singh
   System.out.println("Grade: A");                                  ByteXL
} else if (marks >= 75) {
   System.out.println("Grade: B");
} else if (marks >= 50) {
   System.out.println("Grade: C");
} else {
   System.out.println("Grade: F");
}
```

4. switch Statement

The switch statement is used when you need to select one among many blocks of code based on a value.

Syntax:

```
switch (expression) {
    case value1:
        // Code block for value1
        break;
    case value2:
        // Code block for value2
        break;
        // Add more cases as needed
    default:
        // Code if none of the cases match
}
```

Example:

```
int day = 3;
switch (day) {
    case 1:
        System.out.println("Monday");
        break;
    case 2:
        System.out.println("Tuesday");
        break;

    case 3:

        System.out.println("Wednesday");

        break;

    default:

        System.out.println("Invalid day");

}
```

Key Points to Emphasize

- **Use `if-else` statements** when checking conditions that require logical evaluations.
- **Use `switch` statements** when checking against specific values of an integer, character, string, or enumerated type for better readability and maintainability.
- **`break` Statement in `switch`:** The `break` statement is crucial to prevent fall-through behavior, where subsequent cases execute without checking their conditions.

Common Pitfalls

- **Missing `break` in `switch` statements:** This can lead to unintentional fall-through, executing multiple cases.
- **Incorrect placement of brackets:** Ensure proper use of curly braces `{}` to define code blocks.
- **Overuse of nested `if` statements:** Nested `if` statements can make code complex and harder to read. Use `if-else-if` or `switch` for clarity.

Practical Activities

- **Activity 1:** Write a program to determine if a number is positive, negative, or zero using an `if-else-if` ladder.
- **Activity 2:** Create a menu-driven program using a `switch` statement that performs different arithmetic operations based on user input.

byteXL