DAY-2

Basic terminologies in Java Program

1. Class: The class is a blueprint (plan) of the instance of a class (object). It can be defined as a logical template that share common properties and methods.

- Example1: Blueprint of the house is class.

2. Object: The object is an instance of a class. It is an entity that has behavior and state.

- Example: Dog, Cat, Monkey etc. are the object of "Animal" class.
- **Behavior:** Running on the road.

3. Method: The behavior of an object is the method.

- **Example**: The fuel indicator indicates the amount of fuel left in the car.

4. Instance variables: Every object has its own unique set of instance variables. The state of an object is generally created by the values that are assigned to these instance variables.

Steps to Implement Java Program

Implementation of a Java application program involves the following step. They include:

1. Creating the program
2. Compiling the program
3. Running the program

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

1. Class Definition

This line uses the keyword **class** to declare that a new class is being defined.

```
Class HelloWorld {
   //
   //Statements
}
```

2. HelloWorld

It is an identifier that is the name of the class. The entire class definition, including all of its members, will be between the opening curly brace "**{**" and the closing curly brace "**}**".

3. main Method

In the Java programming language, every application must contain a main method. The main function(method) is the entry point of your Java application, and it's mandatory in a Java program. whose signature in Java is:

```
public static void main(String[] args)
```

Explanation of the above syntax

- ***public****: So that JVM can execute the method from anywhere.*

- ***static****: The main method is to be called without an object. The modifiers are public and static can be written in either order.*
- ***void****: The main method doesn't return anything.*
- ***main()****: Name configured in the JVM. The main method must be inside the class definition. The compiler executes the codes starting always from the main function.*
- ***String[]****: The main method accepts a single argument, i.e., an array of elements of type String.*

Like in C/C++, the main method is the entry point for your application and will subsequently invoke all the other methods required by your program.

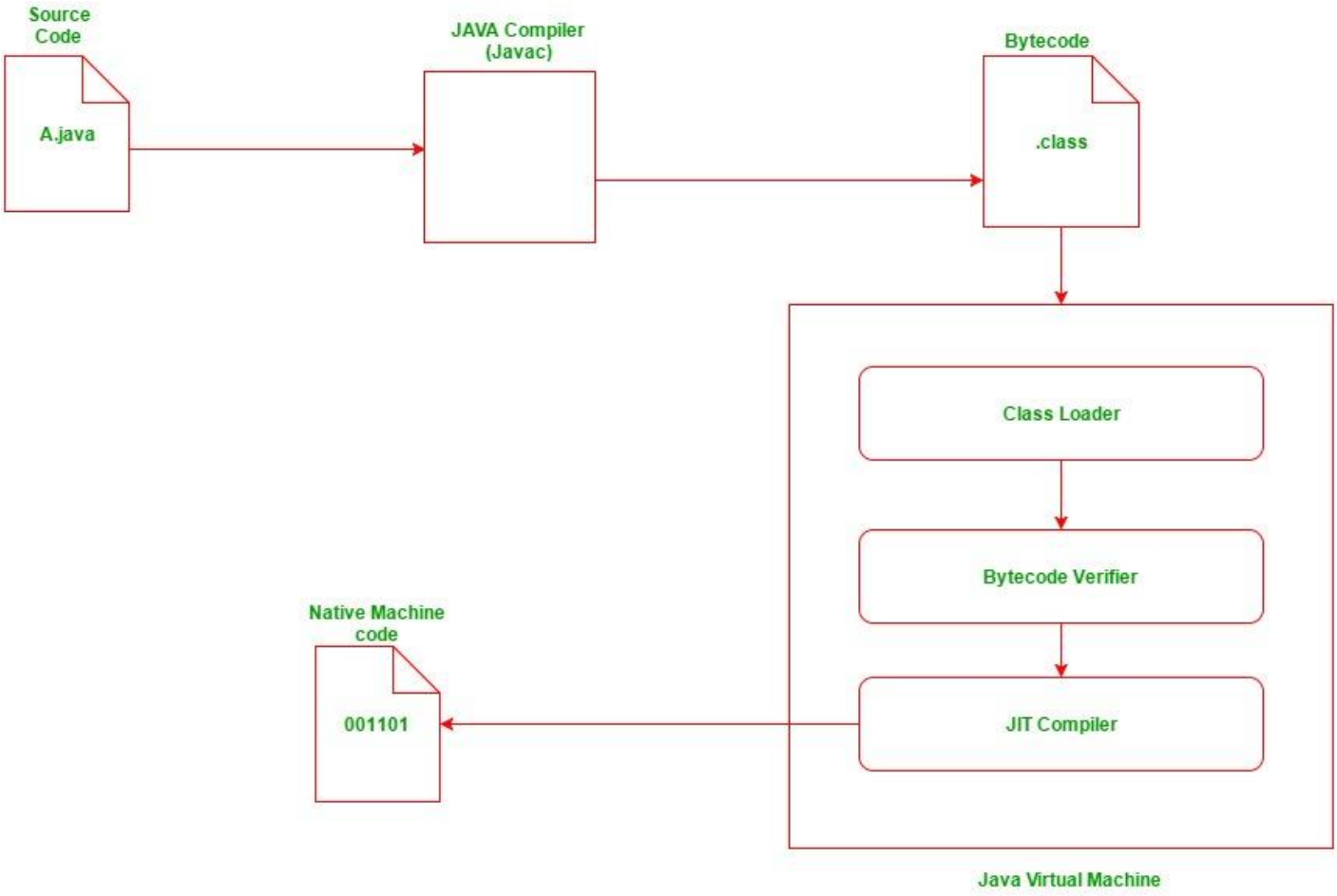
```
System.out.print("Hello, World");
```

This line outputs the string "Hello, World" followed by a new line on the screen. Output is accomplished by the built-in print( ) method. The **System** is a predefined class that provides access to the system and **out** is the variable of type output stream connected to the console.

Important Points

- *The name of the class defined by the program is HelloWorld, which is the same as the name of the file (HelloWorld.java). This is not a coincidence. In Java, all codes must reside inside a class, and there is at most one public class which contains the main() method.*
- *By convention, the name of the main class (a class that contains the main method) should match the name of the file that holds the program.*
- *Every Java program must have a class definition that matches the filename (class name and file name should be same)*

Compilation and Execution of a Java Program



Java Compilation and Execution

Compilation

1. **Parse:** Converts .java files into an Abstract Syntax Tree (AST).
2. **Enter:** Adds definitions to the symbol table.
3. **Process Annotations:** Handles annotations if requested.
4. **Attribute:** Performs name resolution, type checking, and constant folding.
5. **Flow:** Conducts data flow analysis, checking assignments and reachability.
6. **Desugar:** Simplifies the AST by removing syntactic sugar.
7. **Generate:** Creates .class files with bytecode.

Execution

1. **Class Loader:** Loads `.class` files into memory. It includes:
    - **Primordial Class Loader:** Default loader embedded in JVM.

- **Non-Primordial Class Loader:** User-defined for custom loading.

Class r = loadClass(String className, boolean resolveIt);

2. **Bytecode Verifier:** Ensures bytecode safety by checking:
   - Variables are initialized.
   - Method calls match object types.
   - Private data and method access rules.
   - Local variables are within runtime stack bounds.
   - No runtime stack overflow.
3. **Just-In-Time (JIT) Compiler:** Converts bytecode to machine code for execution, enhancing performance by reducing repeated bytecode interpretation.

Data Types

Java is a statically typed and strongly typed language, meaning every piece of data has a specific type that must be defined before using it. There are two main categories of data types in Java: primitive and non-primitive.

1. boolean

- **Description**: The boolean data type is used to store true or false values. It is primarily used for conditional statements and control flow in Java.
- **Default Value**: false
- **Size**: While the exact size of a boolean is not explicitly defined in the Java specification and can be JVM-dependent, it is typically represented using 1 bit.
- **Example**:

  boolean isTrue = true;

- **Usage**:

  ```
  boolean isJavaFun = true;
  if (isJavaFun) {
     System.out.println("Java is fun!");
  }
  ```

2. byte

- **Description**: The byte data type is an 8-bit signed integer. It is useful for saving memory in large arrays where memory savings are important.
- **Default Value**: 0
- **Size**: 1 byte (8 bits)
- **Range**: -128 to 127

- **Example**:

  byte byteValue = 100;

- **Usage**:

  byte age = 25;
  System.out.println("Age: " + age);

3. short

- **Description**: The short data type is a 16-bit signed integer. Like byte, it can be used to save memory in large arrays.
- **Default Value**: 0
- **Size**: 2 bytes (16 bits)
- **Range**: -32,768 to 32,767
- **Example**:

  short shortValue = 1000;

- **Usage**:

  short distance = 150;
  System.out.println("Distance: " + distance);

4. int

- **Description**: The int data type is a 32-bit signed integer. It is the most commonly used integer type.
- **Default Value**: 0
- **Size**: 4 bytes (32 bits)
- **Range**: -2,147,483,648 to 2,147,483,647
- **Example**:

  int intValue = 100000;

- **Usage**:

  int salary = 50000;
  System.out.println("Salary: " + salary);

5. long

- **Description**: The long data type is a 64-bit signed integer. It is used when a wider range than int is needed.
- **Default Value**: 0L
- **Size**: 8 bytes (64 bits)
- **Range**: -9,223,372,036,854,775,808 to 9,223,372,036,854,775,807
- **Example**:

  ```
  long longValue = 100000L;
  ```

- **Usage**:

  ```
  long population = 7800000000L;
  System.out.println("World Population: " + population);
  ```

6. float

- **Description**: The float data type is a single-precision 32-bit IEEE 754 floating-point. It is used for fractional numbers with less precision compared to double.
- **Default Value**: 0.0f
- **Size**: 4 bytes (32 bits)
- **Range**: Approximately 7 decimal digits of precision
- **Example**:

  ```
  float floatValue = 10.5f;
  ```

- **Usage**:

  ```
  float temperature = 36.6f;
  System.out.println("Temperature: " + temperature);
  ```

7. double

- **Description**: The double data type is a double-precision 64-bit IEEE 754 floating-point. It is used for decimal values with higher precision.
- **Default Value**: 0.0d
- **Size**: 8 bytes (64 bits)
- **Range**: Approximately 16 decimal digits of precision
- **Example**:

  ```
  double doubleValue = 10.5;
  ```

- **Usage**:

  ```
  double pi = 3.141592653589793;
  ```

```
System.out.println("Pi: " + pi);
```

8. char

- **Description**: The char data type is a single 16-bit Unicode character. It is used to store characters.
- **Default Value**: '\u0000' (null character)
- **Size**: 2 bytes (16 bits)
- **Range**: 0 to 65,535 (Unicode values)
- **Example**:

  ```
  char charValue = 'A';
  ```

- **Usage**:

  ```
  char grade = 'A';
  System.out.println("Grade: " + grade);
  ```

Non-Primitive / (Reference Types) / Object type Data Types :

Non-primitive data types in Java are more complex types that store references (memory addresses) to the actual data rather than the data itself. These include:

1. **Strings**
   - **Description:** Strings are sequences of characters.
   - **Example:**

     ```
     String s = "Hello";
     String s1 = new String("World");
     ```

2. **Classes**
   - **Description:** A blueprint for creating objects. It defines properties (attributes) and behaviors (methods).
   - **Example:**

     ```
     public class Car {
        String color;
        void drive() {
           // Driving behavior
        }
     }
     ```

3. **Objects**
   - **Description:** Instances of classes representing real-world entities with state (attributes) and behavior (methods).

- **Example:**

```
Car myCar = new Car();
myCar.color = "Red";
myCar.drive();
```

4. **Interfaces**
   - **Description:** A contract that a class can implement. It specifies what methods a class must have but not how they should work.
   - **Example:**

```
interface Animal {
   void eat();
}
class Dog implements Animal {
   public void eat() {
      // Eating behavior
   }
}
```

5. **Arrays**
   - **Description:** A collection of variables of the same type.
   - **Example:**

```
int[] numbers = {1, 2, 3, 4, 5};
int length = numbers.length; // Access array length
```

Q. Difference between Primitive and Object type Data Type.

Java Identifiers

In Java, identifiers are used for identification purposes. Java Identifiers can be a class name, method name, variable name, or label.

Example of Java Identifiers

```
public class Test
{
   public static void main(String[] args)
   {
      int a = 20;
   }
}
```

In the above Java code, we have 5 identifiers namely:

- **Test**: class name.
- **main**: method name.
- **String**: predefined class name.

- **args**: variable name.
- **a**: variable name.

Java Variables

Variables in Java are containers that hold data values during program execution. Each variable has a specific data type that defines the type of value it can store.

Declaration

To declare a variable, specify the data type followed by the variable name:

```
int age;
String name;
```

Initialization

Variables can be initialized when declared or later in the program:

```
int age = 25;
name = "John";
```

Types of Variables

1. **Local Variables**
   - Declared inside a method, constructor, or block.
   - Created and destroyed within the block scope.
   - Must be initialized before use.
   - Example:

     ```
     void method() {
        int localVar = 10; // Local variable
     }
     ```

2. **Instance Variables**
   - Declared in a class but outside any method, constructor, or block.
   - Created when an object is instantiated and destroyed when the object is destroyed.
   - Can have access specifiers (default is package-private).
   - Default values depend on the data type (e.g., `null` for objects, `0` for int).
   - Example:

     ```
     public class MyClass {
        int instanceVar; // Instance variable
     }
     ```

3. **Static Variables**
   - Declared with the `static` keyword inside a class, but outside any method, constructor, or block.
   - Only one copy per class, shared among all instances.

- Created at the start of program execution and destroyed at the end.
- Default values depend on the data type (similar to instance variables).
- Example:

```
public class MyClass {
    static int staticVar; // Static variable
}
```

1. Arithmetic Operators

Arithmetic operators perform basic mathematical operations.

- **Multiplication (`*`)**: Multiplies two operands.

```
int result = a * b; // result is the product of a and b
```

- **Division (`/`)**: Divides the first operand by the second.

```
int result = a / b; // result is the quotient of a divided by b
```

- **Modulo (`%`)**: Finds the remainder when the first operand is divided by the second.

```
int result = a % b; // result is the remainder of a divided by b
```

- **Addition (`+`)**: Adds two operands.

```
int result = a + b; // result is the sum of a and b
```

- **Subtraction (`-`)**: Subtracts the second operand from the first.

```
int result = a - b; // result is the difference between a and b
```

2. Unary Operators

Unary operators operate on a single operand to perform various tasks.

- **Unary minus (`-`)**: Negates an expression.

```
int result = -a; // result is the negation of a
```

- **Unary plus (`+`)**: Indicates a positive value.

```
int result = +a; // result is the value of a
```

- **Increment (`++`)**: Increases the value of an operand by 1. It has two forms:
  - **Post-increment (`a++`)**: Returns the value before incrementing.

```
int result = a++; // result is the value of a before incrementing
```

- **Pre-increment (`++a`)**: Returns the value after incrementing.

```
int result = ++a; // result is the value of a after incrementing
```

- **Decrement (`--`)**: Decreases the value of an operand by 1. It has two forms:
  - **Post-decrement (`a--`)**: Returns the value before decrementing.

```
int result = a--; // result is the value of a before decrementing
```

  - **Pre-decrement (`--a`)**: Returns the value after decrementing.

```
int result = --a; // result is the value of a after decrementing
```

- **Logical NOT (`!`)**: Inverts the value of a boolean expression.

```
boolean result = !isTrue; // result is the logical negation of isTrue
```

3. Assignment Operators

Assignment operators assign values to variables. They also support compound operations.

- **Basic assignment (`=`)**: Assigns the right-hand operand to the left-hand variable.

```
int f = 7; // f is assigned the value 7
```

- **Addition assignment (`+=`)**: Adds the right-hand operand to the left-hand variable and assigns the result to the left-hand variable.

```
f += 3; // f is now 10
```

- **Subtraction assignment (`-=`)**: Subtracts the right-hand operand from the left-hand variable and assigns the result to the left-hand variable.

```
f -= 3; // f is now 4
```

- **Multiplication assignment (`*=`)**: Multiplies the left-hand variable by the right-hand operand and assigns the result to the left-hand variable.

```
f *= 3; // f is now 21
```

- **Division assignment (`/=`)**: Divides the left-hand variable by the right-hand operand and assigns the result to the left-hand variable.

```
f /= 3; // f is now 2
```

- **Modulo assignment (`%=`)**: Applies modulo operation on the left-hand variable with the right-hand operand and assigns the result to the left-hand variable.

```
f %= 3; // f is now 1
```

4. Relational Operators

Relational operators compare two values and return a boolean result.

- **Equal to (`==`)**: Checks if two operands are equal.

```
boolean result = (a == b); // result is true if a is equal to b
```

- **Not equal to (`!=`)**: Checks if two operands are not equal.

```
boolean result = (a != b); // result is true if a is not equal to b
```

- **Less than (`<`)**: Checks if the first operand is less than the second.

```
boolean result = (a < b); // result is true if a is less than b
```

- **Less than or equal to (`<=`)**: Checks if the first operand is less than or equal to the second.

```
boolean result = (a <= b); // result is true if a is less than or equal to b
```

- **Greater than (`>`)**: Checks if the first operand is greater than the second.

```
boolean result = (a > b); // result is true if a is greater than b
```

- **Greater than or equal to (`>=`)**: Checks if the first operand is greater than or equal to the second.

```
boolean result = (a >= b); // result is true if a is greater than or equal to
b
```

5. Logical Operators

Logical operators are used to combine multiple boolean expressions.

- **Logical AND (`&&`)**: Returns true if both operands are true.

```
boolean result = (x && y); // result is true if both x and y are true
```

- **Logical OR (`||`)**: Returns true if at least one operand is true.

```
boolean result = (x || y); // result is true if either x or y is true
```

- **Logical NOT (`!`)**: Inverts the value of a boolean expression.

```
boolean result = !x; // result is the logical negation of x
```

6. Ternary Operator

The ternary operator is a shorthand for the if-else statement.

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

```
int result = (a > b) ? a : b; // result is a if a is greater than b,
otherwise result is b
```

7. Bitwise Operators

Bitwise operators perform operations on individual bits of integer types.

- **Bitwise AND (`&`)**: Performs a bitwise AND operation.

```
int result = a & b; // result is a bitwise AND of a and b
```

- **Bitwise OR (`|`)**: Performs a bitwise OR operation.

```
int result = a | b; // result is a bitwise OR of a and b
```

- **Bitwise XOR (`^`)**: Performs a bitwise XOR operation.

```
int result = a ^ b; // result is a bitwise XOR of a and b
```

- **Bitwise Complement (`~`)**: Inverts all the bits of the operand.

```
int result = ~a; // result is the bitwise complement of a
```

- **Left shift (`<<`)**: Shifts bits to the left.

```
int result = a << 1; // result is a shifted left by 1 bit
```

- **Signed right shift (`>>`)**: Shifts bits to the right, preserving the sign bit.

```
int result = a >> 1; // result is a shifted right by 1 bit, with sign bit
preserved
```

- **Unsigned right shift (`>>>`)**: Shifts bits to the right, filling with zeroes.

```
int result = a >>> 1; // result is a shifted right by 1 bit, with zeroes
filled in
```

8. Shift Operators

Shift operators are used to shift bits left or right.

- **Left shift (<<)**: Shifts bits to the left.

  ```
  int result = a << 1; // result is a shifted left by 1 bit
  ```

- **Signed right shift (>>)**: Shifts bits to the right, preserving the sign bit.

  ```
  int result = a >> 1; // result is a shifted right by 1 bit, with sign bit
  preserved
  ```

- **Unsigned right shift (>>>)**: Shifts bits to the right, filling with zeroes.

  ```
  int result = a >>> 1; // result is a shifted right by 1 bit, with zeroes
  filled in
  ```