Introduction to Object Oriented Programming and Methodology

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What is Programming?

- Programming is somewhat like working with building blocks.
- The five basic elements in programming are:
  - **input**: getting data and commands into the computer
  - **output**: getting your results out of the computer
  - **arithmetic**: performing mathematical calculations on your data
  - **conditional**: testing to see if a condition is true or false
  - **looping**: cycling through a set of instructions until some condition is met
- Example: ATM Machine

Computer Programming

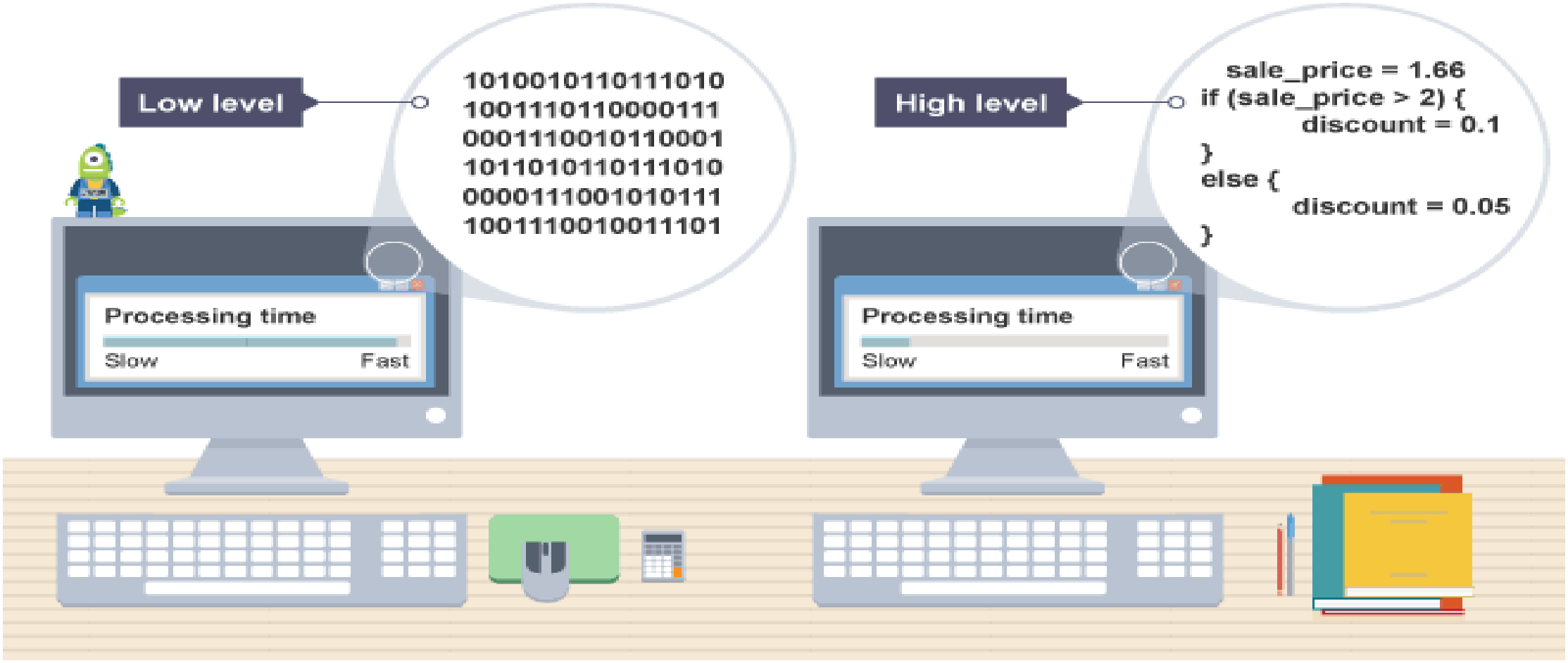
- Way of giving computers instructions about what they should do next.

  These ***instructions are known as code***, and computer programmers write code to solve problems or perform a task.

- End goal is to create something:

  Anything from a web page or a piece of software or even just a pretty picture.

- A computer program is a list of instructions that enable a computer to perform a specific task.
- Computer programs can be written in high and low level languages, depending on the task and the hardware being used.


Low level
1010010110111010
1001110110000111
0001110010110001
1011010110111010
0000111001010111
1001110010011101
Processing time
Slow
Fast
High level
sale_price = 1.66
if (sale_price > 2) {
discount = 0.1
}
else {
discount = 0.05
}
Processing time
Slow
Fast

Approaches of Programming

Programming can be approached in various ways, each catering to different requirements and goals. Here are some common approaches to programming:

- Imperative Programming:
  - Focuses on specifying a sequence of instructions that manipulate program state directly.
  - Emphasizes how to achieve the desired results step by step.
  - Commonly used in low-level languages like Assembly and C.
- Procedural Programming:
  - Organizes the program as a collection of procedures (functions/methods).
  - Emphasizes code reusability and modularity.
  - Commonly used in languages like C, Pascal, and Fortran.
- Object-Oriented Programming (OOP):
  - Organizes code into objects, each encapsulating data and behavior.
  - Emphasizes concepts like encapsulation, inheritance, and polymorphism.
  - Commonly used in languages like Java, C++, Python, and C#.

- Declarative Programming:
  - Focuses on describing what needs to be accomplished rather than how.
  - Common examples are SQL for querying databases and HTML/CSS for describing web layouts.
- Event-Driven Programming:
  - Relies on events and event handlers to control program flow.
  - Commonly used in graphical user interfaces and web development.
- Concurrent Programming:
  - Involves dealing with multiple tasks or processes simultaneously.
  - Often used for multi-threaded and parallel programming.

Structured Programming Approach

Definition and Importance:

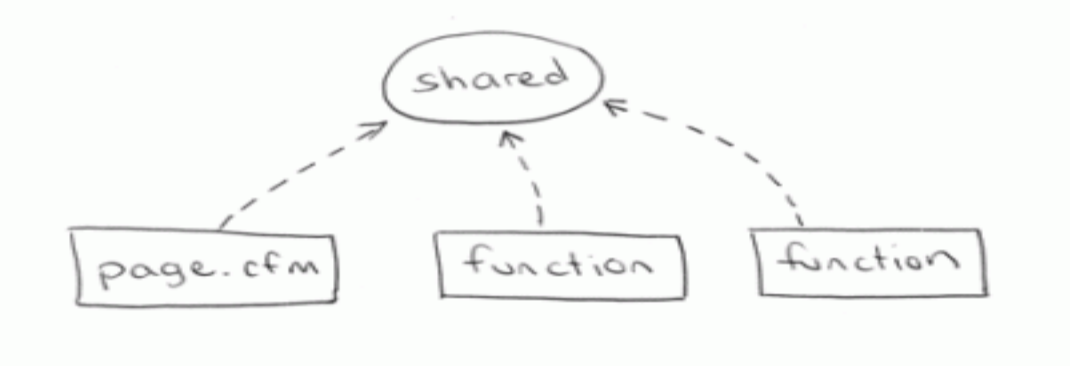
- Improves clarity, quality, and development time by using subroutines, block structures, loops, and control structures.
- Divides programs into small, manageable sections with single entry and exit points.

Key Principles:

- **Top-Down Design**:
  - Breaks down tasks into smaller sub-tasks.
  - Each sub-task is further divided until simple enough to implement independently.
- **Block Structures**:
  - Uses grouped sections of code, each serving a specific function.
- **Control Structures**:
  - **Sequence**: Executes statements linearly.
  - **Selection**: Uses conditional statements (if-else, switch-case).
  - **Iteration**: Uses loops (for, while, do-while) to repeat code blocks.

Procedural programming

- Programming paradigm, derived from structured programming, based on the concept of the *procedure call*.
- Procedures, also known as routines, subroutines, or functions, simply contain a series of computational steps to be carried out.
- Example: Fortran, ALGOL, COBOL, BASIC, Pascal and C, C++



Modular Programming Approach

Definition and Importance:

- Modular programming is a design technique that emphasizes dividing a program into separate, self-contained modules.
- Each module performs a specific part of the overall program functionality.
- Modules can be developed, tested, and debugged independently.
- Enhances code reusability, maintainability, and scalability.

Key Concepts:

- **Modules and Interfaces**:
  - Modules are independent units with well-defined interfaces.
  - Interfaces specify the methods and data structures that modules expose to other parts of the program.
- **Encapsulation**:
  - Encapsulates data and functions within modules to prevent unintended interference.
  - Promotes data hiding and abstraction.
- **Reusability**:
  - Modules can be reused across different programs.
  - Reduces redundancy and enhances productivity.

Object-Oriented Programming (OOP) Approach

Definition and Importance:

Object-Oriented Programming (OOP) is a programming paradigm based on the concept of "objects", which can contain data and code: data in the form of fields (often known as attributes or properties), and code in the form of procedures (often known as methods).

Key Concepts:

- **Classes and Objects:**
  - Class: A blueprint for creating objects (a particular data structure).
  - Object: An instance of a class.
- **Inheritance:**
  - Mechanism by which one class can inherit properties and methods from another class.
  - Promotes code reuse and hierarchical classifications.
- **Polymorphism:**
  - Ability to present the same interface for different underlying data types.
  - Methods can be overridden or overloaded to provide specific behaviors.

- **Encapsulation:**
  - Bundling of data and methods that operate on the data within one unit (class).
  - Restricts direct access to some of the object's components, which can prevent accidental interference and misuse of the data.
- **Abstraction:**
  - Hiding the complex implementation details and showing only the essential features of the object.
  - Simplifies the interaction with objects and reduces complexity.

Difference Between C,C++,Java

Feature	c	C++	Java
Paradigms	Procedural	Procedural , OOP	Purely Object oriented
Pointers	Yes,Very commonly used	Yes, very commonly used, but some form of references available too.	No Pointers; references are used instead
Pre-processor directives	Supported (#include, #define)	Supported (#include, #define)	Not Supported
Header files	Supported	Supported	Use Packages (import)

Storage Allocation	Uses malloc, calloc	Uses new, delete	uses garbage collector
Database Connectivity	Not Supported	Not Supported	Supported
Code Translation	Compiled	Compiled	Interpreted
Complex Data Types	Structures, Unions	Structures, Unions, Classes	Classes
String Type	Character ,Arrays	Character ,Arrays, Objects	Objects
Use of Exception handling	C does uses exception handling for exception generated while execution of program.	C++ makes use of exception handling for handling various types of exceptions generated while execution of program.	Java makes use of exception handling in a very effective way to handle exceptions generated while execution of program.

Operator overloading	There is no such concept of operator overloading in C	C++ uses concept of operator overloading	There is no such concept of operator overloading in Java
Multithreading and Interfaces	Not Supported	Not Supported	Supported
Inheritance	No Inheritance	Supported	Multiple Inheritance not Supported

What is java ?

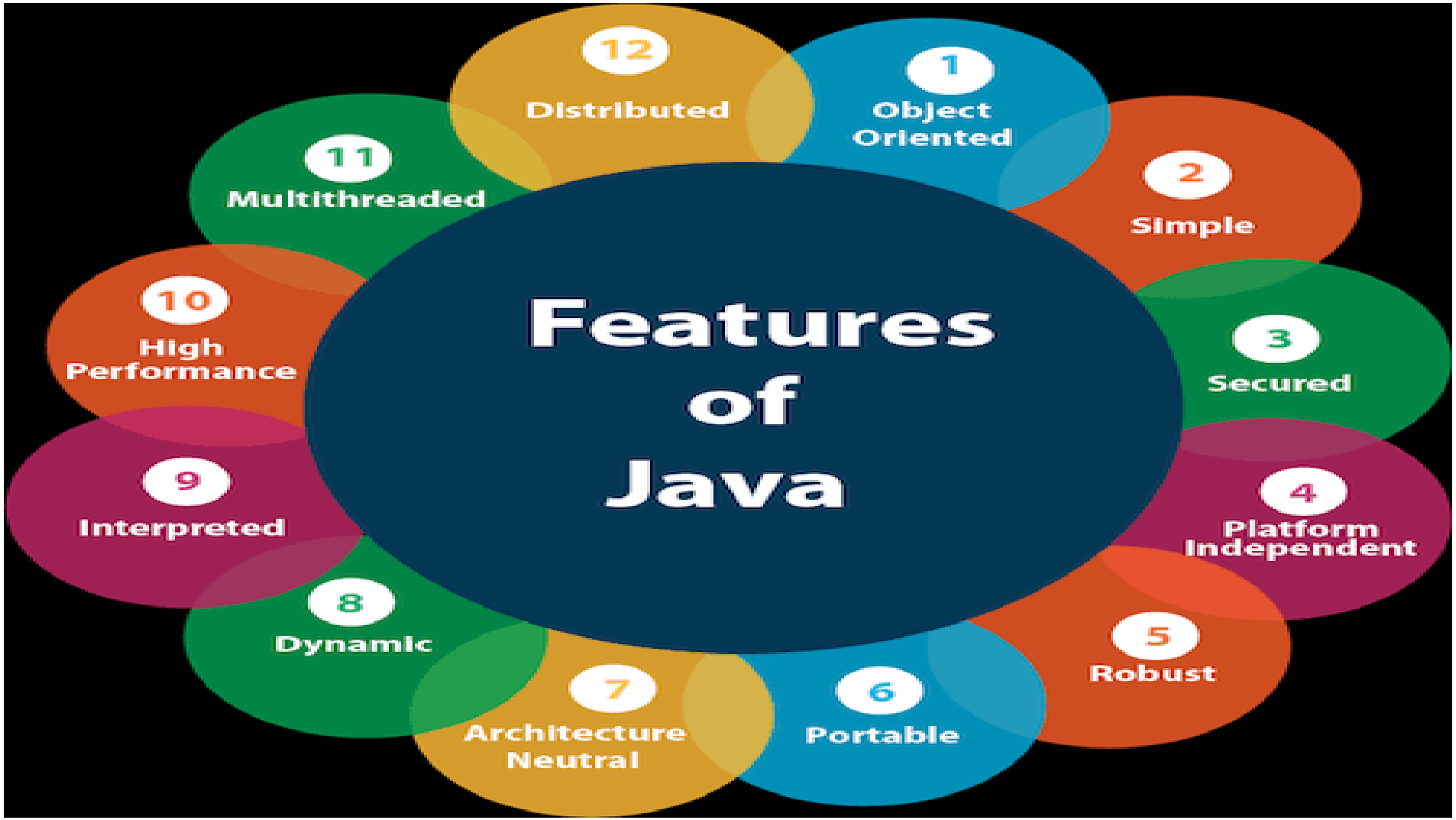
- Java is a **programming language** and a **platform**.
- Java is a high level, robust, object-oriented and secure programming language.
- **Platform**: Any hardware or software environment in which a program runs, is known as a platform.

Different Programming Paradigms

- Functional/procedural programming:
  - program is a list of instructions to the computer

- Object-oriented programming
  - program is composed of a collection *objects that communicate with each other*

Features of Java



A list of most important features of Java language is given below

- Simple
- Object-Oriented
- Portable
- Platform independent
- Secured
- Robust
- Architecture neutral
- Interpreted
- High Performance
- Multithreaded
- Distributed
- Dynamic

Simple

- Java is very easy to learn, and its syntax is simple, clean and easy to understand. According to Sun, Java language is a simple programming language because
- Java syntax is based on C++ (so easier for programmers to learn it after C++).

Object-oriented

- Java is an **object-oriented** programming language. Everything in Java is an object. Object-oriented means we organize our software as a combination of different types of objects that incorporates both data and behaviour.
- Object-oriented programming (OOPs) is a methodology that simplifies software development and maintenance by providing some rules.
- Basic concepts of OOPs are:
- Object
- Class
- Inheritance
- Polymorphism
- Abstraction
- Encapsulation

Objects and Classes in Java

- An object in Java is the physical as well as a logical entity, whereas, a class in Java is a logical entity only.
- An entity that has state and behaviour is known as an object e.g., chair, bike, marker, pen, table, car, etc. An object has three characteristics:
- **State: represents** the data (value) of an object.
- **Behaviour:** represents the behaviour (functionality) of an object such as deposit, withdraw, etc.
- **Identity:** An object identity is typically implemented via a unique ID. The value of the ID is not visible to the external user. However, it is used internally by the JVM to identify each object uniquely.

- **An object is an instance of a class.** A class is a template or blueprint from which objects are created. So, an object is the instance(result) of a class.
- **Object Definitions:**
- An object is *a real-world entity*.
- An object is *a runtime entity*.
- The object is *an entity which has state and behavior*.
- The object is *an instance of a class*.

Class

- A class is a group of objects which have common properties. It is a template or blueprint from which objects are created. It is a logical entity. It can't be physical.
- A class in Java can contain:
- **Fields**
- **Methods**
- **Constructors**
- **Blocks**
- **Nested class and interface**

Inheritance

- **Inheritance in Java** is a mechanism in which one object acquires all the properties and behaviours of a parent object. It is an important part of OOPs (Object Oriented programming system).
- The idea behind inheritance in Java is that you can create new classes that are built upon existing classes. When you inherit from an existing class, you can reuse methods and fields of the parent class. Moreover, you can add new methods and fields in your current class also.
- Inheritance represents the **IS-A relationship** which is also known as a *parent-child* relationship.

Polymorphism

- **Polymorphism in Java** is a concept by which we can perform a *single action in different ways*. Polymorphism is derived from 2 Greek words: poly and morphs. The word "poly" means many and "morphs" means forms. So polymorphism means many forms.
- There are two types of polymorphism in Java: compile-time polymorphism and runtime polymorphism.
- We can perform polymorphism in java by method overloading and method overriding.

Abstraction

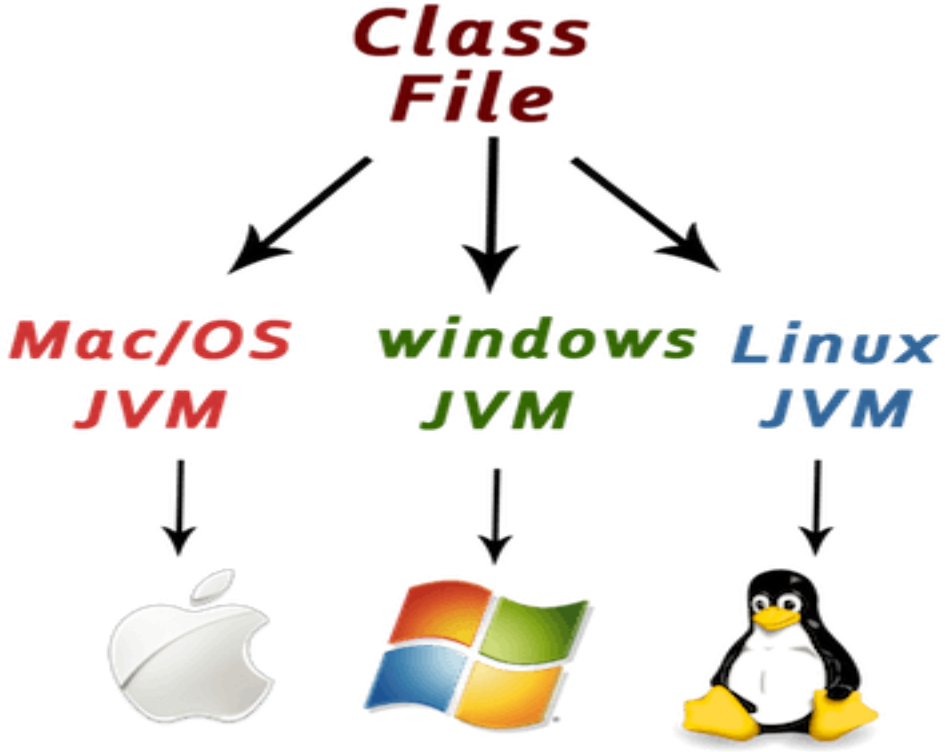
- **Abstraction** is a process of hiding the implementation details and showing only functionality to the user.
- Another way, it shows only essential things to the user and hides the internal details, for **Example**:sending SMS where you type the text and send the message. You don't know the internal processing about the message delivery.

Encapsulation

- **Encapsulation in Java** is a *process of wrapping code and data together into a single unit*.
- Example, a capsule which is mixed of several medicines.
- Key aspects of encapsulation include:
  - Data Hiding: Encapsulation shields the internal data of an object from direct access by external code. The object's data is accessible only through carefully controlled methods, which ensures that the data remains consistent and secure.
  - Information Hiding: It abstracts the implementation details of an object, allowing the object to be treated as a black box with a well-defined interface. This simplifies the usage of the object and promotes a clear separation between the object's internal workings and the code that interacts with it.

Platform Independent

- Java is platform independent because it is different from other languages like C, C++, etc. which are compiled into platform specific machines
- while Java is **a write once, run anywhere language**. A platform is the hardware or software environment in which a program runs.



Secured

- Java is best known for its security. With Java, we can develop virus-free systems. Java is secured because:
- **No explicit pointer**
- **Java Programs run inside a virtual machine**

Robust

- Robust simply means strong. Java is robust because:
- It uses strong memory management.
- There is a lack of pointers that avoids security problems.
- There are exception handling and the type checking mechanism in Java. All these points make Java robust.

Architecture-neutral

- Java is architecture neutral because there are no implementation dependent features, for example, the size of primitive types is fixed.

Portable

- Java is portable because it facilitates you to carry the Java bytecode to any platform. It doesn't require any implementation

High-performance

- Java is faster than other traditional interpreted programming languages because Java bytecode is "close" to native code. It is still a little bit slower than a compiled language (e.g., C++).
- Java is an interpreted language that is why it is slower than compiled languages, e.g., C, C++, etc.

Distributed

- Java is distributed because it facilitates users to create distributed applications in Java.

Multi-threaded

- A thread is like a separate program, executing concurrently. We can write Java programs that deal with many tasks at once by defining multiple threads.
- The main advantage of multi-threading is that it doesn't occupy memory for each thread. It shares a common memory area. Threads are important for multi-media, Web applications, etc.

Dynamic

- Java is a dynamic language. It supports dynamic loading of classes. It means classes are loaded on demand. It also supports functions from its native languages, i.e., C and C++.
- Java supports dynamic compilation and automatic memory management (garbage collection)

Getting Started with Java Programming

- A Simple Java Application
- Compiling Programs
- Executing Applications

A Simple Java Program

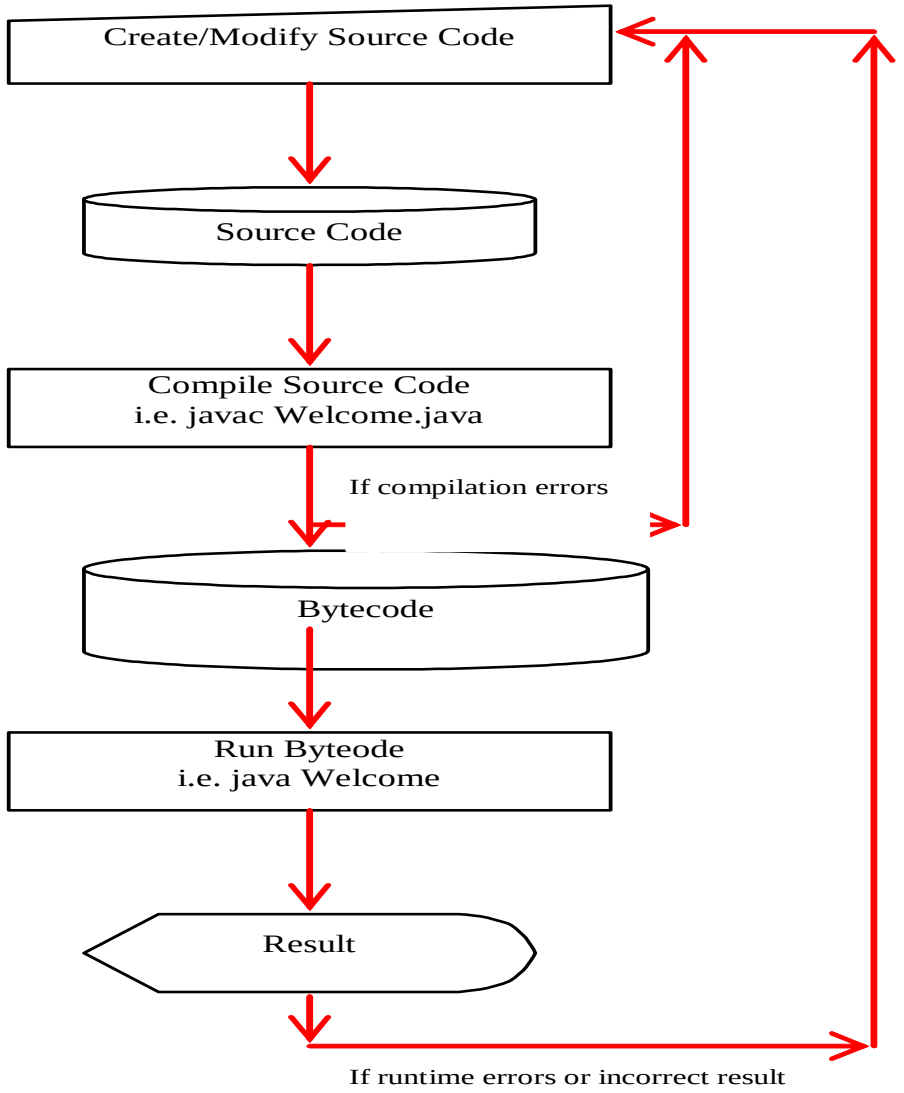
Example 1.1

```
//This application program prints Welcome to Java!

public class Welcome
 {
 public static void main(String[] args)
 {
    System.out.println("Welcome to Java!");
  }
}
```

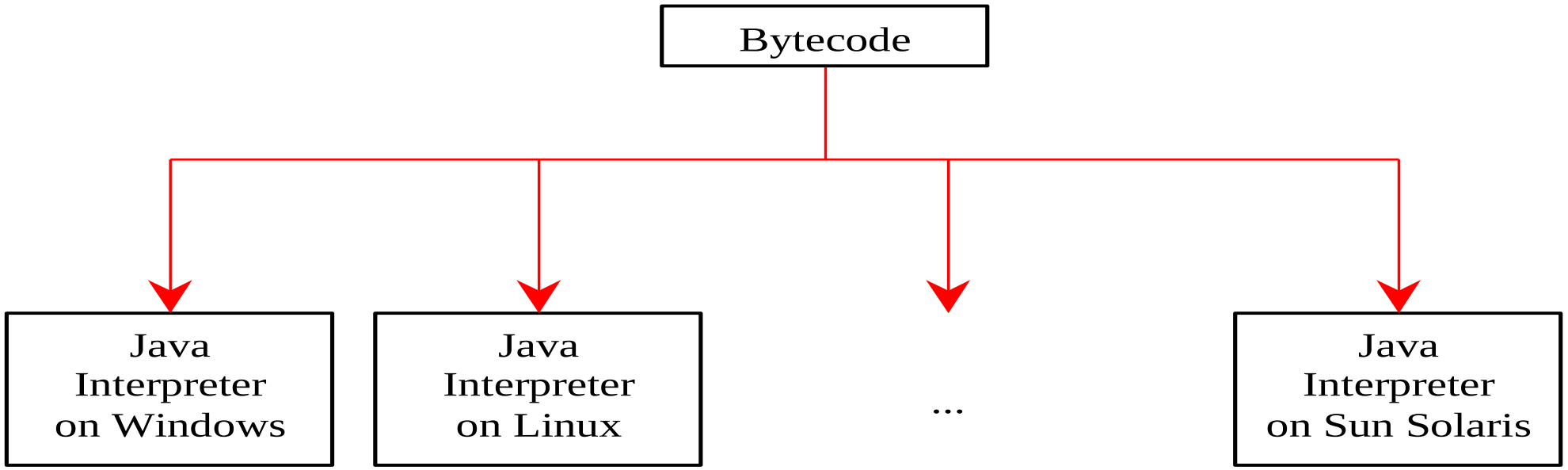
Creating and Compiling Programs

- On command line
  - `javac file.java`



Executing Applications

- On command line
  - `java classname`



```
javac Welcome.java

java Welcome

output:...
```