

Fundamentals of Java

Session: 1

Introduction to Java





- ◆ Explain the structured programming paradigm
- ◆ Explain the object-oriented programming paradigm
- ◆ Explain the features of Java as a OOP language
- ◆ Describe Java platform and its components
- ◆ List the different editions of Java
- ◆ Explain the evolution of Java Standard Edition (Java SE)
- ◆ Describe the steps for downloading and installing Java Development Kit (JDK)



- ◆ The most prominent use of computers is to solve problems quickly and accurately.
- ◆ The solution adopted to solve a problem is provided as a sequence of instructions or specifications of activity which enables a user to achieve the desired result.



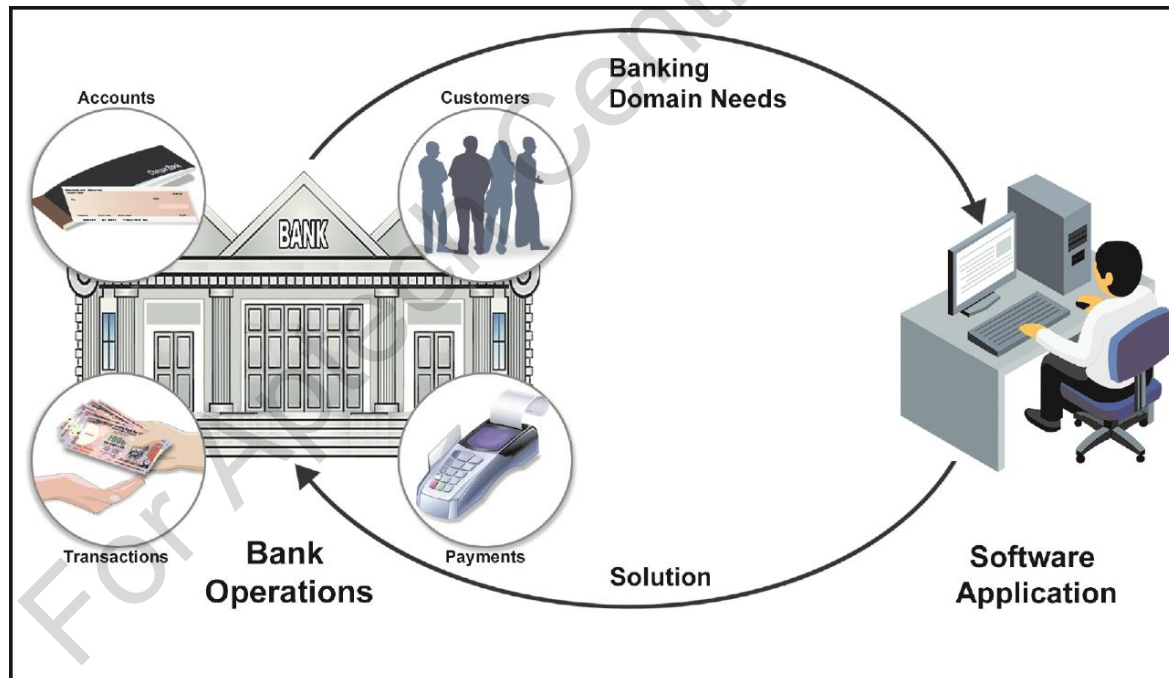
Software Applications

- The solution for solving a problem in the field of information technology is achieved by developing software applications.
- A software application can be defined as a collection of programs that are written in high-level programming languages to solve a particular problem.



◆ Knowledge of Domain:

- ◆ It plays an important role while developing software applications.
- ◆ It can be defined as the field of business or technology to which a problem belongs.
- ◆ Following figure shows the development of software application as a solution for managing various operations in a banking domain:





◆ Programming Languages:

- ◆ The development of software application is done using a programming language.
- ◆ A programming language is used as a medium for communicating the instruction to the computer.
- ◆ The programming language enforces a particular style of programming that is referred to as a programming paradigm.
- ◆ Following are the two types of programming paradigm:

Structured
Programming
Paradigm

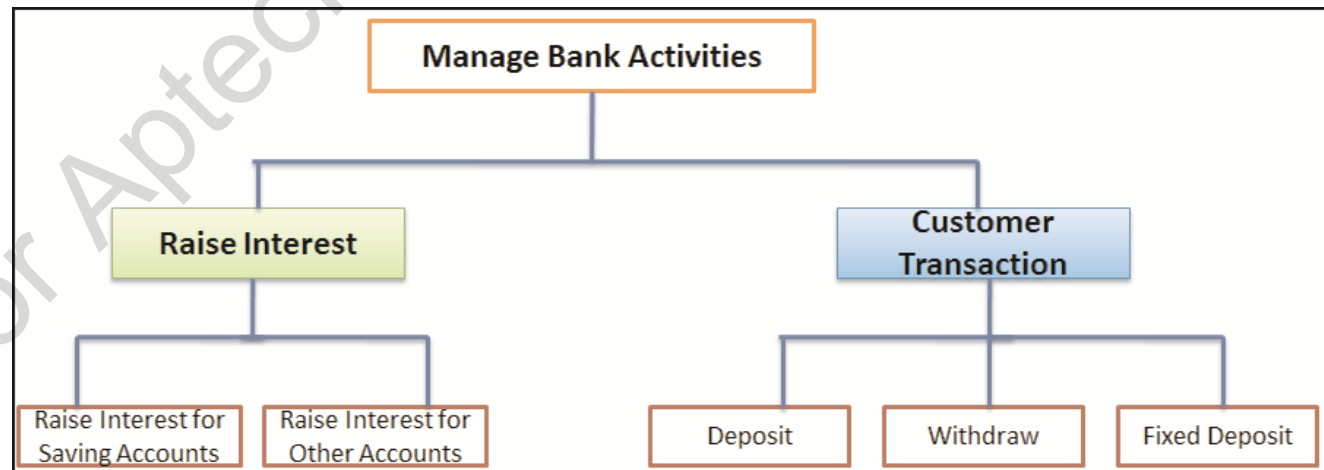
Object-oriented
Programming
Paradigm



Structured Programming

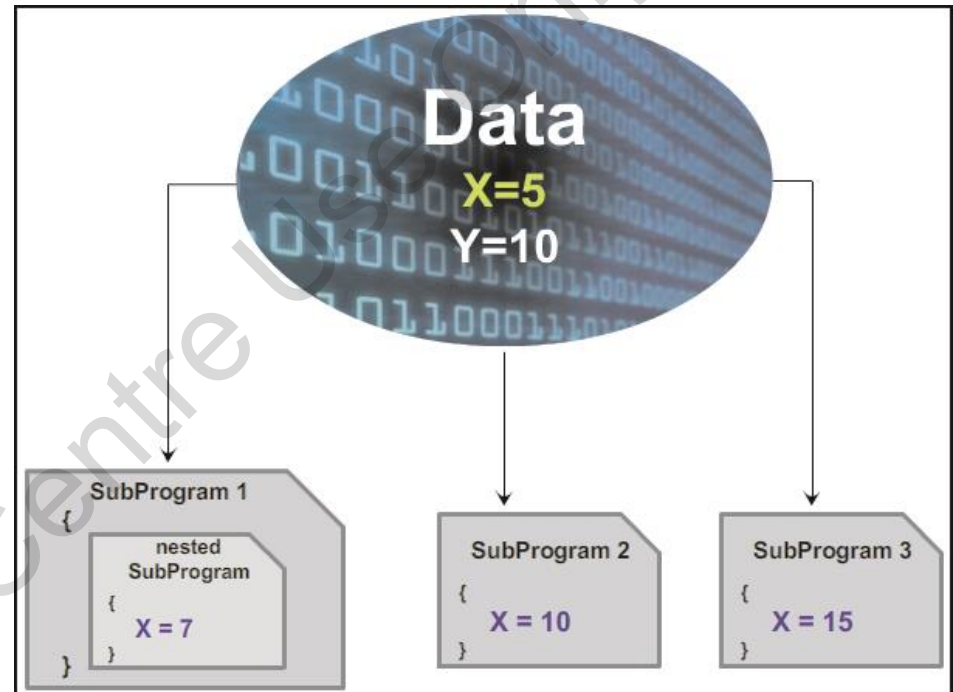
- In structured programming paradigm, the application development is decomposed into a hierarchy of subprograms.
- The subprograms are referred to as procedures, functions, or modules in different structured programming languages.
- Each subprogram is defined to perform a specific task.
- Some of structured programming languages are C, Pascal, and Cobol.

- ◆ Following figure displays bank application activities broken down into subprograms:





- ◆ Main disadvantage of structured programming languages are as follows:
 - ◆ Data is shared globally between the subprograms.
 - ◆ Efforts are spent on accomplishing the solution rather than focusing on problem domain.
- ◆ This often led to a software crisis, as the maintenance cost of complex applications became high and availability of reliable software was reduced.



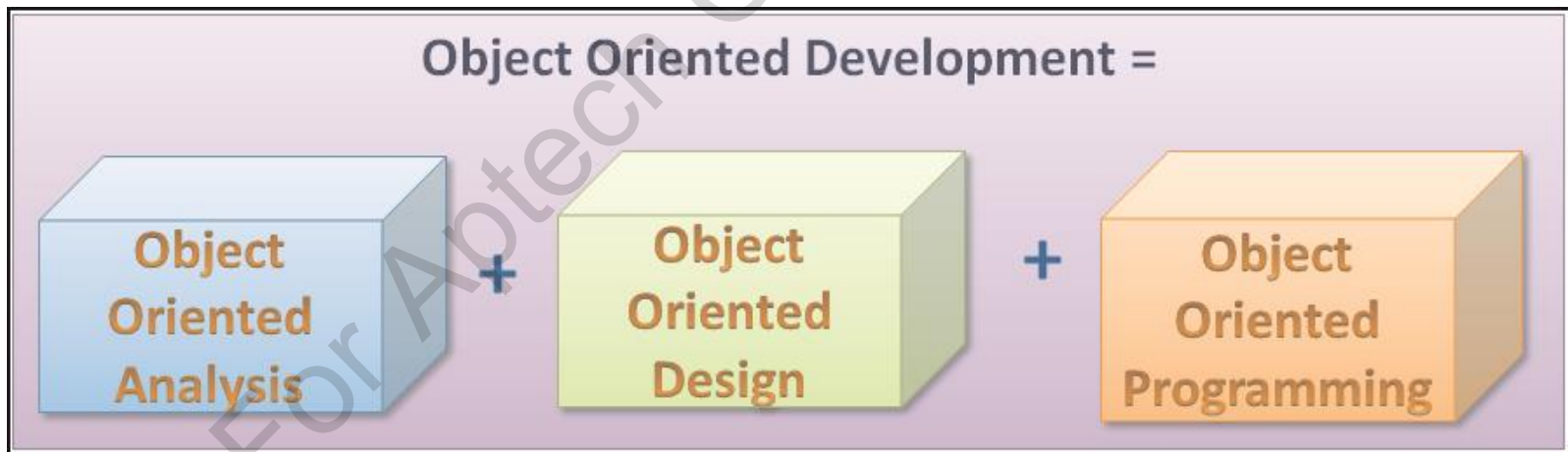


- ◆ Growing complexity of software required change in programming style.
- ◆ Some of the features that were aimed are as follows:
 - ◆ Development of reliable software at reduced cost.
 - ◆ Reduction in the maintenance cost.
 - ◆ Development of reusable software components.
 - ◆ Completion of software development with the specified time interval.
- ◆ These features resulted in the evolution of **object-oriented programming paradigm**.

Object-oriented Programming Paradigm 2-4



- ◆ The software applications developed using object-oriented programming paradigm is:
 - ◆ Designed around data, rather than focusing only on the functionalities.
- ◆ Following shows different activities involved in the object-oriented software development:





Object-oriented Analysis (OOA) phase determines the functionality of the system.

Object-oriented Design (OOD) phases determines the process of planning a system in which objects interact with each other to solve a software problem.

Object-oriented Programming (OOP) deals with the actual implementation of the application.

- ◆ Unified Modeling Language (UML) helps to create visual models in the system.
- ◆ The actual implementation of these visual models is done using an OOP language.

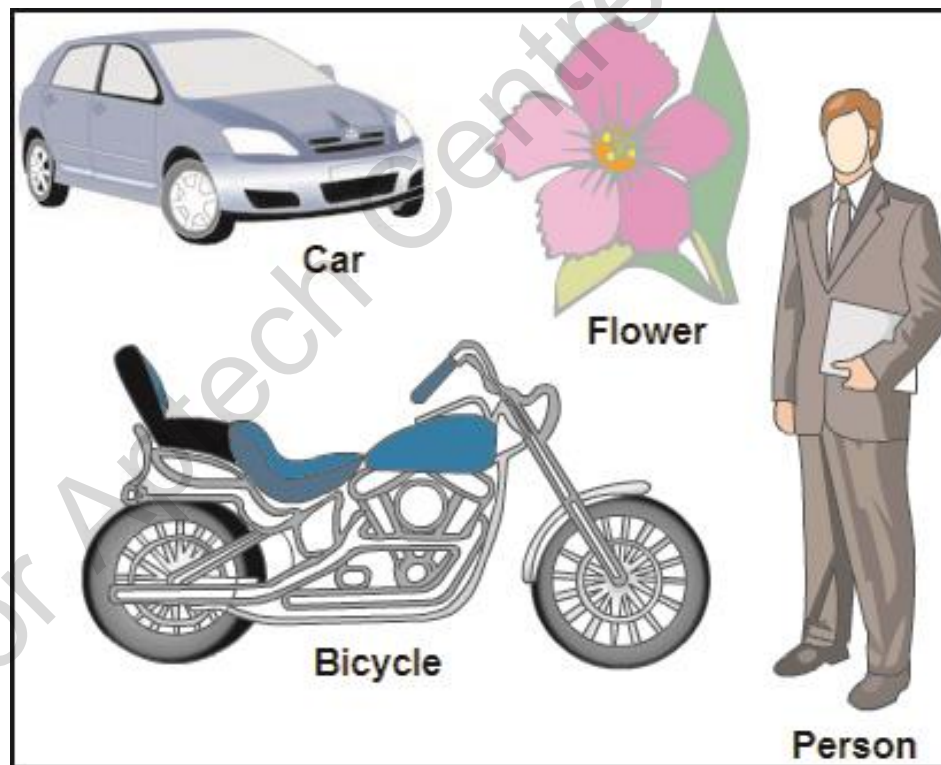


- ◆ An OOP language is based on certain principles that are as follows:
 - ◆ **Object** – Represents an entity which possesses certain features and behaviors.
 - ◆ **Class** – Is a template that is used to create objects of that class.
 - ◆ **Abstraction** – Is a design technique that focuses only on the essential features of an entity for a specific problem domain.
 - ◆ **Encapsulation** – Is a mechanism that combines data and implementation details into a single unit called class.
 - ◆ **Inheritance** – Enables the developer to extend and reuse the features of existing classes and create new classes. The new classes are referred to as derived classes.
 - ◆ **Polymorphism** – Is the ability of an object to respond to same message in different ways.

Concept of an Object 1-4



- ◆ An object represents a real-world entity.
- ◆ Any tangible or touchable entity in the real-world can be described as an object.
- ◆ Following figure shows some real-world entities:

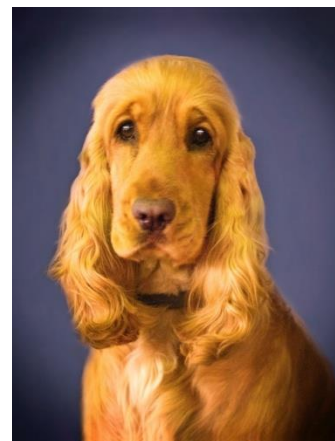




- ◆ Each object has:
 - ◆ **Characteristics** – Defined as attributes, properties, or features describing the object.
 - ◆ **Actions** – Defined as activities or operations performed by the object.

- ◆ Example of an object, **Dog**.

- ◆ **Properties** – Breed, Color, and Age
 - ◆ **Actions** – Barking, Eating, and Running

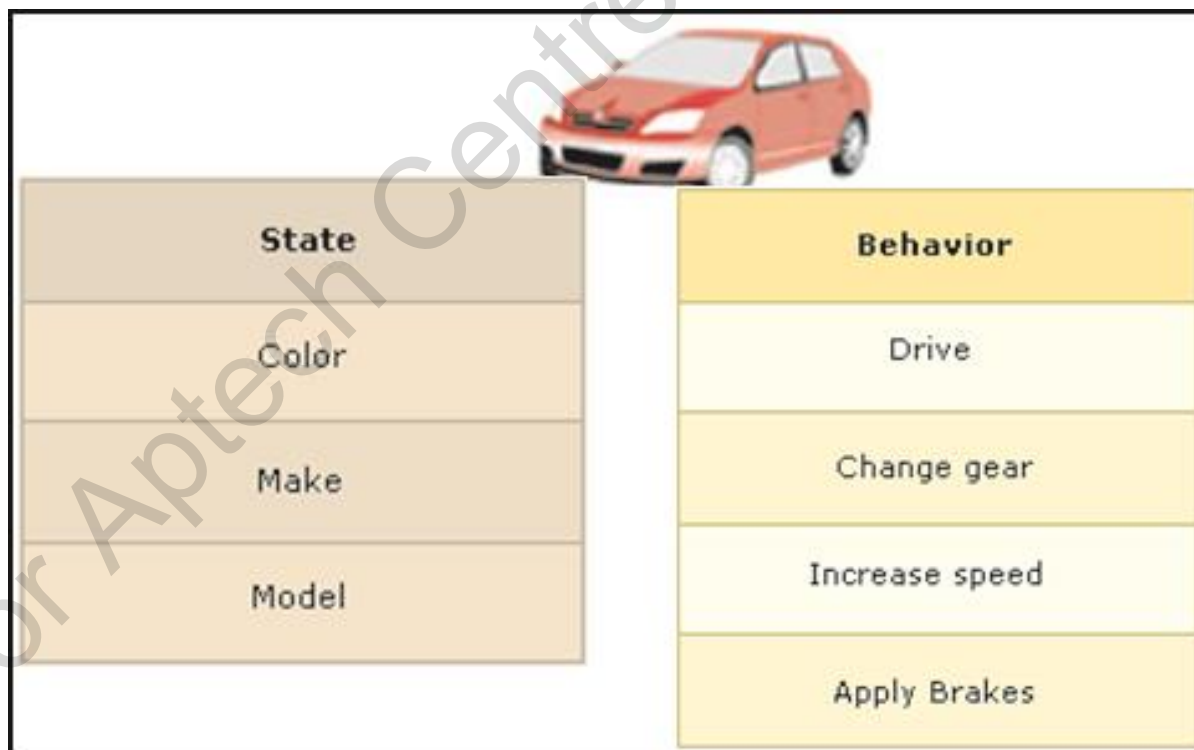


- ◆ The concept of objects in the real-world can be extended to the programming world where software 'objects' can be defined.

Concept of an Object 3-4



- ◆ A software object has state and behavior.
- ◆ **'State'** refers to object's characteristics or attributes.
- ◆ **'Behavior'** of the software object comprises its actions.
- ◆ Following figure shows a software object, a **Car** with its state and behavior:





- ◆ The advantages of using objects are as follows:

1

- They help to understand the real-world.

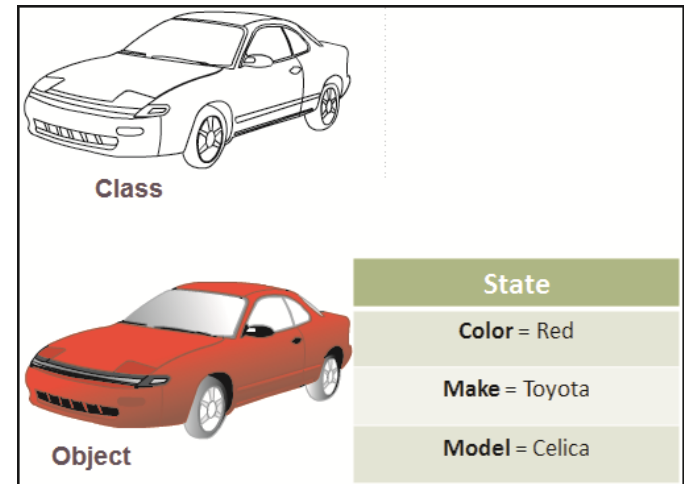
2

- They map attributes and actions of real-world entities with state and behavior of software objects.

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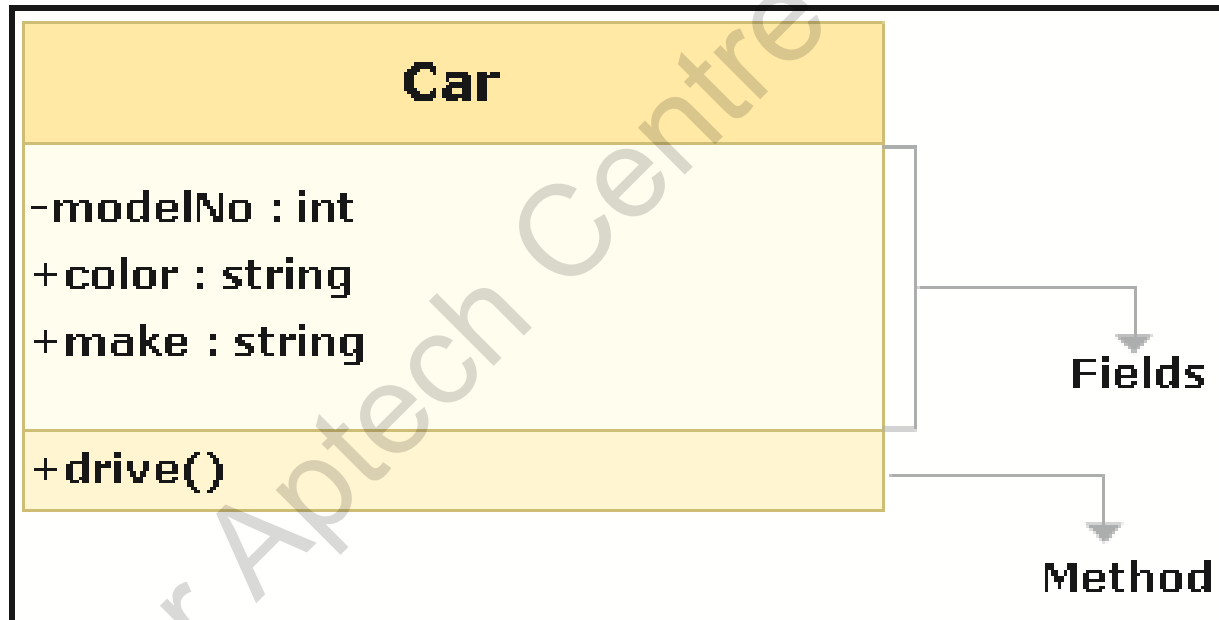


- ◆ In the real-world, several objects:
 - ◆ Have common state and behavior.
 - ◆ Can be grouped under a single class.
 - ◆ Example: All car objects have attributes, such as color, make, or model.
- ◆ **Class:**
 - ◆ Can be defined that a class is a template or blueprint which defines the state and behavior for all objects belonging to that class.
 - ◆ Following figure shows a car as a template and a Toyota car as an object or instance of the class:





- ◆ Class comprises fields and methods, collectively called as members.
 - ◆ **Fields** – Are variables that depict the state of objects.
 - ◆ **Methods** – Are functions that depict the behavior of objects.





- ◆ Following table shows the difference between a class and an object:

| Class | Object |
|---|----------------------------------|
| Class is a conceptual model | Object is a real thing |
| Class describes an entity | Object is the actual entity |
| Class consists of fields (data members) and functions | Object is an instance of a class |

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- ◆ It is one of the most popular OOP language.
- ◆ It helps programmers to develop wide range of applications that can run on various hardware and Operating System (OS).
- ◆ It is also a platform that creates an environment for executing Java application.
- ◆ It caters to small-scale to large-scale problems across the Internet.
- ◆ Java applications are built on variety of platforms that range from:
 - ◆ Embedded devices to desktop applications
 - ◆ Web applications to mobile phones
 - ◆ Large business applications to supercomputers





♦ Java Origins: Embedded Systems

A large blue arrow pointing downwards, containing the year 1991.

1991

- Team of engineers from Sun Microsystems wanted to design a language for consumer devices.
- Project was named as '**Green Project**'.
- Team included: James Gosling, Mike Sheridan, and Patrick Naughton.
- Efforts were taken to produce portable and a platform independent language that can run on any machine.
- Result was evolution of Java.
- Initially called '**OAK**' and later renamed to **Java** .



♦ Java Wonder: Internet

1995

- Internet and Web started emerging and was used worldwide.
- Sun Microsystems turned Java into an Internet programming language.
- It emerged as a Web technology that added dynamic capabilities to the Web pages.

♦ Java Moved: Middle-tier

1997

- Sun Microsystems defined Servlets API to generate dynamic HTML for Web pages and Enterprise JavaBeans for developing business logics.

2006

- Sun Microsystems released three versions for free under General Public License (GPL)
- These are: Java Platform, Standard Edition (Java SE), Java Platform, Enterprise Edition (Java EE), and Java Platform Micro Edition (Java ME)



◆ Java Ahead: Acquisition

2009

- Sun Microsystems was acquired by Oracle Corporation.
- The project **Coin** was launched to enhance Java programming language.
- Java EE 6 was released with simplified development and deployment model.

2010

- The specification for Java 7 was approved by the Java Community Process (JCP).



- ◆ Java is a high level OOP language as well a platform used for developing applications that can be executed on different platforms.
- ◆ It is characterized by following features:

Simple

- Inherits its syntax from predecessor programming languages, such as C/C++.
- Helps programmers to adapt to Java language without any extra skills and extensive trainings.
- Eliminates the use of pointers, operator overloading, and multiple inheritance features supported by predecessor languages.



Object-oriented

- Java is a pure OOP language that uses classes and objects that address to the real-world problem domains.
- Even, the application development in Java starts with a class designing.

Robust

- **C and C++ languages** - Dynamic memory allocation/deallocation is done manually through pointers that resulted in memory related errors.
- Java incorporates:
 - **Strong memory management** - Handles memory allocation and deallocation using Garbage Collection Mechanism that destroys unused objects in memory automatically.
 - **Exception handling mechanism** - Stops abnormal termination of code at runtime.
 - **Compile-time checking** – Ensures variables are declared which contain specific type of data.
 - **Run-time checking** – Ensures purity of Java code during execution.



Secure

- Security checks applied at different layers ensures that the Java programs are protected against malicious codes.
- Java programs that are accessed on the network are known as applets.
- Java applies security to applets by placing them in a sandbox that ensures it should not have direct access to files or resources available on the local system.
- Java Virtual Machine (JVM) which is a runtime environment for executing Java programs applies its own security features to Java language.
- JVM ensures that the code loaded for execution is well-formed and conforms to Java standards.



Architecture Neutral and Portable

- Supports portability by converting application into architecture neutral bytecode during compilation.
- Java has defined language specifications, such as size of primitive data types and operators that are independent of the hardware platform.
- For example, an integer variable in Java always occupies 32 bits on whichever machine the code is executed.
- These features satisfies the major goal of Java language which is 'Write once, run anywhere'.

Multithreaded

- Allows a single program to perform multiple tasks simultaneously with different threads.



Distributed

- Supports distributed programming in which resources can be accessed across the network.

Dynamic

- At runtime an application can dynamically decide which classes it requires and loads them accordingly.
- This gives new perspective to Java for designing and developing applications.

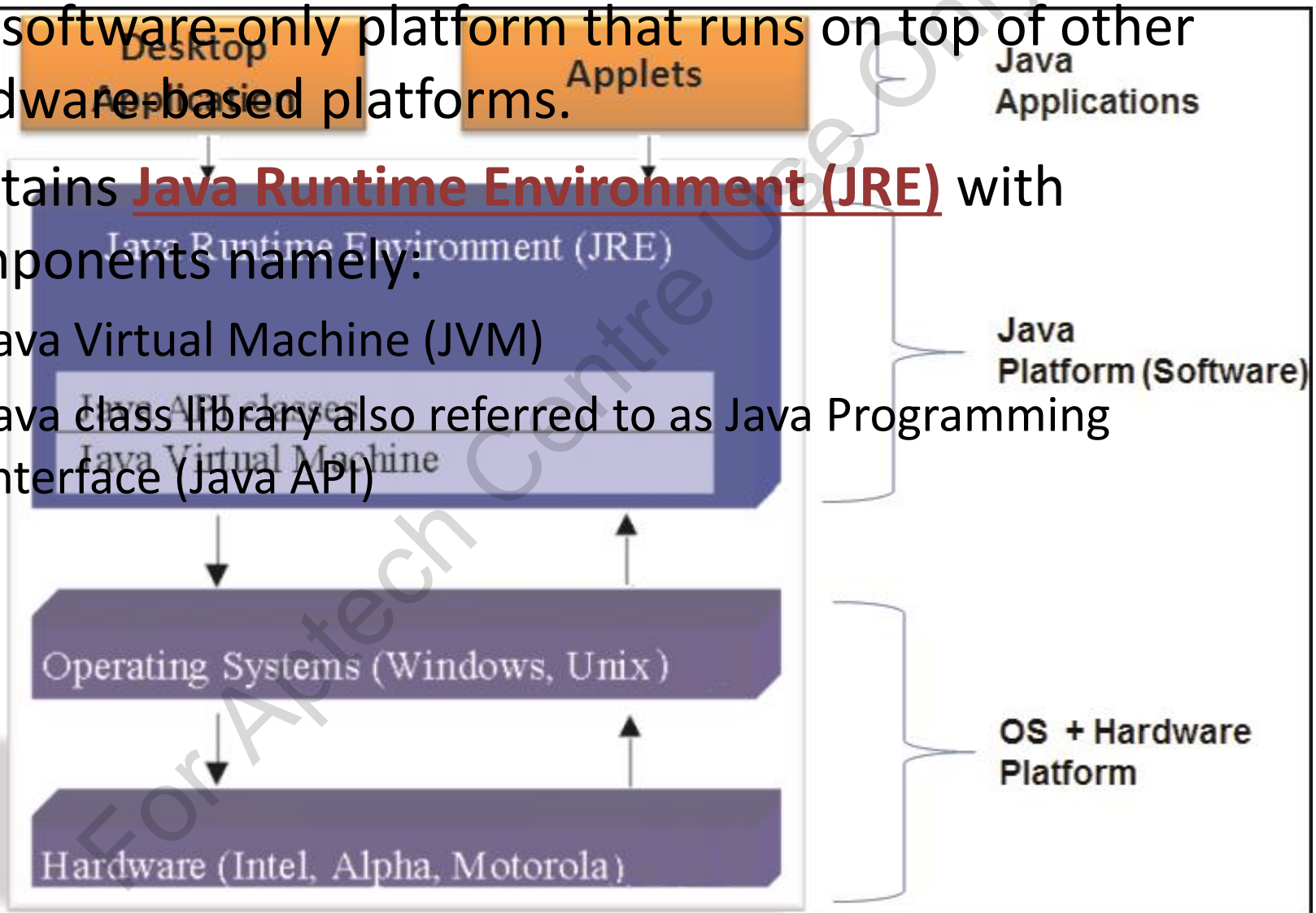
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- ◆ Is a software-only platform that runs on top of other hardware based platforms.

- ◆ Contains **Java Runtime Environment (JRE)** with components namely:

- ◆ Java Virtual Machine (JVM)
- ◆ Java class library also referred to as Java Programming Interface (Java API)





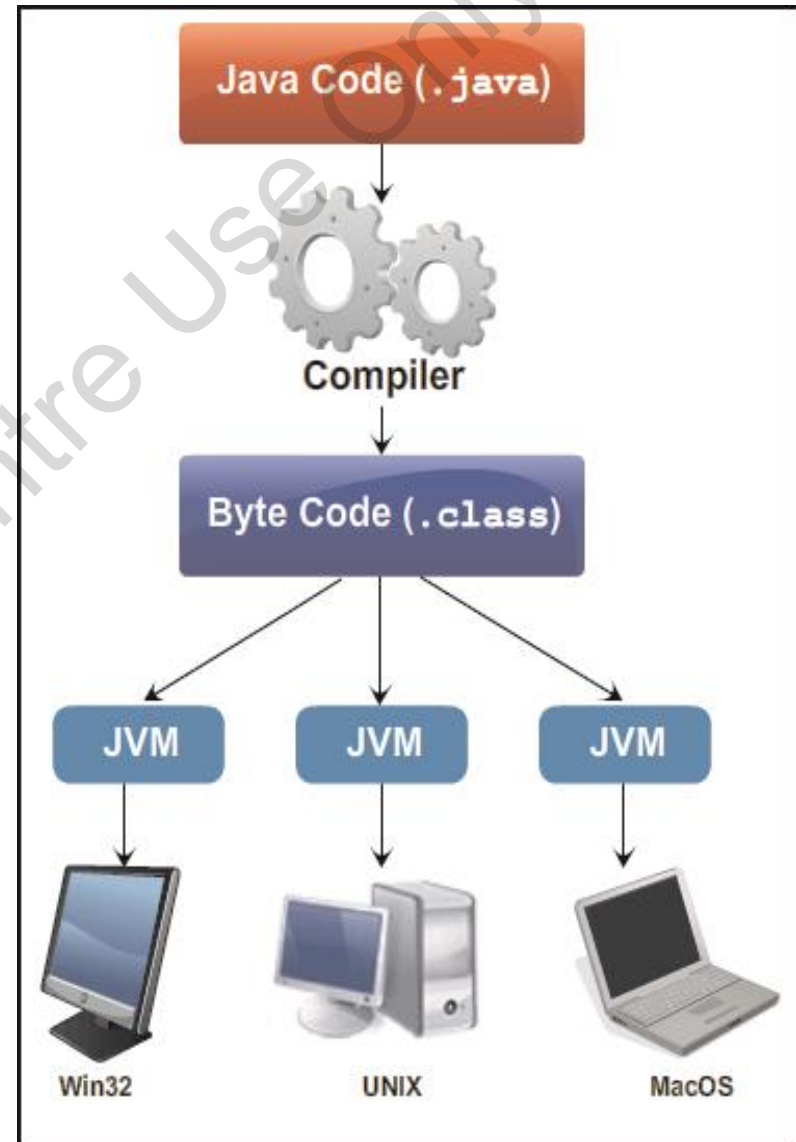
- ◆ It is an executable engine that creates an environment for executing Java compiled code, that is, bytecode.
- ◆ It is known as a virtual machine because it is an imitation of a Java processor on the physical machine.
- ◆ There are different implementations of JVM available for different platforms, such as Windows, Unix, and Solaris.

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◆ Bytecode:

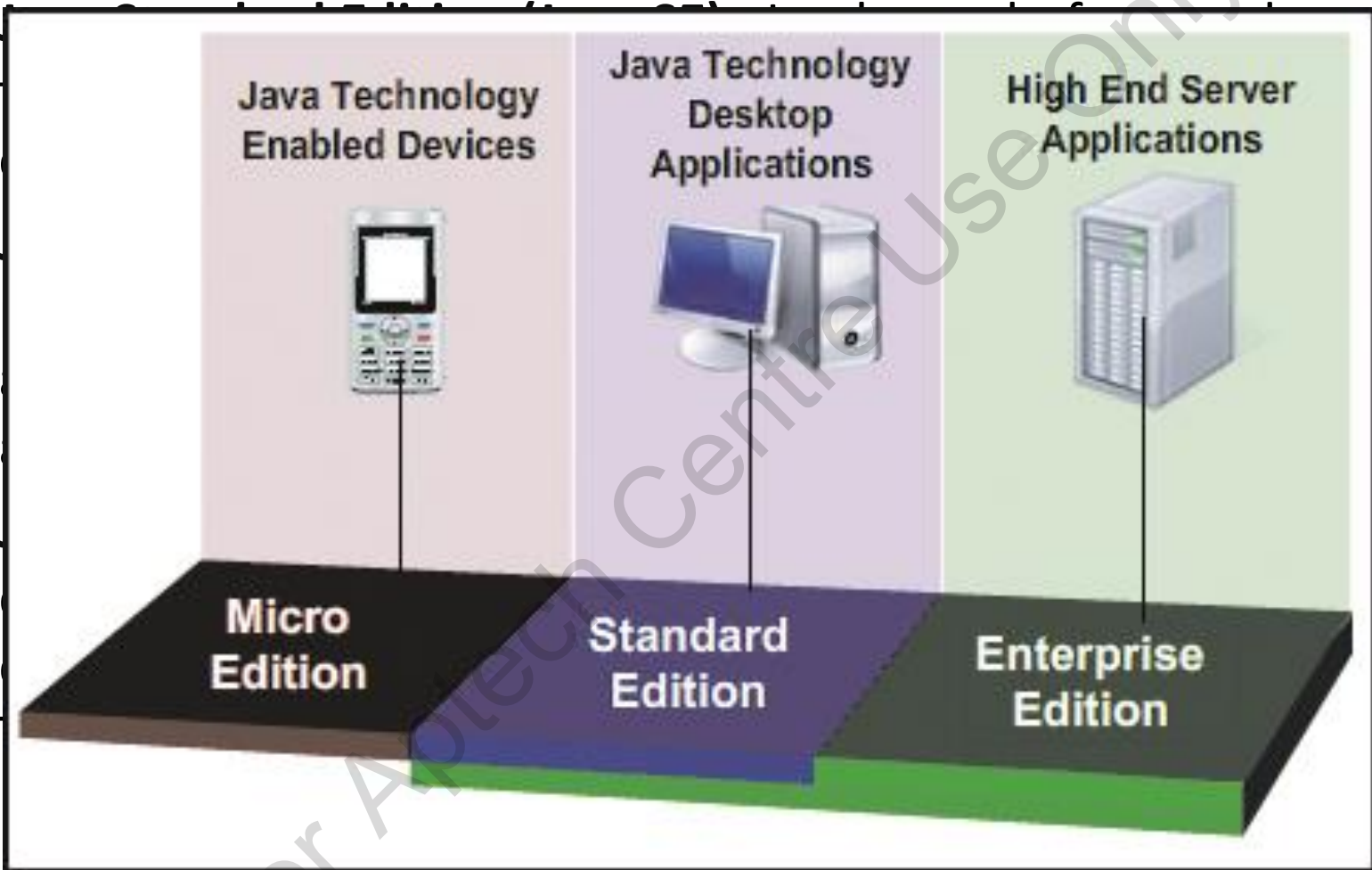
- ◆ Is an intermediate form closer to machine representation.
 - ◆ Is an optimized set of instructions executed by the Java runtime environment.
 - ◆ This environment is known as JVM.
- ◆ The same bytecode can be executed by different implementations of JVM on various platforms.





- ◆ It is a large collection of ready-made software components.
- ◆ These components are classes and interface grouped into libraries referred to as packages in Java.
- ◆ Example:
 - ◆ The **Swing** library provides classes for User Interface (UI) components.
 - ◆ The **Input/Output (I/O)** library provides the standard interface for reading and writing data into files stored in the system.

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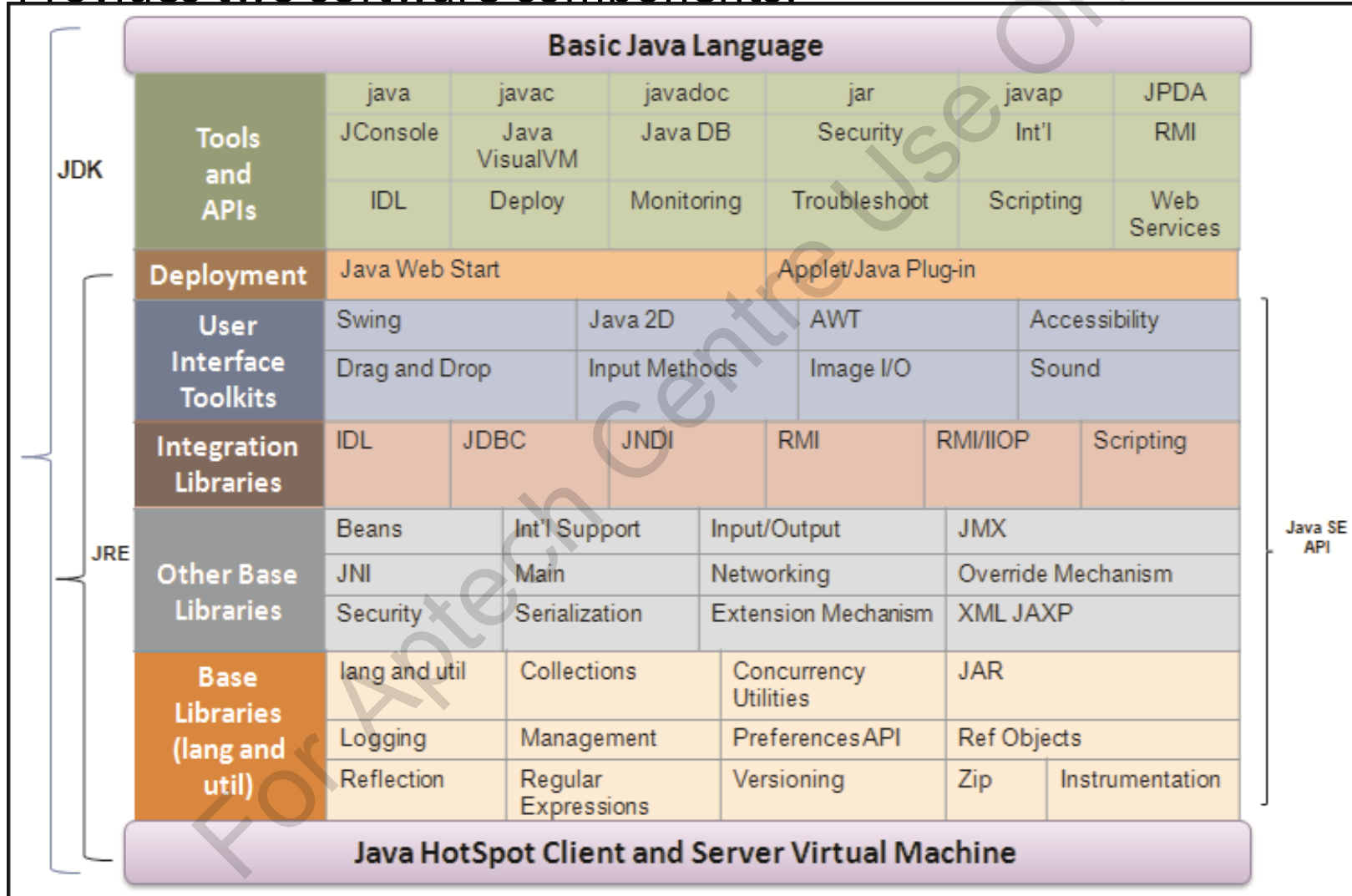
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Components of Java SE Platform 1-2



- Provides two software components:





- ◆ **Development Tools** – Include tools used for compiling, running, debugging, and documenting a Java application.

| | | | | | |
|------|-------|---------|-----|-------|------|
| java | javac | javadoc | jar | javap | JPDA |
|------|-------|---------|-----|-------|------|

- ◆ **API** - Provides the core functionality of the Java programming language.
- ◆ **Deployment Tools** – Provides software for deploying the developed applications to end-users.
- ◆ **User Interface Toolkits** - Enables the developer to create graphical interfaces in a Java application.
- ◆ **Integration libraries** - Enable developers to access and manipulate database and remote objects in an application.



| Releases | Implementation |
|------------------|---|
| JDK 1.0 | Creation of packages with classes in the standard library |
| JDK 1.1 | Included an event delegation model for Graphical User Interface (GUI) package AWT, JavaBeans, and Java Database Connectivity (JDBC) API |
| JDK 1.2 (Java 2) | Included a new graphical API, named Swing. Also, added APIs for reflection and collection framework (based on data structure) |
| JDK 1.3 | Included a directory interface to lookup for components, named, Java Naming and Directory Interface (JNDI) |
| JDK 1.4 | Included regular expression API, assertions, exception chaining, channel-based I/O API, an XML API for parsing and processing |
| JDK 1.5 | Included new features in the language such as for-each loop, generics, annotations, and auto-boxing |
| JDK 1.6 | Included script language, visual basic language support, and improvements in the GUI |



- ◆ Java SE 7 is the new major release of Java with internal version number as 1.7.
- ◆ The lists of new features that are incorporated in the language are as follows:
 - ◆ Supports the use of `String` class in the `switch` decision-making construct.
 - ◆ Integer types can be assigned with a binary number value.
 - ◆ Supports the use of underscore character (`_`) between the digits of a numeric value.
 - ◆ An expandable `try` statement called `try-with-resources` statement used for automatic resource management.
 - ◆ Constructor of a generic class declaration can be replaced with an empty set of parameters (`<>`).
 - ◆ Enhancement in exception handling mechanism. In exception handling code, a single catch can be used to handle one or more exceptions.
 - ◆ Compiler warnings generated for `varargs` methods has been improved.

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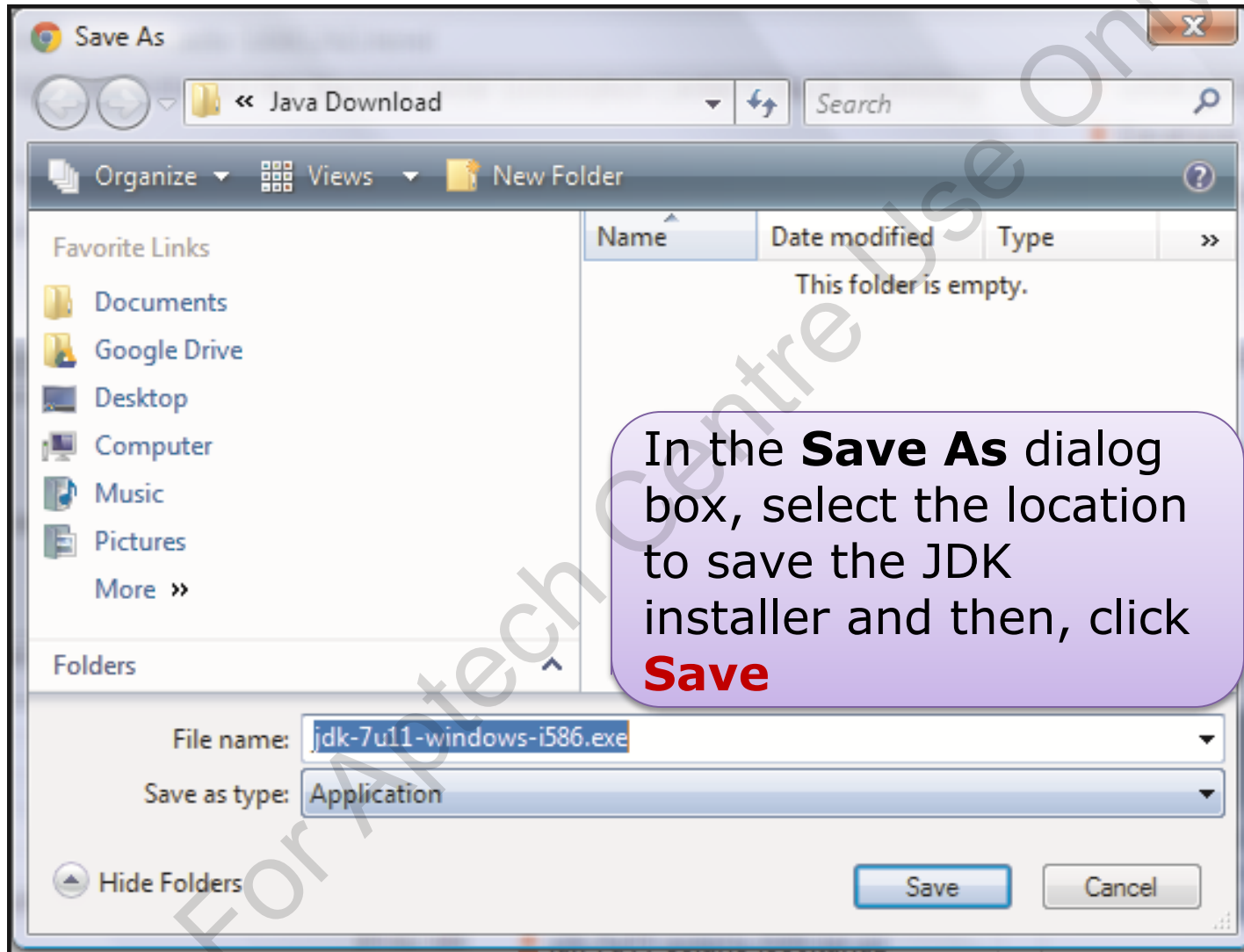
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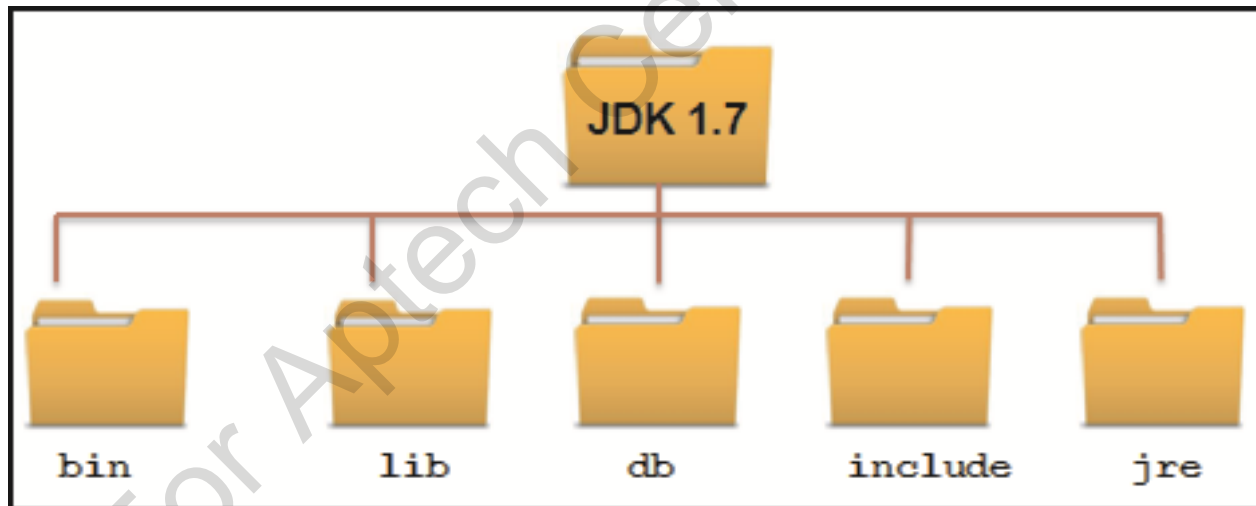
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Downloading and Installing JDK 5-6



- ◆ Double-click the installer icon and follow the instructions provided by the JDK installer.
- ◆ The installer installs development tools, source code, and the JRE in the default directory, `C:\Program Files\Java`.
- ◆ Following figure shows the directory structure of the installed JDK on the system:





- ◆ Following table lists the common directories that are part of the typical JDK installation:

| Directory | Description |
|-----------|--|
| bin | Contains tools that are used for developing a Java application, such as compiler and JVM |
| db | Contains a relational database named Apache Derby |
| include | Contains header files that are used to interact with C applications |
| jre | Represents the JRE used by the JDK |



- ◆ To work with JDK and Java programs, certain settings need to be made to the environment variables .
- ◆ Environment variables are pointers pointing to programs or other resources. The variables to be configured are as follows:
 - ◆ **PATH** - Set to point to the location of Java executables (javac.exe and java.exe).
 - ◆ **CLASSPATH** - Specifies the location of the class files and libraries needed by the Java compiler to compile applications.

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- ◆ To set the value for the `PATH` variable, perform the following steps in Windows 7:
 - ◆ Right-click **My Computer** icon on the desktop and then, click **Properties** from the context menu.
 - ◆ Click **Advanced system** settings link on the left tab.
 - ◆ Under **Advanced** tab, click **Environment Variables**.
 - ◆ In the System variables area, select the **PATH** variable and then, click **Edit** button to enter the JDK installation folder path.
 - ◆ Type path of the bin folder in the **Variable Value** text box.
 - ◆ For example, the path can be:
`C:\WINDOWS\system32;C:\WINDOWS;C:\Program Files\Java\jdk1.7.0\bin`



- ◆ To set **CLASSPATH** variable in Windows 7, perform the following steps:
 - ◆ Right-click **My Computer** icon on the desktop and click **Properties** from the context menu.
 - ◆ Click **Advanced system** settings link on the left tab.
 - ◆ Under **Advanced** tab, click **Environment Variables**.
 - ◆ In the System variables area, click **New** button.
 - ◆ Type **CLASSPATH** in **Variable Name** and then, type `C:\<jdk _ installation _ folder>` in the **Variable Value**.



- ◆ The development of application software is performed using a programming language that enforces a particular style of programming, also referred to as programming paradigm.
- ◆ In structured programming paradigm, the application development is decomposed into a hierarchy of subprograms.
- ◆ In object-oriented programming paradigm, applications are designed around data, rather than focusing only on the functionalities.
- ◆ The main building blocks of an OOP language are classes and objects. An object represents a real-world entity and a class is a conceptual model.



- ◆ Java is an OOP language as well a platform used for developing applications that can be executed on different platforms. Java platform is a software-only platform that runs on top of the other hardware-based platforms.
- ◆ The editions of Java platform are Java SE, Java EE, and Java ME.
- ◆ The components of Java SE platform are JDK and JRE. JRE provides JVM and Java libraries that are used to run a Java program. JDK includes the necessary development tools, runtime environment, and APIs for creating Java programs.

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