OBJECT ORIENTED PROGRAMMING WITH JAVA

Concept of Java Programming

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Additional resources

- **Books**

  The Complete Reference Java 2 (10th Edition)
  Hebert Schildt, Tata Mc Graw Hill

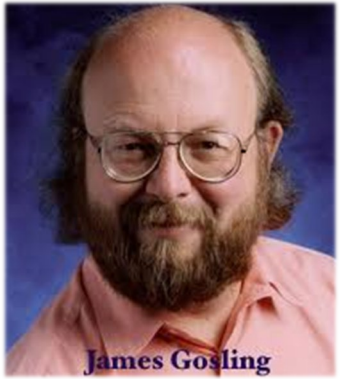
  Object-Oriented Programming with C++ and Java
  Debasis Samanta, Prentice Hall of India

- **Website**

  https://cse.iitkgp.ac.in/~dsamanta/java/index.htm

Concept of Java Programming

History of Java



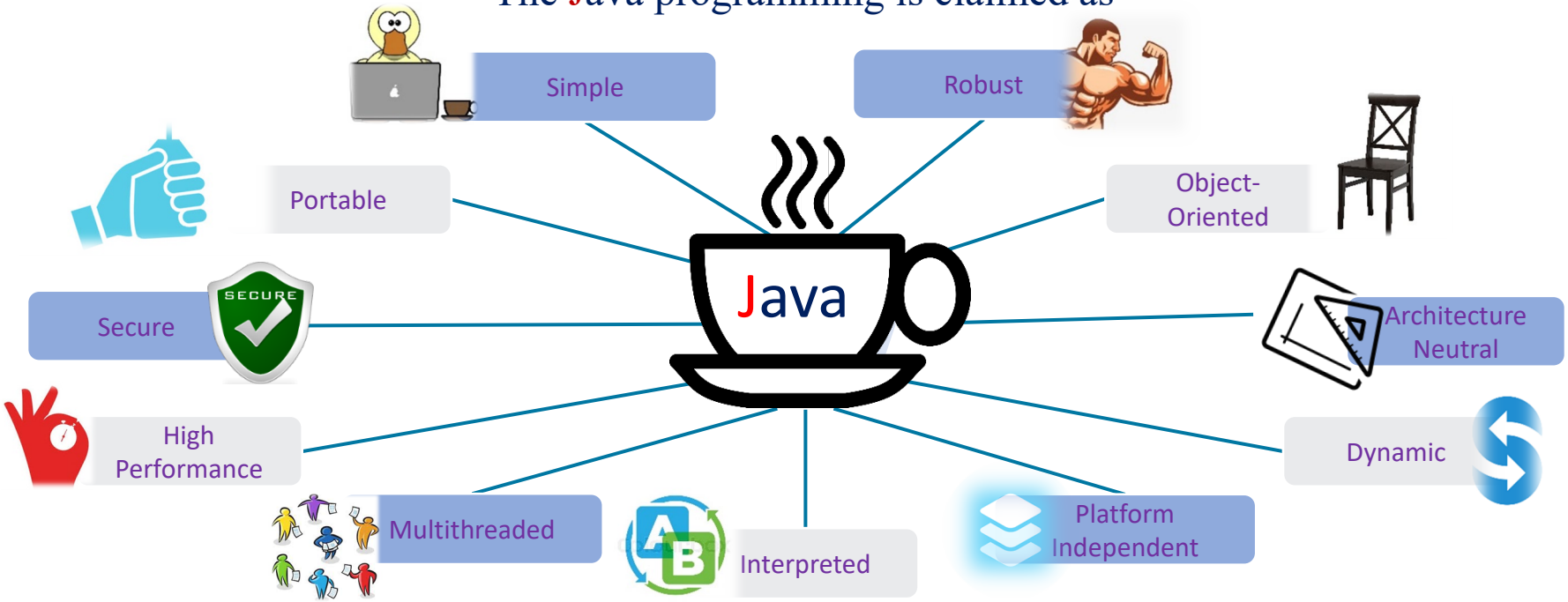
- **James Gosling**, **Mike Sheridan**, and **Patrick Naughton** initiated the Java language project in June 1991. The small team of Sun engineers called **Green Team**.
- Firstly, it was called **"Greentalk"** by James Gosling, and file extension was .**gt**.
- Java was originally designed for small, embedded systems in electronic appliances like set-top boxes, but it was too advanced technology for the digital cable television industry at the time.
- After that, it was called **Oak** and was developed as a part of the Green project. Java team members initiated this project to develop a language for digital devices.
- Later, Java technology was incorporated by Netscape as it was suited for networking.

Why Java is named Java?

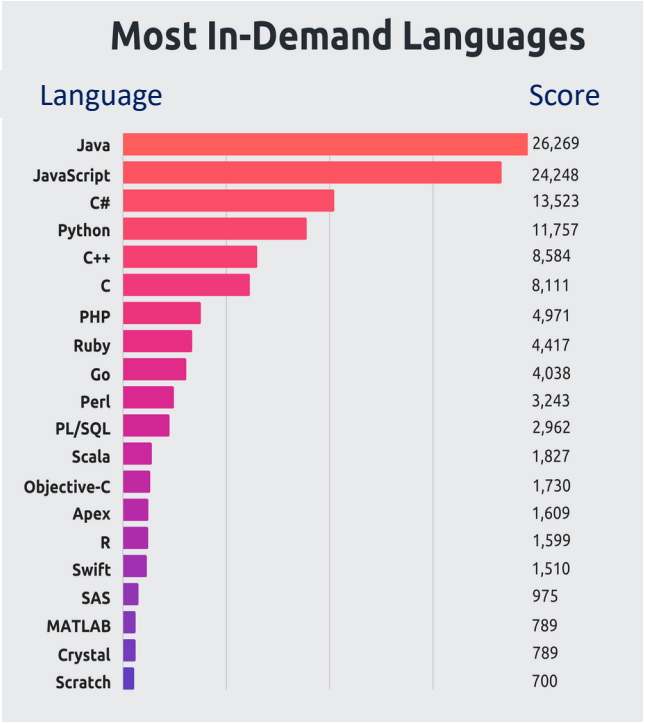
- Java was called Oak as it is a symbol of strength and chosen as a national tree of many countries like U.S.A., France, Germany, Romania, etc.
- The team wanted something that reflected the essence of the technology: revolutionary, dynamic, lively, cool, unique, and easy to spell and fun to say.
- In 1995, Oak was renamed as **Java**
  - Java is an island of Indonesia where first coffee was produced (called java coffee).
- In 1995, Time magazine called **Java one of the Ten Best Products of 1995**.
- JDK (Java Development Kit) 1.0 released in January 23, 1996.

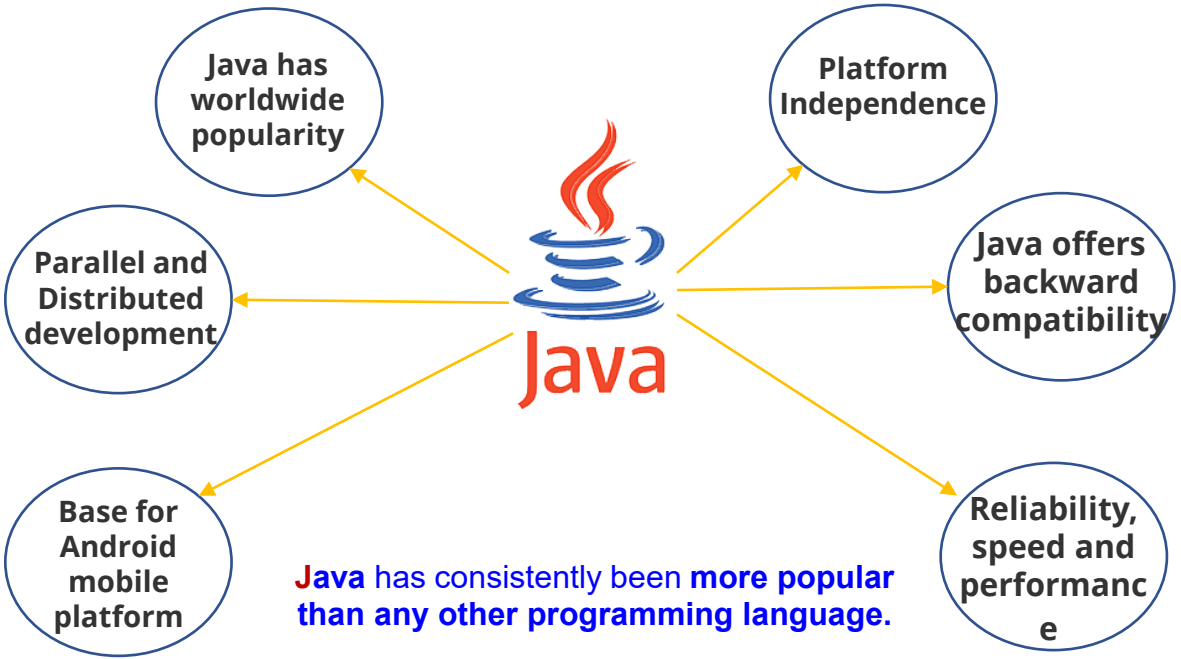
Java !

The Java programming is claimed as



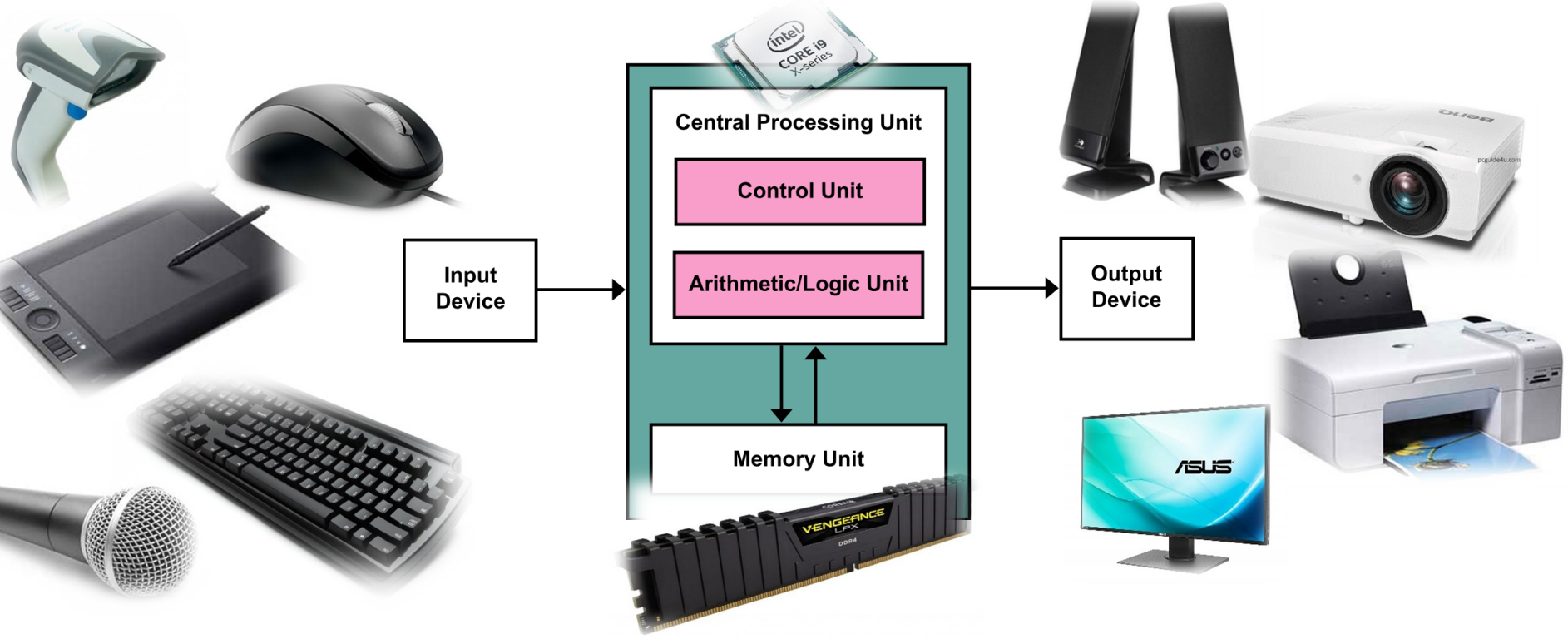
Current popularity



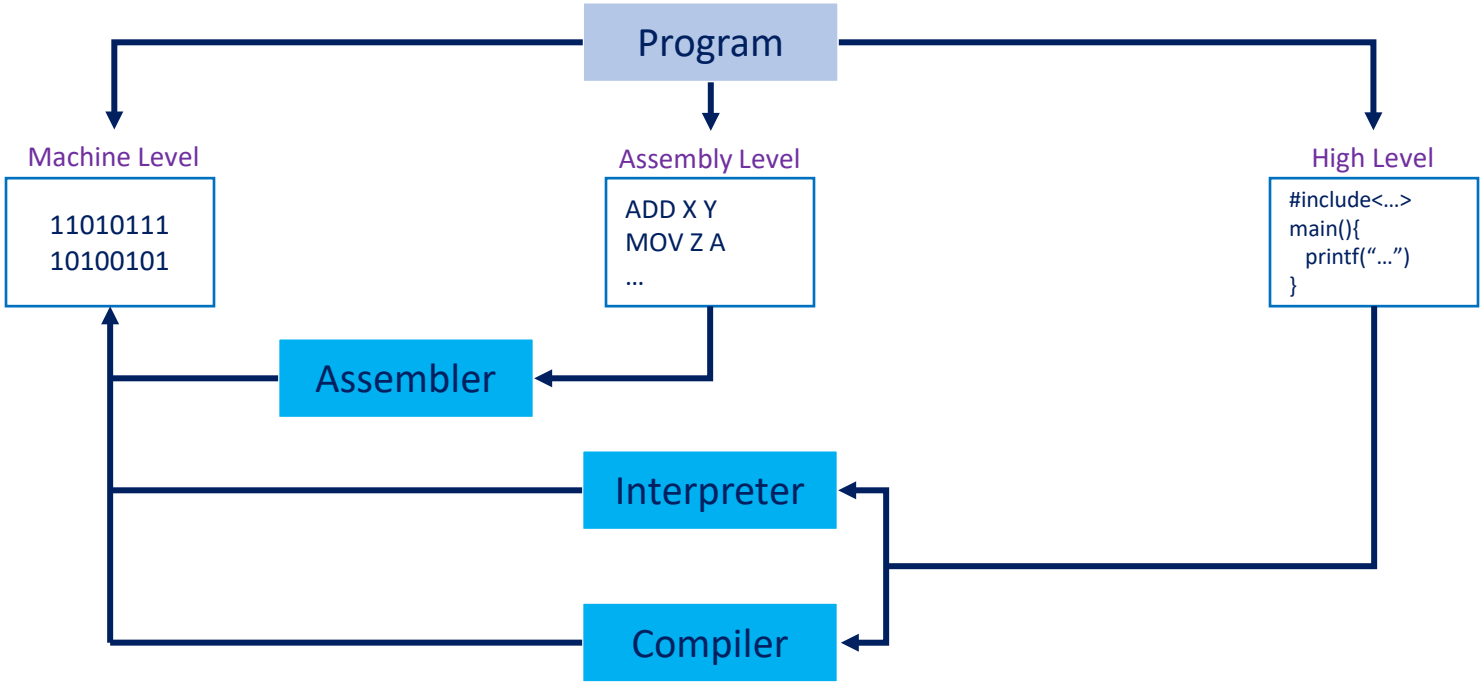


How is Java Unique?

Von Neumann architecture of computing



Programming languages



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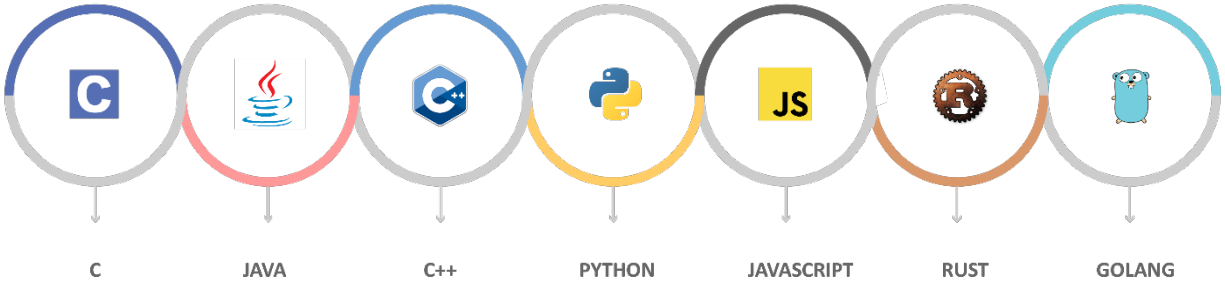
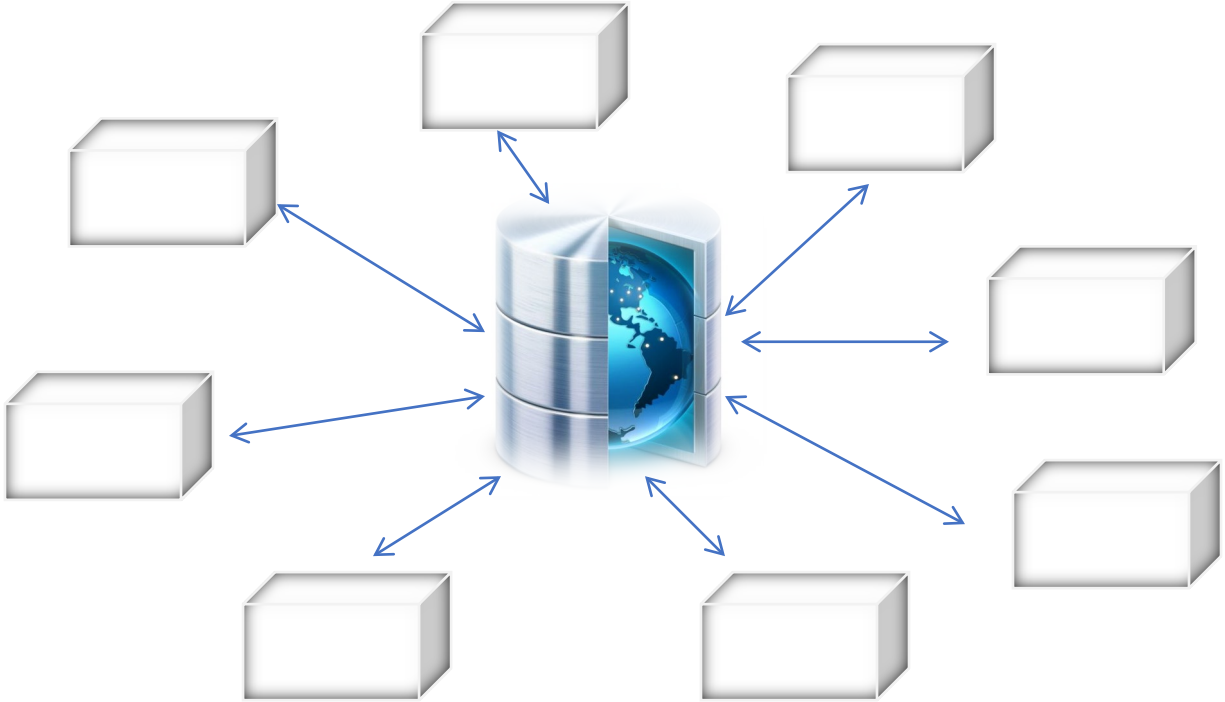
Third generation programming languages



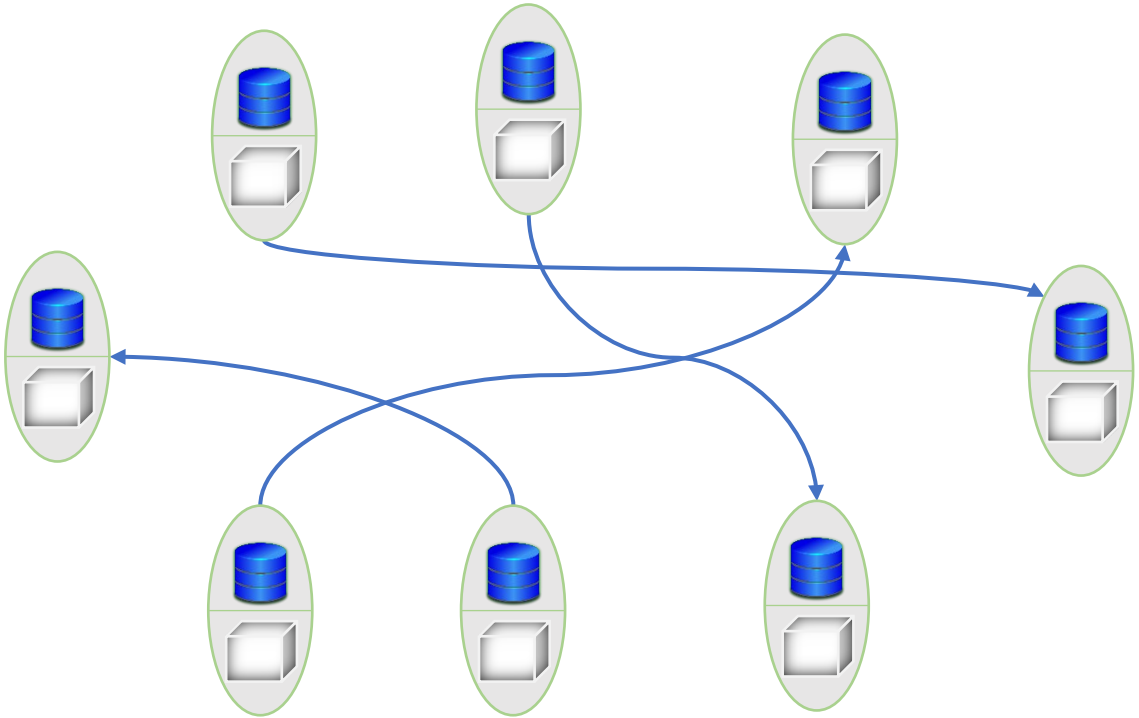
- A third generation (programming) language (3GL) is a grouping of programming languages that introduced significant enhancements to second generation languages, primarily intended to make the programming language more programmer-friendly.
- English words are used to denote variables, programming structures and commands, and Structured Programming is supported by most 3GLs.
- Commonly known 3GLs are FORTRAN, BASIC, Pascal, JAVA and the C-family (C, C+, C++, C#, Objective-C) of languages. Also known as a high-level programming language.

High-level Programming Principles

Function-oriented programming



Object-oriented programming



FOP versus OOP

	Function Oriented Programming (FOP)	Object Oriented Programming (OOP)
Program organization	Program is divided into small parts called functions.	Program is divided into parts called objects.
Importance	Importance is not given to data but to functions	Importance is given to the data rather than procedures
Approach	FOP follows top down approach	OOP follows bottom up approach
Access Specifiers	Does not have any access specifier	Has three access specifiers, namely Public, Private, Protected
Data Moving	Data can move freely from function to function in the system	Objects can move and communicate with each other
Maintainability	To add new data and function is not so easy	Provides an easy way to add new data and function
Data Access	Function uses global data for sharing that can be accessed freely from function to function in the system.	Object uses local data and can be accessed in a control manner
Data Hiding	No data hiding is possible, hence security is not possible	Provides data hiding, hence secured programming is possible
Overloading	Polymorphism is not possible	Polymorphism is possible
Examples	C, Visual Basic, FORTRAN, Pascal.	C++, JAVA, VB.NET, C#.NET.

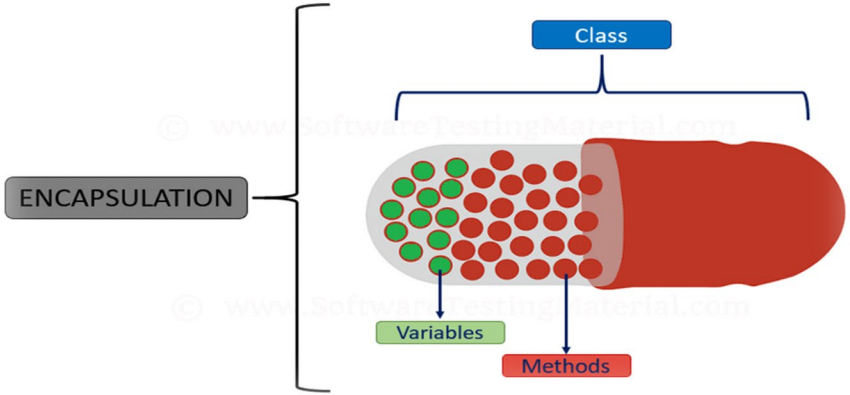
Java Programming Paradigm

Java programming paradigms

Java is based on the concept of object-oriented programming. As the name suggests, at the center of it all is an object. Objects contain both data and the functionality that operates on that data. This is controlled by the following four paradigms

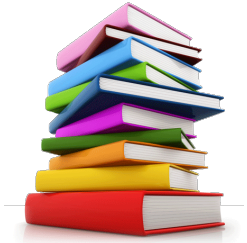
- **Encapsulation**
- **Inheritance**
- **Information hiding**
- **Polymorphism**

Encapsulation in Java



Encapsulation in Java is a process of wrapping code and data together into a single unit, for example, a capsule which is mixed of several medicines.

Encapsulation: Example



Book

data

Title
Author
Accession No.
Cost
Borrower DOI

methods

Issue()
Fine()
Return()
Open()
Close()

data

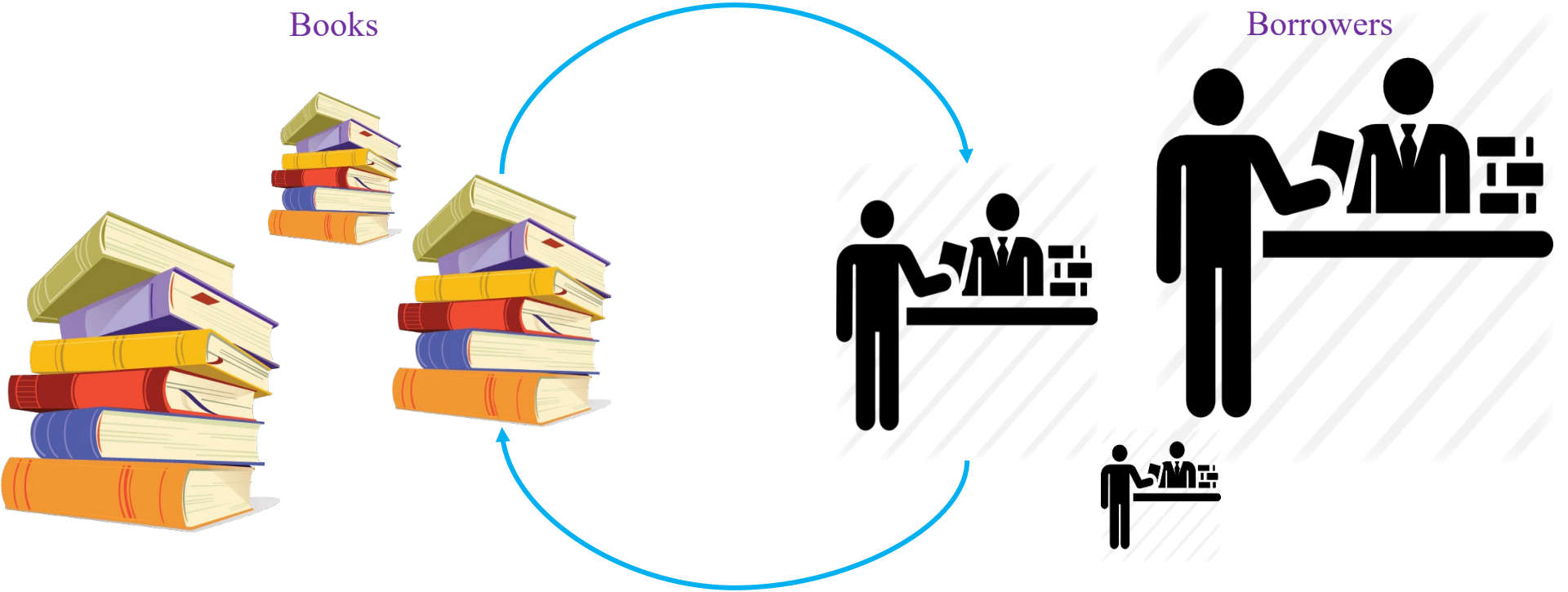
Name
Roll No.
Address
Marks
Books[]

methods

Search Books()
Request()
Renew()
Enroll()
Exit()

Borrower

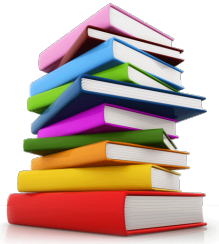
Encapsulation: Example



Inheritance in Java

Inheritance in Java is a mechanism in which one object acquires all the properties and behaviors of a parent object. It is an important part of OOPs (Object-Oriented Programming system).

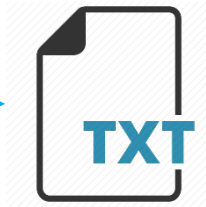
Inheritance: Example



Book

Title
Author
Accession No.
Cost
Borrower DOI

Issue()
Fine()
Return()
Open()
Close()



Text

DOP
Version
Department

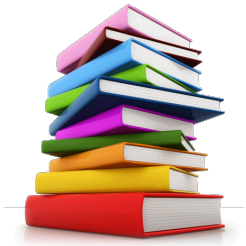
Add()
Remove()

Reference

Publisher
Rack No.
Permission
Copy Type

Display()
Close()
Open()
Copy()

Information hiding



Book

Public
- Title
- Author

Protected
- Account No.

Private
- Cost

Public
- Issues()
- Returns()

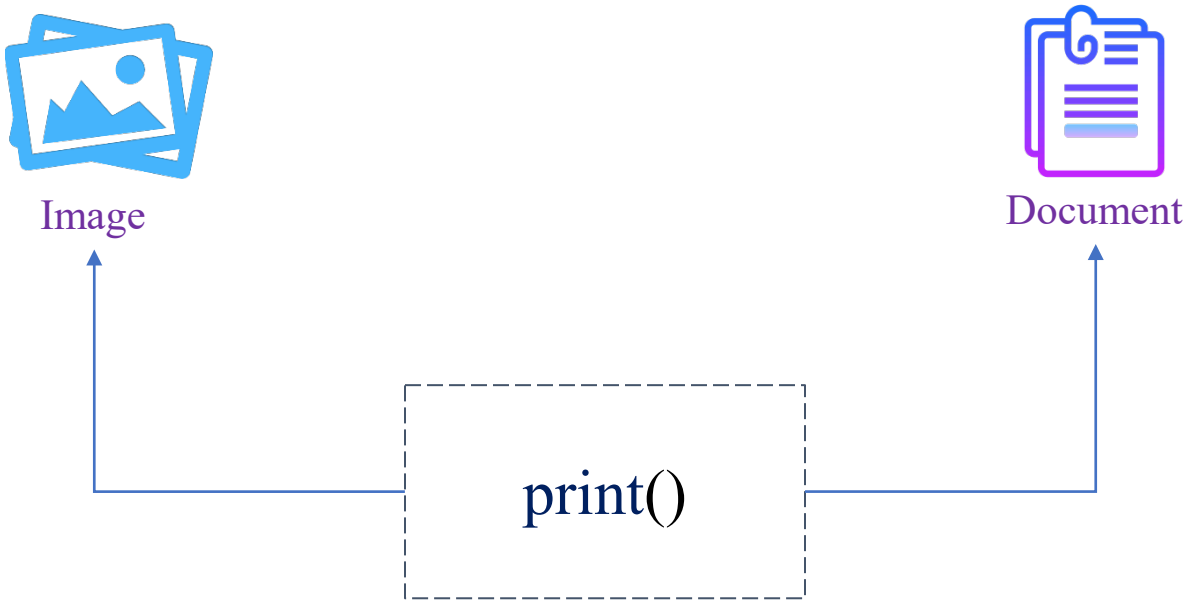
Protected
- Resave()

Private
- Open()
- Close()

Polymorphism

In object-oriented programming,

polymorphism refers to a programming language's ability to process objects depending on their class.



Polymorphism: Example

print()

x, y;
s1, s2;
Img,Doc,Doc1,Doc2

Add(x, y)
Add(s1, s2)
Add(Img, Doc)
Add(Doc1, Doc2)

Add(x, y) : 12 +34 ← Add two numbers

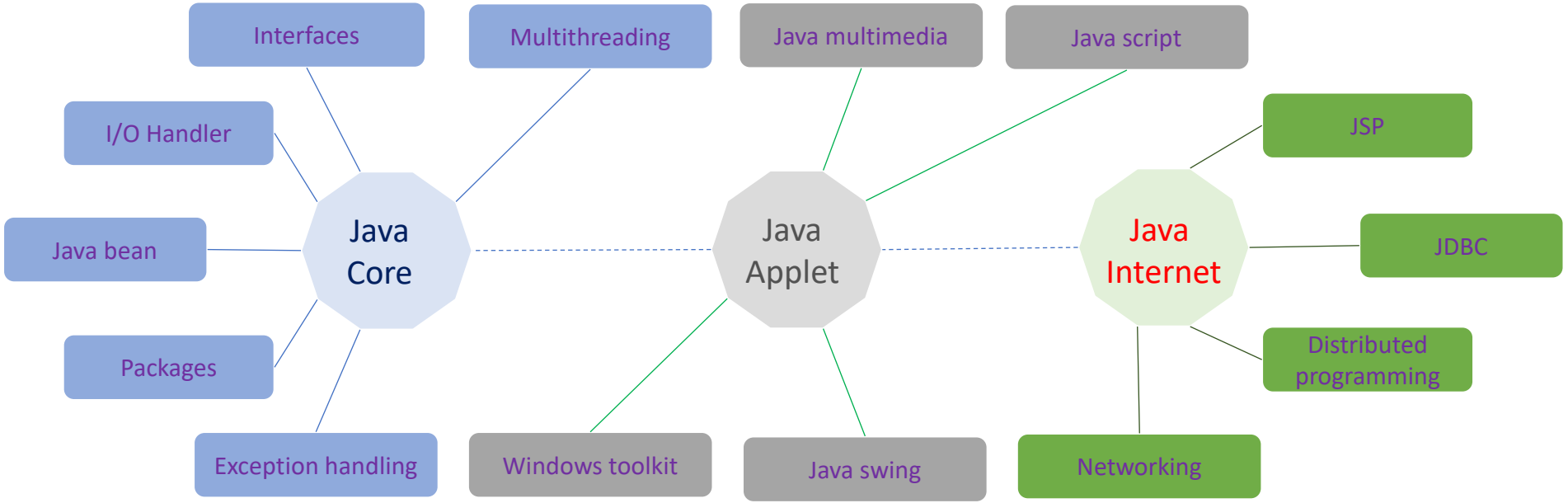
Add(s1 + s2) : Debasis + Samanta ← Merge two strings

Add(Img, Doc) : Image + Document ← Paste an Image to a document

Add(Doc1, Doc2) : Document1 + Document2 ← Merge two documents

Java Programming Features

Features of Java programming



Questions to think…

- Can a software be developed in Java so that it runs in any **OS**? Any machine?
- How a browser (e.g., Mozilla, Google Chrome, Safari, etc.) works in your mobile/ Computer?


Thank You

OBJECT ORIENTED PROGRAMMING WITH JAVA

Java Programming Steps

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Your First Java Program

Program in C and Java

A program in C to display message

```c
#include <stdio.h>

int main()
{
   printf("Hello, World!");
   return 0;
}
```

A program in Java to display message

```java
import java.lang.*;

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

Note: Both the languages are case sensitive

C versus Java

Aspects	C	Java
Paradigms	Procedural	Object-oriented
Platform Dependency	Dependent	Independent
Datatypes : union, structure	Supported	Not supported
Pre-processor directives	Supported (#include, #define)	Not supported
Header files	Supported	Use packages (import)
Storage class	Supported	Not supported

Aspects	C	Java
Inheritance	No inheritance	Supported (Simple inheritance)
Pointers	Supported	No Pointers
Code translation	Compiled	Interpreted
Multi-threading and Interfaces	Not supported	Supported
Exception Handling	No exception handling	Supported
Database Connectivity	Not supported	Supported

Java program editing

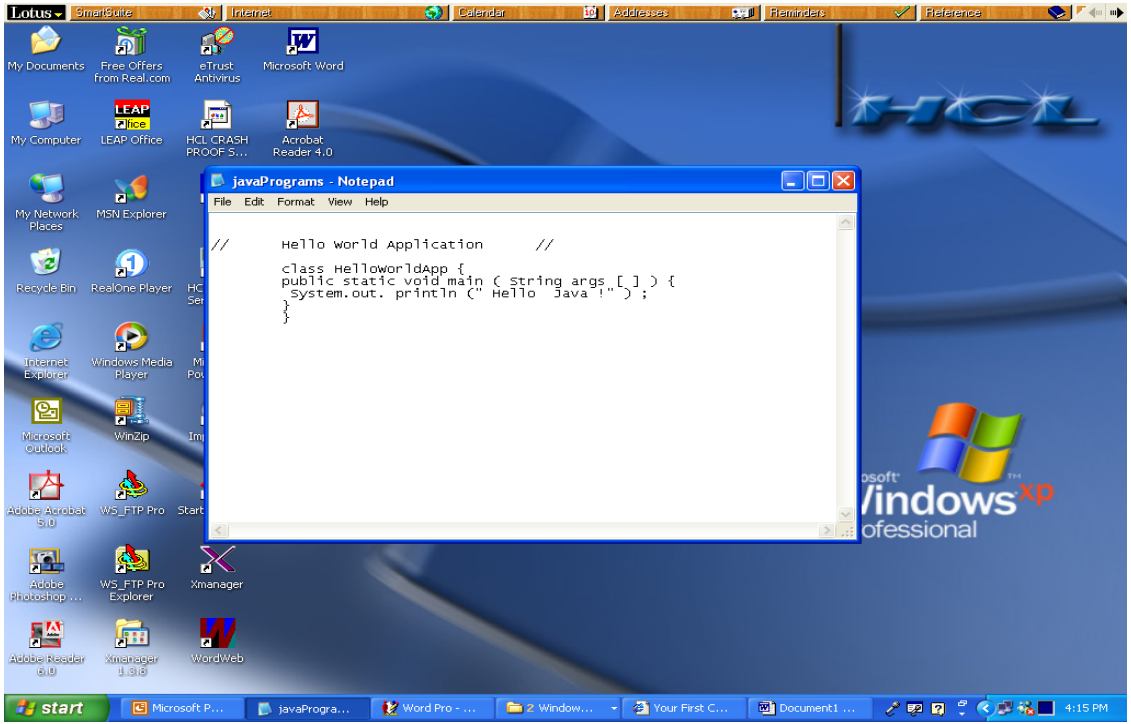
- Any text editor can be used to write Java programs. For example,
  - In Windows
    - **Notepad, Edit, Wordpad, MS-Word,** etc.
  - In Unix
    - **vi**, **emacs, gedit** etc.
- Save the program
  - Save the program in a file with the name

HelloWorldApp.java

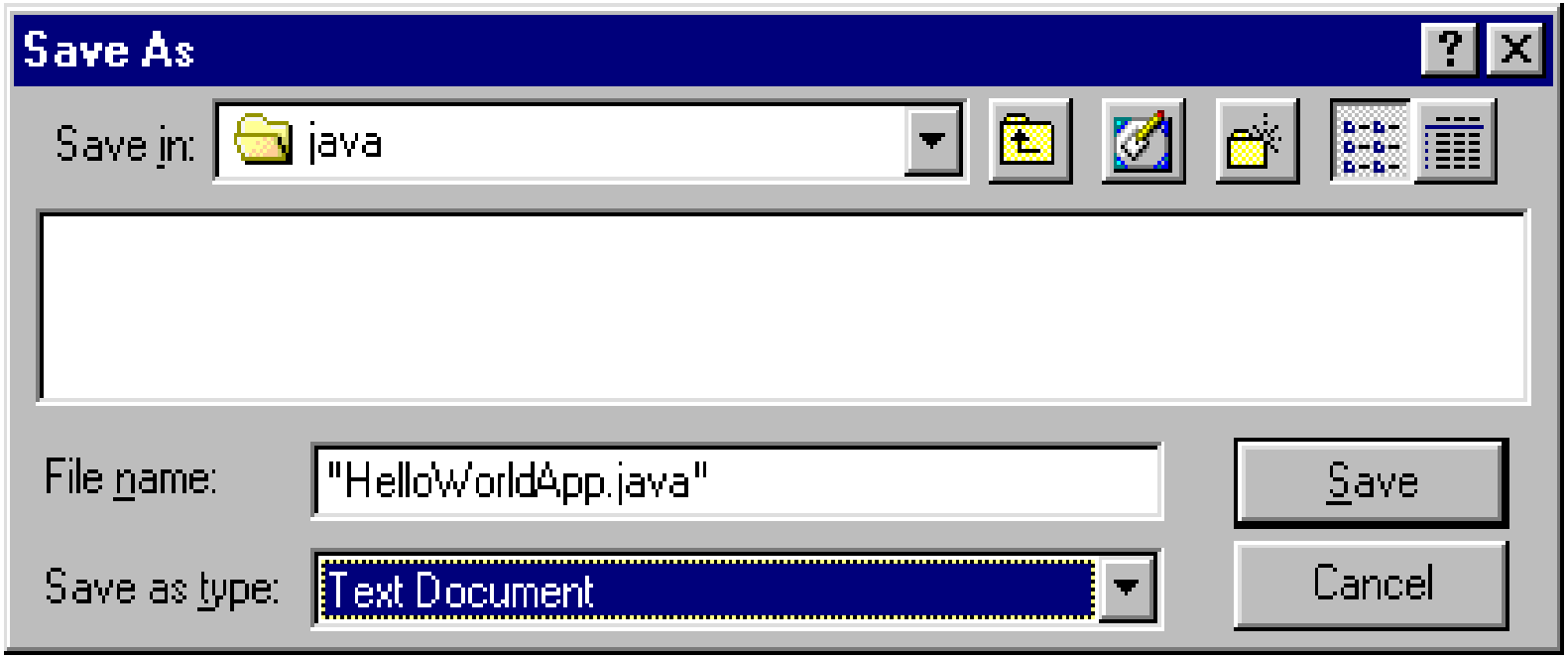
Java program editing

prompt

Java program editing



Java program editing



Java program editing

MS-DOS Prompt

8 x 12

```
C:\WINDOWS>cd C:\java

C:\java>dir

 Volume in drive C is DB02
 Volume Serial Number is F3C4-E800
 Directory of C:\java

.               <DIR>          07-22-99 11:23p .
..              <DIR>          07-22-99 11:23p ..
HELLOW~1 JAV              272  07-22-99 11:23p HelloWorldApp.java
         1 file(s)              3,829 bytes
         2 dir(s)     218,734,592 bytes free

C:\java>
```

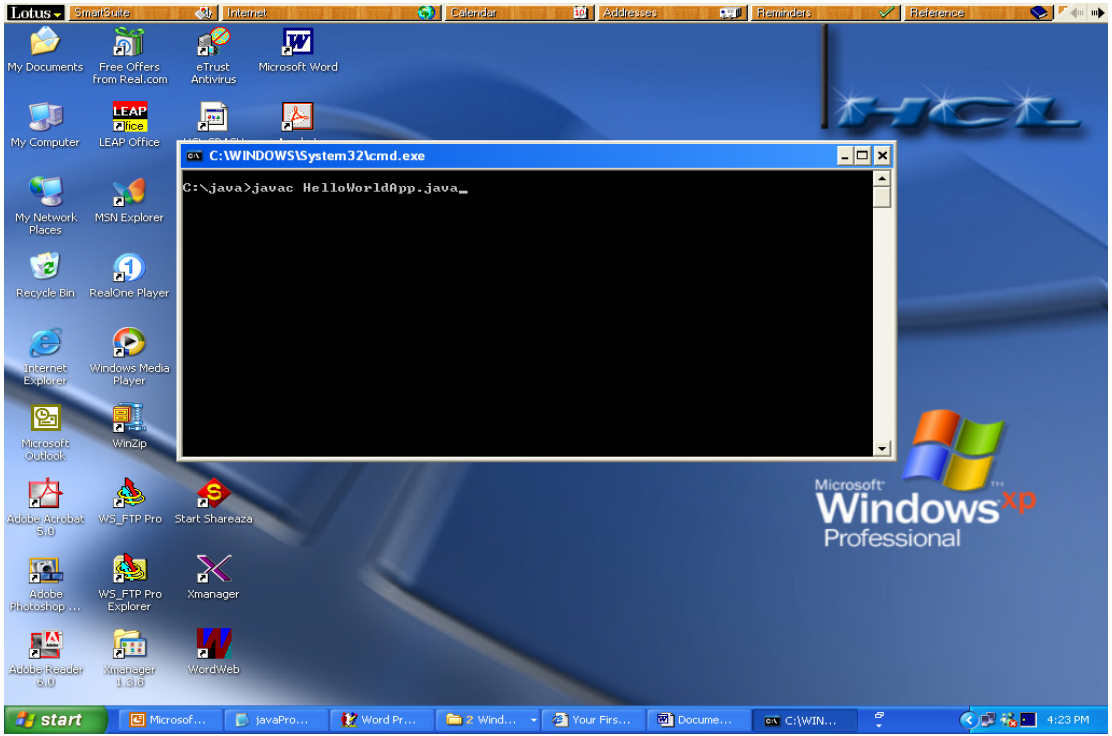
Java program compilation

The Java compiler (javac) converts a Java program into Java byte code

- Open a DOS shell (in Windows) or Terminal (in Unix)
- Move to the directory where your Java program has been saved
- Enter the following command to compile:

```
javac HelloWorldApp.java
```

Java program compilation



Java program compilation

MS-DOS Prompt

8 x 12

```
C:\java>dir

 Volume in drive C is DB02
 Volume Serial Number is F3C4-E800
 Directory of C:\java

.               <DIR>          07-22-99 11:23p .
..              <DIR>          07-22-99 11:23p ..
HELLOW~1 JAV             272   07-23-99 12:39a HelloWorldApp.java
HELLOW~1 CLA             478   07-23-99 12:40a HelloWorldApp.class
         2 file(s)                750 bytes
         2 dir(s)     218,734,592 bytes free

C:\java>_
```

Java program execution

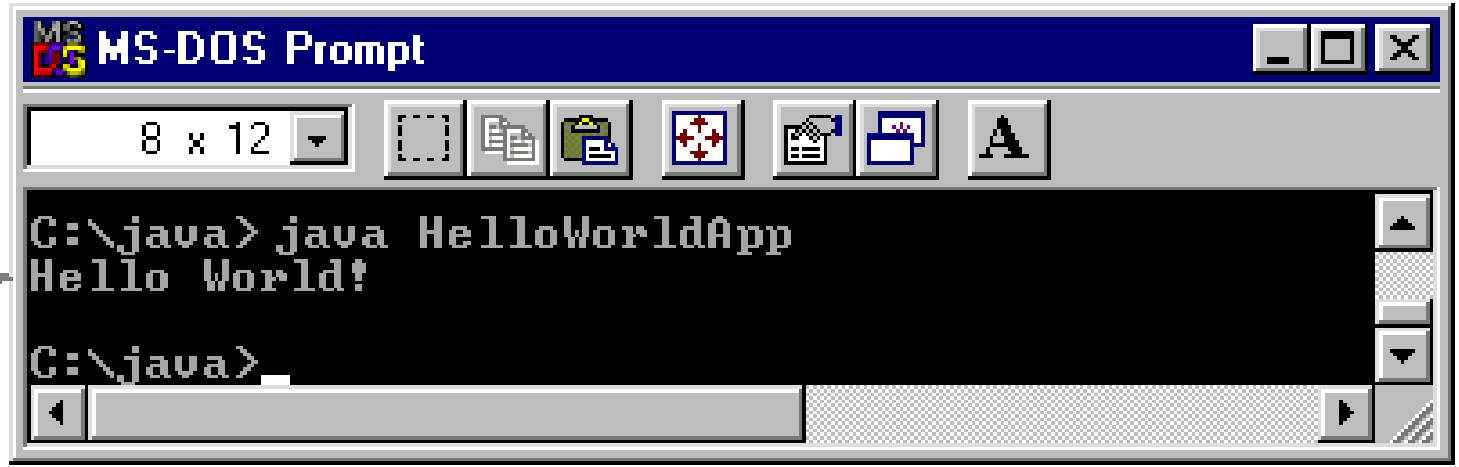
To execute the Java program, type the command **`java`** (from the command prompt).

- For example, the current program `HelloWorldApp.class` can be executed as

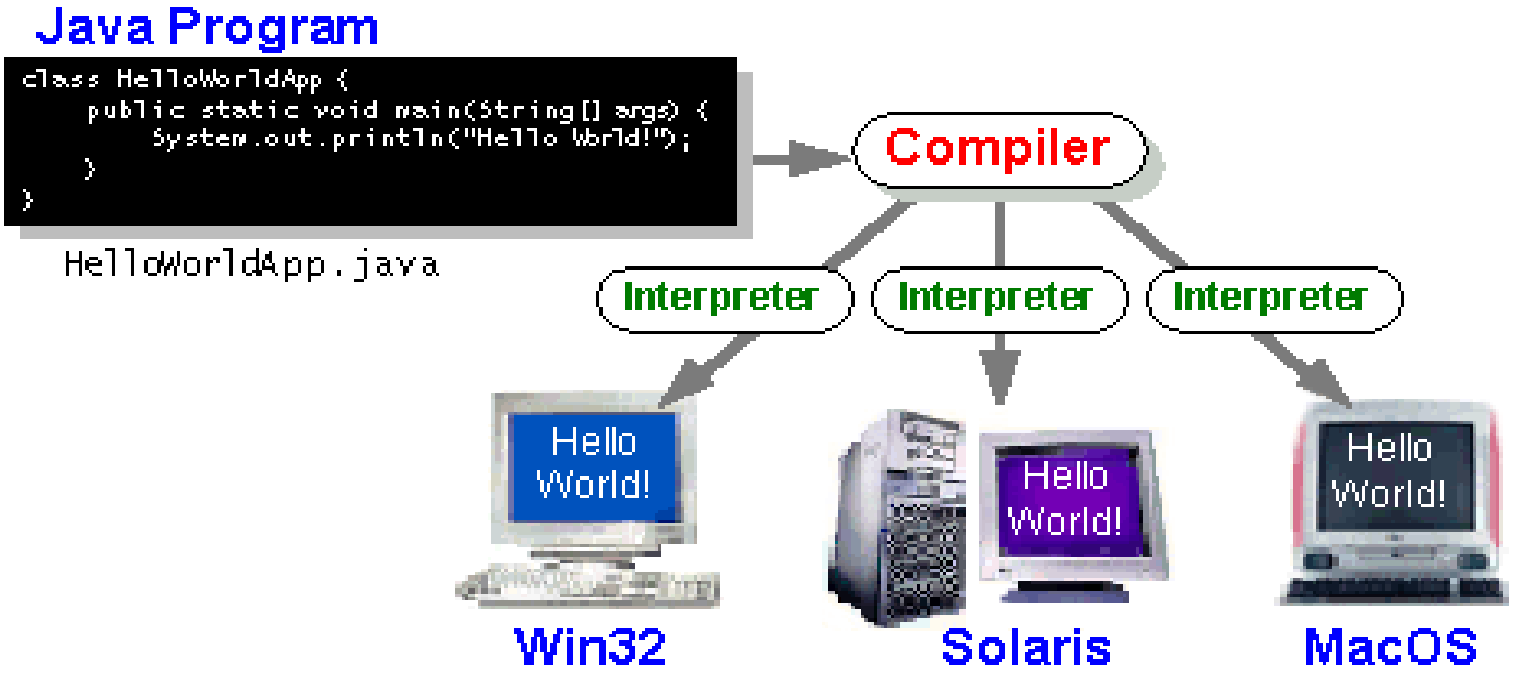
```
java HelloWorldApp
```

Java program execution

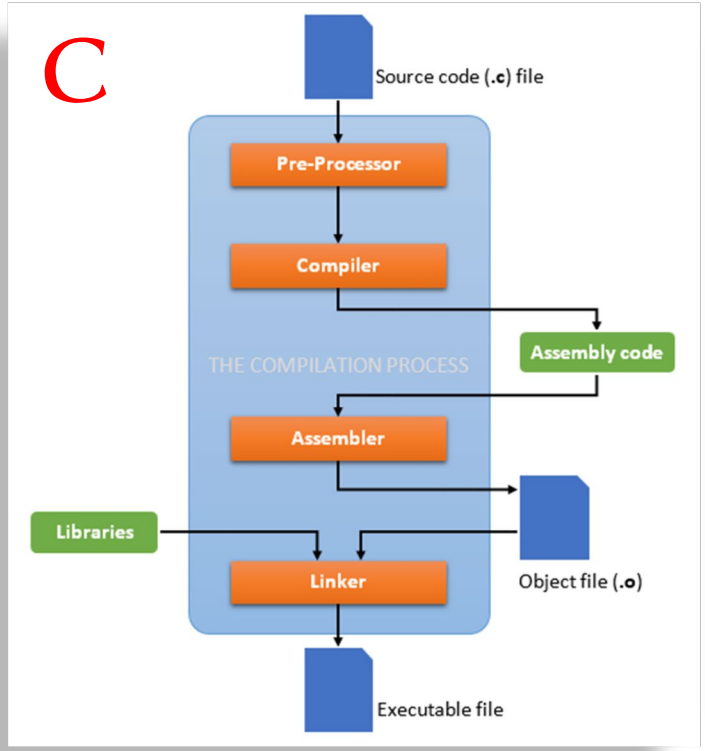
result

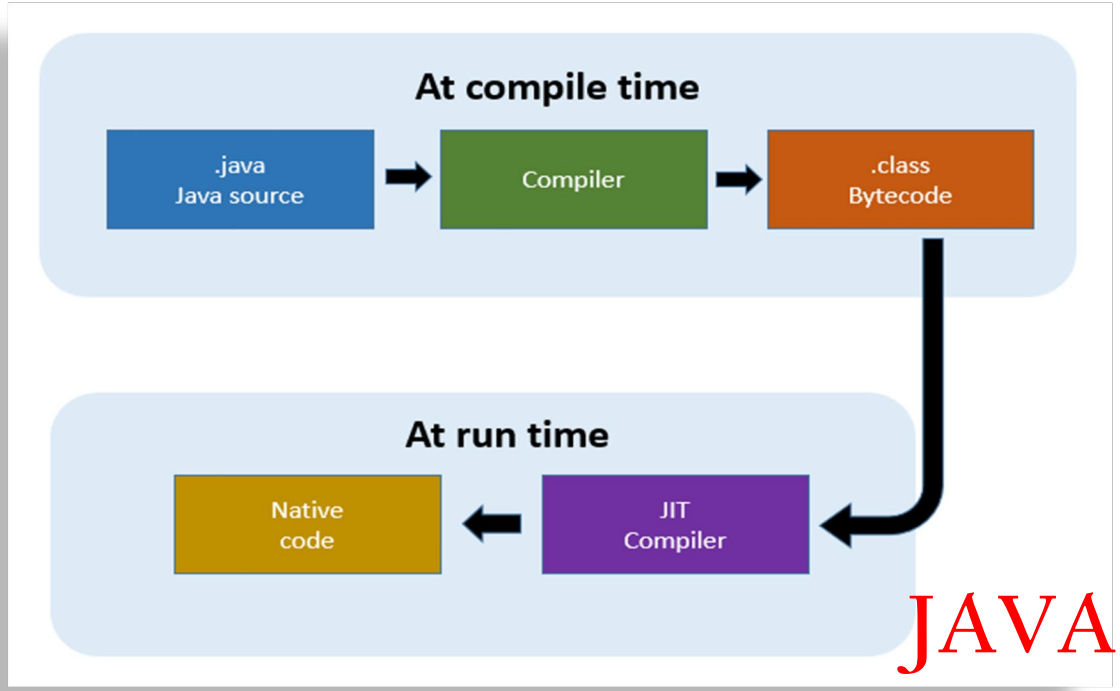


Java program execution



C/C++ versus Java execution





C++ versus Java

C++ versus Java

Areas of applications

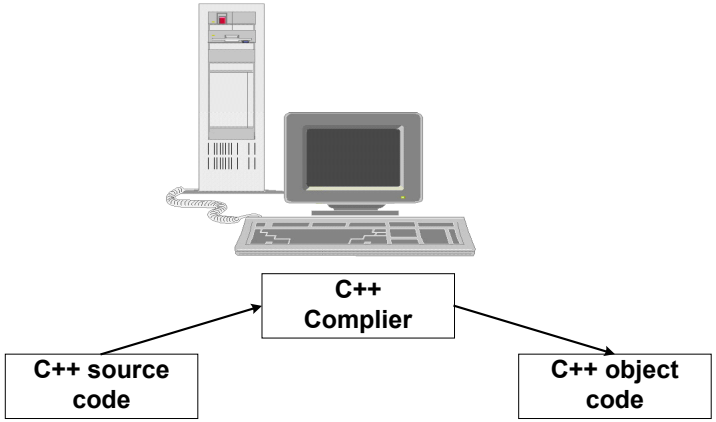
- C++ is best suitable for developing large software.
  - Library management system, Employee management system, Passenger reservation system, etc.

- Java is best suitable for developing communication/ Internet application software.
  - Network protocols, Internet programs, web page, web browser, etc.

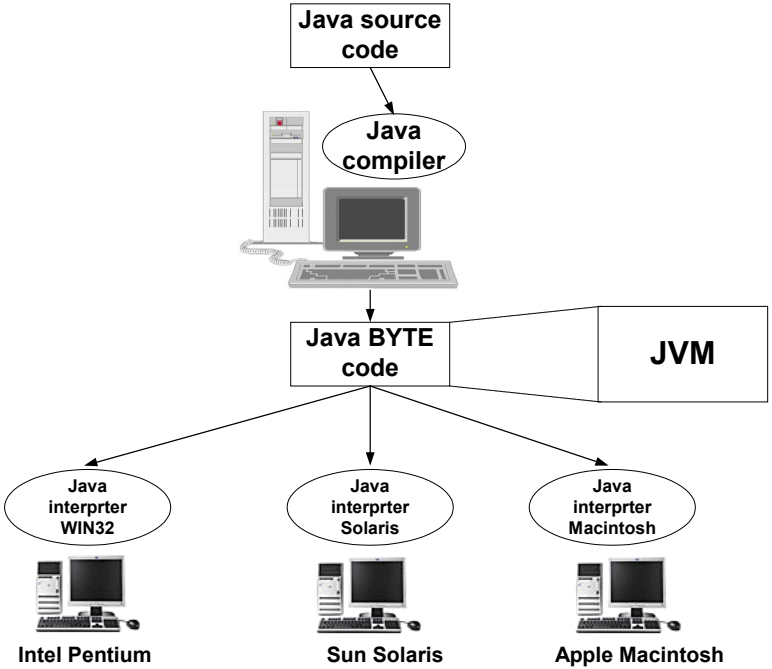
C++ versus Java : Programming features

Features		in C++	in Java
Data abstraction and encapsulation		√	√
Polymorphism		√	√
Binding	Static	√	√
	Dynamic	√	√
Inheritance	Single Inheritance	√	√
	Multiple Inheritance	√	×
Operator overloading		√	×
Template classes		√	×
Global variables		√	×
Header files		√	×
Pointers		√	×
Interface and packages		×	√
API (Application Programming Interface)		×	√

C++ versus Java : Programming environments



C++ provides platform dependent programming



Java provides platform independent programming

Questions to think…

- How a Java program can include two or more classes and then compile them?
- How a browser can run a Java program?

Thank You

OBJECT ORIENTED PROGRAMMING WITH JAVA

Java Tools and Resources

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Java Programming Tools

Tools available for Java programming

- **Java Software Developer's Kit (SDK) :** Java™ 2 SDK
  - SDK from *JavaSoft,* a division of Sun Microsystems Inc.
  - Contains the basic tools and libraries necessary for creating, testing, documenting and executing Java programs.

- Java™ 2 SDK, Standard Edition

  https://java.sun.com/j2se/1.4.2/docs/index.html
  - Official site for Java™ 2 SDK, Standard Edition

Tools available for Java programming

There are seven main programs in SDK

- *javac* – the Java Compiler
- *java* – the Java Interpreter
- *javadoc* – generates documentation in HTML
- *appletviewer* – the Java Interpreter to execute Java applets
- *jdb* – the Java Debugger to find and fix bugs in Java programs
- *javap* – the Java Disassembler to displays the accessible functions and data in a compiled class; it also displays the meaning of byte codes
- *javah* – to create interface between Java and C routines

Tools available for Java programming

- **Additional few sources**
  - Javatpoint website : Another official site for Java™ 2 SDK, Standard Edition, help, tutorial, etc.

    https://www.javatpoint.com/java-tutorial

  - Free Java Download : Download Java for your desktop computer now

    https://www.java.com/en/download/index.jsp

Resource for Java programming

- There are many resources for learning Java
  - The Java™2 Tutorials
    - The Java tutorials are practical guides for programmers who want to use the Java programming language to create applications.

      https://java.sun.com/docs/books/tutorial/index.html
  - Sun Developer Network
    - Sun Microsystem's official website listing down all the API documentation, latest Java Technologies, books and other resources.

      https://java.sun.com/reference/docs/

Packages in Java

API (Application Programming Interface) in Java SDK

- The API enables Java programmers to develop varieties of applets and applications
- It contains **nine** packages
  - *java.applet – for applet programming*
  - *java.awt* – the Abstract Windowing Toolkit for designing GUI like *Button*, *Checkbox*, *Choice*, *Menu*, *Pannel*, etc.
  - *java.io* – file input/output handling
  - *java.lang* – provides useful classes like to handle *Object*, *Thread*, *Exception*, *String*, *System*, *Math*, *Float*, *Integer*, etc.

Packages in Java

- *java.lang* – provides useful classes like to handle *Object*, *Thread*, *Exception*, *String*, *System*, *Math*, *Float*, *Integer* etc.
- *java.net* – classes for network programming; supports TCP/IP networking protocols
- *java.util* – it contains miscellaneous classes like *Vector*, *Stack*, *List*, *Date*, *Dictionary*, *Hash* etc.
- *javax.swing* – for designing graphical user interface (GUI)
- *java.sql* – for database connectivity (JDBC)

Other third part tools for Java programming

Java IDE (Integrated Development Environment)

- Number of IDEs are available to support the productivity of software development
  - ***Sun's Java Workshop*** from *Sun's JavaSoft* (recently powered with Visual Java)
  - ***Mojo*** from *Penumbra Software* (best visual environment for creating Java applets)
  - ***Jumba*** from *Aimtech and IBM* (graphical applet builder)
  - ***Semantic Café*** from *Semantics* (a de-facto standard for Java development on Windows systems)

Other third part tools for Java programming

Web browser

- Java environment requires Java-enabled web browser to supports Java applets
- Few (free) popular Java-enabled web browsers:
  - ***HotJava*** from JavaSoft web site (http://java.sun.com)
  - ***Netscape Navigator*** from Netscape home page (http://home.nescape.com)
  - ***Internet Explorer*** from Microsoft's web page (http://www.microsoft.com)

Few more from Java professionals

Net Beans - https://netbeans.org/downloads/

– This is one of the most commonly used IDEs for Java and some major languages.

NotePad++ - https://notepad-plus-plus.org/download/v7.5.8.html

– This is a very advanced and handy NotePad,
it has several built-in tools and functions for making programming easy.

Java Language Subset

A rich subset of the Java language

Built-In Types	
int	double
long	String
char	boolean

System
System.out.println()
System.out.print()
System.out.printf()

Flow Control	
if	else
for	while

Parsing
Integer.parseInt()
Double.parseDouble()

Boolean	
true	false
||	&&
!	

Arrays
a[i]
new
a.length

Punctuation	
{	}
(	)
,	;

String	
+	""
length()	compareTo()
charAt()	matches()

Assignment
=

Objects	
class	static
public	private
toString()	equals()
new	main()

Primitive Numeric Types		
+	-	*
/	%	++
--	>	<
<=	>=	==
!=		

Math Library	
Math.sin()	Math.cos()
Math.log()	Math.exp()
Math.sqrt()	Math.pow()
Math.min()	Math.max()
Math.abs()	Math.PI

Built-in data types in Java

In Java, every variable has a type declared in the source code. There are two kinds of types: reference types and primitive types. Reference types are references to objects. Primitive types directly contain values.

Type	Size
boolean	1 bit
byte	8 bits
char	16 bits
short	16 bits

Type	Size
int	32 bits
long	64 bits
float	32 bits
double	64 bits

The Java character set

- **The Java language alphabet**
  - Uppercase letters ‘A’ to ‘Z’
  - Lowercase letters ‘a’ to ‘z’
  - Digits ‘0’ to ‘9’
  - Java special characters:

,	<	>	.	_
(	)	;	$	:
%	[	]	#	?
'	&	{	}	"
^	!	*	/	|
-	\	~	+	

Identifiers in Java

- **Identifiers**
  - Names given to various program elements (variables, constants, class, methods, etc.)
  - May consist of letters, digits and the underscore ('_') character, with no space between.
  - Blank and comma are not allowed.
  - First character must be an alphabet or underscore.
  - An identifier can be arbitrary long.
  - Identifier should not be a reserved word.

- Java programming language is case sensitive.
  - `area`, `AREA` and `Area` are all different!

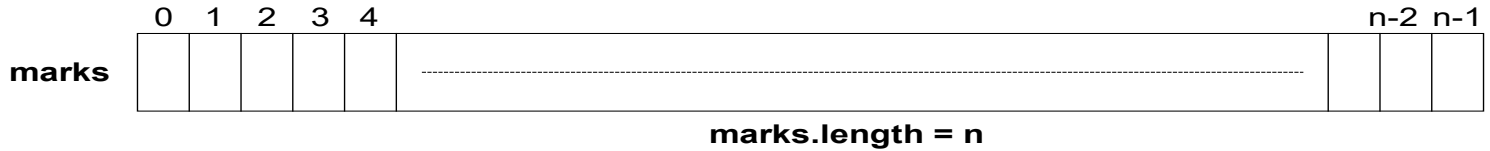
Datatype declaration rule

Declaration and assignment statements

```
int a, b = 0;

a = 123;

b = 45;

int c = a + b;

System.out.print("The sum is" + c);
```

Array in Java

Array in Java



An *array* is a finite ordered and collection of homogeneous data elements.

Following are the three tasks to manipulate an array in Java

- Declaration of an array.
- Allocate memory for it.
- Loading the values into array.

Creating an array

Declaration of array

<type> <arrayName>[ ];

Example:

```
int x[ ];
```

<type>[ ] <arrayName>;

Example:

```
int [ ] x;
```

Allocate memory for an array

<arrayName> = new <type> [<size>];

Example:

```
x = new int [100 ];
```

Creating an array

Define and allocate memory together

<type> <arrayName> [ ] = new <type> [<size>];

Example:

```
int x [ ] = new int [100];
```

Storing elements in array

Initialization of Array

<arrayName> [<subscript>] = <value>;

Example:

```
x [5] = 100;

for (int i = 0; i < 100; i++)
   x[i] = <value>;
```

Storing elements in array

Initialization of array: An alternative way

<type> <arrayName> [ ] = { <list of values> };

Example:

```
int x [ ] = {12, 3, 9, 15};
```

Here, declaration, allocation of memory and array initialization all are at one go!

Processing elements in an array

- **Insertion**
  - Insertion at any location
  - Insertion at front
  - Insertion at end
  - Insertion is sorted order
- **Deletion**
  - Deletion a particular element
  - Deletion an element at a particular location
  - Deletion the element at front
  - Deletion the element at end
- **Searching and Traversal**
  - Finding the smallest and largest element
  - Printing all element or some specific element
- **Sorting**
  - In ascending order, descending order, lexicographical order etc.

Array in Java: A quick visit

- Declaration of an array

  Examples

```
int numbers[ ];
float averageScores[ ];
int [ ] rollNo;
float [ ] marks;
```

- Memory allocation for an array

  Examples

```
numbers = new int [5];
averageScores = new float [20];
rollNo = new int [49];
marks = new float [54];
```

- Initialization of an array

  Examples

```
int numbers[] = {5, 4, 2, 1, 3};
float marks[] = {2.5, 3.4, 4.5};
```

What is the size of the array `marks`?

```
n = marks.length;
```

How to define a two dimensional array?

Creating a 2D array

Declare and Allocate

Example:

```
int myArray [ ] [ ];
myArray = new int [3] [4];
```

OR

```
int myArray [ ] [ ] = new int [3] [4];
```

Loading a 2D array

Initializing a 2D array : An example

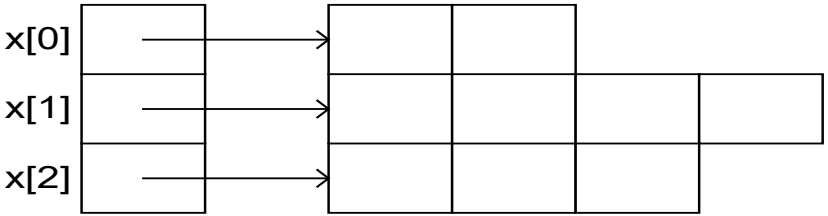
1	2	3
4	5	6

```
int myArray [2] [3] = {1, 2, 3, 4, 5, 6};
```

OR

```
int myArray [ ] [ ] = { {1, 2, 3}, {4, 5, 6} };
```

Variable sized 2D array



- **Creating a variable-sized 2D array**

```
<type><2DarrayName>[][] = new <type> [<rowSize>][];
for (int i = 0; i < <rowSize>; i++)
   <2DarrayName>[i] = new <type> [<colSize_i>];
```

Another way: Example

```
int x [ ] [ ] = new int [3][ ];
x[0] = new int [2];
x[1] = new int [4];
x[2] = new int [3];
```

3D arrays : An example

```
class a3DArray {
      public static void main(String args[]) {
            int my3DArray [ ][ ][ ] = new int [3][4][5];
            int i, j, k;
            for(i=0; i<3; i++)
                  for(j=0; j<4; j++)
                        for(k=0; k<5; k++)
                            my3DArray[i][j][k] = i * j * k;
            for(i=0; i<3; i++) {
                  for(j=0; j<4; j++) {
                        for(k=0; k<5; k++)
                            System.out.print(my3DArray[i][j][k] + " ");
                            System.out.println();
                  }
                            System.out.println();
            }
      }
}
```

Example program using an array

```
class TestArray{
   public static void main(String args[]){

        int a[] = new int[5];         //Declaration and instantiation
        a = {10, 20, 30, 40, 50};  //Initialization
       //Traversing array
       for(int i=0;i<a.length;i++){     //length is the property of array
          System.out.println(a[i]);
       }
       // Average calculation
       float sum = 0; avg;
       for(i=0;i<a.length;i++)     //Calculating the sum of the numbers
          sum += a[i];
       avg = sum/a.length;
       System.out.println("Avergae = " + avg);
   }
}
```

Questions to think…

- How to write recursive programs in Java?
- Which program? Application or applet?

Thank You