SCHOOL OF FUTURE TECH

ITM SKILLS UNIVERSITY

COURSE:- Java Programming

Sem:- III

Module -1

By:
Dr. Ritu Jain,
Associate Professor,
Computer Science-ISU

History of Java

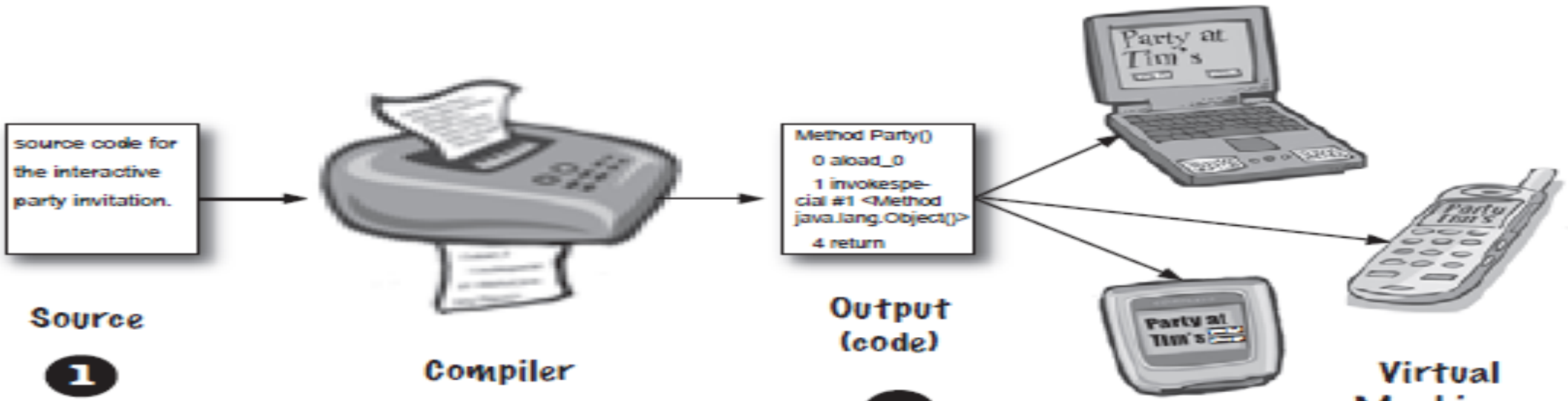
- Java was conceived by James Gosling, Patrick Naughton, Chris Warth, Ed Frank, and Mike Sheridan at Sun Microsystems, Inc. in 1991.
- Primary motivation was the need for a **platform-independent (that is, architecture-neutral) language** that could be used to create embedded software to be embedded in various consumer electronic devices, such as microwave ovens and remote controls.
- Initially, it was called **Oak** and was developed as a part of the Green project.
- In 1995, Oak was renamed as **"Java"** because it was already a trademark by Oak Technologies.
- JDK 1.0 was released on January 23, 1996. After the first release of Java, there have been many additional features added to the language.
- Now Java is being used in desktop applications, web applications, enterprise applications, mobile applications, etc.
- **James Gosling** is known as the Father of Java.

Bytecode

- Java is **platform independent as**:
  - *"Output of Java compiler is not executable code."*
- Rather, it is bytecode.
- *Bytecode is a highly optimized set of instructions designed to be executed by the Java run-time system, which is called the Java Virtual Machine (JVM).*
- Translating a Java program into bytecode makes it much easier to run a program in a wide variety of environments because only the JVM needs to be implemented for each platform. Once the run-time package exists for a given system, any Java program can run on it.
- The fact that Java program is executed by JVM also helps to make it secure. Because execution in under the control of the JVM, it ensures that no side effects outside the system are generated.
- In this way, Java addressed **portability and security** concerns

The Way Java Works

The goal is to write one application (in this example, an interactive party invitation) and have it work on whatever device your friends have.



Source

1

Create a source document. Use an established protocol (in this case, the Java language).

Compiler

2

Run your document through a source code compiler. The compiler checks for errors and won't let you compile until it's satisfied that everything will run correctly.

Output (code)

3

The compiler creates a new document, coded into Java ***bytecode***. Any device capable of running Java will be able to interpret/translate this file into something it can run. The compiled bytecode is platform-independent.

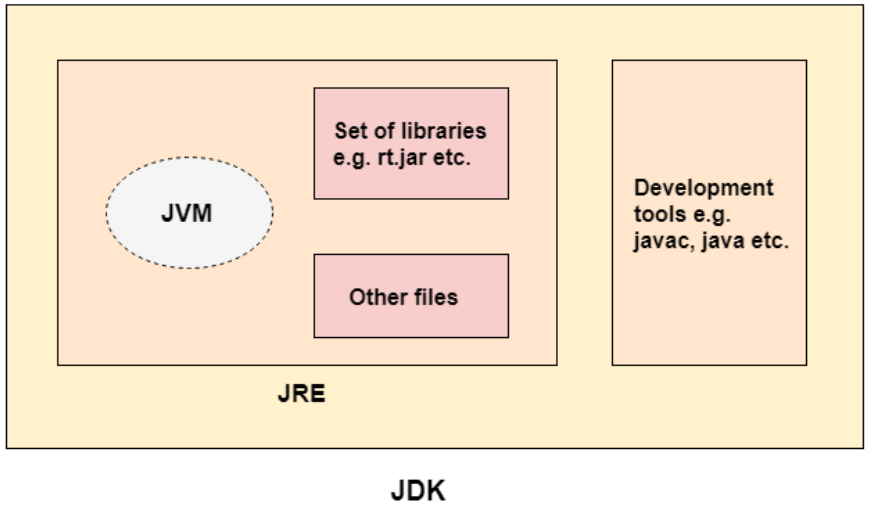
Virtual Machines

4

Your friends don't have a physical Java Machine, but they all have a ***virtual*** Java machine (implemented in software) running inside their electronic gadgets. The virtual machine reads and *runs* the bytecode.

Java Development Kit (JDK)

- It is a software development environment used for developing Java applications and applets.
- It includes the Java Runtime Environment (JRE), an interpreter/loader (java), a compiler (javac), an archiver (jar), a documentation generator (Javadoc), and other tools needed in Java development.
- JDK is a kit(or package) that includes two things:
  - Development Tools(to provide an environment to develop your java programs)
  - JRE (to execute your java program).
- We need to install JDK on our computer in order to create, compile and run the java program.

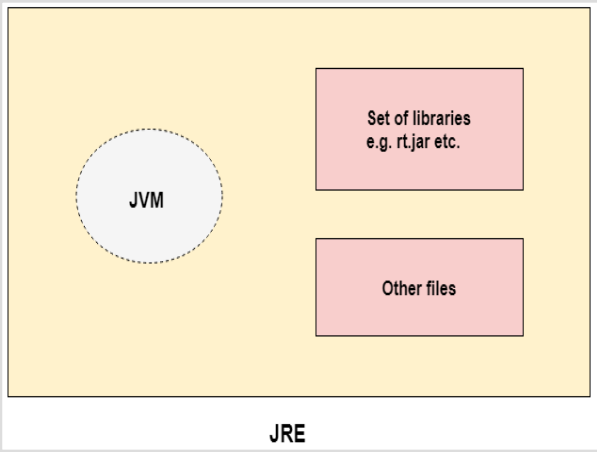


Java Runtime Environment

JRE stands for **"Java Runtime Environment"** and may also be written as **"Java RTE".** The Java Runtime Environment provides the minimum requirements for executing a Java application; it consists of the *Java Virtual Machine (JVM), core classes*, and *supporting files*.

JRE (Java Runtime Environment) is an installation package that provides an environment to **only run(not develop)** the java program(or application)onto your machine. JRE is only used by those who only want to run Java programs that are end-users of your system.

3. JVM (Java Virtual Machine): Function of Java Virtual Machine is to execute the bytecode produced by the compiler. Every Operating System has a different JVM but the output they produce after the execution of bytecode is the same across all the operating systems. This is why Java is known as a **platform-independent language.**



Types of Java Applications

There are mainly 4 types of applications that can be created using Java programming:

- **Standalone Application**: Standalone applications are also known as desktop applications or window-based applications. These are traditional software that we need to install on every machine. Examples of standalone application are Media player, antivirus, etc.
- **Web Application:** java is perfect for developing web applications because of its ability to interact with a large number of systems. The presence of JSP, web servers, Spring, and Hibernate provides feasibility in the web development process. There are several advantages of using Java for web development, such as, *presence of a wide range of APIs, excellent IDEs and tools, reusability of code, enhanced security features* ,and many more.
- **Enterprise Application:** Java is a popular choice for building enterprise-level applications due to its scalability, reliability, and security. Java's powerful libraries and frameworks enable developers to create robust applications for managing business processes.
- **Mobile Application:** Java is also used to build applications that run across smartphones and other small-screen devices.

Features of Java

The Java programming language is a high-level language that can be characterized by all of the following buzzwords:

- **Simple**
- **Object oriented**
- **Distributed**
- **Interpreted**
- **Robust**
- **Secure**
- **Architecture neutral**
- **Portable**
- **High performance**
- **Multithreaded**
- **Dynamic**

Features of Java

- **Simple**
  - Java was designed to be easy language for professional programmer to learn and use effectively.
  - It's simple and easy to learn if you already know the basic concepts of Object Oriented Programming.
  - C++ programmer can move to JAVA with very little effort to learn.
  - It does not have complex features like pointers, operator overloading, multiple inheritances, and explicit memory allocation.

Features of Java

- **Object Oriented**
  - Almost “Everything is an Object” paradigm. All program code and data reside within objects and classes.
  - Java comes with an extensive set of classes, arranged in packages that can be used in our programs through inheritance.
  - Organizing the program in the terms of a collection of objects is a way of object-oriented programming, each of which represents an instance of the class.
  - The four main concepts of Object-Oriented programming are:
    - Abstraction: refers to hiding the implementation details of a code and exposing only the necessary information to the user.
    - Encapsulation: Encapsulation is the mechanism that binds together code and the data it manipulates, and keeps both safe from outside interference and misuse.
    - Inheritance: is the mechanism in Java by which one class is allowed to inherit the features(fields and methods) of another class.
    - Polymorphism: is a feature that allows one interface to be used for a general class of actions. The specific action is determined by the exact nature of the situation.

Features of Java

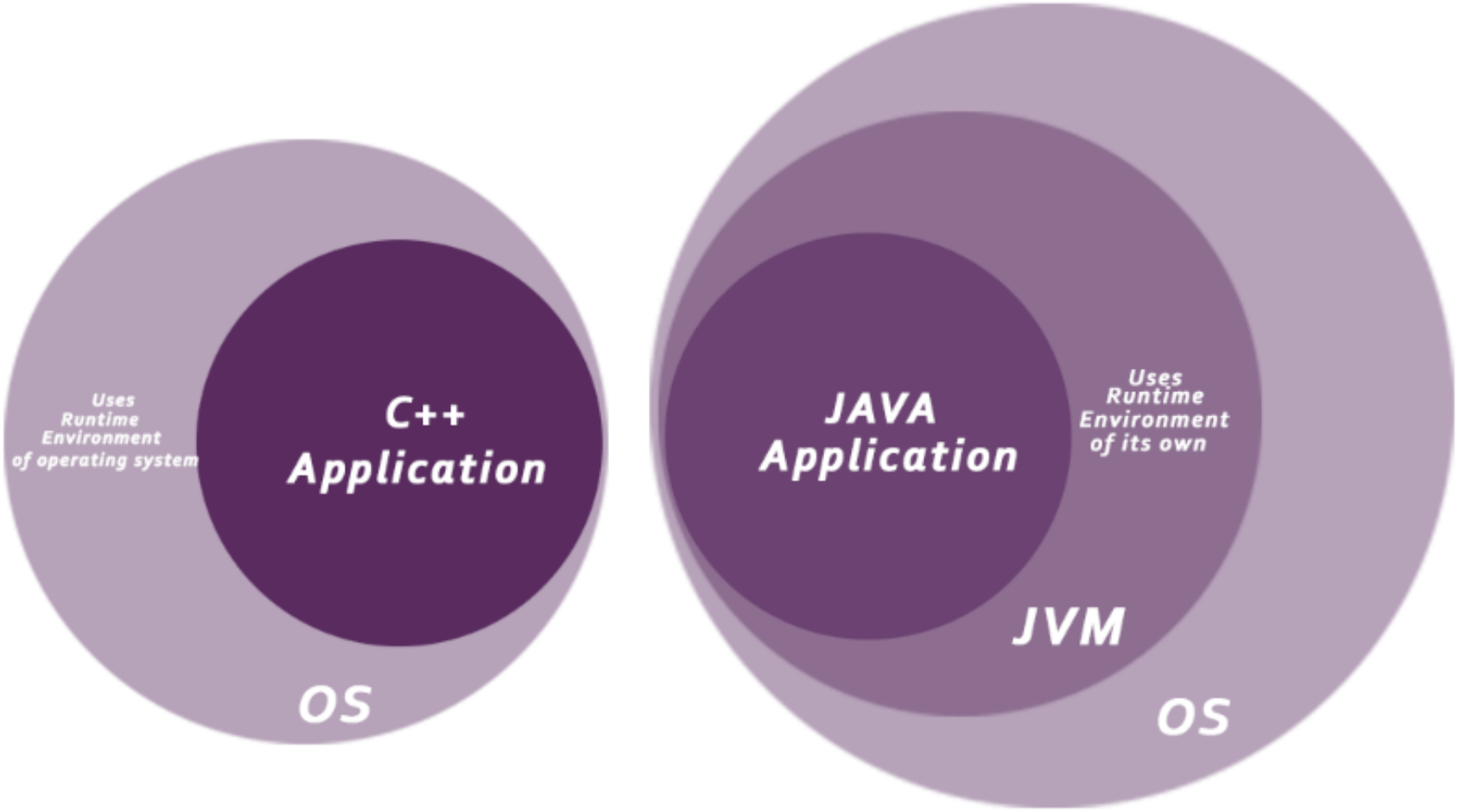
- **Distributed**
  - Java is designed for distributed environment of the Internet. In Java, accessing a resource using a URL is not much different from accessing a file. Remote Method Invocation and Enterprise Java Beans are used for creating distributed applications in java.
- **Compiled and Interpreted**
  - Usually a computer language is either compiled or Interpreted. Java combines both this approach and makes it a two-stage system.
  - Compiled : Java enables creation of a cross platform programs by compiling into an intermediate representation called Java Bytecode.
  - Interpreted : Bytecode is then interpreted, which generates machine code that can be directly executed by the machine that provides a Java Virtual machine.

Features of Java

ITM SKILLS UNIVERSITY

- **Robust**
  - Java language is robust which means reliable.
  - It is developed in such a way that it puts a lot of effort into **checking errors** as early as possible, that is why the java compiler is able to detect even those errors that are not easy to detect by another programming language.
  - The main features of java that make it robust are garbage collection, exception handling, and memory allocation.
- **Secure**
  - In java, we don't have pointers, so we cannot access out-of-bound arrays i.e it shows ArrayIndexOutOfBound Exception if we try to do so. That's why several security flaws are not possible in Java.
  - Also, java programs run in an environment that is independent of the OS (operating system) environment which makes java programs more secure. Java achieves this protection by confining a Java program to the java execution environment and not allowing it to access other parts of the computer.

Java Virtual Machine (JVM)



Features of Java

- **Architecture Neutral**
  - Java language and Java Virtual Machine has been designed to achieve the goal of "**write once; run anywhere**" (WORA).
  - Compiler converts source code to bytecode and then the JVM executes the bytecode generated by the compiler.
  - This bytecode can run on any platform be it Windows, Linux, or macOS which means if we compile a program on Windows, then we can run it on Linux and vice versa.
  - Each operating system has a different JVM, but the output produced by all the OS is the same after the execution of the bytecode. That is why we call java a platform-independent language.
- **Portable**
  - As we know, java code written on one machine can be run on another machine. The platform-independent feature of java in which its platform-independent bytecode can be taken to any platform for execution makes java portable.

Features of Java

- **High Performance**
  - Java architecture is defined in such a way that it reduces overhead during the runtime and at some times java uses Just In Time (JIT) compiler where the compiler compiles code on-demand basics where it only compiles those methods that are called making applications to execute faster.
- **Multithreaded**
  - Java supports multithreading. It is a Java feature that allows concurrent execution of two or more parts of a program for maximum utilization of the CPU.
- **Dynamic**
  - Java programs carry with them substantial amounts of run-time type information that is used to verify and resolve accesses to objects at run time.
  - This makes it possible to dynamically link code in a safe and expedient manner.

A First Simple Program

```
/* This is a simple Java program. Call this file "HelloWorld.java". */
class HelloWorld
{
        public static void main(String args[])
        {
                System.out.println("Hello World");
        }
}
```

Entering the Program

- The first thing that you must learn about Java is that the name you give to a source file is very important. For this example, the name of the source file should be **HelloWorld.java**.
- In Java, all code must reside inside a class. By convention, the name of that class should match the name of the file that holds the program. It should also have same case as Java is case-sensitive.

How to write, compile, execute Java Code in Mac using TextEdit

Step 1: Open TextEdit Application

- To write your code, you will use a text editor application included on all Mac OS X operating systems.
- For more complex computer programming projects, it is recommended to use a java Integrated Development Environment (IDE) to edit your code.
- However, for simple programs, you can use basic text editor. Open the application called TextEdit.
- Click on **Finder**, **Applications**, then click on the **TextEdit** application. Open a new document.

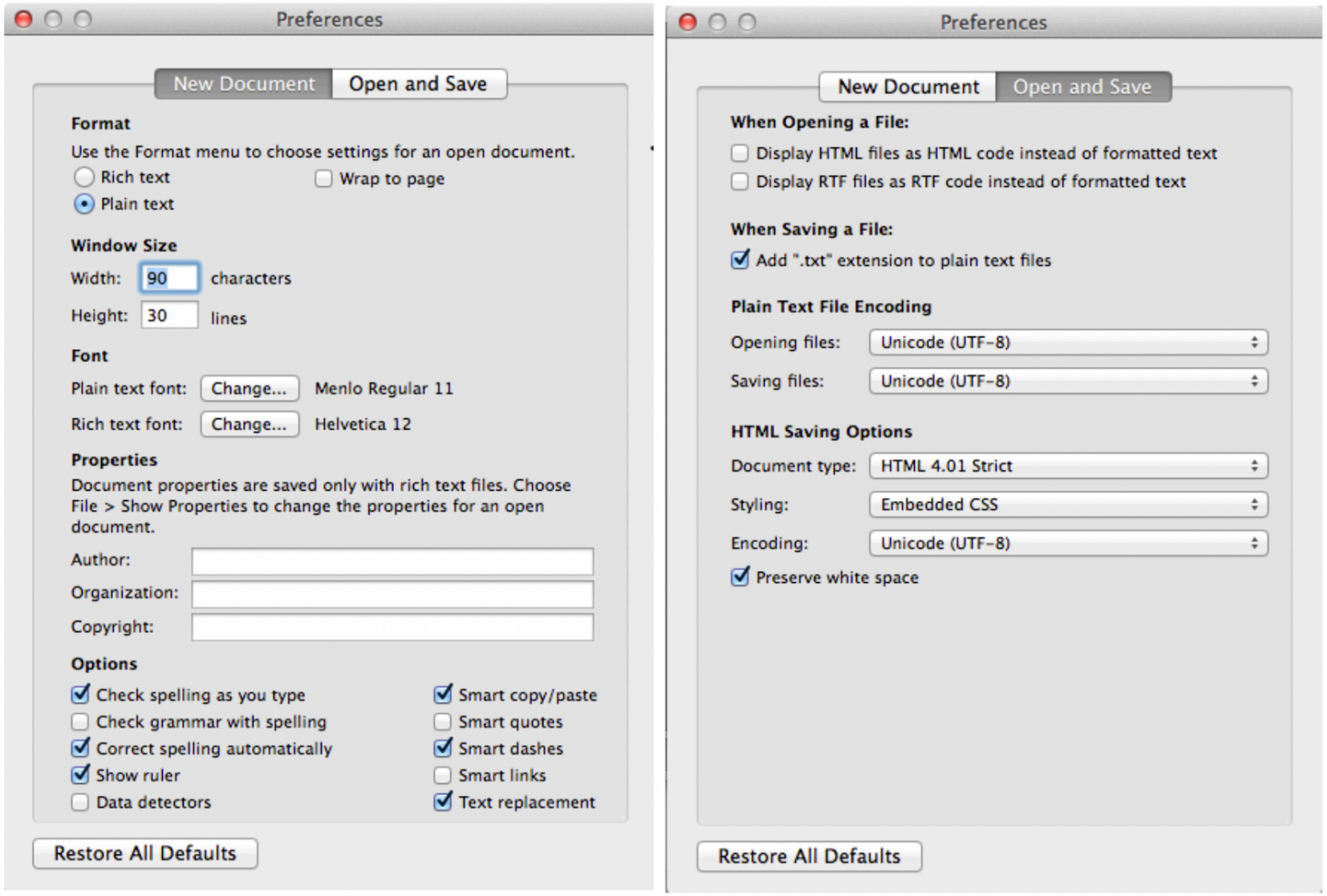
How to write, compile, execute Java Code in Mac using TextEdit

Step 2: Configure TextEdit for Java Programming

- First you must configure the text editor for java code. On the menu bar on the top left corner of your screen, click on **TextEdit**, then **Settings**.
- In the **New Document** tab, change the document format to **Plain Text** under the **Format** section. Uncheck the **Smart quotes** box under the **Options** section towards the bottom of the preference window.
- Switch to the **Open and Save** tab. Change the **Opening files** and **Saving files** to **Unicode (UTF-8)**.
- Close the TextEdit application and re-open it. Open a new document.

How to write, compile, execute Java Code in Mac using TextEdit

Step 2: Configure TextEdit for Java Programming

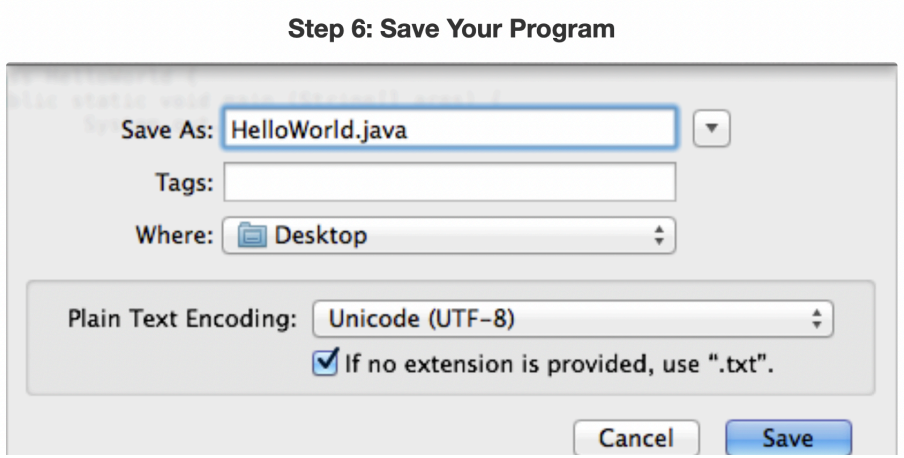


How to write, compile, execute Java Code in Mac using TextEdit

- Open TextEdit and type Java program

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

- Save your program
-



How to write, compile, execute Java Code in Mac using TextEdit

1. Open terminal
2. Change directory to your folder where you have saved your java program (hint: use get info to find path of the folder):

```
dr.ritujain@DrRitus-Air ~ % cd /Users/dr.ritujain/Desktop/java/java_prg
```

3. Compile java program: javac filename.java

```
dr.ritujain@DrRitus-Air java_prg % javac HelloWorld.java
```

4. Execute java program: java filename

```
dr.ritujain@DrRitus-Air java_prg % javac HelloWorld.java
```

5. Output should be: Hello World:

```
dr.ritujain@DrRitus-Air ~ % cd /Users/dr.ritujain/Desktop/java/java_prg
dr.ritujain@DrRitus-Air java_prg % javac HelloWorld.java
dr.ritujain@DrRitus-Air java_prg % java HelloWorld
Hello world
```

Typical cycle in Java

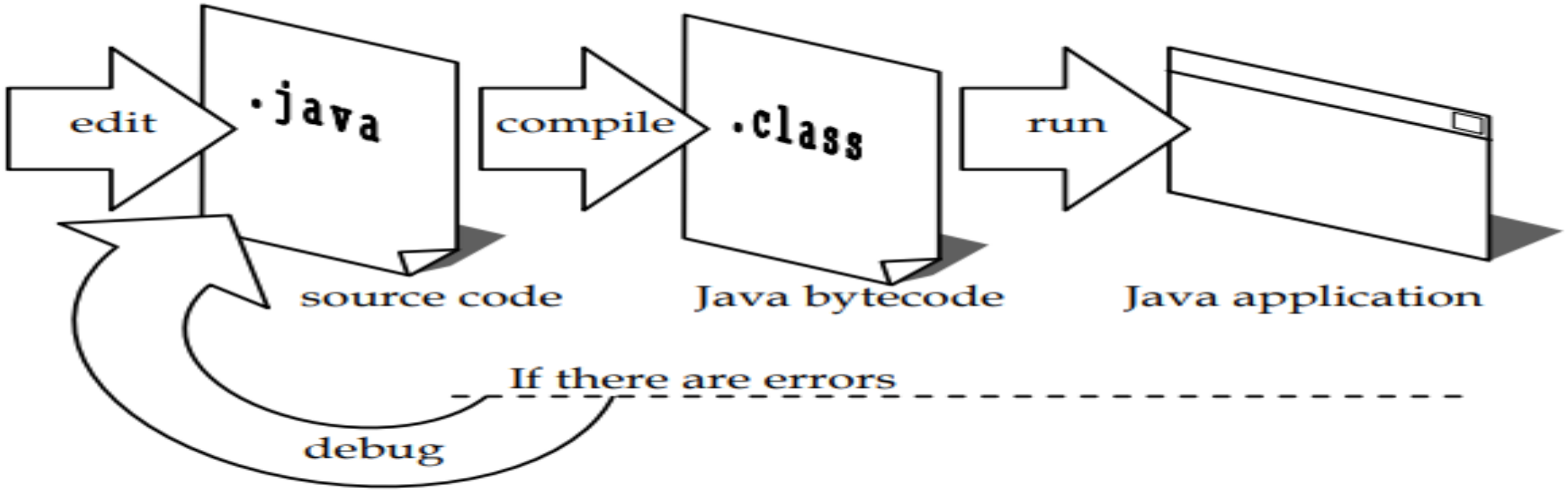


Figure 13: Typical cycle in Java programming

Lexical Issues

- Java programs are a collection of
  - *whitespace -space, tab, newline*
  - *identifiers*
  - *literals- constant, eg: 500, "Hello", 'a', 45.5, 55.5f, 5555555l*
  - *separators- (),[],{},semicolon(;), period(.), comma(,),Ellipse(...)*
  - *operators*
  - *comments- Single line(//), multiple line (/* */), documentation (/** */)*
  - *keywords*

Identifiers

- Identifiers are used for class names, method names, variable, constants or label names.
- An identifier can contain:
    - uppercase letters (A-Z),
    - lowercase letters (a-z),
    - numbers (0-9),
    - underscore (_)
    - and dollar-sign character ($) (not intended for general use)
- Identifier must not begin with a number
- Java is case-sensitive, so **VALUE** is a different identifier than **Value**.
- Some examples of valid identifiers are:

  AvgTemp, count, a4, $test, this_is_ok, _num
- Invalid identifier names include these:

  2count, a+c, high-temp, Not/ok, roll num

Java Keywords

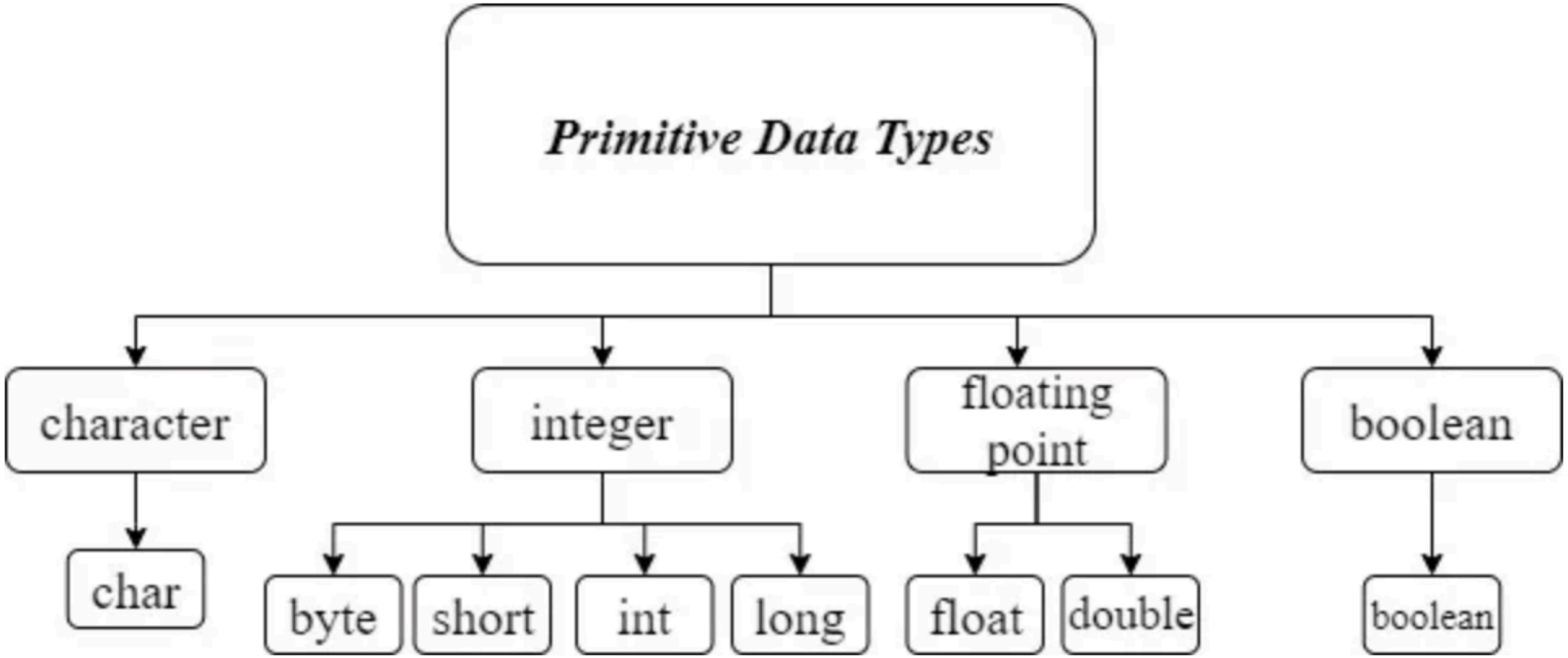
A keyword is **reserved word, that have a predefined meaning in the Java language**.

- These keywords cannot be used as an identifier.
- Java is a case sensitive language so, int and Int are not same.
- All keywords are in lower case.
- The keywords **const** and **goto** are reserved but not used.
- In addition to keywords, Java reserves following values: true, false, null . These values can't be used as identifier.

```
abstract   continue   for          new          switch
assert     default    if           package      synchronized
boolean    do         goto         private      this
break      double     implements   protected    throw
byte       else       import       public       throws
case       enum       instanceof   return       transient
catch      extends    int          short        try
char       final      interface    static       void
class      finally    long         strictfp     volatile
const      float      native       super        while
```

- _ *(underscore)*

Primitive Data Types



Primitive Data Types in Java

ITM SKILLS UNIVERSITY

DATA TYPES	SIZE	DEFAULT	EXPLAINATION
boolean	1 bit	false	Stores true or false values
byte	1 byte/ 8bits	0	Stores whole numbers from -128 to 127
short	2 bytes/ 16bits	0	Stores whole numbers from -32,768 to 32,767
int	4 bytes/ 32bits	0	Stores whole numbers from -2,147,483,648 to 2,147,483,647
long	8 bytes/ 64bits	0L	Stores whole numbers from -9,223,372,036,854,775,808 to 9,223,372,036,854,775,807
float	4 bytes/ 32bits	0.0f	Stores fractional numbers. Sufficient for storing 6 to 7 decimal digits
double	8 bytes/ 64bits	0.0d	Stores fractional numbers. Sufficient for storing 15 decimal digits
char	2 bytes/ 16bits	'\u0000'	Stores a single character/letter or ASCII values

Primitive Data Types in Java

ITM SKILLS UNIVERSITY

- **Primitive data types:** *Represent single values – not objects*
- *All data types have strictly defined range.*
- *Eight* primitive data types include
  - **Integer**: all integers (byte, short, int, long) are signed
    - byte – 8 bits
      - Examples: byte a = 10; byte b = -20;
    - short – 16 bits
      - Examples: short s = 1000;
    - int – 32 bits
      - Example: int num=565;
    - long – 64 bits
- Note: **when byte and short values are used with binary operator, they are *promoted* to int when the expression is evaluated.**

Primitive Data Types in Java

- **Floating point numbers**:
  - **float** - 32 bits; when you don't require a large degree of precision.
  - **double** – 64 bits; All math functions in Java return double values

- **char** – 16 bits; range:0-65536
  - Java uses Unicode to represent characters.
- **boolean**: true, false
  - Example: boolean b=true;

Literals

- A constant value in Java is created by using a literal representation of it. E.g: 100, 98.6, 'X' "This is a test"

- **Integer Literals:** Any whole number value is an integer literal, Eg. 345, 600,1
  - When a literal value is assigned to a **byte** or **short** variable, no error is generated if the literal value is within the range of the target type.
  - Example:
    - byte b1=10;
    - short s=5;
    - byte b2= 500; //DNC
  - Integer literal can be assigned to char as long as it is within range.
    - char c1= 97;
    - char c2= 67000; //DNC
  - Integer literal can always be assigned to a **long** variable. However, to specify a **long** literal, you will need to explicitly tell the compiler that the literal value is of type **long**.
  - Long literal is expressed by appending l or L at the end of the literal.
    - Example:
      - long l1=5000;
      - long l2=999999999999; //DNC

Floating-Point Literals

- represent decimal values with a fractional component.
- They can be expressed in either
  - **Standard notation:** *whole number component . fractional component*
    - E.g.: 2.45, 3.1456
  - **Scientific notation:** floating point number E a suffix specifies a power of 10 by which the number is to be multiplied.
    - E.g.: 6.022E23, 31459E-05, 2e+100
- *Floating-point literals in Java default to* ***double*** *precision.*
- To specify a **float** literal, you must append an *F* or *f* to the constant.
- Can also specify d or D for double literal but it is redundant.

boolean Literals

- There are only two logical values that a **boolean** value can have, **true** and **false**.
- The values of **true** and **false** do not convert into any numerical representation.
- The **true** literal in Java does not equal 1, nor does the **false** literal equal 0.
- In Java, they can only be assigned to variables declared as **boolean**, or used in expressions with boolean operators.

character Literals

- Represented by Unicode character set.
- Can be manipulated with integer operations, such as addition, subtraction operators.
- E.g: ‘a’
- Escape sequences: For characters that are impossible to enter directly, there are several escape sequences that allow you to enter the character you need, such as ‘\’’ for the single-quote character itself and **‘\n’** for the newline character.

character escape sequence

Escape Sequence	Description
\ddd	Octal character (ddd)
\uxxxx	Hexadecimal Unicode character (xxxx)
\'	Single quote
\"	Double quote
\\	Backslash
\r	Carriage return
\n	New line (also known as line feed)
\f	Form feed
\t	Tab
\b	Backspace

String Literals

- A sequence of characters between a pair of double quotes.
- E.g: “Hello World”, “two\nlines”, “\”This is in quotes\”“

Variable

- The variable is the basic unit of storage in a Java program.
- A variable is defined by the combination of an identifier, a type, and an optional initializer.

  Type identifier [= value][, identifier [= value]…];

  - Eg. int x, y, z;
  - int d=3, e, f=5;
  - double pi=3.1.4159;
  - char c='a';
  - byte b=22;

- **Dynamic Initialization:**

  double c = Math.sqrt(25.00); //sqrt() is inbuilt method of Math class

Type Conversion and Casting

Java's Automatic Conversions

- When one type of data is assigned to another type of variable, an *automatic type conversion (widening conversion)* will take place if:
  - The two types are compatible.
  - The destination type is larger than the source type.

•For widening conversions, the **numeric types, including integer and floating-point types, are compatible with each other.**

- However, there are no automatic conversions from the numeric types to **char.**
- **char** and **boolean** are not compatible with each other.
- boolean is not compatible with any datatype
- Java also performs an automatic type conversion when storing a literal integer constant into variables of type **byte**, **short**, **long**, or **char**.

Ex: Automatic Type conversion

```
class AutoTypeConvEx1 {
    public static void main(String[] args)
    {
        int i = 100;
        // Automatic type conversion:int to long type
        long l = i;

        // Automatic type conversion: long to float type
        float f = l;

        System.out.println("Int value " + i);
        System.out.println("Long value " + l);
        System.out.println("Float value " + f);
    }
}
```

Ex: numeric to char: implicit type conversion not allowed, but explicit conversion allowed

```
public class CharIntIncompat {
    public static void main(String[] argv)
    {
        char ch1 = ‘a’;
        char ch2 =98;
        int num = 99;
        // ch = num;          //DNC:incompatible type, automatic conversion not allowed
       ch= (char)num; //this is ok
    }
}
```

Narrowing or Explicit Conversion

- If we want to assign a value of larger data type to a smaller data type we need to perform **explicit type casting or narrowing conversion**.

- **Syntax: (target type) value**
- Example:
  - int i=10;
    byte b=i; //Compile time error
    byte b=(byte) i; //ok

- A different type of conversion will occur when a floating-point value is assigned to an integer type: *truncation*.
  - Example:
    - double d=55.8;
      int i=(int)d; //i=55

.

Narrowing or Explicit Conversion

- If the size of the whole number component is too large to fit into the target type, then that value will be reduced modulo the target type's range.
- Ex:

```
int a=257
byte b=(byte)a;
```

- If int value is larger than the range of byte, it will be reduced modulo byte's range
- Here, value of b will be 1 i.e. 257% 256 (range of byte)
- Fractional part will be lost, if floating point is converted to integer type.

Java program to illustrate explicit type conversion

```
//Java program to illustrate explicit type conversion
class TypeCastingEx
{       public static void main(String[] args)
        {
                double d = 100.23;

                long l = (long)d;                       //explicit type casting :truncation,
                int i = (int)l;                 //explicit type casting

                System.out.println("Long value "+l); //fractional part lost ; value: 100

                System.out.println("Int value "+i);        //fractional part lost; value: 100

        }
}
```

Type promotion in Expressions

- While evaluating expressions, conditions for type promotion are:
  - Java automatically promotes each byte, short, or char operand to int when evaluating an expression having binary operator.
  - If one operand is a long, float or double the whole expression is promoted to long, float or double respectively.

  - What would be the output?
    - byte b = 50;
    - b = b * 2;
    - Output: Compile time error
    - Correct way: b=(byte) (b*2);

Type promotion in Expressions

```
//Java program to illustrate Type promotion in Expressions
class TypePromotionEx
{
        public static void main(String args[])
        {
                byte b = 42;
                short s = 1024;
                float f = 5.67f;
                double d = .1234;
                double result = (f * b) - (d * s);  //if type of res is float, compile error
                System.out.println("result = " + result);
        }
}
```

Format Specifiers

%d : for all integral types
%f: for all floating point types
%c: for characters
%s : for string
%b : for boolean

```
class FormatSpecEx
{
  public static void main(String args[])
    {
        byte b1=2;
        int i =5;
        long l =100;
        short s = 20;
        float f =5.5f;
        double d = 55.5;
        char c = 'a';
        String st = "Hello";
         boolean b_var =false;
        System.out.printf("%d %d %d %d", b1, i, l, s);
        System.out.printf(" \n %c %s", c, st);
        System.out.printf("\n %f %f, ", f, d);
        System.out.printf(“%b”, b_var);
    }
}
```

Operators in java

- **Operator** in java is a symbol that is used to perform operations.
  - Arithmetic Operator
  - Bitwise Operator
  - Relational Operator
  - Boolean Logical Operator
  - Assignment Operator
  - ? Operator

Arithmetic Operator

Operator	Result
+	Addition
–	Subtraction (also unary minus)
*	Multiplication
/	Division
%	Modulus
++	Increment
+=	Addition assignment
–=	Subtraction assignment
*=	Multiplication assignment
/=	Division assignment
%=	Modulus assignment
– –	Decrement

- The operands of the arithmetic operators must be of a numeric type. You cannot use them on **boolean** types, but you can use them on **char** types, since the **char** type in Java is, essentially, a subset of **int**.
- When the division operator is applied to an integer type, there will be no fractional component attached to the result (truncation).

```
// Demonstrate the basic arithmetic operators.
class BasicMath {
public static void main(String args[]) {
        int a = 1 + 1;   //2
        int b = a * 3;    //6
        int c = b / 4;    //1
        int d = c - a;    //-1
        int e = -d;       //1
        System.out.printf("a = %d, b = %d, c= %d, d = %d,  e= %d“, a, b, c, d, e);
         System.out.println("\nFloating Point Arithmetic");
        double da = 1 + 1;     //2.0
        double db = da * 3;    //6.0
        double dc = db / 4;    //1.5
        double dd = dc - a;     //-0.5
        double de = -dd;        //0.5
        System.out.printf(“a = %f, b = %f, c= %f, d = %f,   e= %f”, da, db, dc, dd,
de);
        }
}
```

The Modulus Operator

It can be applied to floating-point types as well as integer types.

```
// Demonstrate the % operator.
class Modulus
{
        public static void main(String args[])
         {
                int x = 42;
                double y = 42.25;
                System.out.println("x mod 10 = " + x % 10);   //2
                System.out.println("y mod 10 = " + y % 10);   //2.25
        }
}
```

Compound assignment operators

- Java provides special operators that can be used to combine an arithmetic operation with an assignment.

  a = a + 4; can be rewritten as a += 4;

  a = a % 4; can be rewritten as a %= 4;

  var = var op expression; can be rewritten as

  var op= expression;

- The compound assignment operators provide two benefits:
  - First, they save you a bit of typing,
  - Second, they are implemented more efficiently by the Java run-time system than are their equivalent long forms.

```
// Demonstrate several assignment operators.
class OpEquals
{
        public static void main(String args[])
        {
                int a = 1;
                int b = 2;
                int c = 3;
                a += 5;                 //6
                b *= 4;                 //8
                c += a * b;             //3+48=51
                c %= 6;                 // 3
                System.out.println("a = " + a);
                System.out.println("b = " + b);
                System.out.println("c = " + c);
        }
}
```

Increment and Decrement

- The increment operator increases its operand by one.
- The decrement operator decreases its operand by one.
- x = x + 1; can be rewritten as x++;
- x = x - 1 is equivalent to x--

Increment and Decrement Operator

- In the **prefix form**, the operand is incremented or decremented before the value is obtained for use in the expression.
- In **postfix form**, the previous value is obtained for use in the expression, and then the operand is modified.
- For example:

```
x = 42;
y = ++x; // y= 43 x = 43
```

- when written like this,

```
x = 42;
y = x++; // y = 42, x= 43
```

Bitwise Operators

- Java defines several *bitwise operators* that can be applied to the integer types, **long**, **int**, **short**, **char**, and **byte**.
- These operators act upon the individual bits of their operands

Operator	Result
~	Bitwise unary NOT
&	Bitwise AND
|	Bitwise OR
^	Bitwise exclusive OR
>>	Shift right
>>>	Shift right zero fill
<<	Shift left
&=	Bitwise AND assignment
|=	Bitwise OR assignment
^=	Bitwise exclusive OR assignment
>>=	Shift right assignment
>>>=	Shift right zero fill assignment
<<=	Shift left assignment

Bitwise Logical Operator

A	B	A | B	A & B	A ^ B	~A
0	0	0	0	0	1
1	0	1	0	1	0
0	1	1	0	1	1
1	1	1	1	0	0

Left Shift

- The left shift operator, **<<**, shifts all of the bits in a value to the left a specified number of times.

  Syntax: *value << num*
- Here, *num* specifies the number of positions to left-shift the value in *value*.

  E.g.:
```
byte a =64;
int i;
i = a<<2;   // i=256
```

- For each shift left, the high-order bit is shifted out (and lost), and a zero is brought in on the right.

  E.g.:
```
b= (byte)(a<<2);
system.out.println("b= "+ b);          //b =0
```
- This means that when a left shift is applied to an **int** operand, bits are lost once they are shifted past bit position 31.
- If the operand is a **long**, then bits are lost after bit position 63.
- Each left shift doubles the original value (multiply by 2).

Left Shift

- Java's automatic type promotions produce unexpected results when you are shifting **byte** and **short** values, as **byte** and **short** values are promoted to **int** when an expression is evaluated.
- Furthermore, the result of such an expression is also an **int**. This means that the outcome of a left shift on a **byte** or **short** value will be an **int**, and the bits shifted left will not be lost until they shift past bit position 31.
- Furthermore, a negative **byte** or **short** value will be sign-extended when it is promoted to **int**. Thus, the high-order bits will be filled with 1's.

Right Shift

- The right shift operator, >>, shifts all of the bits in a value to the right a specified number of times.

  syntax: *value >> num*

- Here, *num* specifies the number of positions to right-shift the value in *value*.

e.g1:

```
int a = 32;
a = a >> 2; // a now contains 8
```

e.g2:

```
int a = 35;
a = a >> 2; // a still contains 8
```

- Each time you shift a value to the right, it divides that value by two—and discards any remainder.

Right Shift

- When you are shifting right, the top (leftmost) bits exposed by the right shift are filled in with the previous contents of the top bit. This is called *sign extension* and serves to preserve the sign of negative numbers when you shift them right.
- For example, –8 >> 1 is –4, which, in binary, is

```
11111000    –8>>1
11111100    –4
```

Unsigned Right Shift

- Java's unsigned, shift-right operator, >>>, which always shifts zeros into the high-order bit.

  int a = -1;

  a = a >>> 24;

  Here is the same operation in binary form:

  11111111 11111111 11111111 11111111 –1 in binary

  >>>24

  00000000 00000000 00000000 11111111 255 in binary

Relational Operators

Operator	Result
==	Equal to
!=	Not equal to
>	Greater than
<	Less than
>=	Greater than or equal to
<=	Less than or equal to

Note: The outcome of these operations is **boolean** value.

Relational Operators

- Most frequently used in the expressions that control the **if** statement and the various **loop** statements.
- Any type in Java, including integers, floating-point numbers, characters, and boolean can be compared using the equality test, **==**, and the inequality test, **!=**.
- Only numeric types can be compared using <, >, <=, >= operators. That is, only integer, floating-point, and character operands may be compared to see which is greater or less than the other.
- int a = 4;
  int b = 1;
  boolean c = a < b;
- In this case, the result of **a<b** (which is **false**) is stored in **c**
- In Java, these statements must be written like this:

```
int done=0;
if(done == 0)... // This is Java-style.
if(done != 0)...
```

Boolean Logical Operators

Operator	Result
&	Logical AND
|	Logical OR
^	Logical XOR (exclusive OR)
||	Short-circuit OR
&&	Short-circuit AND
!	Logical unary NOT
&=	AND assignment
|=	OR assignment
^=	XOR assignment
==	Equal to
!=	Not equal to
?:	Ternary if-then-else

- The Boolean logical operators shown here operate only on **boolean** operands.
- Result will be **boolean** value.

Boolean Logical Operators

A	B	A | B	A & B	A ^ B	!A
False	False	False	False	False	True
True	False	True	False	True	False
False	True	True	False	True	True
True	True	True	True	False	False

```
// Demonstrate the boolean logical operators.
class BoolLogic
{
    public static void main(String args[])
    {
        boolean a = true;
        boolean b = false;
        boolean c = a | b;
        boolean d = a & b;
        boolean e = a ^ b;
        boolean f = (!a & b) | (a & !b);
        boolean g = !a;

        System.out.println(" a|b = " + c);              //true
        System.out.println(" a&b = " + d);              //false
        System.out.println(" a^b = " + e);              //true
        System.out.println("(!a&b)|(a&!b) = " + f);     //true
        System.out.println(" !a = " + g);               //false
    }
}
```

Short-Circuit Logical Operators

- If you use the || and **&&** forms, Java will not bother to evaluate the right-hand operand when the outcome of the expression can be determined by the left operand alone.
- This is very useful when the right-hand operand depends on the value of the left one in order to function properly.
- if (denom != 0 && num / denom > 10)
- If this line of code were written using the single **&** version of AND, both sides would be evaluated, causing a run-time exception when **denom** is zero.
- Use simple Logical operator in the following case:

  if(c==1 & e++ < 100) d = 100;
- Here, using a single **&** ensures that the increment operation will be applied to **e** whether **c** is equal to 1 or not.

The Assignment Operator

Chain of assignments:

int x, y, z;

x = y = z = 100; // set x, y, and z to 100

- The = is an operator that yields the value of the right-hand expression.
- The value of **z = 100** is 100, which is then assigned to **y**, which in turn is assigned to **x**.

The ? Operator

- *expression1* **?** *expression2* **:** *expression3*
- *expression1 can be any expression that evaluates to a* ***boolean*** *value.*
- If *expression1* is **true**, then *expression2* is evaluated; otherwise, *expression3* is evaluated.
- E.g1 : ratio = denom == 0 ? 0 : num / denom;
- E.g2: int s=7;
  System.out.println(s>5? 21: ”a”);
  int n=s>5? 21: ”a”; //DNC

Operator Precedence (Highest to lowest)

Separators [],(), . have highest precedence

Highest						
++ (postfix)	– – (postfix)					
++ (prefix)	– – (prefix)	~	!	+ (unary)	– (unary)	(*type-cast*)
*	/	%				
+	–					
>>	>>>	<<				
>	>=	<	<=	instanceof		
==	!=					
&						
^						
|						
&&						
||						
?:						
->						
=	op=					
Lowest						

Operator Precedence

- Operators with higher precedence are evaluated before operators with relatively lower precedence.
- Operators on the same row have equal precedence.
- When operators of equal precedence appear in the same expression, a rule must govern which is evaluated first.
- Associativity of unary operators, ternary operator, assignment operator is right to left otherwise for all other operators, it is left to right.
- Separators [], (), . have highest precedence.

How to get Java Scanner

To get the instance of Java Scanner which reads input from the user, we need to pass the input stream (System.in) in the constructor of Scanner class. For Example:

```
Scanner in = new Scanner(System.in);
```

Methods of Scanner Class

ITM SKILLS UNIVERSITY

boolean	nextBoolean()	It scans the next token of the input into a boolean value and returns that value.
byte	nextByte()	It scans the next token of the input as a byte.
double	nextDouble()	It scans the next token of the input as a double.
float	nextFloat()	It scans the next token of the input as a float.
int	nextInt()	It scans the next token of the input as an Int.
String	nextLine()	This method can read the input till the end of line.
long	nextLong()	It scans the next token of the input as a long.
short	nextShort()	It scans the next token of the input as a short.
String	next()	This method can read the input only until a space(" ") is encountered.

```
//WAP for Accepting single character, int, float, string and double value from the //keyboard
import java.util.Scanner;
public class UserInput1
{
    public static void main(String args[])
    {
                Scanner sc=new Scanner(System.in);
                System.out.println("Enter an integer number”);
                int i=sc.nextInt();
                System.out.println("int i:  "+i);

                System.out.println("Enter an float number");
                float f=sc.nextFloat();
                System.out.println("float f:  "+f);

                System.out.println("Enter an double number");
                double d=sc.nextDouble();
                System.out.println("double d:  "+d);

                System.out.println("Enter a String");
                String s=sc.next();
                System.out.println("String s:  "+s);

                System.out.println("Enter a character");
                char c=sc.next().charAt(0);
                System.out.println("char c:  “+c);
}
}
```

Control Statements

- Control statements are divided into three groups:
  1. Selection (if and switch)
  2. Iteration (do while, while, for, for each)
  3. Jump (break and continue)

Selection statements

- allow to control the flow of program's execution based upon conditions known only during run-time.
- Java provides four selection statements:
    1) if
    2) if-else
    3) if-else-if
    4) switch

if statement

if (*condition*) {

***statement block1*;**

}

Statement_2;

- If condition is true, statement_block1 is executed and the statement_2 is executed.
- If condition is false, statement_block1 is skipped and the statement_2 is executed.

```
int a, b;
//...
if(a < b) a = 0;
else b = 0;
```

if else statement

```
if (condition) {
        statement block1;
}
else {
   statement block2;
}
```

- Note that the **else** clause is optional.
- If the condition is **true**, then *statement1* is executed, else *statement2* is executed.
- Remember that both *statement1* and *statement2* will not be executed in any situation.

nested if

```
if(condition)
{
    if(condition)
        statement;
}
else
    statement;

statement 2;
```

Nested if

```
if(i == 10) {
  if(j < 20) a = b;
  if(k > 100) c = d;
  else a = c;
}
else a = d;
```

else if ladder

- The general form of the **if-else-if** ladder is :

```
if(condition)
   statement;
else if(condition)
        statement;
else if(condition)
        statement;
:
:
else
        statement;
```

```
// Demonstrate if-else-if statements.
class IfElse {
  public static void main(String args[]) {
    int month = 4; // April
    String season;

    if(month == 12 || month == 1 || month == 2)
      season = "Winter";
    else if(month == 3 || month == 4 || month == 5)
      season = "Spring";
    else if(month == 6 || month == 7 || month == 8)
      season = "Summer";
    else if(month == 9 || month == 10 || month == 11)
      season = "Autumn";
    else
      season = "Bogus Month";

    System.out.println("April is in the " + season + ".");
  }
}
```

switch statement

- The **switch** statement provides multiway branching and is often a better alternative to nested **if-else-if** statements. The general form of the switch statement is :

```
switch(expression) {
        case value1: statement block;
                     break;
        case value2: statement block;
                     break;
        :
        case value n: statement block;
                      break;
        default:    default statement block;
        }
```

Note: The expression must be of type **byte**, **short**, **int, char or String**

switch statement

- Each of the values specified in the case statements must be of a type compatible with the expression.
- Each case value must be a literal.
- Duplicate case values are also not allowed.
- The value of the expression is compared with each literal value in the **case**.
- When a match is found, the set of statements following that **case** statement is executed. If none of the values match, then the default statement is executed.
- Note however, that the **default** statement is optional. If there are no case matches and there is no default statement then no further action takes place.
- The use of the **break** statement is to terminate the statement block, when the **break** is encountered execution branches to the first line of the code that follows the **switch** statement.
- The **break** statement is optional. If you do not use the **break** statement, execution continues with the next **case**.

switch

- *The **switch** statement differs from **if** statement in that, the switch can test only for equality, whereas **if** can evaluate any type of **Boolean** expression.*
- *No two case constants in the same **switch** can have identical values.*
- *A **switch** statement is generally more efficient than a set of nested **if** statements.*

```
// A simple example of the switch.
class SampleSwitch {
  public static void main(String args[]) {
    for(int i=0; i<6; i++)
      switch(i) {
        case 0:
          System.out.println("i is zero.");
          break;
        case 1:
          System.out.println("i is one.");
          break;
        case 2:
          System.out.println("i is two.");
          break;
        case 3:
          System.out.println("i is three.");
          break;
        default:
          System.out.println("i is greater than 3.");
      }
  }
}
```

Using a String to control Switch

```
class StringSwitch
{
  public static void main(String args[])
    {
       String str = “two”;
        switch(str)
         {
           case “one”:
                  System.out.println(“one”);
                                 break;
           case “two”:
                                  System.out.println(“two”);
                                  break;
               case “three”:
                                 System.out.println(“three”);
           default:
                                System.out.println(“no match”);
              }
         }
}
```

Nested switch Statements

```
switch(count) {
        case 1:
                switch(target)
                { // nested switch
                        case 0:
                                System.out.println("target is zero");
                                break;
                        case 1: // no conflicts with outer switch
                                System.out.println("target is one");
                                break;
                }
                break;
        case 2: // ...
```

break statement

- Break can be used to:
  - terminates a statement sequence in a **switch** statement.
  - can be used to exit a loop.
  - Labelled break can be used to terminate can be used as a “civilized” form of goto.

break to exit from a loop

By using **break**, you can force immediate termination of a loop, bypassing the conditional expression and any remaining code in the body of the loop.

```
// Using break to exit a loop.
class BreakLoop {
  public static void main(String args[]) {
    for(int i=0; i<100; i++) {
      if(i == 10) break; // terminate loop if i is 10
      System.out.println("i: " + i);
    }
    System.out.println("Loop complete.");
  }
}
```

ITM SKILLS UNIVERSITY

```
// Using break with nested loops.
class BreakLoop3 {
  public static void main(String args[]) {
    for(int i=0; i<3; i++) {
      System.out.print("Pass " + i + ": ");
      for(int j=0; j<100; j++) {
        if(j == 10) break; // terminate loop if j is 10
        System.out.print(j + " ");
      }
      System.out.println();
    }
    System.out.println("Loops complete.");
  }
}
```

```
  public static void main(String args[]) {
    boolean t = true;

    first: {
      second: {
        third: {
          System.out.println("Before the break.");
          if(t) break second; // break out of second block
          System.out.println("This won't execute");
        }
        System.out.println("This won't execute");
      }
      System.out.println("This is after second block.");
    }
  }
}
```

ITM SKILLS UNIVERSITY

```
// Using break to exit from nested loops
class BreakLoop4 {
  public static void main(String args[]) {
    outer: for(int i=0; i<3; i++) {
      System.out.print("Pass " + i + ": ");
      for(int j=0; j<100; j++) {
        if(j == 10) break outer; // exit both loops
        System.out.print(j + " ");
      }
      System.out.println("This will not print");
    }
    System.out.println("Loops complete.");
  }
}
```

continue

- Sometimes you may want to continue running a loop, but stop processing the remaining loop body for this particular iteration. In such a situation, you make use of the **continue** statement.
- In a **while** and **do-while** loop the **continue** statement causes control to be directly transferred to the conditional expression that controls the loop.
- In the **for** loop, the control first goes to the iteration portion of the **for** statement and then to the conditional expression.
- In all the three cases, any intermediate code is bypassed. **continue** may also specify a label to describe which enclosing loop to continue.

Example of continue statement

```
//Java Program to demonstrate the use of continue statement  inside the for
loop.
public class ContinueExample {
public static void main(String[] args) {
        for(int i=1;i<=10;i++){
        if(i==5){
                        continue;
        }
        System.out.println(i+” “);
    }
}
}
```

Labelled Continue

```
class ContinueLabel
{
   public static void main(String args[])
    {
        outer: for (int i=0; i<3; i++)
          {
            for(int j=0; j<5; j++)
             {
                if(j > i)
                 {
                    System.out.println();
                    continue outer;
                 }
                System.out.print(" " + (i * j));
             }
          }
        System.out.println();
    }
}
```

Output:

```
0
0 1
0 2 4
```