Core Java

Java Buzzwords/Features

1. Simple
    - Java was designed to be easy for a 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.
    - If you are an experienced C++ programmer, moving to Java will require very little effort. Because Java inherits the C/C++ syntax and many of the object-oriented features of C++, most programmers have little trouble learning Java.
    - Java has removed many complicated or rarely-used features of C++, for example, pointers, operator overloading, etc.
    - Java was Simple till Java 1.4. Later many new features are added in language to make it powerful (but complex too).
2. Object Oriented
    - Java is a object-oriented programming language.
    - Almost the "Everything is an Object" paradigm. All program code and data reside within objects and classes.
    - The object model in Java is simple and easy to extend.
    - Java comes with an extensive set of classes, arranged in packages that can be used in our programs through inheritance.
    - The basic concepts of OOPs are:
        - Object
        - Class
        - Abstraction
        - Encapsulation
        - Inheritance
        - Composition
        - Polymorphism
3. Distributed
    - Java is designed to create distributed applications connected over the network.
    - Java applications can access remote objects on the Internet as easily as they can do in the local system.
    - Java is designed for the distributed environment of the Internet. It handles TCP/IP protocols.
4. 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 the creation of cross-platform programs by compiling them into an intermediate representation called Java Bytecode.
    - Interpreted: Bytecode is then interpreted, which generates machine code that can be directly executed by the machine/CPU.
5. Robust
    - It provides many features that make the program execute reliably in a variety of environments.
    - Java is a strictly typed language. It checks code both at compile time and runtime.

    - Java takes care of all memory management problems with garbage collection.
    - Exception handling captures all types of serious errors and eliminates any risk of crashing the system.
6. Secure
    - When a Java Compatible Web browser is used, downloading applets can be done safely without fear of infection or malicious intent.
    - 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.
7. Architecture Neutral
    - Java language and Java Virtual Machine helped in achieving the goal of WORA - Write (Compile) Once Run Anywhere.
    - Java byte code is interpreted and converted into CPU machine code/native code. So Java byte code can execute on any CPU architecture (on which JVM is available) like x86, SPARC, PPC, MIPS, etc.
8. Portable
    - Java is portable because of the Java Virtual Machine (JVM). The JVM is an abstract computing machine that provides a runtime environment for Java programs to execute.
    - The JVM provides a consistent environment for Java programs to run on, regardless of the underlying operating system. Java program can be written on one device and run on any other device with a JVM installed, without any changes or modifications.
9. High Performance
    - Java performance is high because of the use of bytecode.
    - The bytecode was used so that it can be efficiently translated into native machine code by JIT compiler (in JVM).
10. Multithreaded
    - Multithreaded Programs handled multiple tasks simultaneously (within a process), which was helpful in creating interactive, networked programs.
    - Java supports multi-process/thread communication and synchronization.
11. Dynamic
    - Java is capable of linking in new class libraries, methods, and objects.
    - Java classes has run-time type information (reflection) that is used to verify and resolve accesses to objects/members at runtime. This makes it possible to dynamically link code in a safe and expedient manner.

CLASSPATH

- CLASSPATH: Contains set of directories separated by ; (Windows) or : (Linux).
    - Java's environment variable by which one can inform Java compiler, application launcher, JVM and other Java tools about the directories in which Java classes/packages are kept.
    - CLASSPATH variable can be modified using "set" command (Windows) or "export" command (Linux).
        - Windows cmd> set CLASSPATH=\path\to\set;%CLASSPATH%
        - Linux terminal> export CLASSPATH=/path/to/set:$CLASSPATH
    - To display CLASSPATH variable
        - Windows cmd> set CLASSPATH
        - Linux terminal> echo $CLASSPATH
- Compilation and Execution (source code in "src" directory and .class file in "bin" directory)

- terminal> cd \path\of\src directory
- terminal> javac -d ..\bin Program.java
- terminal> set CLASSPATH=..\bin
- terminal> java Program

Console Input/Output

- Java has several ways to take input and print output. Most popular ways in Java 8 are given below:
- Using java.util.Scanner and System.out

```
Scanner sc = new Scanner(System.in);
System.out.print("Enter name: ");
String name = sc.nextLine();
System.out.print("Enter age: ");
int age = sc.nextInt();
System.out.println("Name: " + name + ", Age: " + age);
System.out.printf("Name: %s, Age: %s\n", name, age);
```

Language Fundamentals

Naming conventions

- Names for variables, methods, and types should follow Java naming convention.
- Camel notation for variables, methods, and parameters.
  - First letter each word except first word should be capital.
  - For example:

```
public double calculateTotalSalary(double basicSalary, double
incentives) {
    double totalSalary = basicSalary + incentives;
    return totalSalary;
}
```

- Pascal notation for type names (i.e. class, interface, enum)
  - First letter each word should be capital.
  - For example:

```
class CompanyEmployeeManagement {
    // ...
}
```

- Package names must be in lower case only.
  - For example: javax.servlet.http;
- Constant fields must be in upper case only.
  - For example:

```
final double PI = 3.14;
final int WEEKDAYS = 7;
final String COMPANY_NAME = "Sunbeam Infotech";
```

Keywords

- Keywords are the words whose meaning is already known to Java compiler.
- These words are reserved i.e. cannot be used to declare variable, function or class.
- Java 8 Keywords
    1. abstract - Specifies that a class or method will be implemented later, in a subclass
    2. assert - Verifies the condition. Throws error if false.
    3. boolean- A data type that can hold true and false values only
    4. break - A control statement for breaking out of loops.
    5. byte - A data type that can hold 8-bit data values
    6. case - Used in switch statements to mark blocks of text
    7. catch - Catches exceptions generated by try statements
    8. char - A data type that can hold unsigned 16-bit Unicode characters
    9. class - Declares a new class
    10. continue - Sends control back outside a loop
    11. default - Specifies the default block of code in a switch statement
    12. do - Starts a do-while loop
    13. double - A data type that can hold 64-bit floating-point numbers
    14. else - Indicates alternative branches in an if statement
    15. enum - A Java keyword is used to declare an enumerated type. Enumerations extend the base class.
    16. extends - Indicates that a class is derived from another class or interface
    17. final - Indicates that a variable holds a constant value or that a method will not be overridden
    18. finally - Indicates a block of code in a try-catch structure that will always be executed
    19. float - A data type that holds a 32-bit floating-point number
    20. for - Used to start a for loop
    21. if - Tests a true/false expression and branches accordingly
    22. implements - Specifies that a class implements an interface
    23. import - References other classes
    24. instanceof - Indicates whether an object is an instance of a specific class or implements an interface
    25. int - A data type that can hold a 32-bit signed integer
    26. interface- Declares an interface
    27. long - A data type that holds a 64-bit integer
    28. native - Specifies that a method is implemented with native (platform-specific) code
    29. new - Creates new objects
    30. null - This indicates that a reference does not refer to anything
    31. package - Declares a Java package
    32. private - An access specifier indicating that a method or variable may be accessed only in the class it's declared in

33. protected - An access specifier indicating that a method or variable may only be accessed in the class it’s declared in (or a subclass of the class it’s declared in or other classes in the same package)
34. public - An access specifier used for classes, interfaces, methods, and variables indicating that an item is accessible throughout the application (or where the class that defines it is accessible)
35. return - Sends control and possibly a return value back from a called method
36. short - A data type that can hold a 16-bit integer
37. static - Indicates that a variable or method is a class method (rather than being limited to one particular object)
38. strictfp - A Java keyword is used to restrict the precision and rounding of floating-point calculations to ensure portability.
39. super - Refers to a class’s base class (used in a method or class constructor)
40. switch - A statement that executes code based on a test value
41. synchronized - Specifies critical sections or methods in multithreaded code
42. this - Refers to the current object in a method or constructor
43. throw - Creates an exception
44. throws - Indicates what exceptions may be thrown by a method
45. transient - Specifies that a variable is not part of an object’s persistent state
46. try - Starts a block of code that will be tested for exceptions
47. void - Specifies that a method does not have a return value
48. volatile - This indicates that a variable may change asynchronously
49. while - Starts a while loop
50. goto, const - Unused keywords (Reserved words)
51. true, false, null - Literals (Reserved words)

Data types

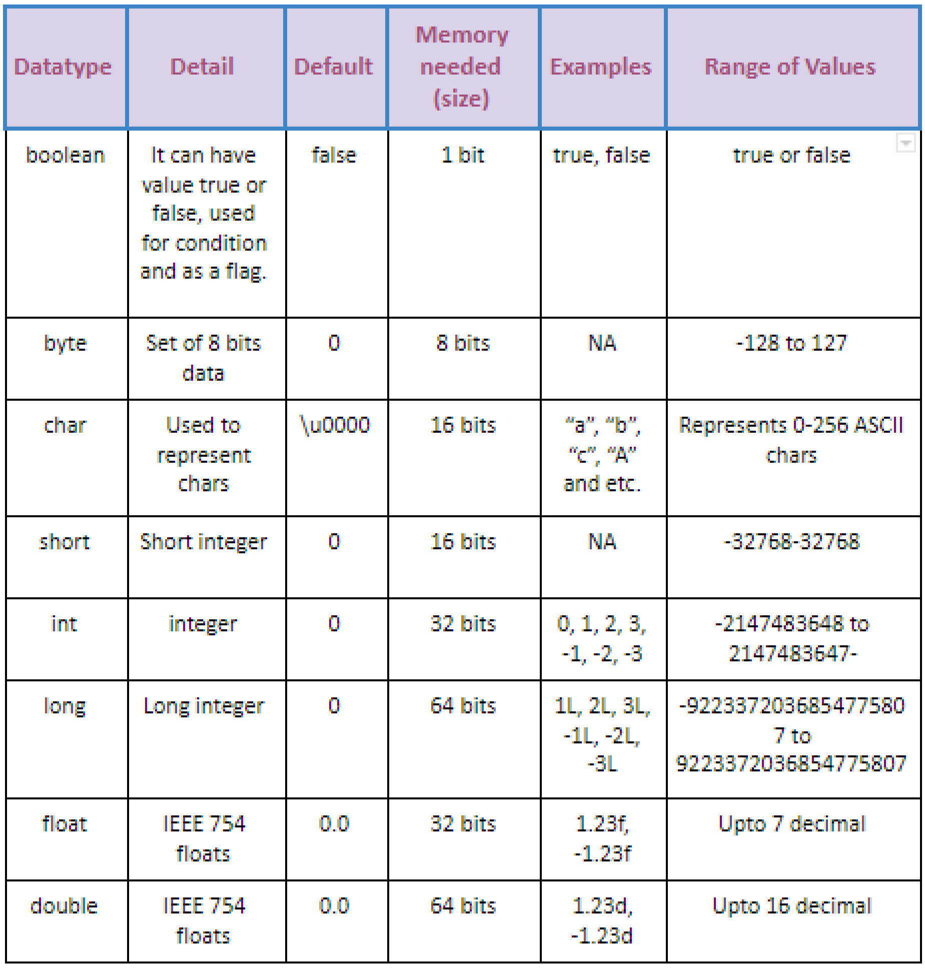
- Data type describes:
  - Memory is required to store the data
  - Kind of data memory holds
  - Operations to perform on the data
- Java is strictly type checked language.
- In java, data types are classified as:
  - Primitive types or Value types
  - Non-primitive types or Reference types

```
Data types
    |- Primitive types (Value types)
    |      |- Boolean: boolean
    |      |- Character: char
    |      |- Integral: byte, short, int, long
    |      |- Floating-point: float, double
    |
    |- Non-Primitive types (Reference types)
           |- class
           |- interface
           |- enum
           |- Array
```

1. boolean (size is not specified)
2. byte (size is 1 byte)
3. char (size is 2 bytes)
4. short (size is 2 bytes)
5. int (size is 4 bytes)
6. float (size is 4 bytes)
7. double (size is 8 bytes)
8. long (size is 8 bytes)

- primitive types(boolean, byte, char, short, int ,float, double, long) are not classes in Java.

```
Stack<int> s1 =  new Stack<int>( ); //Not OK
Stack<Integer> s1 =  new Stack<Integer>( ); //OK
```

- 

Datatype	Detail	Default	Memory needed (size)	Examples	Range of Values
boolean	It can have value true or false, used for condition and as a flag.	false	1 bit	true, false	true or false
byte	Set of 8 bits data	0	8 bits	NA	-128 to 127
char	Used to represent chars	\u0000	16 bits	“a”, “b”, “c”, “A” and etc.	Represents 0-256 ASCII chars
short	Short integer	0	16 bits	NA	-32768-32768
int	integer	0	32 bits	0, 1, 2, 3, -1, -2, -3	-2147483648 to 2147483647-
long	Long integer	0	64 bits	1L, 2L, 3L, -1L, -2L, -3L	-9223372036854775807 to 9223372036854775807
float	IEEE 754 floats	0.0	32 bits	1.23f, -1.23f	Upto 7 decimal
double	IEEE 754 floats	0.0	64 bits	1.23d, -1.23d	Upto 16 decimal

- Widening: We can convert state of object of narrower type into wider type. it is called as "widening".

```
int num1 = 10;
double num2 = num1; //widening
```

- Narrowing: We can convert state of object of wider type into narrower type. It is called "narrowing".

```
double num1 = 10.5;
int num2 = (int) num1; //narrowing
```

- Rules of conversion
  - source and destination must be compatible i.e. destination data type must be able to store larger/equal magnitude of values than that of source data type.
  - Rule 1: Arithmetic operation involving byte, short automatically promoted to int.
  - Rule 2: Arithmetic operation involving int and long promoted to long.
  - Rule 3: Arithmetic operation involving float and long promoted to float.
  - Rule 4: Arithmetic operation involving double and any other type promoted to double.
- Type Conversions

Literals

- Six types of Literals:
  - Integral Literals
  - Floating-point Literals
  - Char Literals
  - String Literals
  - Boolean Literals
  - null Literal

Integral Literals

- Decimal: It has a base of ten, and digits from 0 to 9.
- Octal: It has base eight and allows digits from 0 to 7. Has a prefix 0.
- Hexadecimal: It has base sixteen and allows digits from 0 to 9 and A to F. Has a prefix 0x.
- Binary: It has base 2 and allows digits 0 and 1.
- For example:

```
int x = 65; // decimal const don't need prefix
int y = 0101; // octal values start from 0
int z = 0x41; // hexadecimal values start from 0x
int w = 0b01000001; // binary values start with 0b
```

- Literals may have suffix like U, L.
  - L -- represents long value.

```
long x = 123L; // long const assigned to long variable
long y = 123; // int const assigned to long variable -- widening
```

Floating-Point Literals

- Expressed using decimal fractions or exponential (e) notation.

- Single precision (4 bytes) floating-point number. Suffix f or F.
- Double precision (8 bytes) floating-point number. Suffix d or D.
- For example:

```
float x = 123.456f;
float y = 1.23456e+2;   // 1.23456 x 10^2 = 123.456
double z = 3.142857d;
```

Char Literals

- Each char is internally represented as integer number - ASCII/Unicode value.
- Java follows Unicode char encoding scheme to support multiple langauges.
- For example:

```
char x = 'A';       // char representation
char y = '\101';    // octal value
char z = '\u0041';  // unicode value in hex
char w = 65;        // unicode value in dec as int
```

- There are few special char literals referred as escape sequences.
  - \n -- newline char -- takes cursor to next line
  - \r -- carriage return -- takes cursor to start of current line
  - \t -- tab (group of 8 spaces)
  - \b -- backspace -- takes cursor one position back (on same line)
  - ' -- single quote
  - " -- double quote
  - \ -- prints single \
  - \0 -- ascii/unicode value 0 -- null character

String Literals

- A sequence of zero or more unicode characters in double quotes.
- For example:

```
String s1 = "Sunbeam";
```

Boolean Literals

- Boolean literals allow only two values i.e. true and false. Not compatible with 1 and 0.
- For example:

```
boolean b = true;
boolean d = false;
```

Null Literal

- "null" represents nothing/no value.
- Used with reference/non-primitive types.

```
String s = null;
Object o = null;
```

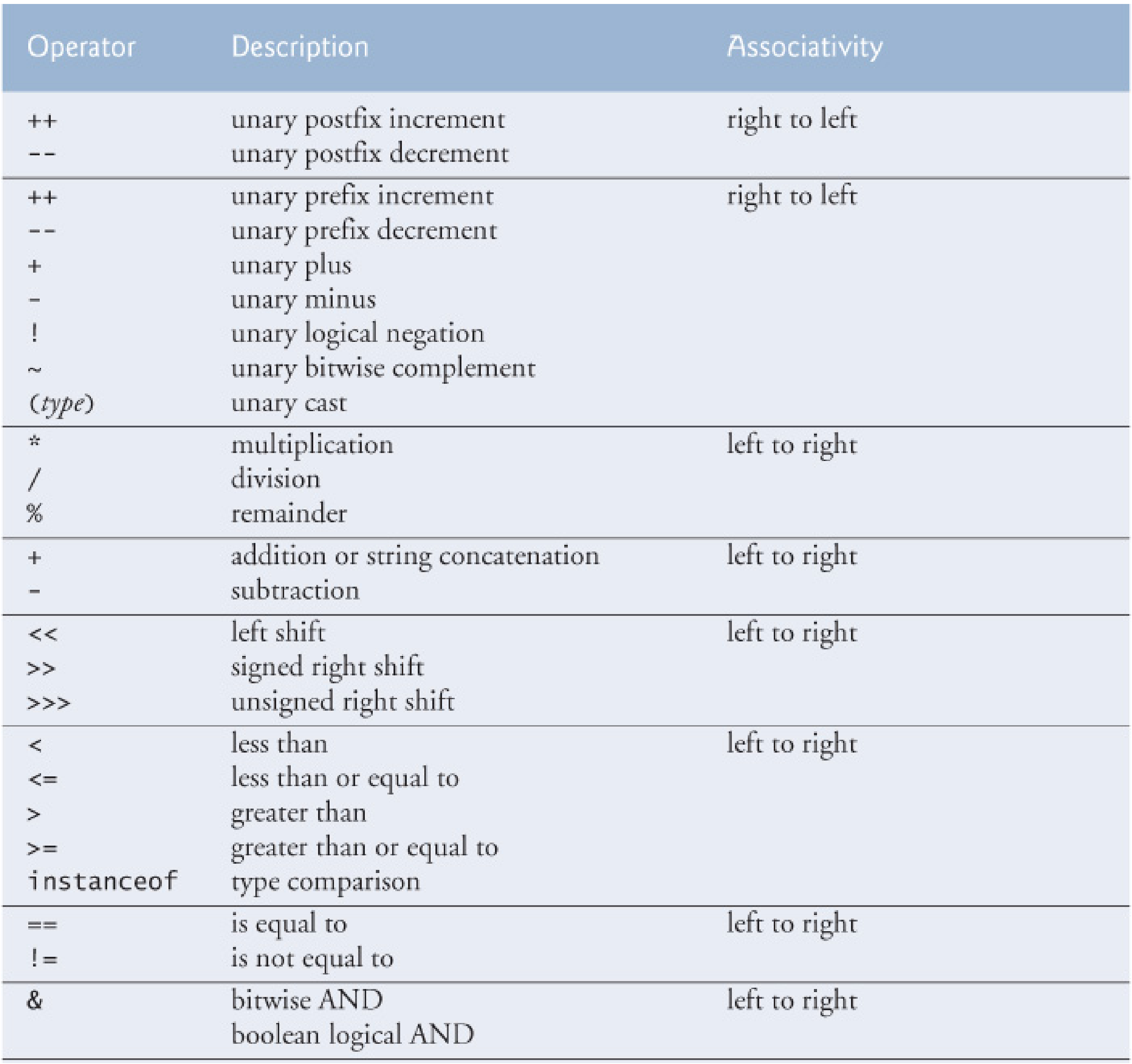
Variables

- A variable is a container which holds a value. It represents a memory location.
- A variable is declared with data type and initialized with another variable or literal.
- In Java, variable can be
    - Local: Within a method -- Created on stack.
    - Non-static/Instance field: Within a class - Accessed using object.
    - Static field: Within a class - Accessed using class-name.

Operators

- Java divides the operators into the following catgories:
    - Arithmetic operators: +, -, *, /, %
    - Assignment operators: =, +=, -=, etc.
    - Comparison operators: ==, !=, <, >, <=, >=, instanceof
    - Logical operators: &&, ||, !
        - Combine the conditions (boolean - true/false)
    - Bitwise operators: &, |, ^, ~, <<, >>, >>>
    - Misc operators: ternary ?:, dot .
        - Dot operator: ClassName.member, objName.member.

- Operator precedence and associativity



Operator	Description	Associativity
++ --	unary postfix increment unary postfix decrement	right to left
++ -- + - ! ~ (*type*)	unary prefix increment unary prefix decrement unary plus unary minus unary logical negation unary bitwise complement unary cast	right to left
* / %	multiplication division remainder	left to right
+ -	addition or string concatenation subtraction	left to right
<< >> >>>	left shift signed right shift unsigned right shift	left to right
< <= > >= instanceof	less than less than or equal to greater than greater than or equal to type comparison	left to right
== !=	is equal to is not equal to	left to right
&	bitwise AND boolean logical AND	left to right

Wrapper types

- In Java primitive types are not classes. So their variables are not objects.
- Java has wrapper class corresponding to each primitive type. Their variables are objects.
- All wrapper classes are final classes i.e we cannot extend it.
- All wrapper classes are declared in java.lang package.

```
Object
    |- Boolean
    |- Character
    |- Number
        |- Byte
        |- Short
        |- Integer
        |- Long
```

```
           |- Float
           |- Double
```

- For every primitive, we get class in Java. It is called Wrapper class.

1. boolean => java.lang.Boolean
2. byte => java.lang.Byte
3. char => java.lang.Character
4. short => java.lang.Short
5. int => java.lang.Integer
6. float => java.lang.Float
7. double => java.lang.Double
8. long => java.lang.Long

- Applications of wrapper classes
  - Use primitive values like objects

    ```
    // int 123 converted to Integer object holding 123.
    Integer i = new Integer(123);
    ```

  - Convert types

    ```
    Integer i = new Integer(123);
    byte b = i.byteValue();
    long l = i.longValue();
    short s = i.shortValue();
    double d = i.doubleValue();
    String str = i.toString();

    String val = "-12345";
    int num = Integer.parseInt(val);
    ```

  - Get size and range of primitive types

    ```
    System.out.printf("int size: %d bytes = %d bits\n", Integer.BYTES, Integer.SIZE);
    System.out.printf("int max: %d, min: %d\n", Integer.MAX_VALUE, Integer.MIN_VALUE);
    ```

  - Helper/utility methods

    ```
    System.out.println("Sum = " + Integer.sum(22, 7));
    System.out.println("Max = " + Integer.max(22, 7));
    System.out.println("Min = " + Integer.min(22, 7));
    ```

Boxing

- Converting from value (primitive) type to reference type.

  ```java
  int x = 123;
  Integer y = new Integer(x); // boxing
  ```

- Java 5 allows auto-conversion from primitive type to corresponding wrapper type. This is called as "auto-boxing".

  ```java
  int x = 123;
  Integer y = x; // auto-boxing
  ```

Unboxing

- Converting from reference type to value (primitive) type.

  ```java
  Integer y = new Integer(123);
  int x = y.intValue(); // unboxing
  ```

- Java 5 allows auto-conversion from wrapper type to corresponding value type. This is called as "auto-unboxing".

  ```java
  Integer y = new Integer(123);
  int x = y; // auto-unboxing
  ```

Control Statements

- By default, Java statements are executed sequentially i.e. statements are executed in order in which they appear in code.
- Java also provide statements to control the flow of execution. These are called as control statements.
- Types of control flow statements.
  - Decision Making statements
    - if statements
    - switch statement
  - Loop statements
    - do while loop
    - while loop
    - for loop
    - for-each loop

        - labeled loop
    - Jump statements
        - break statement
        - continue statement
        - return statement
- Being structured programming language, control flow statements (blocks) can be nested within each other.

if statements

- In Java, conditions are boolean expressions that evaluate to true or false.
- Program execution proceeds depending on condition (true or false).
- Syntax:

```
if(condition) {
    // execute when condition is true
}
```

```
if(condition) {
    // execute when condition is true
}
else {
    // execute when condition is false
}
```

```
if(condition1) {
    // execute when condition1 is true
}
else if(condition2) {
    // execute when condition2 is true
}
else {
    // execute when condition no condition is true
}
```

switch statements

- Selects a code block to be executed based on given expression.
- The expression can be integer, character or String type.

```
switch (expression) {
    case value1:
        // executed when expression equals value1
    break;
    case value2:
        // executed when expression equals value2
    break;
    // ...
    default:
        // executed when expression not equals any case constant
}
```

- We can use String constants/expressions for switch case in Java (along with integer and char types).

```
String course = "DAC";
switch(course) {
case "DAC":
    System.out.println("Welcome to DAC!");
    break;
case "DMC":
    System.out.println("Welcome to DMC!");
    break;
case "DESD":
    System.out.println("Welcome to DESD!");
    break;
default:
    System.out.println("Welcome to C-DAC!");
}
```

do-while loop

- Executes loop body and then evaluate the condition.
- If condition is true, loop is repeated again.

```
do {
    // body
} while(condition);
```

- Typically used to implement menu-driven program with swicth-case.

while loop

- Evaluate the condition and repeat the body if condition is true.

```
initialization;
while(condition) {
    body;
    modification;
}
```

for loop

- Initialize, evaluate the condition, execute the body if condition is true and then execute modification statement.

```
for(initialization; condition; modification) {
    body;
}
```

for-each loop

- Execute once for each element in array/collection.

```
int[] arr = { 11, 22, 33, 44 };
for(int i: arr)
    System.out.println(i);
```

break statement

- Stops switch/loop execution and jump to next statement after the switch/loop.

```
initialization;
while(condition) {
    body;
    if(stop-condition)
        break;
    modification;
}
statements after loop;
```

continue statement

- Jumps to next iteration of the loop.

```
initialization;
while(condition) {
    if(skip-condition)
        continue;
    body;
    modification;
}
statements after loop;
```

Labeled loops

- In case of nested loop, break and continue statements affect the loop in which they are placed.
- Labeled loops overcome this limitation. Programmer can choose the loop to be affected by break/continue statement.
- Labels can be used with while/for loop.

```
outer: for(int i=1; i<=3; i++) {
    middle: for(int j=1; j<=3; j++) {
        inner: for(int k=1; k<=3; k++) {
            if(i==j && j==k && i==K)
                break middle;
            System.out.printf("%d, %d, %d\n", i, j, k);
        }
    }
}
```

```
2 1 1
2 1 2
2 1 3
2 2 1
3 1 1
3 1 2
3 1 3
3 2 1
3 2 2
3 2 3
3 3 1
3 3 2
```

Ternary operator

- Ternary operator/Conditional operator

```
condition? expression1 : expression2;
```

- Equivalent if-else code

```
if(condition)
    expression1;
else
    expression2;
```

- If condition is true, expression1 is executed and if condition is false, expression2 is executed.

```
a = 10;
b = 7;
max = (a > b) ? a : b;
```

```
a = 10;
b = 17;
max = (a > b) ? a : b;
```

Java methods

- A method is a block of code (definition). Executes when it is called (method call).
- Method may take inputs known as parameters.
- Method may yield a output known as return value.
- Method is a logical set of instructions and can be called multiple times (reusability).

```
class ClassName {
    public static ret-type staticMethod(parameters) {
        // method body
    }

    public ret-type nonStaticMethod(parameters) {
        // method body
    }

    public static void main(String[] args) {
        // ...
        res1 = ClassName.staticMethod(arguments);
        ClassName obj = new ClassName();
        res2 = obj.nonStaticMethod(arguments);
    }
}
```

Class and Object

- Class is collection of logically related data members ("fields"/attributes/properties) and the member functions ("methods"/operations/messages) to operate on that data.
- A class is user defined data type. It is used to create one or more instances called as "Objects".
- Class is blueprint/prototype/template of the object; while Object is an instance of the class.
- Class is logical entity and Object represent physical real-world entity.
- Class represents group of such instances which is having common structure and common behavior.

- class is an imaginary entity.
  - Example: Car, Book, Laptop etc.
  - Class implementation represents encapsulation.
  - e.g. Human is a class and You are one of the object of the class.

```java
class Human {
    int age;
    double weight;
    double height;
    // ...
    void walk() { ... }
    void talk() { ... }
    void think() { ... }
    // ...
}
```

- Since class is non-primitive/reference type in Java, its objects are always created on heap (using new operator). Object creation is also referred as "Instantiation" of the class.

  ```java
  Human obj = new Human();
  obj.walk();
  ```

Instance

```
- Definition
    1. In java, object is also called as instance
    2. An entity, which is having physical existance is called as instance.
    3. An entity, which is having state, behavior and identity is called as instance.
- instance is a real time entity.
- Example: "Tata Nano", "Java Complete Reference", "MacBook Air" etc.
```

- Types of methods in a Java class.
  - Methods are at class-level, not at object-level. In other words, same copy of class methods is used by all objects of the class.
  - Parameterless Constructor
    - In Java, fields have default values if unintialized. Primitive types default value is usually zero (refer data types table) and Reference type default value is null. Constructor should initialize fields to the desired values.
    - Has same name as of class name and no return type. Automatically called when object is created (with no arguments).
    - If no construcor defined in class, Java compiler provides a default construcor (Parameterless).

    ```java
    Human obj = new Human();
    ```

  - Parameterized Constructor

        - Constructor should initialize fields to the given values.
        - Has same name as of class name and no return type. Automatically called when object is created (with arguments).

    ```
    Human obj = new Human(40, 76.5, 5.5);
    ```

    - Inspectors/Getters
        - Used to get value of the field outside the class.

    ```
    double ht = obj.getHeight();
    ```

    - Mutators/Setters
        - Used to set value of the field from outside the class.
        - It modifies state of the object.

    ```
    obj.setHeight(5.5);
    ```

        - Getter/setters provide "controlled access" to the fields from outside the class.
    - Facilitators
        - Provides additional functionalities like Console IO, File IO.

    ```
    obj.display();
    ```

    - Other methods/Business logic methods

    ```
    obj.talk();
    ```

- Executing a method on object is also interpreted as
    - Calling member function/method on object.
    - Invoking member function/method on object.
    - Doing operation on the object.
    - Passing message to the object.
- Each object has
    - State: Represents values of fields in the object.
    - Behaviour: Represents methods in the class and also depends on Object state.
    - Identity: Represents uniqueness of the object.
- Object created on heap using new operator is anonymous.

```
new Human().talk();
```

- Assigning reference doesn't create new object.

```
Human h1 = new Human(...);
Human h2 = h1;
```

How to get system date in Java?

- Using Calender class:

```
Calendar c = Calendar.getInstance();
//int day = c.get( Calendar.DAY_OF_MONTH );
int day = c.get( Calendar.DATE );
int month = c.get( Calendar.MONTH) + 1;
int year = c.get( Calendar.YEAR );
```

Initialization

```
int num1 = 10;      //Initialization
int num2 = num1;    //Initialization
```

- Initialization is the process of storing value inside variable during its declaration.
- We can initialize any variable only once.

Assignment

```
int num1 = 10;  //Initialization
//int num1 = 20;  //Not OK
num1 = 20;  //OK:   Assignment
num1 = 30;  //OK:   Assignment
```

- Assignment is the process of storing value inside variable after its declaration.
- We can do assignment multiple times.

Constructor

- It is a method of class which is used to initialize instance.
- Constructor is a special syntax of Java because:
    1. Its name and class name is always same.
    2. It doesn't have any return type
    3. It is designed to call implicitly.
    4. In the lifetime on instance, it gets called only once.

```
public Date(  ){    //Constructor of the class
    System.out.println("Inside constructor");
    Calendar c = Calendar.getInstance( );
    this.day = c.get( Calendar.DATE );
    this.month = c.get( Calendar.MONTH ) + 1;
    this.year = c.get( Calendar.YEAR );
}
```

- We can not call constructor on instance explicitly.

```
Date date = new Date(); //OK
date.Date( );   //Not OK
```

- We can use any access modifer on constructor.
- If constructor is public then we can create instance of a class inside method of same class as well as different class.
- If constructor is private then we can create instance of class inside method of same class only.
- Types of constructor in Java:
    1. Parameterless constructor.
    2. Parameterized constructor.
    3. Default constructor.

Parameterless constructor

- A constructor which do not have any parameter is called parameterless constructor.

```
    public Date(  ){   //Parameterless constructor
        Calendar c = Calendar.getInstance( );
        this.day = c.get( Calendar.DATE );
        this.month = c.get( Calendar.MONTH ) + 1;
        this.year = c.get( Calendar.YEAR );
    }
```

- If we create instance W/O passing arguments then parameterless constructor gets called.

```
Date dt1 = new Date( );  //OK
```

- In the above code, parameterless constructor will call.

Parameterized constructor

- Constructor of a class which take parameters is called parameterized constructor.

```
public Date( int day, int month, int year ){    //Parameterized constructor
    this.day = day;
    this.month = month;
    this.year = year;
}
```

- If we create instance by passing arguments then parameterized constructor gets called.

```
Date date = new Date( 23, 7, 1983 );    //OK
```

- Constructor calling sequence depends on order of instance creation.

Default constructor

- If we do not define any constructor(no parameterless, no parameterized) inside class then compiler generate one constructor for the class by default. It is called default constructor.
- Compiler generated default constructor is zero parameter i.e parameterless constructor.
- Compiler never generate default parameterized constructor. It means that, if we want to create instance with arguments then we must define parameterized constructor inside class.

Constructor chaining

- In Java, we can call constructor from another constructor. It is called constructor chaining.
- For constructor chaining, we should use this statement.
- this statement must be first statement inside constructor body.

```
class Date{
    private int day;    //Default value is 0
    private int month;  //Default value is 0
    private int year;   //Default value is 0

    public Date(  ){    //Parameterless Constructor
        this( 12, 8, 2022);    //Constructor chaining
    }
    public Date( int day, int month, int year ){    //Parameterized constructor
        this.day = day;
        this.month = month;
        this.year = year;
    }
}
```

- Using constructor chaning, we can reduce developers efforts.

this reference

- If we call non static method on instance then non static method get this reference.

- this reference contains reference of current/calling instance.
- Using this reference, non static method and non static field can communicate with each other. Hence this reference is considered as a link/connection between them.
- this reference is considered as a first parameter to the method. Hence it gets space once per method call on Java Stacks.
- We can not use this reference to access local variable. We should use this reference to access non static field/method.
- Use of this reference to access non static field/method is optional.
- If name of the local variable and name of field is same then to refer field we should use this reference.

```
class Complex{
    private int real;
    public void setReal( int real ){
        this.real = real;
    }
}
```

- Definition:
  - this reference is implicit parameter available inside every non static method of the class which is used to store reference of current/calling instance.

OOPS concepts

- Following members do not get space inside instance
  1. Method parameter(e.g this reference, args etc)
  2. Method local variable
  3. Static field
  4. Static as well as non static method
  5. Constructor
- Only non static field get space inside instance.
- If we declare non static field inside class then it gets space once per instance according their order of declaration.

```
class Test{
    private int num1;
    private int num2;
    private int num3;
}
class Program{
    public static void main(String[] args) {
        Test t1 = new Test( );
        Test t2 = new Test( );
        Test t3 = new Test( );
    }
}
```

- Method do not get space inside instance. All the instances of same class share single copy of method declared inside class.
- Instances can share method by passing reference of the instance as argument to the method.

Object Oriented Programming Structure / System(OOPS)

- OOPS is not a syntax. Rather it is a process or a programming methodology that we can use to solve real world use cases / problems. In other words, oops is an object oriented thought process.
- Alan Kay is inventor of oops.
- Ref: https://medium.com/javascript-scene/the-forgotten-history-of-oop-88d71b9b2d9f
- Object Oriented Analysis and Design with application: Grady Booch
- According to Grady Booch, there are 4 major and 3 minor pillars of oops.

4 Major pillars / parts / elemets

1. Abstraction : To achive simplicity
2. Encapsulation : To achive data hiding and data security
3. Modularity : To minimize module dependency
4. Hierarchy : To achive reusability

- By major, we mean that a language without any one of these elements is not object oriented.

3 Minor pillars / parts / elemets

1. Typing : To minimize maintenance of the system.
2. Concurrency : To utilize hardware resources efficiently.
3. Persistence : To maintain state of the instance on secondary storage

- By minor, we mean that each of these elements is a useful, but not essential.

Abstraction

- It is a major pillar of oops.
- Abstraction is the process of getting essential things from system/object.
- Abstraction focuses on the essential characteristics of som object, relative to the perspective of viewer. In simple word, abstraction changes from user to user.
- Abstraction describes external behavior of an instance.
- Creating instance and calling methods on it represents abstraction programatically.

```java
Scanner sc = new Scanner( System.in );
String name = sc.nextLine( );
int empid = sc.nextInt( );
float salary = sc.nextFloat( );
```

```java
Complex c1 = new Complex();
c1.acceptRecord( );
c1.printRecord( );
```

- Using abstraction, we can achive simplicity.

Encapsulation

- It is a major pillar of oops.
- Definition:
    1. To achive abstraction, we need to provide some implementation. This implementation of abstraction is called encapsulation.
    2. Binding of data and code together is called as encapsulation.
- Hiding represents encapsulation.

```
class Complex{
    /* Data*/
    private int real;
    private int imag;
    public Complex( ){
        this.real = 0;
        this.imag = 0;
    }
    /*Code*/
    public void acceptRecord( ){
        Scanner sc = new Scanner( System.in)
        //TODO: accept record for real and imag
    }
    public void printRecord( ){
        //TODO: print state of real and imag
    }
}
class Program{
    public static void main(String[] args) {
        //Abstraction
        Complex c1 = new Complex();
        c1.acceptRecord( );
        c1.printRecord( );
    }
}
```

- Abstraction and encapsulation are complementary concepts: Abstraction focuses on the observable behavior of an object, whereas encapsulation focuses on the implementation that gives rise to this behavior.
- Class implementation represents encapsulation.
- Use of encapsulation:
    1. To achive abstraction
    2. To achive data hiding(also called as data encapsulation).
- Process of declaring field private is called as data hiding.
- Data hiding help to achive data security.

Modularity

- It is a major pillar of oops
- Modularity is the process of designing and developing complex system using small parts/modules.
- Main purpose of modularity is to minimize module dependancy.
- Using .jar file, we can achive modularity in Java.

Hierarchy

- It is a major pillar of oops.
- Level/order/ranking of abstraction is called as hierarchy.
- Using hierarchy, we can achive code reusability.
- Application of reusability:
    1. To reduce development time.
    2. To reduce development cost
    3. To reduce develpers effort.
- Types of hierarchy:
    1. Has-a => Association
    2. Is-a => Generalization(is also called as inheritance)
    3. Use-a => Dependancy
    4. Create-a => Instantiation

Typing

- It is a minor pillar of oops.
- It is also called as polymorphism(poly(many) + morphism(forms/behavior)).
- polymorphism is a Greek word.
- An ability of any instance to take multiple forms is called as polymorphism.
- Using typing/polymorphism, we can reduce maintenance of the application.
- In Java, we can achive polymorphism using two ways:
    1. Method overloading (It represents compile time polymorphism)
    2. Method overriding (It represents run time polymorphism)
- In Java, runtime polymorphism is also called as dynamic method dispatch

Concurrency

- It is a minor pillar of oops.
- Concurrency is the process of executing multiple task simultaneously.
- Using thread, we can achive Concurrency in Java.
- Using Concurrency, we can utilize H/W resources efficiently.

Persistance

- It is a minor pillar of oops.
- Process of maintaining state of instance inside file / database is called as Persistance.
- We can implement it using file handing(serialization / derserialization) and database programming(JDBC).