FAST

National University of Computer and Emerging Sciences Peshawar

Lecture # 10

Software Construction and Development (Java Programming)

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Object Oriented Programming (Classes and objects)

Contents

Object Oriented Programming

- Java is fundamentally object oriented. Every line of code you write in java must be inside a class (not counting import directives).OOP fundamental stones Encapsulation, Inheritance and Polymorphism etc. are all fully supported by java.

- OOP is mythology or paradigm to design a program using class and object. OOP is paradigm that provides many concepts such as:

- Class and objects
- Inheritance
- Modularity
- Polymorphism
- Encapsulation (binding code and its data) etc.
- Paradigm نمونہ

Object Oriented Programming

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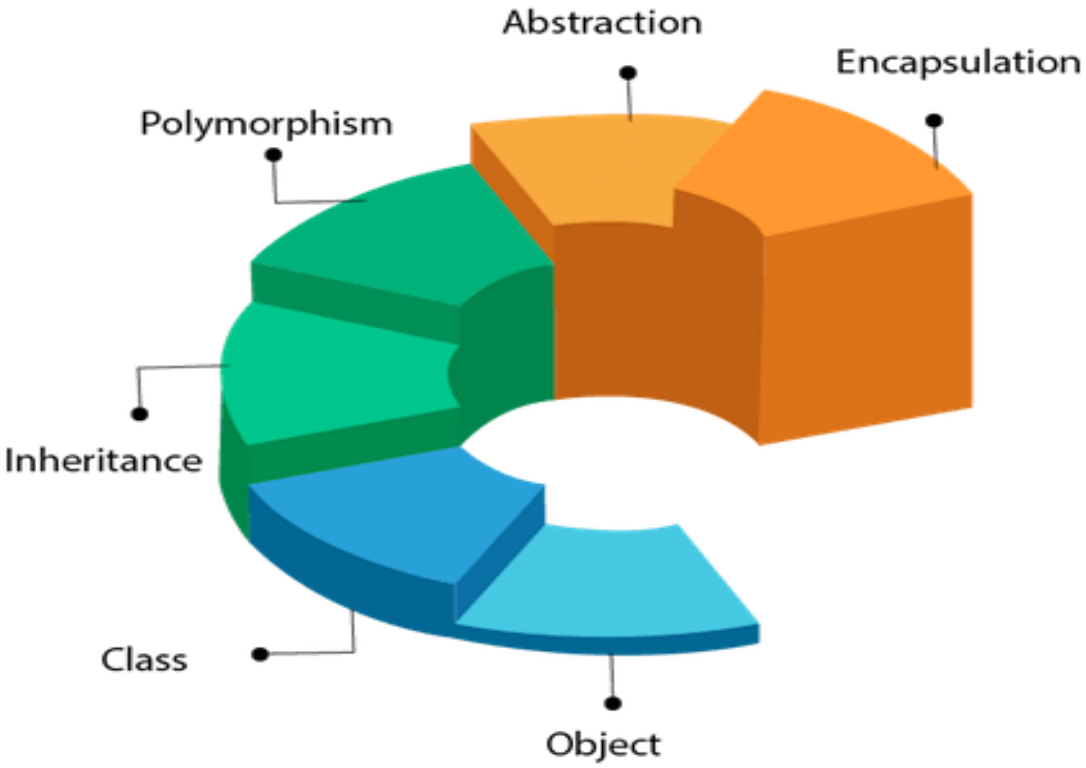
Object Oriented Programming…

OOPs (Object-Oriented Programming System)



Encapsulation

- Data and behaviour (function) are tightly coupled inside an object.
- Combine data (variables) and functions in a single container.
- The combining of both data and functions into a single unit.
- To combine code functions and data (variables) in a single box or wrapper.
- In java class is the example of encapsulation.
- **Capsule: I**t is wrapped with different medicines.

Capsule

Data Hiding

- Means you cannot access data.
- Making data to be accessed from within the class.

Class

- Class is blue print or map for object.
- Class is the logical construct of object.
- Class is the description of object.
- Class is a template which contains behaviour (member functions) and attributes/properties (data/variables) of object.
- Means data members and member functions are defined within a class.
- Class is user defined data type because user defined it.
- **Attribute:** properties abject has.
- **Methods:** actions that an object can do.

Object

- An entity that has state and behaviour.
- An actual existence of a class is called object.
- An object encapsulates data and behaviour.
- When a class template is implemented in real world then it becomes object.
- Object is the instance of the class.
- Class is the template or blue print from which objects are created, so object is the **instance (result) of the class**.
- The space reserved in memory for class.

Object…

- Object is used to perform responsibility of communication between different classes.
- Any entity that has state and behavior is known as an object. For example, a chair, pen, table, keyboard, bike, etc. It can be physical or logical.

Example: A dog is an object because it has states like color, name, breed, etc. as well as behaviors like wagging the tail, barking, eating, etc.

Class VS Object

- **Class:** No data
- **Object:** Having Data

Member data and member function

Member data or data members: The data or the attributes defined within a class is called member data.

Member Function: The functions that are used to work on the data items are called member functions.

Member functions are used to process and access data members of an object.

Member functions are functions that are included within the class.

Instance variable in java

- A variable that is created inside a class but outside a method is called instance variable.
- Instance variable does not get memory at compile time.
- It gets memory at runtime when an object (instance) is created. That is why it called instance variable.

Defining a Class

```
class point {

private int xCord;

private int yCord;

public point()  { ….}

public void display() {  …..

        }

}// end of class
```

Instance variables and symbolic constants

Constructor: how to create and initialize objects

Methods: how to manipulate those objects (may or may not include its own "driver" i.e. main())

Classes and Objects

Example

```
public class Dog {
    String breed;
    int age;
    String color;

    void barking() {
    }

    void hungry() {
    }

    void sleeping() {
    }
}
```

```
MyClass obj = new MyClass();
```

Note: new keyword is used for object instantiation in heap

Classes and Objects…

Object declaration

```
Student obj   ;    // obj is reference variable
```

Object instantiation

```
obj  =  new Student();
```

OR

```
Student obj  =  new Student();
```

How to Access member of a class

1) obj.variableName = value; // to access data member

2) obj.methodName(parameter list); // to access method

Examples

obj.rollNo = 123;

obj.getRollNo();

Classes and Objects…

```
//Java Program to illustrate how to define a class and fields
//Defining a Student class.
class Student{
 //defining fields
int id;        //field or data member or instance variable
String name;
```

Classes and Objects…

```
//creating main method inside the Student class
public static void main(String args[]){
 //Creating an object or instance
 Student s1=new Student();  //creating an object of Student
 //Printing values of the object
 System.out.println(s1.id);
//accessing member through reference variable
 System.out.println(s1.name);
 }
}
```

Output:
0
null

Ways to initialize object

There are 3 ways to initialize object in Java.

1. By reference variable
2. By method
3. By constructor

1) Initialization through reference

Initializing an object means storing data into the object. Let's see a simple example where we are going to initialize the object through a reference variable.

Driver Class: Class which contains main method is called main Class or driver class.

```
class Student{
 int id;
 String name;
}
```

1) Initialization through reference

```
// driver class
class TestStudent2 {
public static void main(String args[]){
 Student s1=new Student();
 s1.id=101;
 s1.name="Sonoo";
 System.out.println(s1.id+" "+s1.name); //printing members with a white space
} }
```

Output
101 Sonoo

2) Initialization through method

In this example, we are creating the two objects of Student class and initializing the value to these objects by invoking the insertRecord method. Here, we are displaying the state (data) of the objects by invoking the displayInformation() method.

2) Initialization through method

```
class Student{
int rollno;
String name;
void insertRecord(int r, String n){
 rollno=r;
 name=n;
}
void displayInformation(){System.out.println(rollno+" "+name);}
}
```

2) Initialization through method…

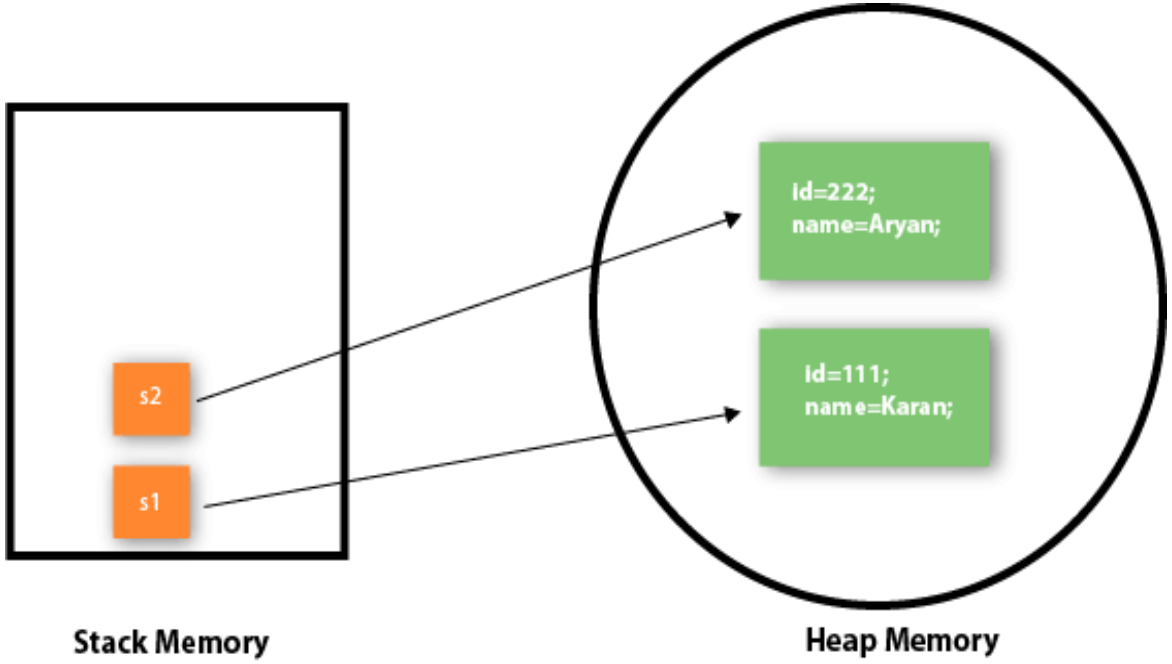
```
class TestStudent4{

 public static void main(String args[]){
  Student s1=new Student();
  Student s2=new Student();
  s1.insertRecord(111,"Karan");
  s2.insertRecord(222,"Aryan");
  s1.displayInformation();
  s2.displayInformation();
 }
}
```

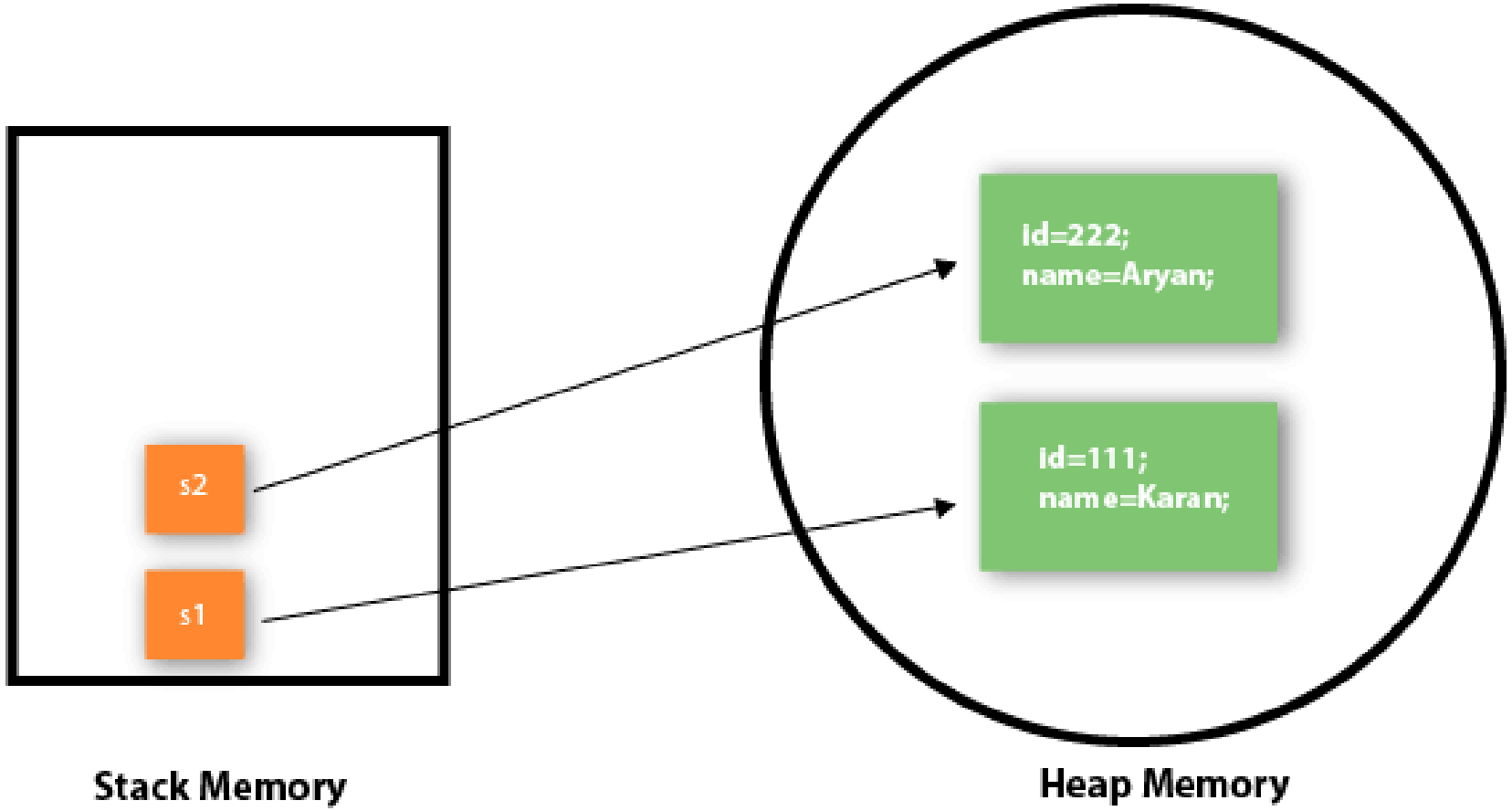
Output
111 Karan
222 Aryan

2) Initialization through method…

As you can see in the below figure, object gets the memory in heap memory area. The reference variable refers to the object allocated in the heap memory area. Here, s1 and s2 both are reference variables that refer to the objects allocated in memory.



2) Initialization through method…



3) Initialization through a constructor

```
class Student4{
int id;
String name;
//creating a parameterized constructor
Student4(int i,String n){
id = i;
name = n;
}
//method to display the values
void display(){System.out.println(id+" "+name);}
```

3) Initialization through a constructor…

```
  public static void main(String args[]){
  //creating objects and passing values
  Student4 s1 = new Student4(111,"Karan");
  Student4 s2 = new Student4(222,"Aryan");
  //calling method to display the values of object
  s1.display();
  s2.display();
 }
}
```

Output:

111 Karan
222 Aryan

Anonymous object

Anonymous simply means nameless. An object which has no reference is known as an anonymous object. It can be used at the time of object creation only.

If you have to use an object only once, an anonymous object is a good approach.

For example:

```
new Calculation();    //anonymous object
```

Anonymous object

Calling method through a reference:

```
Calculation c=new Calculation();
c.fact(5);
```

Calling method through an anonymous object

```
new Calculation().fact(5);
```

Anonymous object…

Let's see the full example of an anonymous object in Java.

```
class Calculation{
 void fact(int  n){
  int fact=1;
  for(int i=1;i<=n;i++){
   fact=fact*i;
  }
 System.out.println("factorial is "+fact);
}
public static void main(String args[]){
 new Calculation().fact(5);     //calling method with anonymous object
}  }
```

Output

Factorial is 120

Access Specifier

It specifies that member of a class is accessible outside or not. It may be public, protected or private or default.

- A **private** member is *only* accessible within the same class as it is declared.
- A member with **no access modifier (Default)** is only accessible within classes in the same package.
- A **protected** member is accessible within all classes in the same package *and* within subclasses in other packages.
- A **public** member is accessible to all classes (unless it resides in a module that does not export the package it is declared in).

Access Specifier…

Private: Limited access to class only

Default (no modifier): Limited access to class and package

Protected: Limited access to class, package and subclasses (both inside and outside package)

Public: Accessible to class, package (all), and subclasses

Access Specifier Table

Access Modifier	within class	within package	outside package by subclass only	outside package
Private	Y	N	N	N
Default	Y	Y	N	N
Protected	Y	Y	Y	N
Public	Y	Y	Y	Y

Access Specifier… (default)

```
// Saved in file A.java
package pack;

class A{
  void msg(){System.out.println("Hello");}
}

// Saved in file B.java
package mypack;
import pack.*;

class B{
  public static void main(String args[]){
   A obj = new A(); // Compile Time Error
   obj.msg(); // Compile Time Error
  }
}
```

Access Specifier… (default)

```
class Teacher {
   String designation = "Teacher";
   String collegeName = "Beginnersbook";
   void does(){
        System.out.println("Teaching");
   }
}

public class PhysicsTeacher extends Teacher{
   String mainSubject = "Physics";
   public static void main(String args[]){
        PhysicsTeacher obj = new PhysicsTeacher();
        System.out.println(obj.collegeName);
        System.out.println(obj.designation);
        System.out.println(obj.mainSubject);
        obj.does();
   }
}
```

Output:

```
Beginnersbook
Teacher
Physics
Teaching
```

Program 01: Data member and member functions

```
package classes_objects_constructors;     // pakage name
public class Student {
int rollNo;
String name;

public void setRollNo(int rno)
{
rollNo = rno;
}
```

Program 01: Data member and member functions

```
public int getRollNo()
{
return rollNo;
}
public void setName(String n)
{
name = n;
}
```

Program 01: Data member and member functions

```
public String getName()
{
return name;
}
```

Program 01: Data member and member functions

```
public String toString()
{
return "Roll No is:" +rollNo + "\n" +"Name is:" +name;
}

}        // Student Class body closed
```

Program 01: Data member and member functions

Main Class: Class which contains main method is called main class or driver class.

```
package classes_objects_constructors;

public class StudentTest {

public static void main(String[] args) {

Student s= new Student();

System.out.println(s.getRollNo());      // This will show "0" because no argument is passed

System.out.println(s.getName());      // This will show "null" because no argument is passed
```

Program 01: Data member and member functions

System.***out.println("\nAfter Passing Arguments to Functions\n");***

s.setRollNo(150535);

s.setName(“Rizwan Ullah");

Program 01: Data member and member functions

System.***out.println("Roll Number is: "+s.getRollNo()); // This will show "150535" because argument is passed***

System.***out.println("Name is: " +s.getName()); // This will show "Rizwan Ullah" because argument is passed***

/*System.out.println(s); /*this will just print object reference because "tostring()" function is not defined in student class */

Program 01: Data member and member functions

```
System.out.println("\nAfter defininig toString() Function in Student Class\n");

System.out.println(s);                //this will call toString function
//System.out.println(s.toString());    // This will also call toString() Function
System.out.println("");
Student s2 = new Student();
s2.setRollNo(150509);
s2.setName("Sami Ullah");
System.out.println(s2);
}
}    // StudentTest class body closed
```

Program 01: Data member and member functions

Note

- When we write it in main class " System.out.print(s); "

This will print reference of an object "s" on screen because toString() function is not defined in student class, means in that class whose object has been created.

- After defining function :

```
public String toString()
    {
        return (which thing do you want to return);
    }
```

Program 01: Data member and member functions

System.out.println(s);

It will call toString() function and will display RollNo and name of object s.

Means it will display member data of object.

System.out.print(s.toString()); This will also call toString function.

toString() function

- Doing object representation.
- Used for combo boxes.

Constructor

- Special method that is implicitly invoked.
- Used to create an object (an instance of the class) and initialize it.
- Every time an object is created using the new() keyword, at least one constructor is called.
- It is special member function having same name as class name and is used to initialize object.

Constructor…

- It is invoked/called at the time of object creation.
- It constructs value i.e. provide data for the object that is why it called constructor.
- Can have parameter list or argument list.
- Can never return any value (no even void).

Constructor…

- Normally declared as public.

- At the time of calling constructor, memory for the object is allocated in the memory.

- It calls a default constructor if there is no constructor available in the class. In such case, Java compiler provides a default constructor by default.

Constructor…

- **Note:** It is called constructor because it constructs the values at the time of object creation. It is not necessary to write a constructor for a class. It is because java compiler creates a default constructor if your class doesn't have any.

Rules for creating Java constructor

There are some rules defined for the constructor.

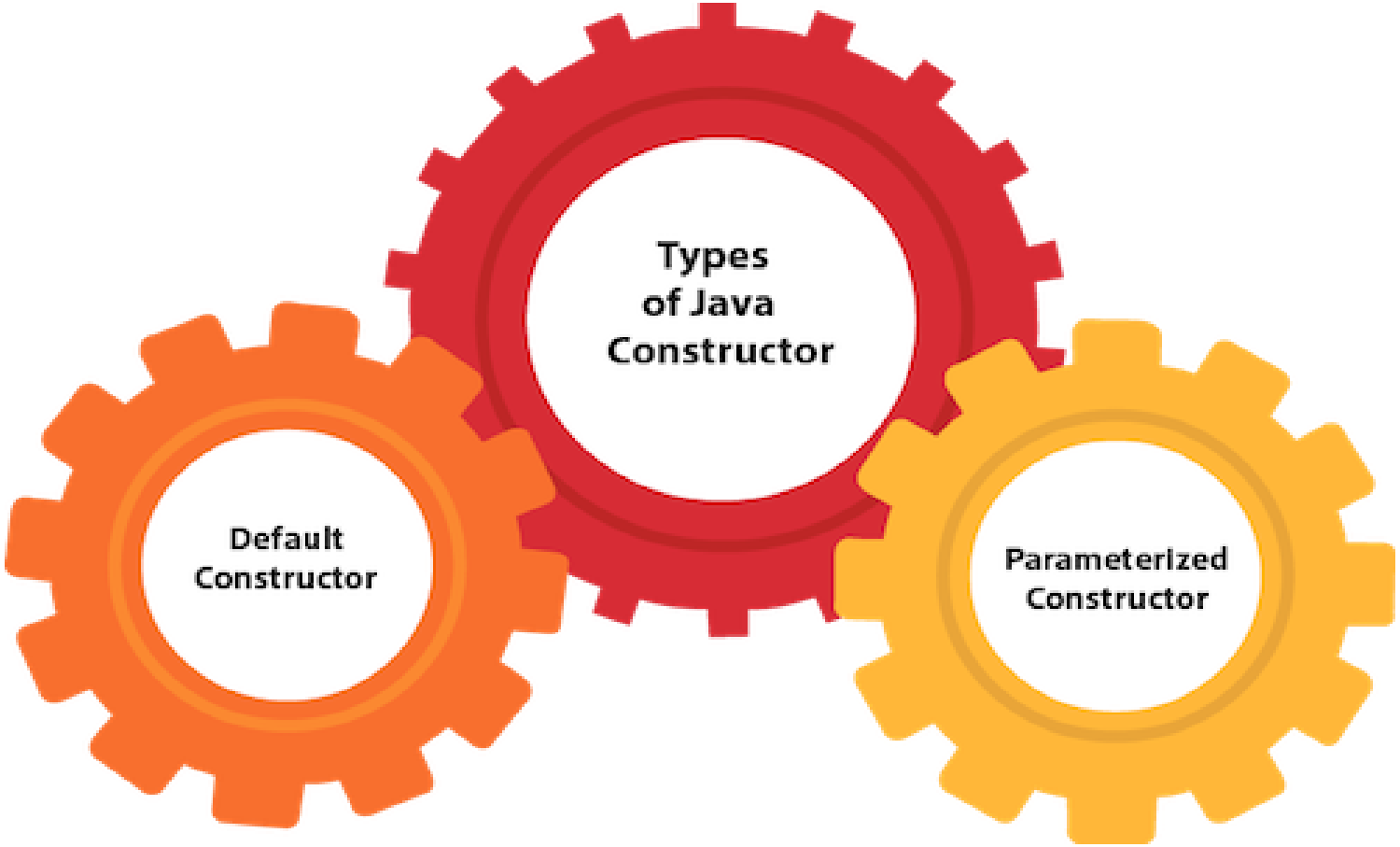
- Constructor name must be the same as its class name
- A Constructor must have no explicit return type.
- A Java constructor cannot be abstract, static, final, and synchronized.

Type of Java constructor

There are two types of constructors in Java:

1. Default constructor (no-arg constructor)
2. Parameterized constructor

Type of Java constructor…



1) Java Default Constructor

- A constructor is called "Default Constructor" when it doesn't have any parameter.
- It is also called non-parameterized constructor.

Syntax of default constructor:

```
Access Specifier className()
{
}
```

Java Default Constructor Example

In this example, we are creating the no-arg constructor in the Bike class. It will be invoked at the time of object creation.

```
//Java Program to create and call a default constructor
class Bike1{
Bike1()                //creating a default constructor
{
System.out.println("Bike class object created");
}  //constructor body
```

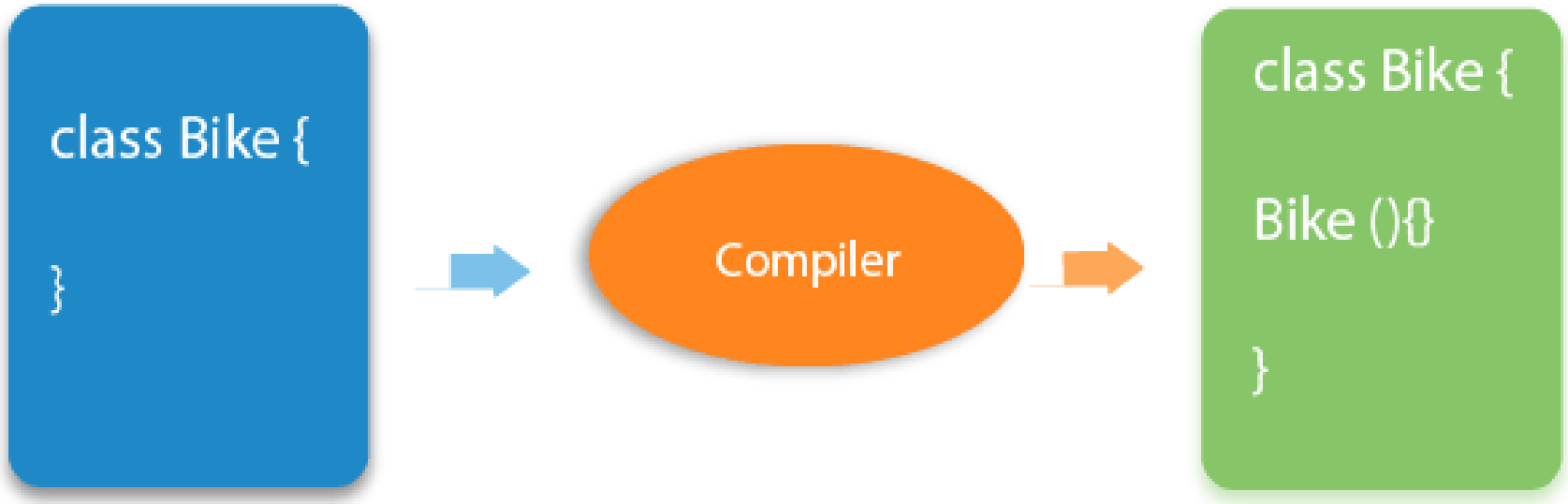
Java Default Constructor Example…

```
public static void main(String args[]){        //main method
//calling a default constructor
Bike1 b=new Bike1();
}

}
```

Java Default Constructor

Rule: If there is no constructor in a class, compiler automatically creates a default constructor.



What is the purpose of a default constructor ?

The default constructor is used to provide the default values to the object like 0, null, etc., depending on the type.

Example of default constructor that displays the default values

```
//Let us see another example of default constructor  which displays the default values
class Student3{
int id;
String name;
//method to display the value of id and name
void display(){
System.out.println(id+" "+name);
}
```

Example of default constructor that displays the default values

```
public static void main(String args[]){
//creating objects
Student3 s1=new Student3();
Student3 s2=new Student3();
//displaying values of the object
s1.display();
s2.display();
}
} // Student3 class body closed
```

Example of default constructor that displays the default values

Output:

0 null

0 null

Explanation:

❖In the above class, you are not creating any constructor so compiler provides you a default constructor.

❖Here 0 and null values are provided by default constructor.

2) Java Parameterized Constructor

A constructor which has a specific number of parameters is called a parameterized constructor.

Why use the parameterized constructor?

- The parameterized constructor is used to provide different values to distinct objects. However, you can provide the same values also.
- Used to initialize objects with different values.

Example of parameterized constructor

In this example, we have created the constructor of Student class that have two parameters. We can have any number of parameters in the constructor.

```
class Student4{
  int id;
  String name;
  //creating a parameterized constructor
  Student4(int i,String n){
  id = i;
  name = n;
  }
  //method to display the values
  void display(){System.out.println(id+" "+name);}
```

Example of parameterized constructor…

```
public static void main(String args[]){
   //creating objects and passing values
   Student4 s1 = new Student4(111,"Karan");
   Student4 s2 = new Student4(222,"Aryan");
   //calling method to display the values of object
   s1.display();
   s2.display();
  }
} // Student4 class body closed
```

Output:

111 Karan
222 Aryan

Constructor Overloading

- In Java, a constructor is just like a method but without return type. It can also be overloaded like Java methods.

- Constructor overloading in Java is a technique of having more than one constructor with different parameter lists.

- They are arranged in a way that each constructor performs a different task. They are differentiated by the compiler by the number of parameters in the list and their types.

Constructor Overloading…

- When we have more than one constructors in a class with different set of parameters i.e. (type, number, order).

Example of Constructor Overloading

```
//Java program to overload constructors
class Student5{
    int id;
    String name;
    int age;
    //creating two argument constructor
    Student5(int i,String n){
    id = i;
    name = n;
    }
```

Example of Constructor Overloading…

```
//creating three arg constructor
    Student5(int i,String n,int a){
    id = i;
    name = n;
    age=a;
    }
    void display()  {    System.out.println(id+" "+name+" "+age);    }
```

Example of Constructor Overloading…

```
public static void main(String args[]){
   Student5 s1 = new Student5(111,"Karan");
   Student5 s2 = new Student5(222,"Aryan",25);
   s1.display();
   s2.display();
  }
}
```

Output:

111 Karan 0
222 Aryan 25

Example of Constructor

Example of constructor

```
public class ConstructorExample {

    int age;
    String name;

    //Default constructor
    ConstructorExample(){
          this.name="Chaitanya";
          this.age=30;
    }

    //Parameterized constructor
    ConstructorExample(String n,int a){
          this.name=n;
          this.age=a;
    }
    public static void main(String args[]){
          ConstructorExample obj1 = new ConstructorExample();
          ConstructorExample obj2 =
                          new ConstructorExample("Steve", 56);
          System.out.println(obj1.name+" "+obj1.age);
          System.out.println(obj2.name+" "+obj2.age);
    }
}
```

Output:

```
Chaitanya 30
Steve 56
```

Destructor

Destructors are not required in java class because memory management is the responsibility of JVM.

Copy Constructor

- A **copy constructor** in a **Java** class is a **constructor** that creates an object using another object of the same **Java** class.
- That's helpful when we want to **copy** a complex object that has several fields, or when we want to make a deep **copy** of an existing object.

Copy Constructor…

There is no copy constructor in Java. However, we can copy the values from one object to another like copy constructor in C++.

There are many ways to copy the values of one object into another in Java. They are:

- By constructor
- By assigning the values of one object into another
- By clone() method of Object class

In this example, we are going to copy the values of one object into another using Java constructor.

Copy Constructor Example 1

```
// This program is about copy constructor and will copy values of one object into another
package classes_objects_constructors;
public class Student6
{
 int id;
 String name;
 Student6(int i,String n)
 {
 id = i;
 name = n;
 }
```

Copy Constructor Example 1…

```
Student6(Student6 s)        // copy constructor
 {
   id = s.id;
   name =s.name;
 }
 void display()
 {
 System.out.println("Id is:" + id +"\nName is:" + name);
 }
```

Copy Constructor Example 1…

```
public static void main(String args[])
{
Student6 s1 = new Student6(11,"Kamran");
Student6 s2 = new Student6(s1);  // Values of s1 will be copied to s2
    s1.display();
    System.out.println("");
    s2.display();
}
}   // Student6 class body closed
```

```
Id is:11
Name is:Kamran

Id is:11
Name is:Kamran
```

Copy Values without constructor

- We can copy the values of one object into another by assigning the objects values to another object.

- In this case, there is no need to create the constructor.

Example

```
package classes_objects_constructors;
public class Student7
{
int id;
String name;
Student7(int i,String n)
 {
     id = i;
     name = n;
 }
```

Example

```
Student7()      // default constructor
{     }
 void display()
 {
 System.out.println("Id is:" + id +"\nName is:" + name);
 }
```

Copy Constructor Example 2…

```
public static void main(String[] args)
{
Student7 s1 = new Student7(111,"Kamran");
Student7 s2 = new Student7();
s2.id=s1.id;
s2.name=s1.name;

s1.display();
System.out.println("");
s2.display();
  }
}
```

```
Id is:111
Name is:Kamran

Id is:111
Name is:Kamran
```

Defining a Student class

The following example will illustrate how to write a class. We want to write a "Student" class that

- Should be able to store the following characteristics of student

  Roll No

  Name

- Provide default, parameterized and copy constructors
- Provide standard getters/setters (discuss shortly) for instance variables
- Make sure, roll no has never assigned a negative value i.e. ensuring the correct state of the object
- Provide print method capable of printing student object on console

Getters / Setters

- The attributes of a class are generally taken as private or protected. So to access them outside of a class, a convention is followed knows as getters & setters.
- These are generally public methods.
- The words *set* and *get* are used prior to the name of an attribute.
- Another important purpose for writing getter & setters to control the values assigned to an attribute.

Student Class Code

```
// File Student.java
public class Student {
private String name;
private int rollNo;
// Standard Setters
public void setName (String name) {
this.name = name;
}
```

Student Class Code…

```
// Note the masking of class level variable rollNo
public void setRollNo (int rollNo)
{
if (rollNo > 0)
{
  this.rollNo = rollNo;
}else {
     this.rollNo = 100;  }
}
```

Student Class Code…

```
// Standard Getters
public String getName ( ) {
return name;
}
public int getRollNo ( ) {
return rollNo;
}
// Default Constructor
public Student() {
name = “not set”;
rollNo = 100;
}
```

Student Class Code…

```
// parameterized Constructor for a new student
public Student(String name, int rollNo) {
setName(name);       //call to setter of name
setRollNo(rollNo);     //call to setter of rollNo
}
// Copy Constructor for a new student
public Student(Student s) {
name = s.name;
rollNo = s.rollNo;
}
```

Student Class Code…

```
// method used to display method on console
public void print () {
System.out.print("Student name: " +name);
System.out.println(", roll no: " +rollNo); }
} // end of Student class
```

Using a Class

Objects of a class are always created on heap using the “new” operator followed by constructor

- Student s = new Student ( ); // no pointer operator “*” between Student and s
- Only String constant is an exception

```
String greet = “Hello” ;     // No new operator
```

However you can also use

- String greet2 = new String(“Hello”);

Using a Class…

Members of a class (member variables and methods also known as instance variables/methods) are accessed using "." operator. There is no "–>" operator in java

- s.setName("Ali");
- s–>setName("Ali") // is incorrect and will not compile in java

Note: Objects are always passed by reference and primitives are always passed by value in java.

Using a Class…

- • Create objects of student class by calling default parameterize and copy constructor.

- • Call student class various methods on these objects.

Student client code

```
// File Test.java

/* This class create Student class objects and demonstrates how to call various
methods on objects

*/

public class Test{

public static void main (String args[]) {

// Make two student objects

Student s1 = new Student("ali", 15);

Student s2 = new Student();     //call to default costructor
```

Student client code…

```
s1.print();     // display ali and 15
s2.print();     // display not set and 100
s2.setName("usman");
s2.setRollNo(20);

System.out.print("Student name:" + s2.getName());
System.out.println(" rollNo:" + s2.getRollNo());

System.out.println("calling copy constructor");
Student s3 = new Student(s2);   //call to copy constructor
```

Student client code…

```
s2.print();
s3.print();
s3.setRollNo(-10);    //Roll No of s3 would be set to 100
s3.print();
}  //end of main
}  //end of class
```

/*NOTE: public vs. private

A statement like "b.rollNo = 10;" will not compile in a client of the Student class when rollNo is declared protected or private */

Compile & Execute

```
C:\ WINDOWS\system32\cmd.exe

D:\examples> javac Student.java
D:\examples> javac Test.java
D:\examples> java Test
Student name:ali, roll no: 15
Student name:Not Set, roll no: 100
Student name:usman rollNo:20
Calling copy constructor
Student name:usman, roll no:20
Student name:usman, roll no:20
Student name:usman, roll no:100
D:\examples>_
```

THANK YOU