Object Oriented Programming :

OOPs concept is based on the concept of objects, which contain data (fields/attributes)and behavior(methods/functions).

Class : Defines thestructure, attributes,and behaviors. It is like a blueprint.

Object : A real instance of the class, holding actual data. It is a physical entity.

Class	Object

classClassName
{
variables
methods
}
	ClassName ObjectName=newClassName();

// Defining the class (Blueprint)
public class Car {
// Fields (attributes)
String make;
char model;
int year;
// Method to display car details
void displayDetails()
{
 	
System.out.println("Car Make: " + make);
System.out.println("Car Model: " + model);
System.out.println("Car Year: " + year);
OR
System.out.prntln(make+" "+model+" "+year);
}
Output : Toyota C 2020
	// Main class to create an object
	public class Main {
	public static void main(String[] args) {
	// Creating an object of the Car class
	Car myCar = new Car();
	// Assigning data using object reference
	myCar.make=Toyota;
	myCar.model=C;
	myCar.year=2020;
	// Calling the method of the object
	myCar.displayDetails(); Input
	Output :
	
	Car Make: Toyota
	Car Model: C
	Car Year: 2020

// User defined method (to directly assign data in main class)
void setCarData(String cMake, char cModel, int cYear)
{
make=cMake;
model=cModel;
year=cYear;
}
	//Assigning data using user defined method
	myCar.setCarData(“Toyota”, ‘C’,2020);
	//Calling the method of the object
	myCar.displayDetails(); Input

// Constructor to initialize the object (this)
Car(String make, char model, int year)
{
this.make = make;
this.model = model;
this.year = year;
}
	//Creating object & Assigning data using constructor
	Car myCar = new Car("Toyota", "Corolla", 2020);

How many ways we can store data into variable ?

1) By using objectreferencevariable
2) By using method
3) By using constructor

Methods :

Block or group of statements whichwill perform certain task.

We must call the method throughobject.

1) No parameters → No returnvalue
2) No parameters → Returnsvalue
3) Takes parameters → No returnvalue
4) Takes parameters → Returnsvalue

Class (without main method)	Class (with main method)

publicclassGreetings {	public class GreetingsMain {
	public static void main(String[] args)
	{
	Greetings gr=new Greetings(); //Object

1) No parameters → No return value void m1() { } System.out.println("Hello..");	gr.m1();
2) No parameters → Returns value String m2() { } return("Hello how are you?");	String s=gr.m2(); System.out.println(s); OR System.out.println(gr.m2());
3) Takes parameters → No return value voidm3(Stringname) { } System.out.println("Hello "+ name);	gr.m3("John");
4) Takes parameters → Returns value Stringm4(Stringname) { } return("Hello "+name);	String s=gr.m4("David"); System.out.println(s); OR System.out.println(gr.m4("David"));

Constructor: A constructor in Java is a special type of method used to initialize objects. Constructors are automatically called when an object is created using the new keyword.

Default Constructor

```
public class ConstructorDemo {
int x,y;
ConstructorDemo()
        {
                x=10;
                y=20;
        }
void sum()
        {
        }       System.out.println(x+y);


public static void main(String[] args) {
ConstructorDdemocd=newConstructorDemo();
cd.sum();

//30
```

ParameterizedConstructor

```
public class ConstructorDemo {
int x,y;
ConstructorDemo(int a, int b)
        {
                x=a;
                y=b;
        }
void sum()
        {
        }       System.out.println(x+y);


public static void main(String[] args) {
ConstructorDemocd=newConstructorDemo(100,200);
cd.sum();

//300
```

Method	Constructor
Method name canbeanything	Constructor nameshould be sameas class name
Method may or may not return a value	Constructor will neverreturn avalue (not even void)
If method is not returning any value, then specify void	We don't specify the void
Method can take parameters/arguments	Constructor can take parameters/arguments
We have to invoke/call methods explicitly through object	Constructor automatically invoked at the time of object creation
Used for specifying logic	Used for initializing the values of the variables

What are the four pillars of OOP?

1. Encapsulation – Hiding implementation details and exposing only necessary features.
2. Inheritance – Acquiring properties of a parent class in a child class.
3. Polymorphism – Same method, different behavior (Overloading & Overriding).
4. Abstraction – Hiding implementation details using abstract classes or interfaces.

Call by Value:

When you pass a primitive type (like int, float, etc.) to a method, a copy of the value is passed. Any changes made to the parameter inside the method do not affect the original variable outside the method.

```
public class Test {

    void m1(int number)
    {
        number=number+10;
        Syso("Value in the method:"+ number);
    }
```

```
//passing copy of the variable
public class CallByValue {
        public static void main(String[] args) {
        Test test=new Test();
        int number=100;
        Syso("Before method:"+number);
        test.m1(number);                          //100
        Syso("After method:"+number);             //110
        //Original number doesn't impact          //100


}
```

Call By Reference:

Instead of value, passingthe object reference.

By taking the reference ofthe object(test), we callthereference.

```
public class Test {

   int number;

// Method to modify the number field of the
Testobject
   void m2(Test t) {

    t.number = t.number + 10;
// Modify the number field of the passed object
Syso("Value in the method: " + t.number);

 // Print the modified value
   }
}
```

This shows that the number field of the Test object is modified inside the m2() method because Java passes the reference (not the actual object) to the method.
The change is reflected in the main method as well.

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

// Create a Test object
      Test test = new Test();
      test.number = 100; // Initializing the number
field

//Print valuebeforemethodcall
   Syso("Value before method: " + test.number);

        //Call the m2methodandpass thetestobject
      test.m2(test);

//Print the value of number after the method
call
   Syso("Value after method: " + test.number);
   }
}

//100
//110
//110
```

Polymorphism: One thing can have many forms. (One method can have many f

i.e. different parameters (int, double etc)

Shape - rectangle, triangle, circle etc...

Water - vapor, ice Burge

In Java, polymorphism can be achieved in two primary ways:

1. Compile-time Polymorphism (Method Overloading) : Occurs when multiple methods in the same class have the same name but differ in the number or type of parameters.

   class X

   {

   void add()

   void add(int x, int y)

   }

2. Runtime Polymorphism (Method Overriding) : Occurs when asubclassprovidesa specific implementation ofamethodthatis already defined in its superclass.Themethod that gets executed is determined at runtime based on the actual object type. e.g. A subclass provides a new implementation for an inherited method. class Animal { void makeSound() { System.out.println("Animal makes a sound"); } } // Child class (Overriding the method) class Dog extends Animal { @Override void makeSound() { System.out.println("Dog barks"); } }

Method Overloading: Defining multiple methods in the same class with the same name but different parameters.

Normal Class, Method creation

```
class Calculator {

//Declarethevariablesoutsidethemethod
    int a = 10; // Instance variable a
    int b = 20; // Instance variable b
//Overloadedmethodwithvoidreturntype

    void add()
    {
        int sum = a + b;
// Use the instance variables a and b
Syso("Sumof"+a+"and"+b+":"+sum);
//Printsthesumdirectlyinsidethemethod
    }

//Overloadedmethodtoaddthreeintegers
    int add(int a, int b, int c)
    {
        return a + b + c;
    }

// Overloaded method to add two double values
    double add(double a, double b)
    {
        return a + b;
    }
}
```

MainClass, Object creation, Method Call

```
publicstatic void main(String[] args) {

    Calculator calc = new Calculator();

// Calls the method that prints the result directly inside it
        calc.add();
// add() method uses instance variables a and b

//Sum of 10 and 20: 30

        Syso(calc.add(2, 3, 4));
// Callsadd(int,int,int)andprintsthe result

//9

        Syso(calc.add(2.5, 3.5));
//Callsadd(double,double)andprints the result
    }
}
//6.0
```

Constructor Overloading: Defining multiple constructors in the same class with the same name but different parameters.

```
public classBox {

double width, height, depth;
Box()                          //1st Constructor {
        {
                width=0;
                height=0;
                depth=0;
                OR
                width=height=depth=0;
        }

Box(double w, double h, double d) //2nd
        {
                width=w;
                height=h;
                depth=d;
        }

Box(double len)                          //3rd
        {
        }
                width=height=depth=len;


double volume()
//normal method for calculation/output
        {
                return (width*height*depth);
        }

}
//w, h, d, len are variables
```

```
public class BoxMain {

        public static void main(String[] args)

        Box b=new Box();                    //1

        Box b=new Box(5.0,5.5,5.7);         //2

        Box b=new Box(10.5);                //3

//Created 3 objects to call 3 constructors

        Syso(b.volume());
//Calling normal method for output
        }
}
```

Day12 1:25

Can we pass parameters to main method? Yes

Can we overload main method? Yes

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

this Keyword:

Whena constructor or method parameter has the same name as an instance variable, this is used to differentiate between them.

OR

If using same name to class variables and local variables, then this keyword is used to differentiate between them. (this keyword always refers to the class)

```
public class ThisKeyword {


        int x, y;
        // class variables/ instance variables


Example for method:
        void setData(int x, int y)
//a,b are the local variables(if taken instead x ,y)
        {
                this.x=x;
                this.y=y;
        }
OR
Example for constructor:
        ThisKeyword(int x, int y)
        {
                this.x=x;
                this.y=y;
        }
        void display()
        {
        System.out.println(x+" "+y);
        }
```

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



//Object creation, methods to assign values and print
        ThisKeyword th=new ThisKeyword();
        th.setData(10,20);
        th.display();



OR
        ThisKeyword th=new ThisKeyword(10,20);
        th.display();


}
```

Types of variables:

- Class variables/Instance variables
- Local variables

Encapsulation: Data hiding by wrapping variables & methods in a single unit (class).

Use: If youwant toprovide some kind of security to the class variables

1) All variables should be private
2) For every variable there should be 2 methods (get & set)
3) Variables can be operated only through methods

```
public class Account {

private int accno;
private String name;
private double amount;

public int getAccno() {
return accno;
        }
public void setAccno(int accno) {
this.accno = accno;
        }
public String getName() {
return name;
        }
public void setName(String name) {
this.name = name;
        }
public double getAmount() {
return amount;
}
public void setAmount(double amount) {
this.amount = amount;
        }

}
```

NOTE: Every getter should return the value instead of only printing

```
publicclass AccountMain {

publicstatic void main(String[] args) {

Account acc=new Account();

acc.setAccno(10101);

acc.setName("John");

acc.setAmount(12552.535);

System.out.println(acc.getAccno());
System.out.println(acc.getName());
System.out.println(acc.getAmount())
        }
}
```

Generate Setters and Getters :

NOTE: Instead ofcreating itmanually -

Go to Source > Generate getters and setters > Select variable to generate getters and setters > Generate

Key Features of Encapsulation:

1. DataHiding: Internaldetailsofaclass are hidden from the outside world. Access to them is controlled using access modifiers.
    - o Private (private): Accessible only within the class.
    - o Protected (protected): Accessible within the class and its subclasses.
    - o Public (public): Accessible from anywhere.
2. Getter and Setter Methods: Instead of directly accessing class variables, encapsulation promotes using getter and setter methods to read and modify data safely.
3. Improves Maintainability and Flexibility: Since data is accessed through methods, logic can be modified without affecting external code.
4. Enhances Security: Preventsunauthorized access and accidental modification of critical data.

System.out.println() What it is ?

System.out.println("welcome")

```
class Test
{
static String s="welcome";
}
Test.s.lenght()

class System
{
}
System.out.print()
System.out.println()
```

static PrintStream out;

System : Predefined class

out : PrintStream type static variable

PrintSteam : Predefined Class

print and println : Methods belongs to PrintStream class

static Keyword:

Make variablestaticonly if we have a common data across multiple objects (eg. dept numbers are same). Then it will be common across multiple object else variables are independent.

Advantage: Saves memory and updating it is easy.

1) static methods can access static stuff directly (without object). NOTE: Bcz public static void main(String[] args) {
2) static methods can access non-static stuff through object.
3) non-static methods can access everything directly.

Class with Main method
(call static & non-static methods from same class)

```
public class StaticDemo {


static int a=10;                // static variable
int b=20;                       // non-static variable

static void m1()                // static method
{
System.out.println("this is m1 static method...");
}
void m2()
                                // non-static
{
System.out.println("this is m2 non-static method...");
}
void m()
{                               // non-static
System.out.println(a);
System.out.println(b);
m1();
m2();
} public static void main(String[] args)
{
System.out.println(a);
m1();
System.out.println(b);
//cannotaccessdirectlybcozvariablebis  non-static  m2(); //
we cannot access directly bcoz method m2 is non-static


// Createan object to call non static method/variable
StaticDemo sd=new StaticDemo();
System.out.println(sd.b);
sd.m2();
sd.m();
}
        }
```

Main class
(call static & non-static methods from another class)

```
public class StaticMain {
public static void main(String[] args) {
//Use reference class name – belongs to which class
System.out.println(StaticDemo.a);


StaticDemo.m1();


// Create an object to call non static method/variable
StaticDemo sd=new StaticDemo();
System.out.println(sd.b);
sd.m2();


sd.m();


        }
}
```

NOTE:
We can call static and non-static method from another class using reference class name.
i.e. StaticDemo

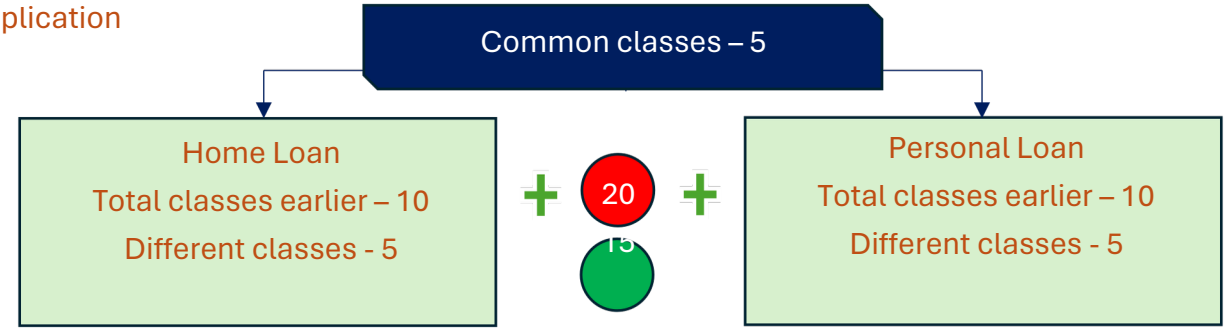
m() is a non – static method
It has static and non-static methods in it 20`, and we called m() method through the object sd.

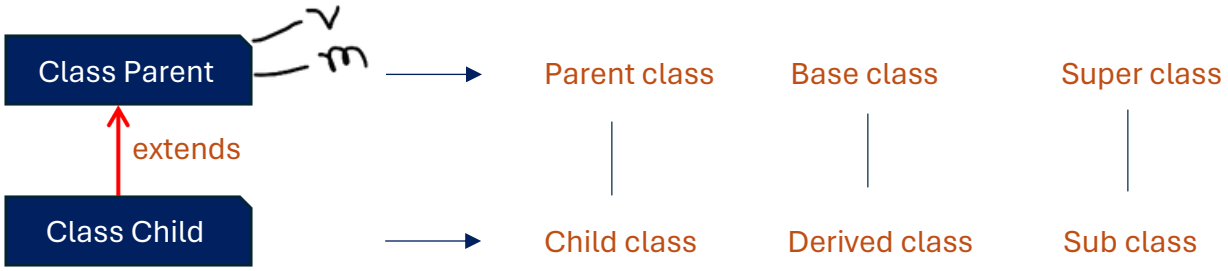
Inheritance:

Acquiring alltheproperties (Variables) & behaviors (methods) from one class to another class is called inheritance. Creating a new class based on an existing class to promote code reuse.

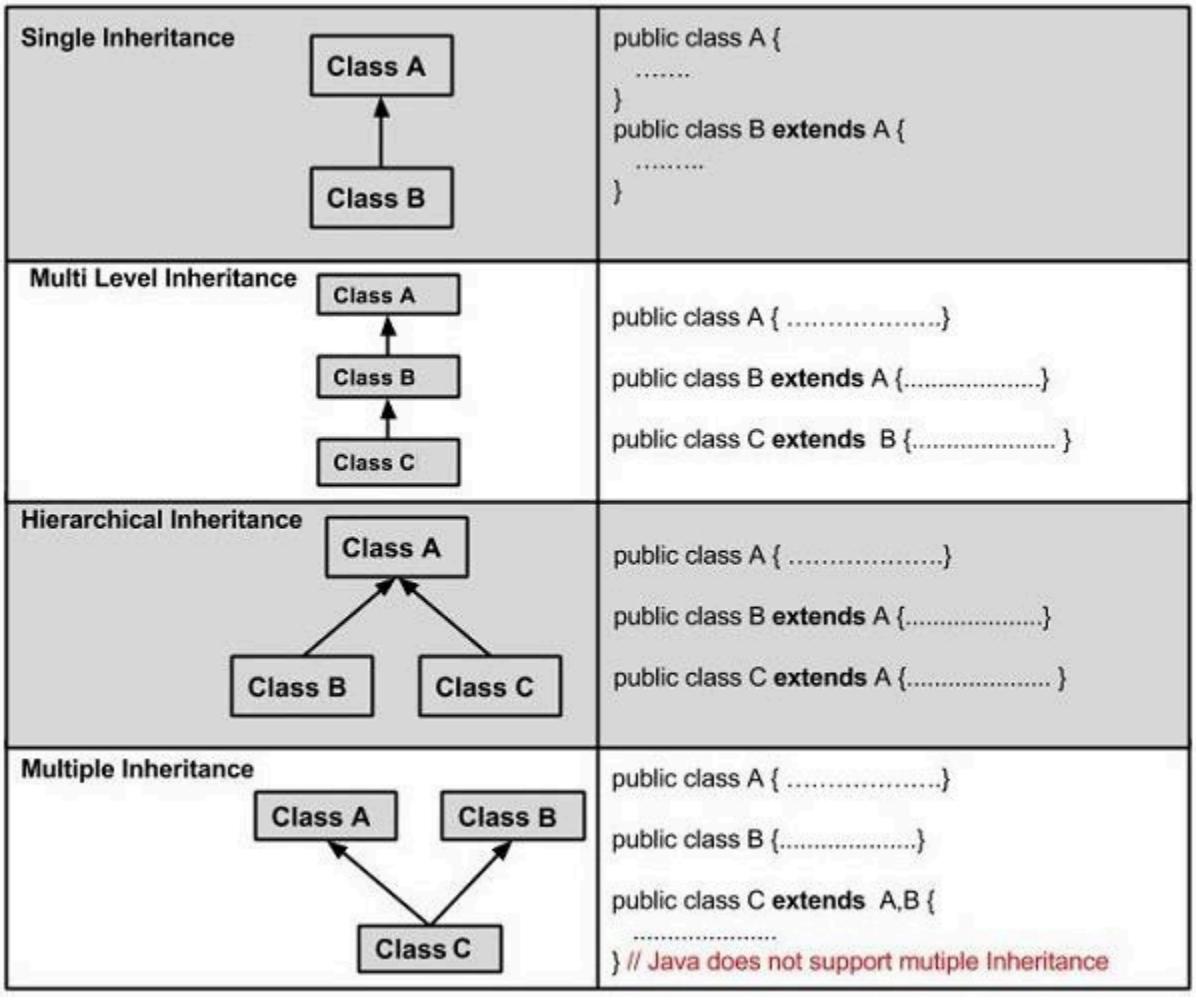
Objective:

1) Re-usability
2) Avoid duplication





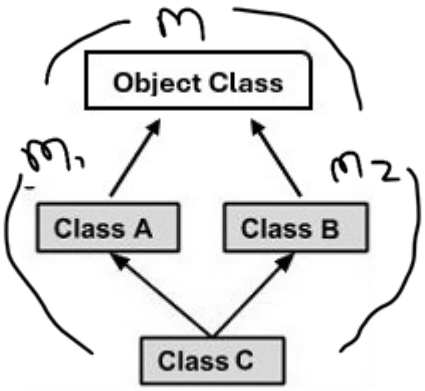
Types: class Child extends Parent



NOTE: We cannot implement multiple inheritance using class concept (bcz we cannot extend multiple class at a time) but with Interface concept (Interface A, B, C instead of parent class A, B, C)

Why cannot we do multiple inheritance?

Eventhoughyou havenot created anyduplicatemethodsinParent class A and B(i.e. m1and m2) stillthoseclasses are having duplicate methods (i.e. m) coming from Object class(i.e. default parent class in java). By default, whenever you create a class, it acquires everything from Predefined class i.e. objectclass in java (e.g. method m).



Predefined

Parent Class

Child class

```
class A
{
        int a;
        void display()
        { }
                System.out.println(a);

}
class B extends A
{
        int b;
        void show()
        { }
                System.out.println(b);

}
class C extends B
{
        int c;
        void print()
        { }
                System.out.println(c);

}
```

Single

Multilevel

```
public class InheritanceTypes {
        public static void main(String[] args)
        {
                B bobj=new B();
                bobj.a=10;
                bobj.b=20;

                bobj.display();
                bobj.show();
```

Single

```
                C cobj=new C();
                cobj.a=100;
                cobj.b=200;
                cobj.c=300;

                cobj.display();
                cobj.show();
                cobj.print();

        }
}
public class HierarchyInheritance {
```

Multilevel

```
class Parent
{
void display(int a)
        {       System.out.println(a);          }
}

class Child1 extends Parent{
void show(int b)
class Child2 extends Parent
void print(int c)
```

Hierarchy

```
        public static void main(String[] args) {
        Child1 c1=new Child1();
        c1.display(100);
        c1.show(200);

        Child2 c2=new Child2();
        c2.display(10);
        c2.print(20);
        }
```

What is ??

publicstatic void main(String args[])

{ } public - static - void -

Access modifier (can accessible everywhere in the project)
Directly called by JVM (without object) (static keyword must be the before method name)
No returned value

String args[] - String type array (It can accept any type of data using " i.e. "10.5" "A" "Arshad" , that's why it is string type array)

public static void main(String a[])	Valid
public static void main(String []a)	Valid
void main(String args[]) public static	Invalid
public static void main(int a[]) static	Invalid
public void main(String args[]) static	Valid
void public main(String args[])	Invalid

Explain the difference between == and .equals() in Java?

== (Reference Comparison) – Compares memory addresses.
.equals() (Content Comparison) – Compares actual values of objects.

e.g.
```
String a = new String("Java");
String b = new String("Java");

System.out.println(a == b);          // false (Different memory locations)
System.out.println(a.equals(b));     // true (Same content)
```

Method Overloading:

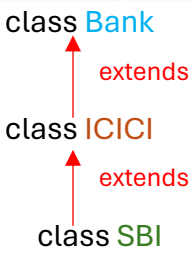
1. Possible onlyin single and multiple classes (inheritance)
2. We should change the signature (Parent) of the method
3. Method names are same
4. Belongs to polymorphism

Method Overriding:

1. Possible only in multiple classes (inheritance)
2. We should not change the signature (Parent) of the method but body(Child) we should change
3. Method names are same
4. Belongs to inheritance

Method Overloading vs. Method Overriding in Java:

Feature	MethodOverloading	MethodOverriding
Definition	Definingmultiplemethods in the sameclasswiththesamename but differentparameters.	Defining a methodina subclass that has the same signature as a method in the superclass, but with a different implementation.
Where It Occurs	Sameclass(multiplemethods with thesamenamebutdifferent parameters).	Subclass & Superclass relationship (subclass provides its own version of a method).
Parameters	Mustbedifferent(eitherinthe number,type,ororderofparameters).	Must be exactly the same as the superclass method.
Return Type	Canbedifferent.	Must be same (or a covariant return type).
Access Modifiers	Canhavedifferentaccesslevels.	Cannot have a more restrictive access level than the overridden method in the superclass.
static Methods	Canbeoverloaded.	Cannot be overridden (but can be hidden if redefined in the subclass).
final Methods	Canbeoverloaded.	Cannot be overridden.
Constructors	Canbeoverloaded(multiple constructorsinthesameclass).	Cannot be overridden (constructors are not inherited).
Polymorphism Type	Compile-timePolymorphism (decisionismadeatcompile-time).	Runtime Polymorphism (decision is made at runtime).
@Override Annotation	Notrequired.	Required (Recommended) to ensure proper overriding.



In above, class Bank is immediate parent class of class ICICI and class ICICI is immediate parent class of class SBI.

super Keyword:

1. super keyword is used to invoke the immediate parent class variable (else latest variable invokes)
2. super keyword is used to invoke the immediate parent class method
3. super keyword is used to invoke the immediate parent class constructor

Overriding: Defining a method in a subclass that has the same signature as a method in the superclass, butwith a different implementation.

```
class Bank
{
        double roi()
        { }
            return 0;

}
class ICICI extends Bank
{
        double roi()
        { }
            return 10.5;
}
class SBI extends Bank
{


        double roi()
        { }
            return 11.5;

}

public class OverridingDemo {

public static void main(String[] args) {


        ICICI ic=new ICICI();
        System.out.println(ic.roi());      //10.5
        SBI sb=new SBI();
        System.out.println(sb.roi());
        }                                  //11.5


}
```

```
class ABC
{
        void m1(int a)
        { }
        void m2(int b)
        { }


            System.out.println(a);


            System.out.println(b);


}

class XYZ extends ABC
{

        void m1(int a)                  // overriding
        { }
        void m2(int b)
        { }
        void m2(int a, int b)           //overriding
        { }
            System.out.println(b*b);

                                        //overloading

            System.out.println(a+b);


}
public class OverloadingVsOverriding {

        public static void main(String[] args) {

            XYZ xyzobj=new XYZ();
            xyzobj.m1(10);
            xyzobj.m2(5);
            xyzobj.m2(10,20);
        }
}
```

Example of Method overriding, Constructor overloading:

```
public class Animal { String

color="white"; void eat()
{ }
Animal()
{ }
Animal(String name)
{ }
class Dog extends Animal {      //constructor
String color="black";
void displayColor()
{ }                             //constructor

        System.out.println(name);

        System.out.println(super.color);

void eat()
{
        //System.out.println("eating bread");
        super.eat();
}
Dog()                           //constructor
{
        super(); //Optional: invoke parent class
                 constructor
        //System.out.println("this is Dog..");
}

Dog(String name)                //constructor
{ }
}       super(name);
```

```
public class TestSuper {

        public static void main(String[] args)
        {
            Dog d=new Dog();

            d.displayColor();
            d.eat();
            or

            Dog d=new Dog("Elephant");

        }

}
```

NOTE:

- No need to use super keyword to invoke constructor from parent class.
  As the constructor invokes at the time of object creation, it will 1st invoke from parent class then child class.
- Constructor name should be same as class name that is why constructor overriding is not possible

E.g. Why constructor overriding not possible..?

```
public class Animal {

Animal()                        //constructor
{ }
class Dog extends Animal{       System.out.println("This is Animal..");
{ }
// Constructor name should be same as class name

                                //constructor

        System.out.println("This is Animal..");
```

final keyword:

Ifapplied finalkeyword on:

Variables - We cannot change the value of the variable (constant)

Methods - We cannot override those methods in Child classes

Class - We cannot extend the class

```
class Test
{
}
public class FinalKeyword{
        final int x=100;



        public static void main(String[] args) {
        Test t=new Test();
        t.x=200;


// we cannot change the value of x. x is final variable.
        System.out.println(t.x);
        }

}
```

```
final class Arshad
{
final void m1()
        {
        System.out.println("m1 from Test1");
        }
}

class Mujawar extends Arshad
// we cannot extend the class (Arshad is final class)
{

        void m1()
// we cannot override final methods (m1 is final method)
        {
        System.out.println("m1 from Test2");
        }
}
public class FinalKeyword2 {
        public static void main(String[] args) {
        }
}
```

Difference between final, finally, and finalize in Java ?

Keyword	Description	Usage
final	Used for constants, prevents modification.	finalvariable:Cannotbereassigned. final method: Cannot be overridden. final class: Cannot be inherited.
finally	Used in exception handling, always executes.	Always executes after try-catch block, even if an exception occurs.
finalize	A method used for garbage collection.	Called by the Garbage Collector before an object is destroyed.

Data abstraction:

Abstraction is a process of hiding the implementation details and showing only functionality to theuser.

Interface

1) An interface is a blueprint of class.
2) Interface contains final & Static variables.
3) Interface contains abstract methods. (also allowed default methods & Static methods from java8 onwards)
4) An abstract method is a method contains signature but not body (Un-implemented method).
5) Methods in interface are public.
6) Interface supports the functionality of multiple inheritance.
7) We can define interface with interface keyword.
8) A class extends another class; an interface extends another interface, but a class implements an interface.
9) We can create Object reference for Interface, but we cannot instantiate interface.

Access modifiers:

public - directly access all variables & methods everywhere

protected - accessible outside of package (sub classes) through inheritance

default – accessible only within the same package

private - access only within the same class

continue

```
interface Shape
{
int length=10;                    // final and static
int width=20;                     // final and static  //
void circle();                    abstract method
default void square()
{
System.out.println("this is square -
                    default method....");
}
static void rectangle()
{
System.out.println("this is
          rectangle- static method...");
}
}
public class InterfaceDemo implements
Shape
{
public void circle()
{
System.out.println(" this is circle –
                    abstract method...");
}
//Whenever you are implementing any method from the
interface into the class need to specify public access
modifier – implementation of abstract method
void triangle()
{
System.out.println("this is
                          triangle..");
}
```

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

//Scenario 1

InterfaceDemo idobj=new InterfaceDemo();

idobj.circle();              // abstract
idobj.square();              // default
Shape.rectangle();           // static
(staticmethoddirectlyaccessedthroughinterfacename )

System.out.println(Shape.length+Shape.width);//30
//System.out.println(idobj.length+idobj.width);

idobj.triangle();            // access


//Scenario 2

Shape sh=new InterfaceDemo();
//useimplementedclassnameatthetimeofobjcreation

sh.circle();                 // abstract method
sh.square();                 // default method
//sh.rectangle();            // cannot access
Shape.rectangle();           // static method
//sh.triangle() ;            // cannot access


        }
}
```

Why interface is needed, where we are going to use.? (Development)

Initially developers awareof requirements but theydon't to know how to implementthem,
they will start creating requirement in the form of interfaces they keep all abstract method, once they understand how to implement then they can start creating classes.

We are going to use existing interface (Selenium WebDriver)(Testing)

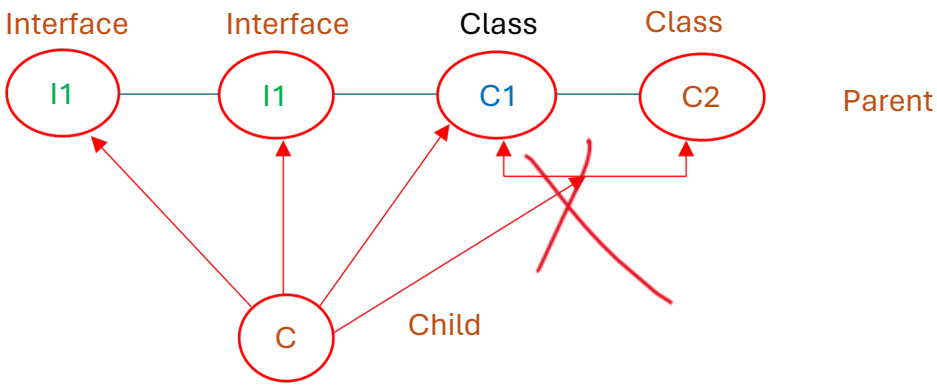
Initially they have created WebDriver which contains so many types of methods later on they have created multiple classes to implement this webdriver.
e.g. ChromBrower class, EdgeBroweser class

Multiple Inheritance:

```
public interface I1 {

        int x=100;
        void m1();

}
```

```
public interface I2 {

        int y=200;
        void m2();
}
```

```
public class MultipleInheritance implements I1,I2
{

 public void m1()
        {
        }
                System.out.println("thisism1...");


 public void m2()
        {
        }
                System.out.println("thisism2...");


 public static void main(String[] args) {

        MultipleInheritance mi=new MultipleInheritance();
        mi.m1();
        mi.m2();

        System.out.println(mi.x);
        System.out.println(mi.y);
 }
}
```



C extends C1 implements I1, I2 //Possible

C extends C1,C2 implements I1, I2 //NotPossible(onlyone class is allowed as parent)

Multiple Inheritance using Interface concept

Wrapper Classes – Data Conversion

InJava, a wrapper refers to a class that encapsulates a primitive data type, allowing it to be treated asanobject.Java provides wrapper classes for all primitive data types in the java.lang package.

- For every primitive data type there is corresponding wrapper class is available.
- Wrapper classes convert primitive to object type and vice versa.
- Collection in java allows only object type of data.

List of Wrapper Classes:

Primitive Type	Wrapper Class
byte	Byte
short	Short
int	Integer
long	Long
float	Float
double	Double
char	Character
boolean	Boolean

Why Use Wrapper Classes?

1. Collection Framework Compatibility – Collections (e.g., ArrayList, HashMap) only work with objects, not primitives.
2. Utility Methods – Wrapper classes provide useful methods for conversions, parsing, etc.
3. Autoboxing & Unboxing – Automatic conversion between primitive types and their wrapper objects.

   Auto boxing (Primitive ⟶ Object)

   Un-boxing (Object ⟶ Primitive)

Key Features:

- Autoboxing: Automatically converts primitives to wrapper objects.
- Unboxing: Automatically converts wrapper objects to primitives.
- Immutable: Wrapper objects are immutable (cannot be changed after creation).
- Parsing & Conversion: Methods like parseInt(), toString(), and valueOf() help in conversions.

```
Example: int x=100;
double d=10.5;
Integer x=100; Double
d=10.5 String
s="welcome"; String
s1="welcome"; String
s1="150"; String
s2="160";
```

// cannot convert to number
// can convert to number //
can convert to number

Scenario 1: int, double, bool, char → String (Possible)

Scenario 2: String → int, double, bool, char (Not possible)

public class WrapperExample {

```
publicstaticvoidmain(String[]args) {

intno=10;

//Autoboxing:Converting primitive to Wrapper Object
Integernum=no;              // Object
Or
Integernum=10;          // Equivalent to Integer.valueOf(10)
Doubleprice=99.99;
Characterletter='A';
Booleanbool=true;

//Unboxing:Converting Wrapper Object to primitive
intn=num;                   // Equivalent to num.intValue()
double p = price;
char l = letter;
boolean b = bool;

//Wrapperclassmethods
Stringstr=Integer.toString(100);
                            // Convert int to String
intparsedValue=Integer.parseInt("50");
                            // Convert String to int

    System.out.println("Autoboxed Integer: " + num);
    System.out.println("Unboxed int: " + n);
    System.out.println("Converted String: " + str);
    System.out.println("Parsed int: " + parsedValue);
  }
}
```

ConversionType	Method
Widening (auto)	int → long → float → double
Narrowing (manual)	(type) value
Primitive → Object	Integer.valueOf(int)
Object → Primitive	obj.intValue()
Primitive → String	String.valueOf(int)
String → Primitive	Integer.parseInt(str)

public class DataConvertions {

1. Implicit (Widening) Conversion

int → double

```
int num = 100;
double d = num;
                        // int to double (automatic conversion)

System.out.println("Integer value: " + num);
System.out.println("Converted to double: " + d);
```

2. Explicit (Narrowing) Conversion

double → int

```
double d = 99.99;
int num = (int) d;              // Explicit conversion (double to int)
                                // type casting
System.out.println("Double value: " + d);
System.out.println("Converted to int: " + num);
                                    // 99 (decimal part lost)
```

3. Type Conversion using Wrapper Classes

```
int num = 50;
Integer obj = Integer.valueOf(num); // Boxing (primitive to object)

int value = obj.intValue();         // Unboxing (object to primitive)

System.out.println("Boxed Integer: " + obj);
System.out.println("Unboxed int: " + value);
```

4. String Conversion

Primitive to String: int, double, bool, char → String

Use String.valueOf() or toString()

```
int num = 100;
String str = String.valueOf(num);
or
Integer.toString(num)
System.out.println("Converted String: " + str);

boolean bool=true;
String str=String.valueOf(bool);
System.out.println("Converted String: " + str);
```

String to Primitive: String → int, double, bool, char (not possible)

Use wrapper class methods like parseInt(), parseDouble()

```
String str = "123";
int num = Integer.parseInt(str);
System.out.println("Converted int: " + num);

String str ="10.5";
double dou = Double.parseDouble(str);
System.out.println("Converted double: " + dou);

String str = "true";
boolean bool = Boolean.parseBoolean(str);
System.out.println("Converted boolean: " + bool);
```

NOTE:

```
String s="welcome";
String → char                   // cannot convert to number
                                // cannot covert - not possible
```

Packages:

built-inpackages - java.util, java.io, etc.
user-defined packages - Custom packages created using package keyword.
sub packages - A package inside another package.

Access modifiers:

public - directly access all variables & methods everywhere
protected - accessible outside of package (sub classes) through inheritance
default – accessible only within the same package
private - access only within the same class

```
package mainPack.subPack2;
import mainPack.subPack1.ClassTest1;
public class ClassTest2 {
                                                    // if accessing outside the package
public class ClassTest2 extends ClassTest1{

                                                    // Protected example
```

Type Casting in Java

- Type casting refers to converting one data type into another.

1. Implicit (Widening) Casting – byte → short → int → long → float → double
   Performed automatically when converting a smaller type to a larger type.
2. Explicit (Narrowing) Casting – double → float → long → int → short → byte
   Requires manual (type) conversion when converting a larger type to a smaller type.

```
int i=100;
double d=i;                    // up casting
System.out.println(d);         //100.0
```

```
double d=10.5;
int i=(int)d;                  // down casting
System.out.println(i);         //10
```

Ex1:
```
Object o=new String("welcome");
StringBuffer sb=(StringBuffer) o;
```
Rule1 Rule2 Rule3

Ex2:
```
String s=new String("welcome");
StringBuffer sb=(StringBuffer) s;
```
Rule1

Ex3:
```
Object o=new String("welcome");
StringBuffer sb=(String) o;
```
Rule1 Rule2

Ex4:
```
String s=new String("welcome");
StringBuffer sb=(String) s;
```
Rule1 Rule2

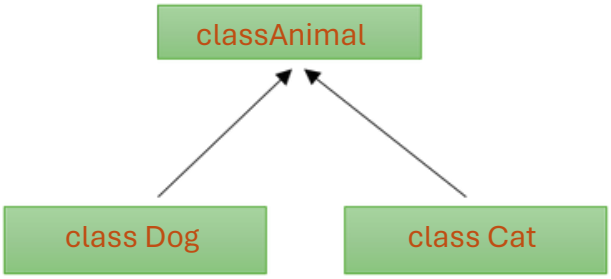
Ex5:
```
Object o=new String("welcome");
String s=(String) o;
System.out.println(s);
```
Rule1 Rules2 Rule3

AB CD

Catct =(Cat)an;

reference variable for cat obj — Converting an to Cat — animaltypeof object/variable

```
class Animal{}
class Dog extends Animal{}
class Cat extends Animal{}
```




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

Rule 1: Conversion is valid or not: The type of 'D' and 'C' must have some relationship (either parent to child or child to parent or same type).

```
Animal an=new Dog(); //Animal reference (an) is being converted into a Dog reference. A Dog object is created, but it is st
Cat ct=(Cat) an;                                                    // Rule 1
Dog dg=new Dog();
Cat ct=(Cat) dg;
                                                                    // Rule1
```

Rule2: Assignment isvalidornot : 'C' must be either same or child of 'A'.

```
Animal an=new Dog();
Cat ct=(Cat) an;                                                    // Rule2

Animal an=new Dog();
Cat ct=(Dog) an;
                                                                    // Rule2
```

Rule3: The underlyingobjecttype of'D' must be either same or child of 'C'.

```
Animal an=new Dog();
Cat ct=(Cat) an;                                                    // Rule 3

Animalan=newDog();          // Upcasting (Dog → Animal)
Dogdg=(Dog) an;             // Down casting (Animal → Dog)
                                                                    // Rule1 – Rule2 – Rule3
```

Step-by-StepBreakdown:

Animalan=newDog();→Upcasting

- ADogobjectiscreated, but it is stored in an Animal reference.
- This issafeandhappens implicitly because Dog is-a Animal (inheritance).

Dog dg=(Dog) an;→Downcasting

- anactuallyholdsaDog object, so downcasting is valid.
- The explicitcast(Dog) an tells Java to treat an as a Dog object.
- Now,dg canaccessboth Animal and Dog methods.

Exception handling:

Exceptionisan eventwhichwillcause program termination.

Types of Errors:

1. Syntax Errors – Issues incode structure, caughtduringcompilation.
2. Logical Errors – Code runs but produces incorrect results.

Types of Exceptions:

1. Checked Exceptions (Compile-time Exceptions)
   - Exceptions identified by the Java compiler.
   - Must be handled using try-catch or declared with throws.
   - Examples:
     - InterruptedException
     - FileNotFoundException
     - IOException
2. Unchecked Exceptions (Runtime Exceptions)
   - Exceptions not checked at compile time, occurring during execution.
   - Usually caused by programming mistakes.
   - Examples:
     - ArithmeticException (e.g., division by zero)
     - NullPointerException (accessing an object reference that is null)
     - ArrayIndexOutOfBoundsException (accessing an invalid array index)

```
import java.util.Scanner;
System.out.println("program is started.....");
Scanner sc=new Scanner(System.in);
```

Example1

```
System.out.println("Enter a number:");
int num=sc.nextInt();

System.out.println(100/num);
                                    // ArithmeticException
```

Example2

```
int a[]=new int[5];

System.out.println("Enter the position(0-4):");
        int pos=sc.nextInt();

System.out.println("Enter the value:");
        int value=sc.nextInt();
        a[pos]=value;
                //ArrayIndexOutOfBoundsException

System.out.println(a[pos]);
```

Example3

```
String s="welcome";
int num=Integer.parseInt(s);
                        //NumberFormatException
System.out.println(num);
```

Example4

```
String s=null;
System.out.println(s.length());
                        //NullPointerException
```

```
System.out.println("program is completed.....");
```

Exception Handling using try-catch-finally

try { } catch("Exception name here and reference variable") { } finally { }

- **try Block:** Thetryblockcontainsthe code that might throw an exception. If an exception occurs, execution jumps to the catch block.
- **catch Block:** Thecatchblockhandles the exception. It catches specific exceptions and prevents program termination.Youcanalsousemultiple catch blocks to handle different exceptions
- **finally Block:** Thefinallyblockexecutes always, whether an exception occurs or not. It is typically used for resourcecleanup(e.g.,closingfiles or database connections).

Example Demonstrating finally

```
public classExceptionHandlingExample {
  public static void main(String[] args) {
    try
    {
      int[] arr = {1, 2, 3};
      System.out.println(arr[5]);                    // This will throw ArrayIndexOutOfBoundsException
    }
    catch (ArrayIndexOutOfBoundsException e)
    { }
    finally
    { System.out.println("Array index is out of bounds: " + e.getMessage());
    }


      System.out.println("This will always execute.");

  }
```

Output:

Array index is out of bounds: Index 5 out of bounds for length 3
This will always execute.

Understanding the finally Block

Thefinallyblockalwaysexecutes,regardless of whether an exception occurs or not.

Case	Exception Occurred?	Catch Block Executed?	Finally Block Executed?
Case 1	Yes	Handled	Yes
Case 2	Yes	Not Handled	Yes
Case 3	No	Ignored	Yes

Handling Unknown Exceptions (2. Unchecked - Runtime)

Ifyou'reunsurewhat typeof exception might occur,you have twosolutions:

1. Multiple catch Blocks

Youcanusemultiple catch blocksto handle different types of exceptions separately.

```
try
{     }
catch(ArithmeticException e)                    // This will throw NumberFormatException
{}
catch(NumberFormatException e)
{}
catch(Exception e)
{}
```

```
System.out.println("Arithmetic Exception: " + e.getMessage());
```

```
System.out.println("Number Format Exception: " + e.getMessage());
```

```
                                                // Catches any other exception
System.out.println("Some other exception occurred: " + e.getMessage());
```

2. Using the Exception Class

If you don’tknow what exception might occur, you can catch all exceptions using the generic Exception class.

```
try
{     }
catch(Exception e)                              // This will throw ArithmeticException
{}                                              // Catches all exception
```

```
System.out.println("Exception occurred: " + e.getMessage());
```

Note:Catching Exception is useful but should be used cautiously, as it hides specific exceptions.

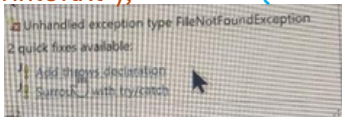
Handling Unknown Exceptions (1. Checked – Compile time)

Checkedexception can be handled using throws and try-catch

```
publicclassCheckedExceptions {
    public static void main(String[] args) throws IOException {
        System.out.println("Program is started..");
        System.out.println("Program is progress..");
        // try { } catch (FileNotFoundException e) { } //
        FileInputStream file=new FileInputStream("C:\\file.txt");
        e.printStackTrace();
        FileInputStream file=new FileInputStream("C:\\file.txt");
        System.out.println(file.read());
        System.out.println("Program is completed..");
```

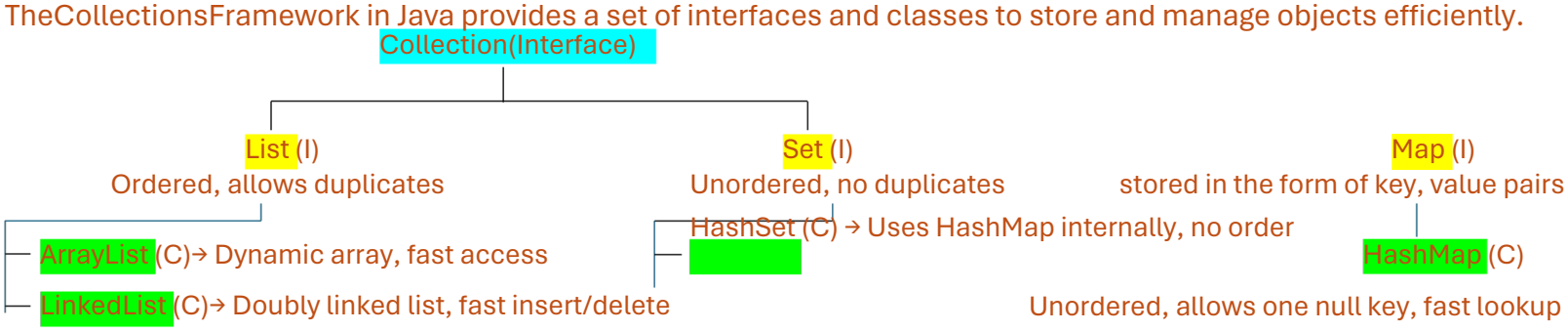
tr y- catch

throws



Collections:

TheCollectionsFramework in Java provides a set of interfaces and classes to store and manage objects efficiently.



ArrayList:

ArrayList is a class in Java that implements the List interface, which is part of the java.util package.

An ArrayList in Java is a resizable array that is part of the java.util package. Unlike a normal array, which has a fixed size, an ArrayList can grow and shrink dynamically.

Key Features:

- Heterogeneous data - allowed
- Insertion order- preserved (Index)
- Duplicate elements - allowed
- Multiple nulls - allowed

Important Methods:

- add(),add(index, element), get(), set(), remove(), contains(), size(), isEmpty(), clear()
- Iterating using for-loop, foreach-loop, Iterator

HashSet:

HashSet isaclass in Java that implements the Set interface, which is part of the java.util package.

Key Features:

- Heterogeneous data - allowed
  Insertion order - Not preserved (Index not supported)
- Duplicate elements - Not Allowed
- Multiple nulls - Not allowed / only single null is allowed

HashMap:

HashMap isaclass in Java that implements the Map interface and is used to store key-value pairs.

Key Features:

- Heterogeneous data - allowed
- Datacan be stored in the form of key, value pairs.
- Key isunique. But we can have duplicate values.
- Insertion order not preserved (Index not followed)
- Allowsone null key but multiple null values

ArrayList Example :

```
import java.util.ArrayList;
import java.util.Iterator;
public class ArrayListExample {
   public static void main(String[] args) {
   1. Creating an ArrayList of Strings
   ArrayList<String> myList = new ArrayList<String>();

   2. Adding elements (directly as Strings)



      myList.add("Alice");                  // String
      myList.add("25");                     // Integer as String
      myList.add("3.14");                   // Double as String
      myList.add("true");                   // Boolean as String
      myList.add("A");                      // Character as String
      myList.add(null);                     // Null value
      myList.add("25");                     // Duplicate value
      myList.add("Alice");                  // Duplicate String


      System.out.println("ArrayList after adding elements: " +
myList);


      3. Inserting element at a specific index
      myList.add(2, "Inserted Element");
      System.out.println("\nAfter inserting at index 2: " +
myList);


      4. Accessing elements using get(index)
      System.out.println("Element at index 3: " + myList.get(3));


      5. Updating an element using set(index, value)
                                    //(modify/replace/change)
      myList.set(1, "99");                  // Changing "25" to "99"

      System.out.println("After updating index 1: " + myList);

      6. Removing an element by index
      myList.remove(4);
      System.out.println("After removing element at index 4: " +
myList);


      7. Removing an element by value

      myList.remove("Alice"); // Removes the first occurrence
of "Alice"
      System.out.println("After removing 'Alice': " + myList);
      8. Checking if an element exists

      System.out.println("Contains '3.14'? " +
myList.contains("3.14"));


      9. Getting the size of the ArrayList
      System.out.println("Size of ArrayList: " + myList.size());
      10. Checking if the ArrayList is empty
      System.out.println("Is the list empty? " +
myList.isEmpty());
      11. Iterating through the ArrayList (3 methods)
      (i) Using for-loop
      System.out.println("\nIterating using for-loop:");
      for (int i = 0; i < myList.size(); i++)
      {
      }
      (ii) Using enhanced for-each loop
      System.out.println(myList.get(i));
      System.out.println("\nIterating using for-each loop:");
      for (Object x : myList)
      { } (iii) Using Iterator
      System.out.println("\nIterating using Iterator:");
      Iterator<String> it = myList.iterator();
      while (it.hasNext())
      {
      } 12. Clearing the ArrayList
      System.out.println(x);
      myList.clear(); System.out.println("\nAfter clearing, is the
      list empty? " +


            System.out.println(it.next());


      myList.isEmpty());
         }
      }
```

Output:

```
2 → ArrayListafteraddingelements:[Alice,25,3.14,true,A,null,
25, Alice]
3 → Afterinsertingatindex2:[Alice,25,InsertedElement,3.14,
true, A,null,25,Alice]
4 → Elementatindex3:3.14
5 → Afterupdatingindex1:[Alice,99,InsertedElement,3.14,true,
A, null,25,Alice]
6 → Afterremovingelementatindex4:[Alice,99,Inserted
Element, 3.14, A, null, 25, Alice]
7 → Afterremoving'Alice':[99,InsertedElement,3.14,A,null,25,
Alice]
8 → Contains'3.14'?true
9 → SizeofArrayList:7
10 → Isthelistempty?false
11 → Iteratingusing(i)for-loop,(ii)for-eachloop,(iii)iterator
99
Inserted Element
3.14
A
null
25
Alice
12 → Afterclearing,isthelistempty?true
```

HashSet Example :

```
import java.util.ArrayList; import java.util.HashSet;
import java.util.Iterator; import java.util.Set;
public class HashSetDemo {
        public static void main(String[] args) {
    Declaration
HashSet myset=new HashSet();
//Set myset=new HashSet();
//HashSet <String>myset=new HashSet<String>();
Use above for homogeneous data

adding elements into HashSet

myset.add(100);
myset.add(10.5);
myset.add("welcome");
myset.add(true);
myset.add('A');
myset.add(100);
myset.add(null);
myset.add(null);

    Printing HashSet
System.out.println(myset);
                        //[null, A, 100, 10.5, welcome, true]

    Size of HashSet
System.out.println("Size of hashset:"+ myset.size());       //6

    Removing element
myset.remove(10.5);                 // 10.5 is value (not an index)
System.out.println("After removing:"+myset);
                        //[null, A, 100, welcome, true]

     inserting elements at a specific position
    Direct access via index is NOT possible in HashSet
    Convert  HashSet  to  ArrayList  for indexed access


ArrayList al=new ArrayList(myset);
System.out.println(al);            //[null, A, 100, welcome, true]
System.out.println(al.get(2)); //100

    Read all the elements → using for..each
for(Object x:myset)
{ }
→       System.out.println(x);

   Using iterator
Iterator <Object> it=myset.iterator();
while(it.hasNext())
{ }
        System.out.println(it.next());

    clearing all the elements in HashSet
myset.clear();
System.out.println(myset.isEmpty());                    //true
}
```

No Duplicates Allowed → If you add 100 twice, only one instance remains.

Unordered Collection → Elements are stored in random order.

Fast Operations → add(), remove(), contains() are very fast due to hashing.

Allows null Value → Only one null is allowed.

No Indexing → You cannot retrieve elements using an index directly.

Basic Operations:

- add(element) → Adds an element to the HashSet (duplicates are not allowed).
- remove(element) → Removes the specified element from the HashSet.
- contains(element) → Returns true if the HashSet contains the specified element.

Size and Checking:

- size() → Returns the number of elements in the HashSet.
- isEmpty() → Returns true if the HashSet is empty.
- clear() → Removes all elements from the HashSet.

Iterating Over HashSet:

- Using for-each loop → Iterates through all elements.
- Using Iterator → Iterates using an Iterator.

HashMap Example:

```
import java.util.Map;
import java.util.Map.Entry;
import java.util.HashMap;
import java.util.Iterator;

public class HashMapDemo {

    public static void main(String[] args) {

        Declaration of HashMap (Key = Integer, Value = String)
        HashMap hm=new HashMap();
        Map hm=new HashMap();
or      HashMap<Integer, String> hm = new HashMap<>();
or      Adding key-value pairs
        hm.put(101, "John");
        hm.put(102, "Scott");
        hm.put(103, "Mary");
        hm.put(104, "Scott");
        hm.put(102, "David"); // Overwrites "Scott" with "David"
        Printing HashMap (Unordered, No duplicate keys)
        System.out.println(hm);
        Size of HashMap
        System.out.println("Size of HashMap: " + hm.size());




Output: 4

        Removing a key-value pair
        hm.remove(103); // Removes key 103 and its associated
                                value
        System.out.println("After removing key 103: " + hm);
Output: {101=John, 102=David, 104=Scott}

        Accessing a value using its key
        System.out.println(hm.get(102));
Output: David

        Getting all keys, values, and key-value pairs
        System.out.println("Keys: " + hm.keySet());
Output: [101, 102, 104]
        System.out.println("Values: " + hm.values());
Output: [John, David, Scott]
        System.out.println("Entries: " + hm.entrySet());
Output: [101=John, 102=David, 104=Scott]

        Read all the elements → using for-each loop


 System.out.println("Using for-each loop:");

  for (int k : hm.keySet())
        {
         System.out.println(k + " " + hm.get(k));
        }
→ using Iterator
        System.out.println("\nUsing Iterator:");
Iterator<Entry<Integer, String>> it = hm.entrySet().iterator();
while (it.hasNext())

 {
  Entry<Integer, String> entry = it.next();
  System.out.println(entry.getKey() + " " + entry.getValue());
 }
        Clearing all elements from HashMap
        hm.clear();
   System.out.println("Is HashMap empty? " + hm.isEmpty());
Output: true
    }
}
```

HashMap with Integer keys and String values (Both Homogeneous)
HashMap<Integer, String> hm = new HashMap<>();

Using Object to store different data types (Heterogeneous)
HashMap<Integer, Object> hm = new HashMap<>();

The Iterator interface allows sequential access to elements in a HashMap.

- put(key, value) → Adds or updates a key-value pair in the HashMap.
- putIfAbsent(key, value) → Adds the key-value pair only if the key does not already exist.
- get(key) →Retrieves the value associated with the given key.
- getOrDefault(key, defaultValue) → Returns the value for a key if it exists; otherwise, returns the provided default value.
- remove(key) → Removes a key-value pair using the key.
- remove(key, value) → Removes the key-value pair only if it matches the given value.

Checking Elements:

- containsKey(key) → Returns true if the key exists in the HashMap.
- containsValue(value) → Returns true if the specified value exists in the HashMap.

Retrieving Keys, Values, and Entries:

- keySet() → Returns a Set of all keys in the HashMap.
- values() → Returns a Collection of all values in the HashMap.
- entrySet() → Returns a Set of all key-value pairs (Map.Entry<K, V>).

Size and Clearing:

- size() → Returns the number of key-value pairs in the HashMap.
- isEmpty() → Returns true if the HashMap is empty.
- clear() → Removes all key-value pairs from the HashMap.

Iterating Over HashMap:

- Using for-each with keySet() → Iterates through all keys.
- Using for-each with entrySet() → Iterates through all key-value pairs.
- Using Iterator on entrySet() → Iterates using an Iterator.

Difference between ArrayList, HashSet, and HashMap:

Feature	ArrayList	HashSet	HashMap
Implements	List interface	Set interface	Map interface
Data Structure	Dynamic array	Hash table	Key-Value pairs stored in Hash table
Duplicates	Allowed	Not Allowed	Keys: Not Allowed Values: Allowed
Insertion Order	Preserved (Index-based)	Not Preserved	Not Preserved (Unordered)
Heterogeneous Data	Allowed (if using ArrayList<Object>)	Allowed (if using HashSet<Object>)	Allowed (if using HashMap<Object, Object>)
Indexing	Allowed (Can access via index)	Not Allowed	Not Allowed (Uses keys instead)
Access Time Complexity	O(1) for get(index) O(n) for contains(value)	O(1) for add/remove O(1) for contains(value)	O(1) for put/get O(n) for containsValue(value)
Iteration Methods	for-loop, foreach, Iterator	foreach, Iterator	foreach, Iterator, Map.Entry
Null Values	Multiple Nulls Allowed	One Null Allowed	One Null Key & Multiple Null Values Allowed
Usage	When ordered collection is needed	When unique elements are needed (won't show duplicate)	When key-value mapping is required
Important Methods	add(), add(index, element), get(), set(), remove(), contains(), size(), isEmpty(), clear()	add(), remove(), contains(), size(), isEmpty(), clear(), addAll(), removeAll(), retainAll()	put(), putIfAbsent(), get(), remove(), containsKey(), containsValue(), size(), isEmpty(), clear(), keySet(), values(), entrySet()

contains(value) in HashSet → O(1)
containsKey(key) in HashMap → O(1)
containsValue(value) in HashMap → O(n) (Slowest) Iterating through all elements is always O(n)

O(1) in ArrayList ?
Accessing an element by index:
ArrayList contains() is O(n) because it must search linearly.

O(1) in HashSet ?
Checking if an element exists (contains())

O(1) in HashMap ?
Getting a value by key (get())
Checking if a key exists (containsKey())
Inserting a key-value pair (put())