OBJECT ORIENTED PROGRAMMING WITH JAVA

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INHERITANCE BASICS

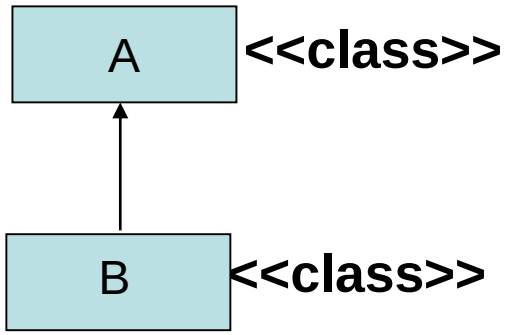
1. **Reusability is achieved by *INHERITANCE***
2. **Java classes Can be Reused by extending a class. Extending an existing class is nothing but reusing properties of the existing classes.**
3. *Inheritance* allows a software developer to derive a new class from an existing one
4. **The class whose properties are extended is known as *super or base or parent class*.**
5. **The class which extends the properties of super class is known as *sub or derived or child class***
6. ***A class can either extends another class or can implement an interface***

Forms of Inheritance

class B extends A { ….. }

A super class

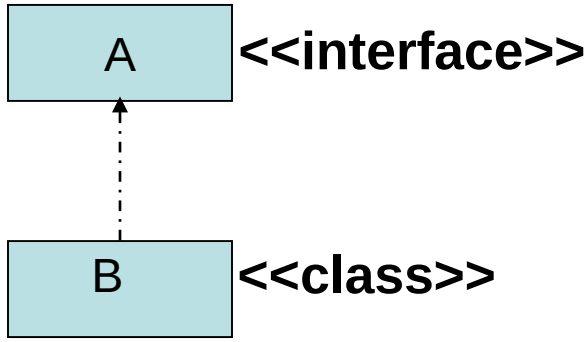
B sub class



class B implements A { ….. }

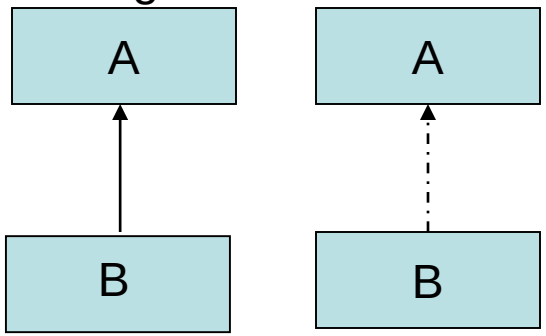
A interface

B sub class

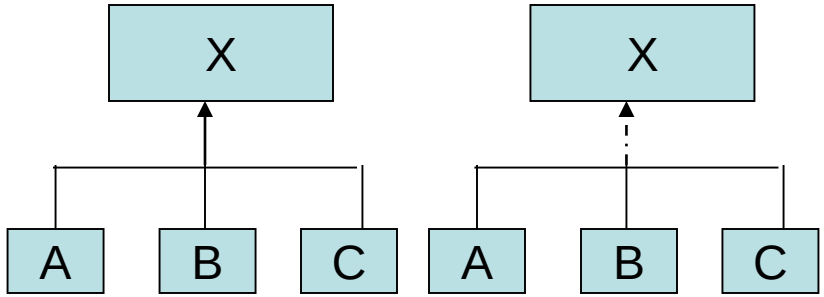


Various Forms of Inheritance

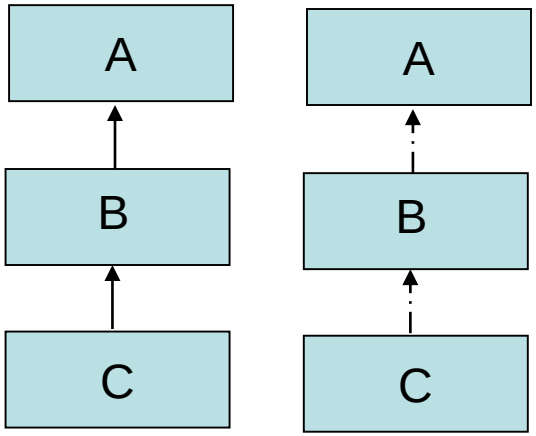
Single Inheritance



Hierarchical Inheritance



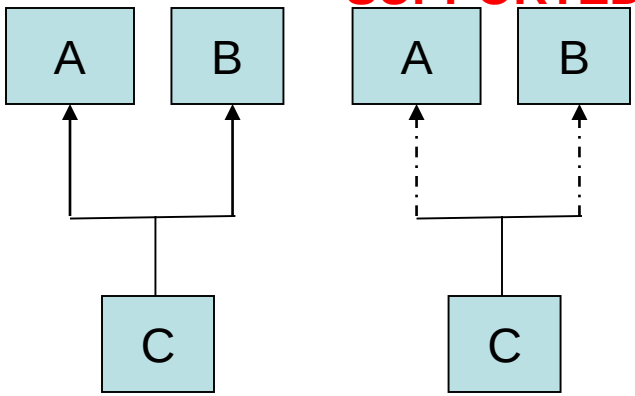
MultiLevel Inheritance



NOT SUPPORTED BY JAVA

Multiple Inheritance

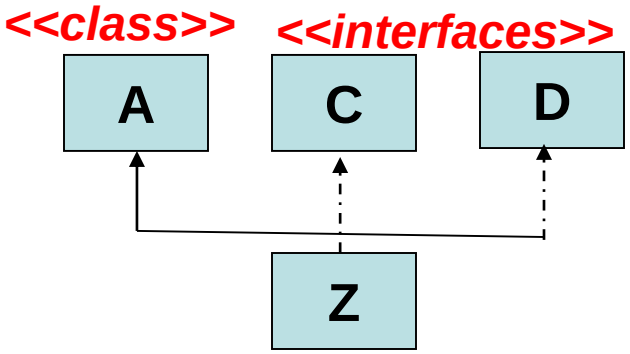
SUPPORTED BY JAVA



An interface can **extend** any number of interfaces but one interface **cannot implement** another interface, because if any interface is implemented then its methods must be defined and interface never has the definition of any method.

Forms of Inheritance

- **Mulitiple Inheritance can be implemented by implementing multiple interfaces not by extending multiple classes**



Example :

```
class Z extends A implements C , D
{ ..........}
```

OK

class A extends B,C
{
}

WRONG

class A extends B extends C
{
}

WRONG

Defining a Subclass

Syntax :

```
class <subclass name> extends <superclass name>
{
 variable declarations;
 method declarations;
}
```

1. Extends keyword signifies that properties of the super class are extended to sub class
2. Sub class will not inherit private members of super class

Access Control

Access Modifiers → / Access Location ↓	public	protected	friendly	private protected	private
Same Class	Yes	Yes	Yes	Yes	Yes
sub classes in same package	Yes	Yes	Yes	Yes	No
Other Classes in Same package	Yes	Yes	Yes	No	No
Subclasses in other packages	Yes	Yes	No	Yes	No
Non-subclasses in other packages	Yes	No	No	No	No

INHERITANCE BASICS

1. Whenever a sub class object is created ,super class constructor is called first.
2. If super class constructor does not have any constructor of its own OR has an unparametrized constructor then it is automatically called by Java Run Time by using call super()
3. If a super class has a parameterized constructor then it is the responsibility of the sub class constructor to call the super class constructor by call

   super(<parameters required by super class>)
4. Call to super class constructor must be the first statement in sub class constructor

INHERITANCE BASICS

When super class has a Unparametrized constructor

```
class A
{
A()
{
System.out.println("This is constructor of class A");
}
} // End of class A
class B extends A
{
B()
{
super();
System.out.println("This is constructor of class B");
}
} // End of class B
```

Optional

Cont…..

INHERITANCE BASICS

```
class inhtest
{
public static void main(String args[])
{
B b1 = new B();
}
}
```

OUTPUT

This is constructor of class A
This is constructor of class B

INHERITANCE BASICS

```
class A
{
A()
{
System.out.println("This is class A");
}
}
class B extends A
{
B()
{System.out.println("This is class B");}
}
class inherit1
{
public static void main(String args[])
{
B b1 = new B();
}   }
```

File Name is xyz.java

```
/*
E:\Java>javac xyz.java

E:\Java>java xyz
Exception in thread "main"
java.lang.NoClassDefFoundError:
xyz

E:\Java>java inherit1
This is class A
This is class B

E:\Java>
*/
```

INHERITANCE BASICS

```
class A
{
private A()
{
System.out.println("This is class A");
}
}
class B extends A
{
B()
{
System.out.println("This is class B");
}
}
class inherit2
{
public static void main(String args[])
{
B b1 = new B();
}
}
```

Private Constructor in super class

```
/*
E:\Java>javac xyz1.java
xyz1.java:12: A() has private access
in A
{
^
1 error
*/
```

INHERITANCE BASICS

```
class A
{
private A()
{
System.out.println("This is class A");
}
A()
{
System.out.println("This is class A");
}
}
class B extends A
{
B()
{
System.out.println("This is class B");
}
}
class inherit2
{
public static void main(String args[])
{
B b1 = new B();
} }
```

```
/*
E:\Java>javac xyz2.java
xyz2.java:7: A() is already defined in
A
A()
^
xyz2.java:16: A() has private access
in A
{
^
2 errors
*/
```

When Super class has a parameterized constructor.

```
class A
{
private int a;
A( int a)
{
this.a =a;
System.out.println("This is constructor
of class A");
} }
class B extends A
{
private int b;
private double c;
B(int b,double c)
{
this.b=b;
this.c=c;
System.out.println("This is constructor
of class B");
} }
```

```
B b1 = new B(10,8.6);
```

```
D:\java\bin>javac inhtest.java
inhtest.java:15: cannot find
symbol
symbol  : constructor A()
location: class A
{
^
1 errors
```

INHERITANCE BASICS

```
class A
{
private int a;
A( int a)
{
this.a =a;
System.out.println("This is
constructor of class A");
} }
class B extends A
{
private int b;
private double c;
B(int a,int b,double c)
{
super(a);
this.b=b;
this.c=c;
System.out.println("This is
constructor of class B");
} }
```

```
B b1 = new B(8,10,8.6);
```

OUTPUT

```
This is constructor of class A
This is constructor of class B
```

INHERITANCE BASICS

```
class A
{
private int a;
protected String name;
A(int a, String n)
{
this.a = a;
this.name = n;
}
void print()
{
System.out.println("a="+a);
}
}
```

```
class B extends A
{
int b;
double c;
B(int a,String n,int b,double c)
{
super(a,n);
this.b=b;
this.c =c;
}
void show()
{
//System.out.println("a="+a);
print();
System.out.println("name="+name);
System.out.println("b="+b);
System.out.println("c="+c);
}
}
```

Can Not use *a*
a is private in
super class

Calls print() from
super class A

INHERITANCE BASICS

```
class xyz3
{
public static void main(String args[])
{
B b1 = new B(10,"OOP",8,10.56);
b1.show();
}
}
```

```
E:\Java>java xyz3
a=10
name=OOP
b=8
c=10.56
```

USE OF super KEYWORD

- Can be used to call super class constrctor

  super();

  super(<parameter-list>);

- Can refer to super class instance variables/Methods

  super.<super class instance variable/Method>

INHERITANCE BASICS

```
class A
{
private int a;
A( int a)
{
this.a =a;
System.out.println("This is constructor
of class A");
}
void print()
{
System.out.println("a="+a);
}
void display()
{
System.out.println("hello This is Display
in A");
}
}
```

```
class B extends A
{
private int b;
private double c;
B(int a,int b,double c)
{
super(a);
this.b=b;
this.c=c;
System.out.println("This is constructor
of class B");
}
void show()
{
print();
System.out.println("b="+b);
System.out.println("c="+c);
}
}
```

INHERITANCE BASICS

```
class inhtest1
{
public static void main(String args[])
{
B b1 = new B(10,8,4.5);
b1.show();
}
}
/* OutPUt
D:\java\bin>java inhtest1
This is constructor of class A
This is constructor of class B
a=10
b=8
c=4.5
*/
```

INHERITANCE BASICS

```
class A
{
private int a;
A( int a)
{
this.a =a;
System.out.println("This is constructor
of class A");
}
void show()
{
System.out.println("a="+a);
}
void display()
{
System.out.println("hello This is Display
in A");
}
}
```

```
class B extends A
{
private int b;
private double c;
B(int a,int b,double c)
{
super(a);
this.b=b;
this.c=c;
System.out.println("This is constructor
of class B");
}
void show()
{
// show();
super.show();
System.out.println("b="+b);
System.out.println("c="+c);
display();
}
}
```

INHERITANCE BASICS

```
class inhtest1
{
public static void main(String args[])
{
B b1 = new B(10,8,4.5);
b1.show();
}
}
/* OutPut
D:\java\bin>java inhtest1
This is constructor of class A
This is constructor of class B
a=10
b=8
c=4.5
hello This is Display in A
*/
```

INHERITANCE BASICS

```
class A
{
int a;
A( int a)
{ this.a =a; }
void show()
{
System.out.println("a="+a);
}
void display()
{
System.out.println("hello This is Display
in A");
}
}
```

```
class B extends A
{
int b;
double c;
B(int a,int b,double c)
{
super(a);
this.b=b;
this.c=c;
}
void show()
{
//super.show();
System.out.println("a="+a);
System.out.println("b="+b);
System.out.println("c="+c);
}
}
```

INHERITANCE BASICS

```
class inhtest2
{
public static void main(String args[])
{
B b1 = new B(10,20,8.4);
b1.show();
}
}
/*
D:\java\bin>java inhtest2
a=10
b=20
c=8.4
*/
```

INHERITANCE BASICS

```
class A
{
int a;
A( int a)
{ this.a =a; }
}
```

```
class B extends A
{
int a;   // super class variable a hides here
int b;
double c;
B(int a,int b,double c)
{
super(100);
this.a = a;
this.b=b;
this.c=c;
}
void show()
{
// How can we print the value of super class variable "a"?
System.out.println("Super class a="+super.a);
System.out.println("a="+a);
System.out.println("b="+b);
System.out.println("c="+c);
}  }
```

Use of super to refer to super class varible a

INHERITANCE BASICS

```
class inhtest2
{
public static void main(String args[])
{
B b1 = new B(10,20,8.4);
b1.show();
}
}

/* Out Put
D:\java\bin>java inhtest2
Super class a=100
a=10
b=20
c=8.4
*/
```

Dynamic Method Dispatch or Runtime Polymorphism

- Method overriding is one of the ways in which Java supports Runtime Polymorphism.
- Dynamic method dispatch is the mechanism by which a call to an overridden method is resolved at run time, rather than compile time.

Example

```
class A
{
    void m1()
    {
        System.out.println("Inside A's
m1 method");
    }
}

class B extends A
{
   // overriding m1()
   void m1()
   {
       System.out.println("Inside B's m1
method");
   }
}

class C extends A
{
   // overriding m1()
   void m1()
   {
       System.out.println("Inside C's m1
method");
   }
}
```

Example

```
// Driver class
class Dispatch
{
    public static void main(String args[])
    {
        // object of type A
        A a = new A();

        // object of type B
        B b = new B();

        // object of type C
        C c = new C();

        // obtain a reference of type A
        A ref;

        // ref refers to an A object
        ref = a;

        // calling A's version of m1()
        ref.m1();

        // now ref refers to a B object
        ref = b;

        // calling B's version of m1()
        ref.m1();

        // now ref refers to a C object
        ref = c;

        // calling C's version of m1()
        ref.m1();
    }
}
```

OUTPUT:

```
Inside A's m1 method
Inside B's m1 method
Inside C's m1 method
```

EXAMPLE 2

```
// class A
class A
{
    int x = 10;
}

// class B
class B extends A
{
    int x = 20;
}

// Driver class
public class Test
{
    public static void main(String args[])
    {
        A a = new B(); // object of type B

        // Data member of class A will be accessed
        System.out.println(a.x);
    }
}
```

Output:

10

In Java, we can override methods only, not the variables(data members), so **runtime polymorphism cannot be achieved by data members.**

Advantages of Dynamic Method Dispatch

- Dynamic method dispatch allow Java to support overriding of methods which is central for run-time polymorphism.
- It allows a class to specify methods that will be common to all of its derivatives, while allowing subclasses to define the specific implementation of some or all of those methods.
- It also allow subclasses to add its specific methods subclasses to define the specific implementation of some.

Exercise1

```
public class Animal {
    public static void testClassMethod() {
        System.out.println("The static method in Animal");
    }
    public void testInstanceMethod() {
        System.out.println("The instance method in Animal");
    }
}
```

The second class, a subclass of `Animal`, is called `Cat`:

```
public class Cat extends Animal {
    public static void testClassMethod() {
        System.out.println("The static method in Cat");
    }
    public void testInstanceMethod() {
        System.out.println("The instance method in Cat");
    }

    public static void main(String[] args) {
        Cat myCat = new Cat();
        Animal myAnimal = myCat;
        Animal.testClassMethod();
        myAnimal.testInstanceMethod();
    }
}
```

Output :

The static method in Animal
The instance method in Cat

Exercise1

The distinction between hiding a static method and overriding an instance method has important implications:

- The version of the overridden instance method that gets invoked is the one in the subclass.
- The version of the hidden static method that gets invoked depends on whether it is invoked from the superclass or the subclass.

Exercise2

Writing Final Classes and Methods

- You can declare some or all of a class's methods *final*. You use the final keyword in a method declaration to indicate that the method cannot be overridden by subclasses. The Object class does this—a number of its methods are final.
- You might wish to make a method final if it has an implementation that should not be changed and it is critical to the consistent state of the object. For example, you might want to make the getFirstPlayer method in this ChessAlgorithm class final:

```
class ChessAlgorithm
{……
 final ChessPlayer getFirstPlayer()
            {
            return ChessPlayer.WHITE;
             }
...
}
```

Note that you can also declare an entire class final. A class that is declared final cannot be subclassed. This is particularly useful, for example, when creating an immutable class like the **String class.**

OBJECT ORIENTED PROGRAMMING WITH JAVA

Exercise3

In Java, Constructor over-riding is possible?

In Java, Constructor overriding is not possible as the constructors are not inherited as overriding is always happens on child class or subclass but constructor name is same as a class name so constructor overriding is not possible but constructor overloading is possible.

Can we override static method in Java?

No, you cannot override a static method in Java because it's resolved at compile time. In order for overriding to work, a method should be virtual and resolved at runtime because objects are only available at runtime.

Can we overload a static method in Java?

Yes, you can overload a static method in Java. Overloading has nothing to do with runtime but the signature of each method must be different. In Java, to change the method signature, you must change either number of arguments, type of arguments or order of arguments.

Exercise 3: Static vs Dynamic binding

- Static binding is done during compile-time while dynamic binding is done during run-time.
- private, final and static methods and variables uses static binding and bonded by compiler while overridden methods are bonded during runtime based upon type of runtime object

THANK YOU

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INTERFACES IN JAVA

1. *Java Does not support Multiple Inheritance directly. Multiple inheritance can be achieved in java by the use of interfaces.*
2. *We need interfaces when we want functionality to be included but does not want to impose implementation.*
3. *Implementation issue is left to the individual classes implementing the interfaces.*
4. *Interfaces can have only **abstract methods** and **final fields**.*
5. *You can declare a variable to be of type interface. But you can not create an object belonging to type interface.*
6. *Interface variable can point to objects of any class implementing the interface.*
7. *Another way of implementing Run Time Polymorphism.*
8. *In an interface, access specifier is by default **public***

Similarities between Interfaces and classes

- is compiled into byte code file
- can be either public,protected, private or package accessibility
- can not be public unless defined in the file having same name as interface name
- serve as a type for declaring variables and parameters

Differences between Interfaces and classes

- Declares only method headers and public constants
- Has no constructors
- Can be implemented by a class
- Can not extend a class
- Can extend several other interfaces

General Form

- ***Syntax :***

<access specifier> interface <interface name> extends [<interface1> , <interface 2> ……]

{

[public][final] variablename 1 = value;

……

[public][final] variablename N = value;

[public][abstract] <return type> methodname 1(<parameter lis>);

[public][abstract] <return type> methodname 2(<parameter lis>);

……

[public][abstract] <return type> methodname N(<parameter lis>);

}

Examples

Should be typed in file A.java

```
public interface  A
{
double PI = 3.14156;
void show();
void display();
}
```

By Default public final Should be initialized

double PI; → Wrong

Can have only abstract methods. Each method is by default public abstract

```
class XYZ implements A
{
public void show()    { ….. }
public void display() { …..  }
}
```

Example 2

```
interface X
{
int x;
void show();
void display();
}
```

A.java:3: = expected
int x;

Every variable in interface is by defauly public final and hence should be initialized to some value

Implementing Interface Methods

Use public access specifer for implementing interface methods

```
interface X
{
int x =10;
void show();
void display();
}
class A implements X
{
void show()
{
System.out.println("Hello");
}
void display()
{
System.out.println("Hi");
}
}
```

```
E:\oop>javac A.java
A.java:13: display() in A cannot
implement display() in X; attempting
to assign
weaker access privileges; was
public
void display()
     ^
A.java:9: show() in A cannot
implement show() in X; attempting
to assign weaker
access privileges; was public
void show()
     ^
2 errors
```

Use public access specifer for implementing interface methods

```
interface X
{
int x =10;
void show();
void display();
}
class A implements X
{
public void show()
{
System.out.println("Hello");
}
public void display()
{
System.out.println("Hi");
}
}
```

By Default public final

By Default public abstract

- Default access modifier means we do not explicitly declare an access modifier for a class, field, method, etc.
- A variable or method declared without any access control modifier is available to any other class in the same package.
- The fields in an interface are implicitly public static final and the methods in an interface are by default public.

Exercise

1) Can interfaces have constructors?
No. Interfaces can't have constructors. They show 100% abstractness.
2) Can we re-assign a value to a field of interfaces?
No. The fields of interfaces are static and final by default. They are just like constants. You can't change their value once they got.
3) Can we declare an Interface with "abstract" keyword?
Yes, we can declare an interface with "abstract" keyword. But, there is no need to write like that. All interfaces in java are abstract by default.
4) For every Interface in java, .class file will be generated after compilation. True or false?
True. .class file will be generated for every interface after compilation.
5) Can we override an interface method with visibility other than public?
No. While overriding any interface methods, we should use public only. Because, all interface methods are public by default and you should not reduce the visibility while overriding them.

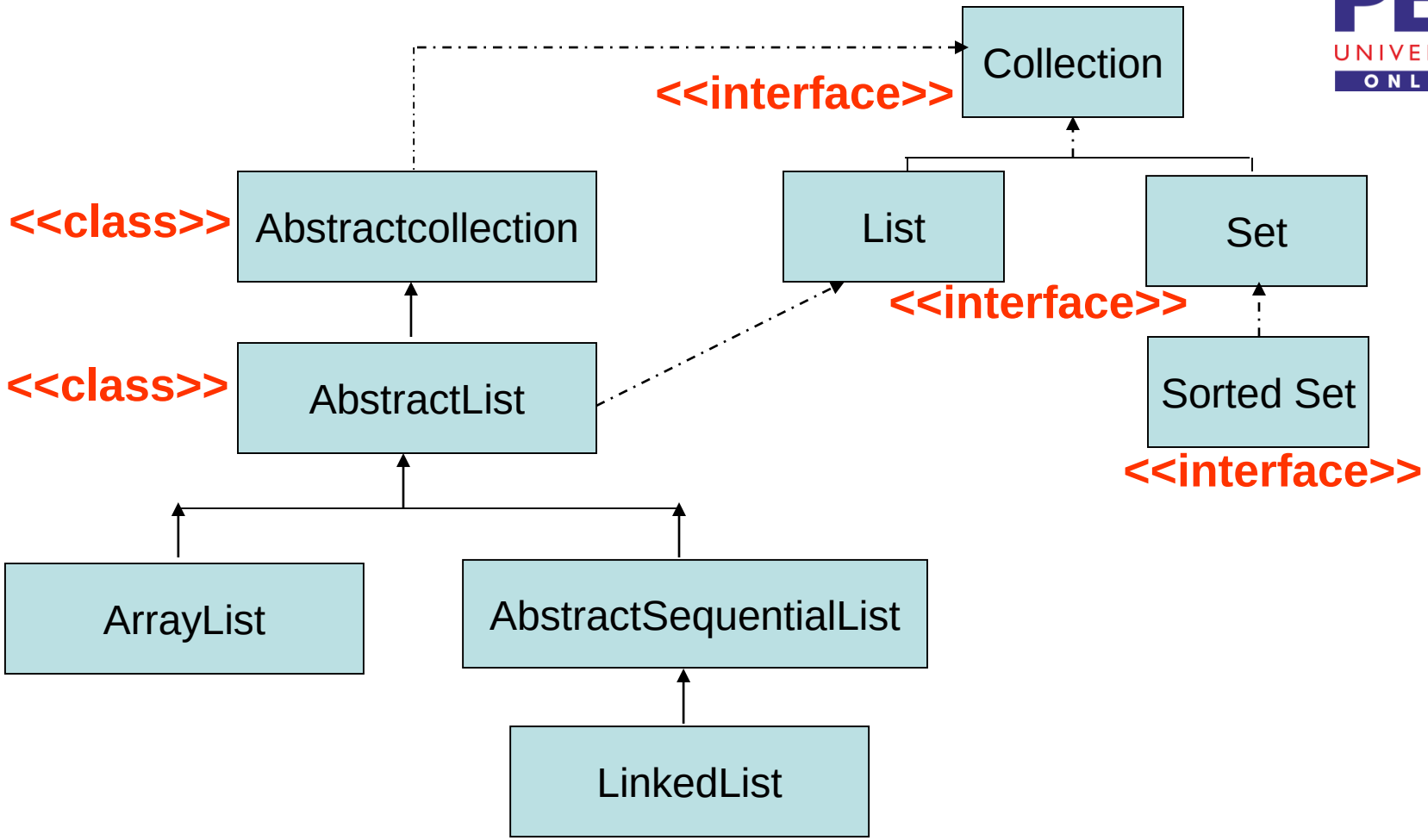
Exercise

6) Can interfaces become local members of the methods?
No. You can't define interfaces as local members of methods like local inner classes. They can be a part of top level class or interface.
7) Can an interface extend a class?
No, a class can not become super interface to any interface. Super interface must be an interface. That means, interfaces don't extend classes but can extend other interfaces.
8) Like classes, does interfaces also extend Object class by default?
No. Interfaces don't extend Object class.
9) Can interfaces have static methods?
No. Interfaces can't have static methods.

http://www.codespaghetti.com/interfaces-interview-questions/

https://www.shristitechlabs.com/java/interviewquestions/top-10-interview-questions-in-interfaces/

Interfaces from Java's Collection Framework



Collections in Java
Introduction To Java's Collection Framework

What are Collections

- ***Group of Objects treated as a single Object.***
- ***Take group of students and maintain it as a LinkedList. <<Linked List is a Collection>>***
- ***Java provides supports for manipulating collections in the form of***

1. ***Collection Interfaces***
2. ***Collection Classes***

- ***Collection interfaces provide basic functionalities whereas collection classes provides their concrete implementation***

Collection Interfaces

There are Five Collection Interfaces

1. Collection

- *Enables You to work with collections. << Top of Collection Hierarchy>>*

2. List

- *Extends Collection to handle list of elements [objects]*
- *Allows duplicate elements in the list*
- *Uses indexing technique starting with 0 to access elements*

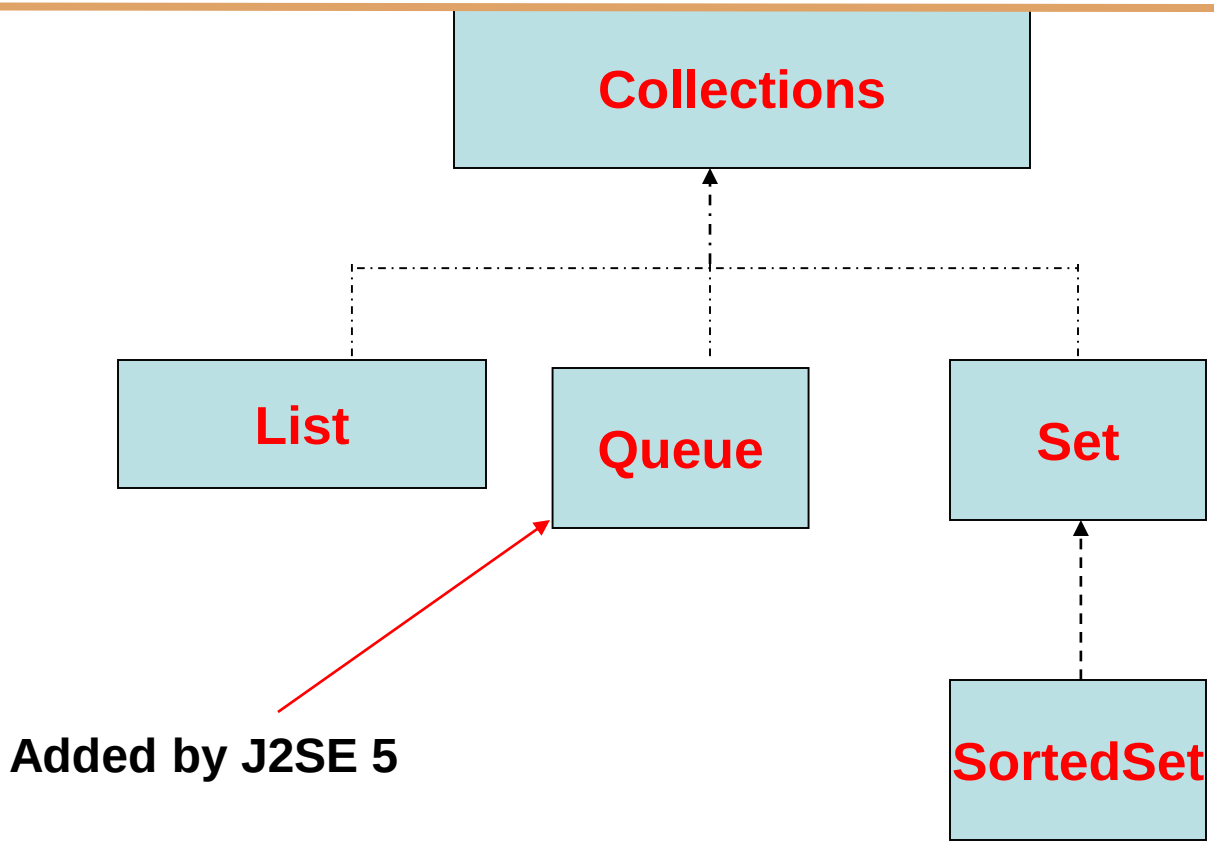
3. Set

- *Extends Collection to handle set of elements [objects], which must contain unique elements*

4. SortedSet

- *Extends Set to handle sorted elements in a set*

Collection Interfaces



Collections also uses following interfaces:

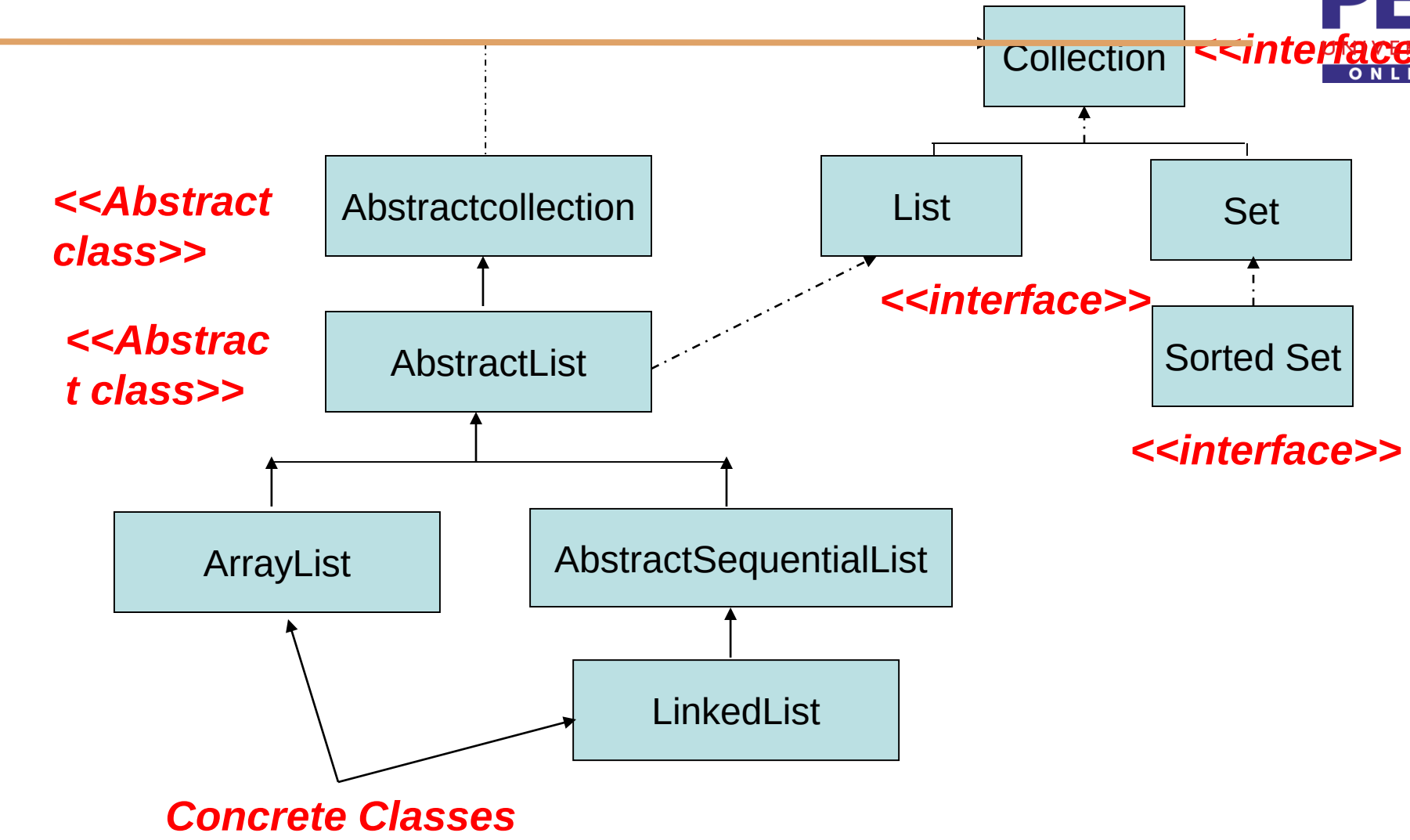
1. Comparator 2. Iterator 3. ListIterator 4. RandomAccess

Collection Classes

- ***Collection classes are standard classes that implement collection interfaces***
- ***Some Collection Classes are abstract and some classes are concrete and can be used as it is.***
- ***Important Collection Classes:***

1. ***AbstractCollection***
2. ***AbstractList***
3. ***AbstractSequentialList***
4. ***LinkedList***
5. ***ArrayList***
6. ***AbstractSet***
7. ***HasSet***
8. ***LinkedHashSet***
9. ***TreeSet***

Partial View of Java's Collection Framework



Important Method in Collection Interfaces

1. boolean add(Object obj) / boolean addAll(Collection c)
   - Adds in to collection either a single Object or all elements from another collection. [Addition only in the end]
2. void clear() // clears all elements from the Collection
3. boolean contains(Object obj)
   - Returns true if obj is there in the collection otherwise false
4. boolean containsAll(Collection c)
   - Returns true if invoking collection contains all elements of c
5. boolean equals(Object obj)
   - Returns true if invoking collection and obj are equal or not
6. boolean isEmpty()
   - Returns true if invoking collection is Empty otherwise false
7. int size() // returns size of collection
8. boolean remove(Object obj) / boolean removeAll(Collection c)
9. Iterator iterator()
   - Returns an iterator for a collection for traversing purpose

Important Method in List Interfaces

1. boolean add(int index, Object obj) / boolean addAll(int index, Collection c)
   - Adds in to collection either a single Object or all elements from another collection at a mentioned index.
2. Object get(int index)
   - Return object at given index. Index >=0 and < size();
3. int indexOf(Object obj)
   - Returns index of obj in the invoking collection otherwise -1
4. int lastIndexOf(Object obj)
   - Returns index of obj in the invoking collection from last otherwise -1 will be returned if obj not found
5. ListIterator listIterator()
   - Returns a list iterator for a given collection
   - ListIterator allows both way traversal . Iterator allows only forward traversal
6. Object remove(int index)
   - Removes elements from invoking collection at index. iIndex >=0 and < size();
7. Object set(int index,Object obj)
   - Sets the obj as elements for location specified by index. Index >=0 and < size();

ArrayList class

- **Supports Dynamic Arrays that can grow as needed.**
- **Variable length array of object references**
- **ArrayList can increase or decrease in size.**
- **Earlier versions of java supports dynamic arrays by a legacy class Vector.**

public class ArrayList<E>
extends AbstractList<E>
implements List<E>, RandomAccess, Cloneable, Serializable

<E> Type of the Objects/Elements stored

Types of ArraysList

1. ***Unparametrized ArrayLists***

- ***Supported in earlier versions of Java (1.3 and earlier)***
- ***Can store/handle objects of any type.***

2. ***Parametrized ArrayLists***

- ***Supported in later versions after 1.4 onwards***
- ***Can handle objects of only mentioned type***

Note :

If you are using unparametrized arraylists and are using latest java compiler then use the following to compile:

javac -Xlint <sourcefile>

ArrayList Constructors

Unparametrized Type

parametrized Type

1. ArrayList()

- ***Empty ArrayList() size() =0***
- ***Examples :***

ArrayList arr = new ArrayList();

ArrayList<BOX> boxes = new ArrayList();

ArrayList<Student> students = new ArrayList<Student>();

2. ArrayList(Collection c)

- ***Creates an ArrayList which is initialized with elements from other collection***

3. ArrayList(int capacity)

- ***Creates an arraylist with initial capacity.***
- ***Examples***

ArrayList arr = new ArrayList(10);

ArrayList<BOX> boxes = new ArrayList(10);

ArrayList<Student> students = new ArrayList(20);

ArrayList<Student> students1 = new ArrayList<Student>(20);

Example Unparametrized ArrayLists

*To Use ArrayList import java.util.**

Empty ArrayList size() == 0, Type is unparametrized

```
import java.util.*;
class list
{
public static void main(String args[])
{
ArrayList arr = new ArrayList();

ArrayList arr1 = new ArrayList(20);

System.out.println(arr.size());
System.out.println(arr.size());

// Adding Elements
```

Unparametrized ArrayList with size() == 0 and capacity = 20

0

Won't work in jdk1.3 and previous versions.

```
// arr.add(10);
arr.add(new Integer(10));          Adds integer 10 at index 0

arr.add("A");                      Adds String "A" at index 1

arr.add(new Double(12.56));        Adds 12.56 at index 2

arr.add(new Boolean(true));        Adds boolean true  at index 3

arr.add(new Integer(30));          Adds integer 30 at index 4

// arr.add(6,new Integer(50)); // IndexOutOfBoundsException

System.out.println(arr.size());  5

arr1.addAll(arr);
}
}
```

Adds all elements of arr to end of arr1

```
E:\oop>javac  list.java
Note: list.java uses unchecked or unsafe operations.
Note: Recompile with -Xlint:unchecked for details.
```

```
E:\oop>javac  -Xlint list.java
list.java:13: warning: [unchecked] unchecked call to add(E) as a member of the
raw type java.util.ArrayList
arr.add(new Integer(10));
……….
list.java:21: warning: [unchecked] unchecked call to addAll(java.util.Collection
<? extends E>) as a member of the raw type java.util.ArrayList
arr1.addAll(arr);
          ^
6 warnings
```

```
E:\oop>java list
0
0
5
```

Example Parametrized ArrayLists

*To Use ArrayList import java.util.**

```
import java.util.*;
class list
{
public static void main(String args[])
{
ArrayList<String> arr = new ArrayList();

//ArrayList<BOX> arr1 = new ArrayList(20);

System.out.println(arr.size());
//System.out.println(arr1.size());

// Adding Elements
```

Parametrized ArrayList of type <String>. Can Hold Only String Type Data

Parametrized ArrayList of type <BOX>. Can Hold Only BOX Type Data

Won't work arr can hold only String Data

```
// arr.add(10);
//arr.add(new Integer(10));

arr.add("A");                          Adds String "A" at index 0

//arr.add(new Double(12.56));   Won't Work. arr can hold only String Data

arr.add("B");                          Adds "B"  at index 1

arr.add(new String("OOP"));    Adds "OOP" at index 2

// arr.add(6,new Integer(50)); // IndexOutOfBoundsException

System.out.println(arr.size());  3

//arr1.addAll(arr);
}
}
```

Won't work Elemments of different types

Traversing ArrayLists

- *Traversing means visiting thru the arrayList and retrieving individual elements.*
- *Traversal can be forward or backward*
- *There can be following ways of traversal*

1. *Use for(…) loop along*
2. *Use of Iterator interface [For Forward Traversing Only]*
3. *Use of ListInterator interface [For Both Way Traversing]*

Use for loop

```
import java.util.*;
class arraylis
{
public static void main(String args[])
{
ArrayList<String> arrStr = new ArrayList(20);
arrStr.add("A");
arrStr.add("B");
arrStr.add("X");
arrStr.add("Y");
arrStr.add("Z");


// For Forward Traversing
System.out.println("Forward");
for(int i=0;i<arrStr.size();i++)
{
String str = arrStr.get(i);
System.out.println("Hello "+str);
}
```

Other form of for loop known as for each in collection

```
/* For Forward Traversing using for each
for(int i : arrStr)
{
String str = arrStr.get(i);
System.out.println("Hello "+str);
}
*/
```

```
// For Backward Traversal
System.out.println("Backward");
for(int i= arrStr.size()-1;i>=0;i--)
{
String str = arrStr.get(i);
System.out.println("Hello "+str);
}
}
}
```

```
E:\oop>java arraylis
Forward
Hello A
Hello B
Hello X
Hello Y
Hello Z
Backward
Hello Z
Hello Y
Hello X
Hello B
Hello A
```

Iterator Interface

- Allows the traversal of collections only in forward direction
- All Collections use iterator interface and provides method for attaching iterator for any collection.

Iterator iterator();

- Methods :

1. ***boolean hasNext()***
   - *Returns true/false if there exists next element or not*
2. ***E next() / Object next()***
   - *Returns the next element.*
   - *Used in conjunction with hasNext()*
3. ***void remove()***
   - *Removes the element from location pointed to by iterator*

Use of iterator

```
import java.util.*;
class arraylis
{
public static void main(String args[])
{
ArrayList<String> arrStr = new ArrayList(20);
arrStr.add("A");
arrStr.add("B");
arrStr.add("X");
arrStr.add("Y");
arrStr.add("Z");


// How to get an iterator for any collection
Iterator itr = arrStr.iterator();
while(itr.hasNext())
{
String str = itr.next();
System.out.println("Hello "+str);
}
```

```
E:\oop>java arraylis
Forward
Hello A
Hello B
Hello X
Hello Y
Hello Z
```

ListIterator Interface

- **Extends Iterator interface**
- **Allows both way traversal**

List*Iterator listIterator();*

- **Methods :**

1. ***boolean hasNext() / boolean hasPrevious()***
   - ***Returns true/false if there exists next/previous element or not***
2. ***E next() / Object next() || E previous() / Object previous()***
   - ***Returns the next/previous element.***
   - ***Used in conjunction with hasNext()/hasPrevious***
3. ***void remove() / void add(E obj)***
   - ***Removes/adds the element from/to location pointed to by iterator***
4. ***int nextIndex() /int previousIndex()***
   - ***Returns the index of previous/next element index***

Use of Listiterator loop

```
import java.util.*;
class arraylis
{
public static void main(String args[])
{
ArrayList<String> arrStr = new ArrayList(20);
arrStr.add("A");
arrStr.add("B");
arrStr.add("X");
arrStr.add("Y");
arrStr.add("Z");


// How to get an ListIterator for any collection for forward Traversal
System.out.println("Forward");
ListIterator Litr = arrStr.listIterator();
while(Litr.hasNext())
{
String str = (String) Litr.next();
System.out.println("Hello "+str);
}
```

```
// How to get an ListIterator for any collection for Backward Traversal
System.out.println("Backward");
ListIterator Litr1 = arrStr.listIterator(arrStr.size());
while(Litr1.hasPrevious())
{
String str = (String) Litr1.previous();
System.out.println("Hello "+str);
}
}
}
```

```
E:\oop>java arraylis
Forward
Hello A
Hello B
Hello X
Hello Y
Hello Z
```

```
import java.util.*;
class arraylis
{
public static void main(String args[])
{
ArrayList<String> arrStr = new ArrayList(20);
arrStr.add("A");
arrStr.add("B");
arrStr.add("X");
arrStr.add("Y");
arrStr.add("Z");

// For Forward Traversing
System.out.println("Forward");

ListIterator<String> Litr = arrStr.listIterator();
while(Litr.hasNext())
{
String str = Litr.next(); // No Need of type casting
System.out.println("Hello "+str);
}
```

Parametrized Iterator at the start of list

```
// For Backward Traversing
System.out.println("Backward");
ListIterator<String> Litr1 = arrStr.listIterator(arrStr.size());
while(Litr1.hasPrevious())
{
String str = Litr1.previous();
System.out.println("Hello "+str);
}
}
}
```

List Itearator sets at the end of the list

```
E:\oop>java arraylis
Forward
Hello A
Hello B
Hello X
Hello Y
Hello Z
```

Collections.sort()

```
// Java program to demonstrate working of Collections.sort()
import java.util.*;

public class Collectionsorting
{
    public static void main(String[] args)
    {
        // Create a list of strings
        ArrayList<String> al = new ArrayList<String>();
        al.add("Geeks For Geeks");
        al.add("Friends");
        al.add("Dear");
        al.add("Is");
        al.add("Superb");

        /* Collections.sort method is sorting the
        elements of ArrayList in ascending order. */
        Collections.sort(al);

        // Let us print the sorted list
        System.out.println("List after the use of" +
                           " Collection.sort() :\n" + al);
    }
}
```

OUTPUT:

List after the use of Collection.sort() :
[Dear, Friends, Geeks For Geeks, Is, Superb]

Collections.sort()

```
// Java program to demonstrate working of
Collections.sort()
// to descending order.
import java.util.*;

public class Collectionsorting
{
    public static void main(String[] args)
    {
        // Create a list of strings
        ArrayList<String> al = new ArrayList<String>();
        al.add("Geeks For Geeks");
        al.add("Friends");
        al.add("Dear");
        al.add("Is");
        al.add("Superb");

        /* Collections.sort method is sorting the
        elements of ArrayList in ascending order. */
        Collections.sort(al, Collections.reverseOrder());

        // Let us print the sorted list
        System.out.println("List after the use of" +
                           " Collection.sort() :\n" + al);
    }
}
```

Arrays.sort works for arrays which can be of primitive data type also. Collections.sort() works for objects Collections like ArrayList, LinkedList, etc. We can use Collections.sort() to sort an array after creating a ArrayList of given array items.

OUTPUT:

List after the use of Collection.sort() :
[Dear, Friends, Geeks For Geeks, Is, Superb]

Comparable Interface

1. **Provides an interface for comparing any two objects of same class.**

General Form Unparameterized:

```
public interface Comparable
{
int compareTo(Object other );
}
```

General Form Parameterized:

```
public interface Comparable<T>
   {
   int compareTo(T other );
   }
```

<<T>> is the type of object

Note : other parameter should be type caste to the class type implementing Comparable interface for un parametrized Type

Collections. sort method can sort objects of any class that implements comparable interface.

By implementing this interface , programmers can implement the logic for comparing two objects of same class for less than, greater than or equal to.

Examples for Implementation For Unparametrized

```
class BOX Implements Comparable
{
.....
.....
.....
public int compareTo(Object other)
{
BOX box = (BOX) other;
.....Logic for comparison ….
}
.....
}
```

```
class Student Implements Comparable
{
.....
.....
.....
public int compareTo(Object other)
{
Student std = (Student) other;
.....Logic for comparison ….
}
.....
}
```

Example 1 [Importance of comparable]

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// Name of source File comparatorTest.java

```
import java.util.*;
class A
{
int a;
int b;
A(int a,int b)
{
this.a=a;
this.b=b;
}
public String toString()
{
return "a="+a+"b="+b;
}
} // End of class A
```

```
class comparableTest1
{
public static void main(String args[])
{
int a[] ={10,6,8,9,45,-67};
String names[] = {"OOP","Java","UML","list"};
double values[] = {10.56,3.45,8.56,2.67};

Arrays.sort(a);
for(int i=0;i<a.length;i++)
System.out.print(a[i]+" ");
System.out.println("");
Arrays.sort(a, Collections.reverseOrder());
Arrays.sort(names);
for(int i=0;i<names.length;i++)
System.out.print(names[i]+" ");
System.out.println("");
```

*Sorts the Elements of array **a***

Prints the Elements

-67 6 8 9 10 45

*Sorts the Elements of array **names***

Prints the Elements

Java OOP UML list

74 79 85 108

```
Arrays.sort(values);
for(int i=0;i<values.length;i++)
System.out.print(values[i]+" ");
System.out.println("");
```

Sorts the Elements of array values

Prints the Elements

2.67 3.45 8.56 10.56


```
A[] arr = new A[10];
```

Array of Object References

```
arr[0] = new A(10,6);
arr[1] = new A(8,16);
arr[2] = new A(4,3);
arr[3] = new A(5,21);
arr[4] = new A(34,16);

Arrays.sort(arr);
```

Can not sort elements of arr

```
Arrays.sort(arr);
for(int i=0;i<arr.length;i++)
System.out.print(arr[i]+" ");
System.out.println("");
}
} // End of class comparableTest1
```

TO USE **Arrays.sort()** METHOD FOR OBJECT REFERENCES, THE CLASS OF OBJECT REFERENCES MUST IMPLEMENT **Comparable** OR **Comparator** INTERFACE.

OutPut


```
E:\oop>java comparableTest1
-67 6 8 9 10 45
Java OOP UML list
2.67 3.45 8.56 10.56
Exception in thread "main" java.lang.ClassCastException: A
        at java.util.Arrays.mergeSort(Arrays.java:1156)
        at java.util.Arrays.mergeSort(Arrays.java:1167)
        at java.util.Arrays.sort(Arrays.java:1080)
        at comparableTest1.main(comparableTest.java:46)
```

Example 2 [Importance of comparable]

```
// Name of source File comparatorTest2.java.

// Same Program Using ArrayLists
    import java.util.*;
    class A
    {
    int a;
    int b;
    A(int a,int b)
    {
    this.a=a;
    this.b=b;
    }
    public String toString()
    {
    return "a="+a+"b="+b;
    }
    } // End of class A
```

```
class comparableTest2
{
public static void main(String args[])
{
ArrayList<Integer> arr1 = new ArrayList<Integer>();
ArrayList<String> arr2 = new ArrayList<String>();
ArrayList<Double> arr3 = new ArrayList<Double>();

// Adding into integer arraylist
arr1.add(10);
arr1.add(30);
arr1.add(20);
arr1.add(5);
```

```
// Adding into String arraylist
arr2.add("10");
arr2.add("30");
arr2.add("20");
arr2.add("5");

// Adding into Double arraylist
arr3.add(10.56);
arr3.add(30.12);
arr3.add(20.34);
arr3.add(5.56);

Collections.sort(arr1);
System.out.println(arr1);

Collections.sort(arr2);
System.out.println(arr2);

Collections.sort(arr3);
System.out.println(arr3);
```

```
ArrayList<A> arr4 = new ArrayList<A>();
arr4.add(new A(10,6));
arr4.add(new A(2,4));
arr4.add(new A(5,16));
arr4.add(new A(100,16));

Collections.sort(arr4);
System.out.println(arr4);

}
}
```

```
E:\loop>javac comparableTest2.java
comparableTest2.java:58: cannot find symbol
symbol  : method sort(java.util.ArrayList<A>)
location: class java.util.Collections
 Collections.sort(arr4);
             ^
```

Example 3

```
class BOX implements Comparable
{
private double length;
private double width;
private double height;
BOX(double l,double b,double h)
{
length=l;width=b;height=h;
}
public double getLength() { return length;}
public double getWidth()  { return width;}
public double getHeight() { return height;}
public double getArea()
{
return 2*(length*width + width*height+height*length);
}
public double getVolume()
{
return length*width*height;
}
```

Unparametrized Comparators

```
public int compareTo(Object other)
{
BOX b1 =(BOX) other;
if(this.getVolume() > b1.getVolume())
return 1;
if(this.getVolume() < b1.getVolume())
return -1;
return 0;
}
public String toString()
{
return “Length:”+length+” Width :”+width +” Height :”+height;
}
} // End of BOX class
```

Other parameter has to be type caste to BOX type before use

Sorting Using Arrays

```
import java.util.*;
class ComparableTest
{
public static void main(String[] args)
{
BOX[] box = new BOX[5];
box[0] = new BOX(10,8,6);
box[1] = new BOX(5,10,5);
box[2] = new BOX(8,8,8);
box[3] = new BOX(10,20,30);
box[4] = new BOX(1,2,3);
Arrays.sort(box);
for(int i=0;i<box.length;i++)
System.out.println(box[i]);
}
} // End of class
```

Sorting Using ArrayLists

```
Import java.util.*;
class ComparableTest
{
public static void main(String[] args)
{
ArrayList box = new ArrayList();
box.add( new BOX(10,8,6));
box.add( new BOX(5,10,5));
box.add( new BOX(8,8,8));
box.add( new BOX(10,20,30));
box.add( new BOX(1,2,3));
Collections.sort(box);
Iterator itr = ar.iterator();
while(itr.hasNext())
{
BOX b =(BOX) itr.next();
System.out.println(b);
}
}
}// End of class
```

Problems With Comparable Interface

- ***Method int compareTo(Object obj) needs to be included in the base class itself.***
- ***We can include only single ordering logic.***
- ***Different order requires logic to be included and requires changes in the base class itself.***
- ***Each time we need different order we need to change the code itself.***

```
import java.util.*;
class Student implements Comparable
{
private String name;
private String idno;
private int age;
private String city;
……..
……..
public int compareTo(Object other)
{
Student std = (Student) other;
return
this.name.compareTo(other.name);
}
public String toString()
{
Return “Name:”+name+”Id
No:”+idno+”Age:”+age;
}
} // End of class
```

Comparison By name

```
Student[] students = new
Student[10];
……
……
……
Arrays.sort(students);
for(int i=0 ; i<students.length;i++)
System.out.println(students[i]);
```

OUTPUT List sorted by Name

Comparison By idno

```
import java.util.*;
class Student implements Comparable
{
private String name;
private String idno;
private int age;
private String city;
……..
……..
public int compareTo(Object other)
{
Student std = (Student) other;
return this.idno.compareTo(other.idno);
}
public String toString()
{
Return “Name:”+name+”Id
No:”+idno+”Age:”+age;
}
} // End of class
```

```
Student[] students = new
Student[10];
……
……
……
Arrays.sort(students);
for(int i=0 ; i<students.length;i++)
System.out.println(students[i]);
```

OUTPUT List sorted by idno

Comparator Interface

- ***Allows two objects to compare explicitly.***
- ***Syntax For Unparametrized:***

```
public interface Comparator
{
 int compare(Object O1, Object O2);
}
```

- ***Syntax For Parametrized:***

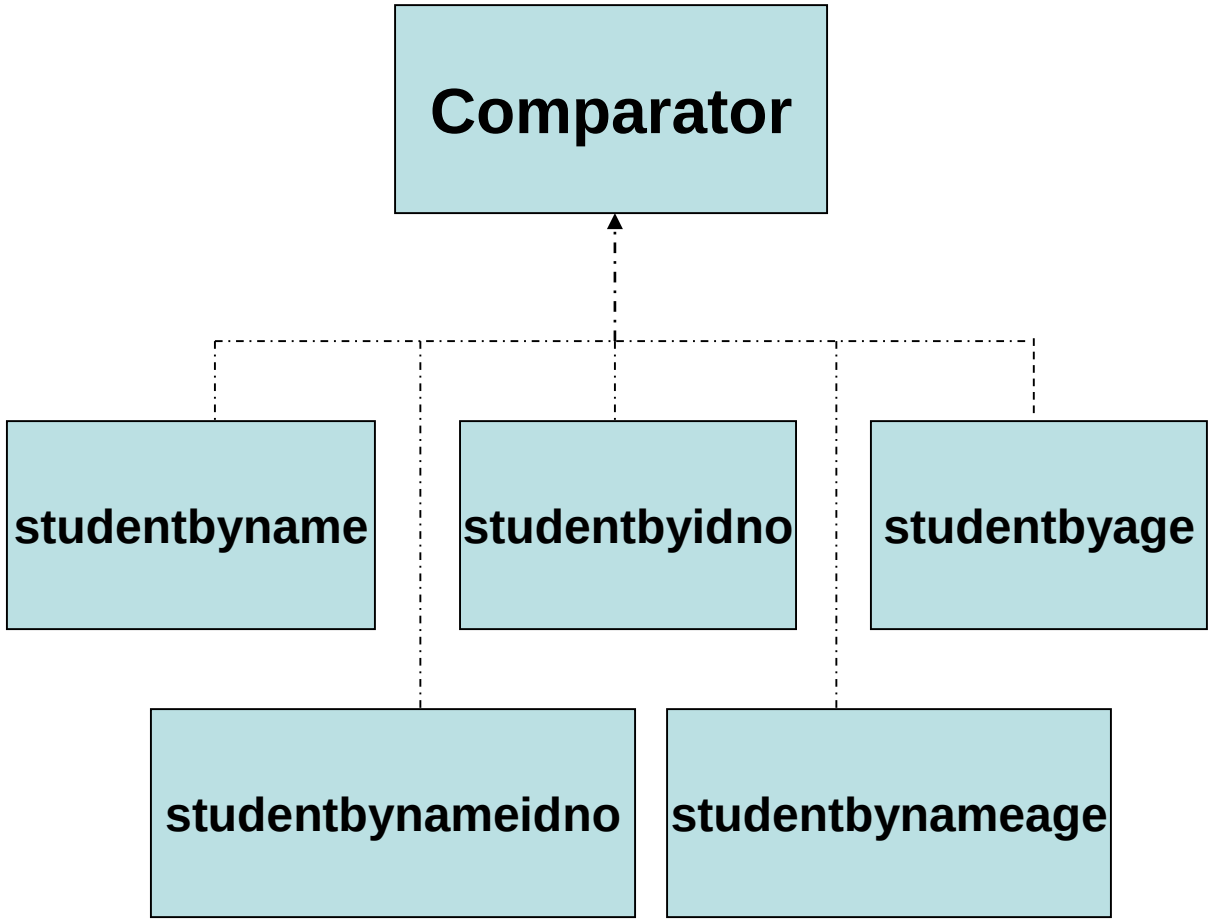
```
public interface Comparator<T>
{
 int compare(T O1, T O2);
}
```

<<T>> type of object reference

- ***Does not require change in the base class.***
- ***We can define as many comparator classes for the base class.***
- ***Each Comparator class implements Comparator interface and provides different logic for comparisons of objects.***
- ***But as we are passing both parameters explicitly, we have to type cast both Object types to their base type before implementing the logic.***

Student

```
class Student
{
private String name;
private String idno;
private int age;
private String city;
……..
……..
```



```
class studentbyname implements comparator
{
public int compare(Object o1,Object o2)
{
Student s1 = (Student) o1;
Student s2 = (Student) o2;
return s1.getName().compareTo(s2.getName());
}
}
class studentbyidno implements comparator
{
public int compare(Object o1,Object o2)
{
Student s1 = (Student) o1;
Student s2 = (Student) o2;
return s1.getIdNo().compareTo(s2.getIdNo());
}
}
```

```
class studentbyage implements comparator
{
public int compare(Object o1,Object o2)
{
Student s1 = (Student) o1;
Student s2 = (Student) o2;
if( s1.getAge() > s2.getAge() ) return 1;
if( s1.getAge() < s2.getAge() ) return -1;
return 0;
}
}
class studentbynameidno implements comparator
{
public int compare(Object o1,Object o2)
{
Student s1 = (Student) o1;
Student s2 = (Student) o2;
if( s1.getName().compareTo(s2.getName()) == 0)
return s1.getIdNo().compareTo(s2.getIdNo());
else
return s1.getName().compareTo(s2.getName());
} }
```

```
class studentbynameage implements comparator
{
public int compare(Object o1,Object o2)
{
Student s1 = (Student) o1;
Student s2 = (Student) o2;
if( s1.getName().compareTo(s2.getName()) == 0)
return s1.getAge() – s2.getAge();
else
return s1.getName().compareTo(s2.getName());
}
}
```

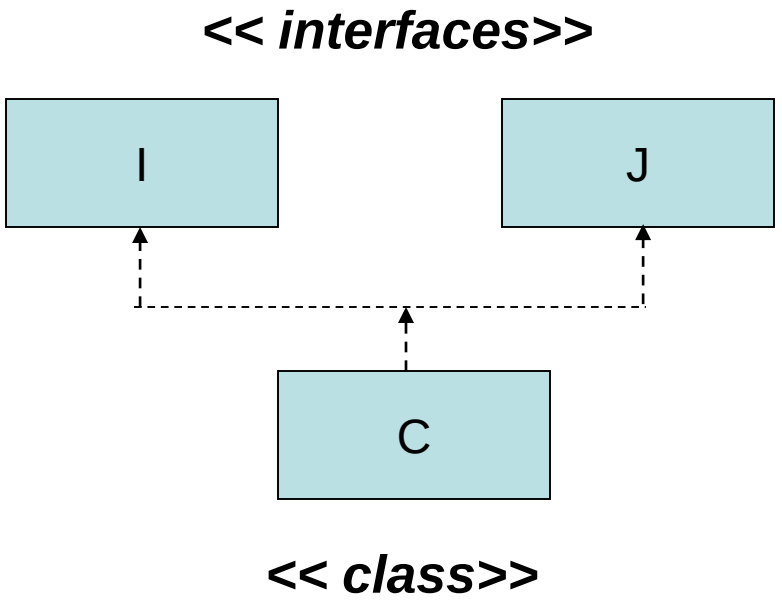
```
Import java.util.*;
class comparatorTest
{
public static void main(String args[])
{
Student[] students = new Student[5];
Student[0] = new Student(“John”,”2000A1Ps234”,23,”Pilani”);
Student[1] = new Student(“Meera”,”2001A1Ps234”,23,”Pilani”);
Student[2] = new Student(“Kamal”,”2001A1Ps344”,23,”Pilani”);
Student[3] = new Student(“Ram”,”2000A2Ps644”,23,”Pilani”);
Student[4] = new Student(“Sham”,”2000A7Ps543”,23,”Pilani”);

// Sort By Name
Comparator c1 = new studentbyname();
Arrays.sort(students,c1);
for(int i=0;i<students.length;i++)
System.out.println(students[i]);
```

```
// Sort By Idno
c1 = new studentbyidno();
Arrays.sort(students,c1);
for(int i=0;i<students.length;i++)
System.out.println(students[i]);

// Sort By Age
c1 = new studentbyage();
Arrays.sort(students,c1);
for(int i=0;i<students.length;i++)
System.out.println(students[i]);

// Sort by Name & Idno
c1 = new studentbynameidno();
Arrays.sort(students,c1);
for(int i=0;i<students.length;i++)
System.out.println(students[i]);

// Sort by Name & Age
c1 = new studentbynameage();
Arrays.sort(students,c1);
for(int i=0;i<students.length;i++)
System.out.println(students[i]);
} // End of Main
} // End of test class.
```

Exercise 1

- *Suppose C is a class that implements interfaces I and J. Which of the following Requires a type cast?*

```
C   c =     ……?
I   i =     …..?
J   j =     …..?

1.  c = i
2.  j = c
3.  i = j
```

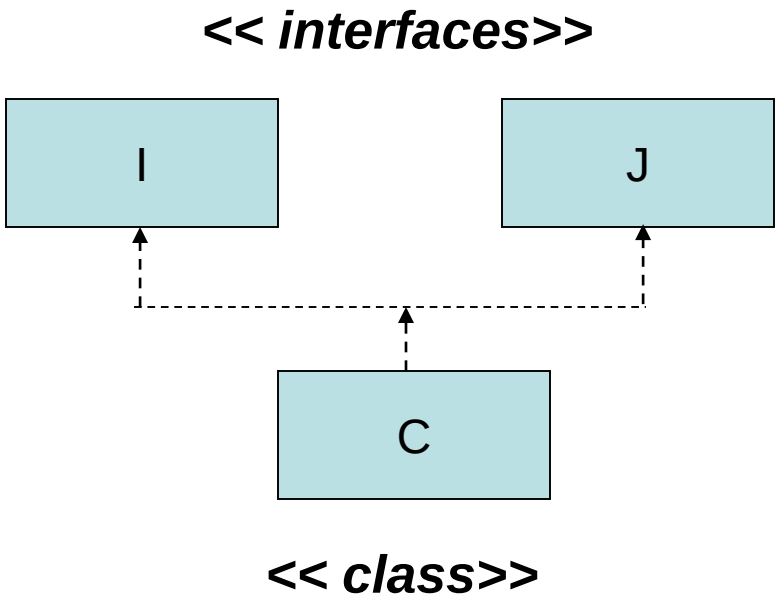


First c = (C) i

Exercise 2

- *Suppose C is a class that implements interfaces I and J. Which of the following will throw an Exception?*

```
C    c = new C()

1.   I i      = c;
2.   J j      = (J) i;
3.   C d      = (C) i;
```



Second

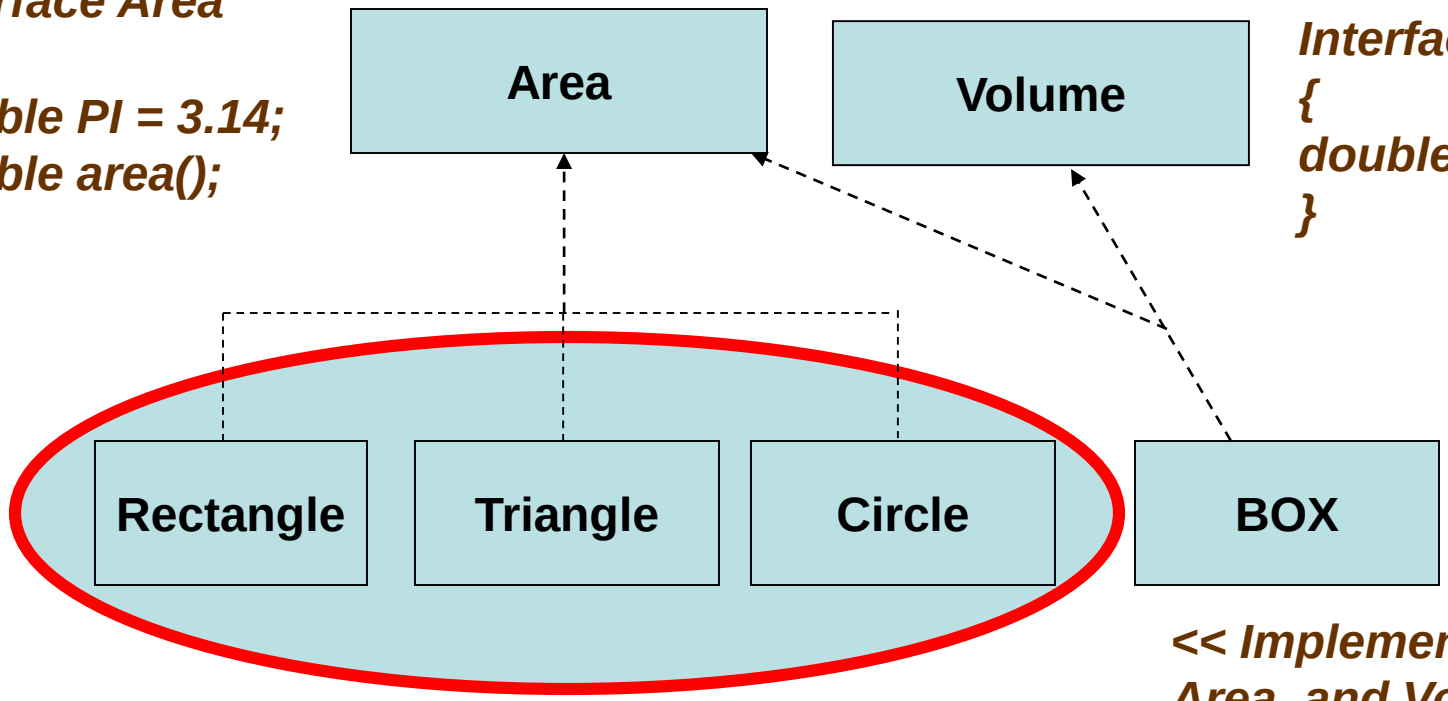
Exercise 3

- *Suppose the class Sandwich implements Editable interface. Which Of the following statements are legal?*

1. `Sandwich sub = new Sandwich();` **OK**
2. `Editable e = sub;` **OK**
3. `sub = e` ***Illegal***
4. `sub = (Sandwich) e;` **OK**

Write classes Implementing the Area and Volume Interface

Interface Area
{
double PI = 3.14;
double area();
}



Interface Volume
{
double volume();
}

<< Implements only Area interface>>

<< Implements both Area and Volume interface>>

Cont…

```
class circle implements Area
{
.....
.....
public double area()
{
.....
}
.....
.....
}
```

```
class Rectangle implements Area
{
.....
.....
public double area()
{
.....
}
.....
.....
}
```

```
class BOX implements Area , Volume
{
.....
.....
public double area()
{.....}
public double volume()
{.....}
}
```

<< Implement the methods from interface with public scope>>

```
import java.util.*;
class A
{ int a;
}
class ctest
{
public static void main(String args[])
{
String[] names = {"OOP","PES","BANGALORE"};
Arrays.sort(names);
int[] data = { 10,-45,87,0,20,21 };
Arrays.sort(data);
A[] arr = new A[5];
arr[0] = new A();
arr[1] = new A();
arr[2] = new A();
arr[3] = new A();
arr[4] = new A();
Arrays.sort(arr);
} }
```

Exception in thread "main"
java.lang.ClassCastException: A
at
java.util.Arrays.mergeSort(Arrays.java:1156)
at java.util.Arrays.sort(Arrays.java:1080)
at ctest.main(ctest.java:21)

Ok As String class implements Comparable

Ok As Integer class implements Comparable

NOT Ok as A class does not implements Comparable.

Unparametrized Comparator

```
import java.util.*;
class A implements Comparable
{
int a;
public int compareTo(Object other)
{
A a1 = (A) other;
if(this.a == a1.a ) return 0;
if(this.a < a1.a )  return -1;
return 1;
}
}
```

Type cast Object type to Base Type Before use

Unparametrized Comparable

```
class ctest
{
public static void main(String args[])
{
String[] names =
{"OOP","SPECIAL","TOPIC"};
Arrays.sort(names);
int[] data = { 10,-45,87,0,20,21 };
Arrays.sort(data);

A[] arr = new A[5];
arr[0] = new A();
arr[1] = new A();
arr[2] = new A();
arr[3] = new A();
arr[4] = new A();
Arrays.sort(arr);
}
}
```

Will Work

Will Work

Will Work

Parametrized Comparator

```
import java.util.*;
class A implements Comparable<A>
{
int a;
public int compareTo(A other)
{
// A a1 = (A) other; //No need of cast
if(this.a == other.a ) return 0;
if(this.a < other.a )  return -1;
return 1;
}
}
```

Parametrized Comparable

```
class ctest
{
public static void main(String args[])
{
String[] names =
{"OOP","SPECIAL","TOPIC"};
Arrays.sort(names);
int[] data = { 10,-45,87,0,20,21 };
Arrays.sort(data);

A[] arr = new A[5];
arr[0] = new A();
arr[1] = new A();
arr[2] = new A();
arr[3] = new A();
arr[4] = new A();
Arrays.sort(arr);
}
}
```

Will Work

Will Work

Will Work

```
import java.util.*;
class BOX implements Comparable<BOX>
{
private double l,b,h;
// Overloaded Constructors
BOX(double a)
{ l=b=h=a;
}
BOX(double l,double b,double h)
{ this.l=l; this.b=b; this.h=h;
}
// Acessor Methods
public double getL()
{  return l;
}
public double getB()
{ return b;
}
public double getH()
{ return h;
}
```

Parametrized Comparable of type BOX

Cont….

```
// area() Volume()  Methods
double area()
{
return 2*(l*b+b*h+h*l);
}
double volume()
{
return l*b*h;
}
// isEquals() method
boolean isEquals(BOX other)
{
if(this.area() == other.area()) return true;
return false;
/* OR
if(area() == other.area()) return true
return false;
*/
}
static boolean isEquals(BOX b1, BOX b2)
{
if(b1.area() == b2.area()) return true;
return false;
}
```

```
// compareTo method
public int compareTo(BOX other)
{
if(area() > other.area()) return 1;
if(area() < other.area()) return -1;
return 0;
}
public String toString()
{
String s1="length:"+l;
String s2="width:"+b;
String s3="area:"+h;
String s4="Area:"+area();
String s5="Volume:"+volume();
return s1+s2+s3+s4+s5;
}
} // End of class BOX
```

```
class comparableTest10
{
public static void main(String args[])
{
ArrayList<BOX> boxes = new ArrayList<BOX>();
boxes.add(new BOX(10));
boxes.add(new BOX(20));
boxes.add(new BOX(10,6,8));
boxes.add(new BOX(4,6,10));
boxes.add(new BOX(10,12,14));

Iterator itr = boxes.iterator();
while(itr.hasNext())
System.out.println((BOX)itr.next());

Collections.sort(boxes);

Iterator itr1 = boxes.iterator();
while(itr1.hasNext())
System.out.println((BOX)itr1.next());
}
}
```

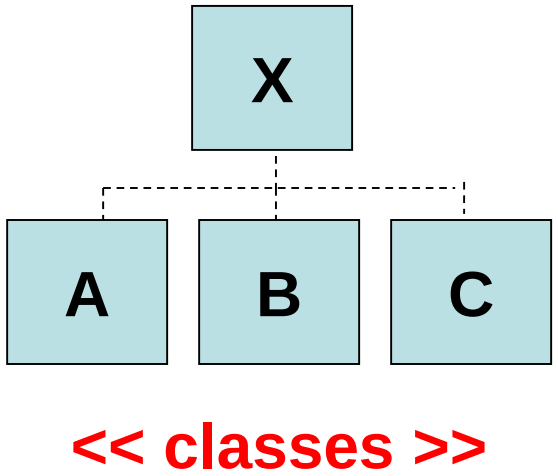
Converting a Class To an Interface Type

1. Interface acts as a super class for the implementation classes.

2. A reference variable belonging to type interface can point to any of the object of the classes implementing the interface.

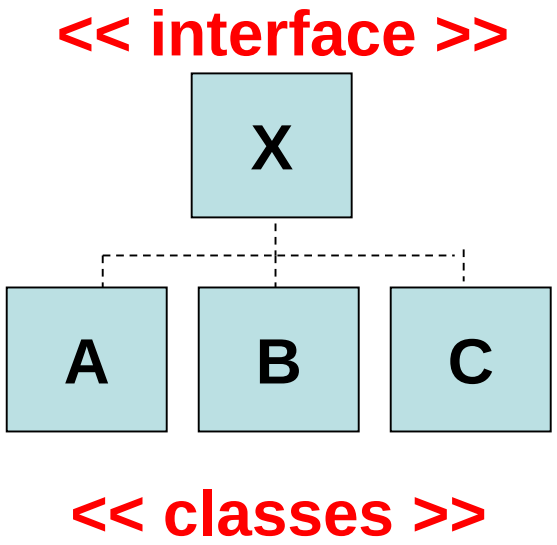
```
A a1 = new A();

X  x1 = a1;
```

Class to interface type Conversion



Converting an Interface to a class Type

```
X x1 = new A();

A a1 = (A) x1;


X x1 = new B();
B b1 = (B) x1;


X x1 = new C();
C c1 = (C) x1;
```



Interface to Class type Conversion

Comparator Example

- ***Supply comparators for BOX class so that BOX[] OR ArrayList<BOX> can be sorted by any of the following orders:***

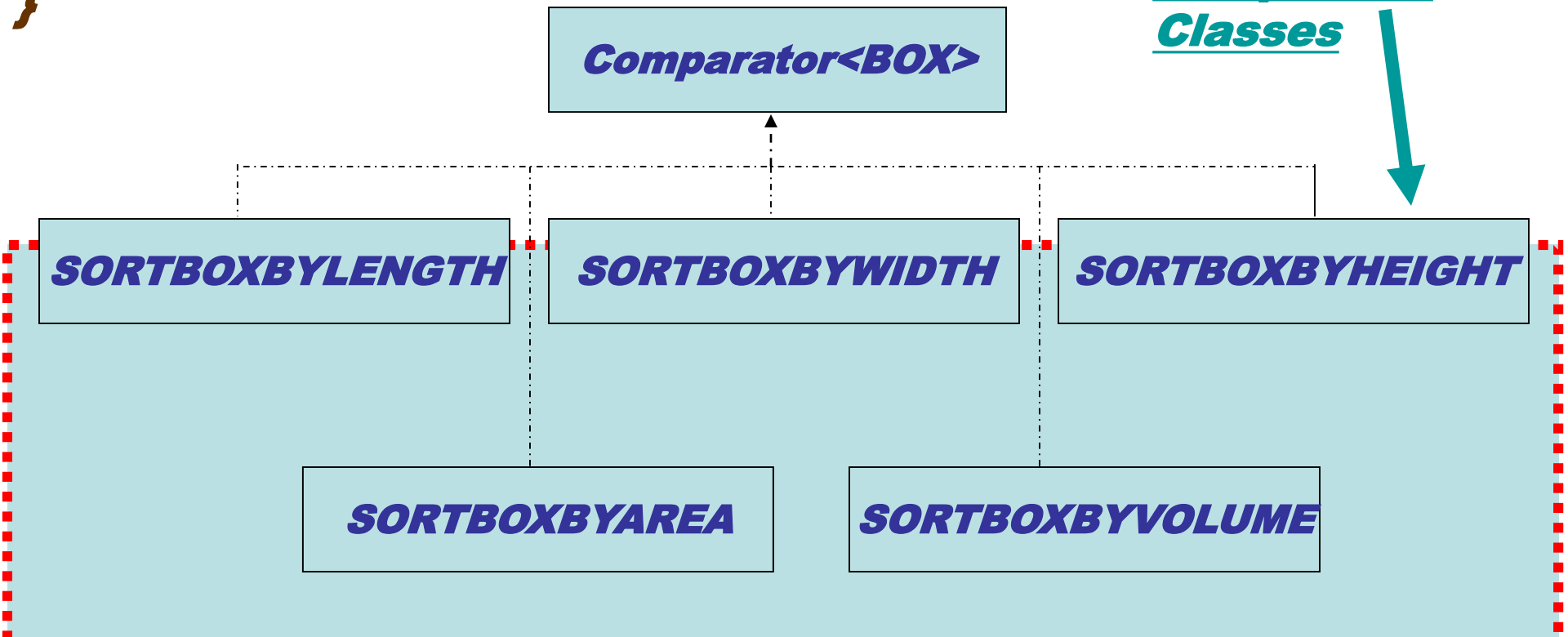
1. ***Sort By Length Either in Ascending or descending order***
2. ***Sort By Width Either in Ascending or descending order***
3. ***Sort By Height Either in Ascending or descending order***
4. ***Sort By Area Either in Ascending or descending order***
5. ***Sort By Volume Either in Ascending or descending order***

BOX is base class whose references stored either in Arrays or in Any Collection class such as ArrayList, Vector or LinkedList Needs to be sorted

```
class BOX
{
.....instance fields
.....instance methods
.....
}
```

BOX class does not implement any comparable or comparatorinterface

Comparator Classes



```
import java.util.*;
class BOX
{
private double l,b,h;
// Overloaded Constructors
BOX(double a)
{ l=b=h=a;
}
BOX(double l,double b,double h)
{
this.l=l;
this.b=b;
this.h=h;
}
// Acessor Methods
public double getL()
{ return l;
}
public double getB()
{ return b;
}
public double getH()
{ return h;
}
```

```
// area() Volume()  Methods
double area()
{
return 2*(l*b+b*h+h*l);
}
double volume()
{
return l*b*h;
}
// isEquals() method
boolean isEqual(BOX other)
{
if(this.area() == other.area()) return true;
return false;
/* OR
if(area() == other.area()) return true
return false;
*/
}
```

Cont …..

```
static boolean isEquals(BOX b1, BOX b2)
{
if(b1.area() == b2.area()) return true;
return false;
}
public String toString()
{
String s1="length:"+l;
String s2="width:"+b;
String s3="area:"+h;
String s4="Area:"+area();
String s5="Volume:"+volume();
return s1+s2+s3+s4+s5;
}
} // End of class BOX
```

NOTE :

BOX class is base class whose references needs to be sorted. It does not implement either comparable or comparator class

Cont .....

// Comparator class for Sorting by BOX references By length

```
class SORTBOXBYLENGTH implements Comparator<BOX>
{
private int order; // Defines Order of sorting 1 for Ascending -1 for Descending
SORTBOXBYLENGTH(boolean isAscending)
{
if(isAscending)
order =1;
else
order =-1;
}
public int compare(BOX b1,BOX b2)
{
if(b1.getL() > b2.getL()) return 1*order;
if(b1.getL() < b2.getL()) return -1*order;
return 0;
}
}// End of class
```

// Comparator class for Sorting by BOX references By Width

```
class SORTBOXBYWIDTH implements Comparator<BOX>
{
private int order;
SORTBOXBYWIDTH(boolean isAscending)
{
if(isAscending)
order =1;
else
order =-1;
}
public int compare(BOX b1,BOX b2)
{
if(b1.getB() > b2.getB()) return 1*order;
if(b1.getB() < b2.getB()) return -1*order;
return 0;
}
} // End of class
```

Comparator class for Sorting by BOX references By Height

```
class SORTBOXBYHEIGHT implements Comparator<BOX>
{
private int order;
SORTBOXBYHEIGHT(boolean isAscending)
{
if(isAscending)
order =1;
else
order =-1;
}
public int compare(BOX b1,BOX b2)
{
if(b1.getH() > b2.getH()) return 1*order;
if(b1.getH() < b2.getH()) return -1*order;
return 0;
}
} // End of class
```

Comparator class for Sorting by BOX references By Area

```
class SORTBOXBYAREA implements Comparator<BOX>
{
private int order;
SORTBOXBYAREA(boolean isAscending)
{
if(isAscending)
order =1;
else
order =-1;
}
public int compare(BOX b1,BOX b2)
{
if(b1.area() > b2.area()) return 1*order;
if(b1.area() < b2.area()) return -1*order;
return 0;
}
} // End of class
```

Comparator class for Sorting by BOX references By Volume


```
class SORTBOXBYVOLUME implements Comparator<BOX>
{
private int order;
SORTBOXBYVOLUME(boolean isAscending)
{
if(isAscending)
order =1;
else
order =-1;
}
public int compare(BOX b1,BOX b2)
{
if(b1.volume() > b2.volume()) return 1*order;
if(b1.volume() < b2.volume()) return -1*order;
return 0;
}
} // End of class
```

```
class comparatorTest
{
public static void main(String args[]) {
ArrayList<BOX> boxes = new ArrayList<BOX>();
boxes.add(new BOX(10));
boxes.add(new BOX(20));
boxes.add(new BOX(10,6,8));
boxes.add(new BOX(4,6,10));
boxes.add(new BOX(10,12,14));

// SORT BY LENTH ORDER:Ascending
Comparator<BOX> c1 = new SORTBOXBYLENGTH(true);
Collections.sort(boxes,c1);
for(int i=0;i<boxes.size();i++)
System.out.println(boxes.get(i));
System.out.println("");

// SORT BY LENTH ORDER:Descending
c1 = new SORTBOXBYLENGTH(false);
Collections.sort(boxes,c1);
for(int i=0;i<boxes.size();i++)
System.out.println(boxes.get(i));
System.out.println("");
```

```
// SORT BY Volume ORDER:Ascending
c1 = new SORTBOXBYVOLUME(true);
Collections.sort(boxes,c1);
for(int i=0;i<boxes.size();i++)
System.out.println(boxes.get(i));
System.out.println("");
// SORT BY Volume ORDER:Descending
c1 = new SORTBOXBYVOLUME(false);
Collections.sort(boxes,c1);
for(int i=0;i<boxes.size();i++)
System.out.println(boxes.get(i));
System.out.println("");
}
} // End of Main class
```

OUTPUT


```
length:4.0width:6.0area:10.0Area:248.0Volume:240.0
length:10.0width:10.0area:10.0Area:600.0Volume:1000.0
length:10.0width:6.0area:8.0Area:376.0Volume:480.0
length:10.0width:12.0area:14.0Area:856.0Volume:1680.0
length:20.0width:20.0area:20.0Area:2400.0Volume:8000.0
```

```
length:20.0width:20.0area:20.0Area:2400.0Volume:8000.0
length:10.0width:10.0area:10.0Area:600.0Volume:1000.0
length:10.0width:6.0area:8.0Area:376.0Volume:480.0
length:10.0width:12.0area:14.0Area:856.0Volume:1680.0
length:4.0width:6.0area:10.0Area:248.0Volume:240.0
```

```
length:4.0width:6.0area:10.0Area:248.0Volume:240.0
length:10.0width:6.0area:8.0Area:376.0Volume:480.0
length:10.0width:10.0area:10.0Area:600.0Volume:1000.0
length:10.0width:12.0area:14.0Area:856.0Volume:1680.0
length:20.0width:20.0area:20.0Area:2400.0Volume:8000.0
```

```
length:20.0width:20.0area:20.0Area:2400.0Volume:8000.0
length:10.0width:12.0area:14.0Area:856.0Volume:1680.0
length:10.0width:10.0area:10.0Area:600.0Volume:1000.0
length:10.0width:6.0area:8.0Area:376.0Volume:480.0
length:4.0width:6.0area:10.0Area:248.0Volume:240.0
```

THANK YOU

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Abstract Classes

1. An abstract class is a class that has at least one *abstract method* (i.e a method with only heading with no body of executable statements)
2. We can not create an object of abstract classes i.e abstract class objects can not be instantiated
3. An abstract class needs to be extended by sub classes to provide the implementation for the abstract methods.
4. Abstract classes may contain static methods
5. abstract and static keyword combination is wrong
   abstract static void print(); wrong
6. Abstract classes may extend either another abstract class or concrete class
7. Abstract classes may include constructors, nested classes and interfaces
8. Abstract classes has either public, protected, private or package accessibility

Abstract Classes

- **Syntax :**

```
abstract class <classname>
{
  ..........................
  abstract <return type> methodname(<parameter List>);
  abstract <return type> methodname(<parameter List>);
}
```

Note:

1. **Abstract Class should have atleast one abstract method**
2. **Abstract classes may extend another class , implements another interface , may have concrete methods**

Example

```
abstract class A
{
private int a;
void display()
{
System.out.println("Concrete Method of class A");
}
abstract void show();
}
```

Abstract method without body

Abstract declaration is must for both class as well as method

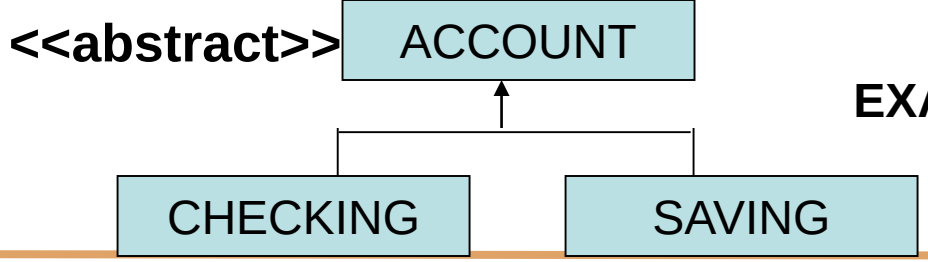
Example 2

```
class A
{
}
abstract class B extends A
{
private int a;
void display()
{
System.out.println("Concrete Method of class A");
}
abstract void show();
}
```

A is Complete Class

B is abstract class extending a complete class

Abstract class either extends a complete class or an abstract class



EXAMPLES ABSTRACT CLASS

```
abstract class Account
{
private String name;
private String actno;
private double balance;
private Address addr;

// Overloaded Constructors
Account(String n,String a)
{
name = n;
actno= a;
balance = 0.0;
}
Account(String n,String a,double b)
{
name = n;
actno= a;
balance = b;
}
```

```
// Accessor Methods
String getName()  { return name;}
String getactno() { return actno;}
double getbalance() { return balance;}

// Mutator Method only for balance
void setbalance(double amount)
{  this.balance = amount;}
void showAccountDetails()
{
System.out.println("Name :"+this.getName());
System.out.println("Account No
:"+this.getactno());
System.out.println("Balance
:"+this.getbalance());
}
// provide abstract methods
abstract double withdraw(double amount);
abstract void deposit(double amount);
} // END OF Account CLASS
```

```
class Saving extends Account
{
Saving(String n,String a)
{
super(n,a);
System.out.println("Saving Account Created");
System.out.println("Name :"+this.getName());
System.out.println("Account No :"+this.getactno());
System.out.println("Balance :"+this.getbalance());
showAccountDetails();
}
Saving(String n,String a,double b)
{
super(n,a,b);
System.out.println("Saving Account Created");
System.out.println("Name :"+this.getName());
System.out.println("Account No :"+this.getactno());
System.out.println("Balance :"+this.getbalance());
showAccountDetails();
}
```

```
double withdraw(double amount)
{
 /*
 if( balance == 0) return 0.0;
 if( balance < amount ) return 0.0;
 balance = balance - amount;
*/

 if(this.getbalance() == 0) return 0.0;
 if(this.getbalance() < amount ) return 0.0;
 setbalance(getbalance() - amount);
 return amount;
}
void deposit(double amount)
{
 setbalance(getbalance() + amount);
 return ;
}
}//end of Saving class
```

```
class Checking extends Account
{
Checking(String n,String a,double b)
{
super(n,a,b);
System.out.println("Checking Account
Created");
showAccountDetails();
}
double withdraw(double amount)
{
/*
 if( balance - 100 == 0) return 0.0;
 if( balance -100 < amount ) return 0.0;
 balance = balance - amount;
*/

 if(this.getbalance() - 100 == 0) return 0.0;
 if(this.getbalance() - 100 < amount ) return 0.0;
 setbalance(this.getbalance() - amount);
 return amount;
}
void deposit(double amount)
{
 setbalance(this.getbalance() + 0.9 *
amount)  ;
 return ;
}
}//end of Checking class
```

```
class AccountTest
{
public static void main(String args[])
{
Checking c1 =  new Checking("Rahul Sharma","C106726",100000);
Checking c2 =  new Checking("Raman Kumar","C106727",100000);

Saving s1 =  new Saving("Kumar Sharma","S106726",100000);
Saving s2 =  new Saving("Mohan Lal","S106727");

c1.withdraw(2000);
c1.showAccountDetails();
c2.deposit(10000);
c2.showAccountDetails();
s1.deposit(900);
s1.showAccountDetails();
s2.withdraw(400);
s2.showAccountDetails();
}
}
```

1) Abstract class must have only abstract methods. True or false?
False. Abstract methods can also have concrete methods.

2) Is it compulsory for a class which is declared as abstract to have at least one abstract method?
Not necessarily. Abstract class may or may not have abstract methods.

3) Can we use “abstract” keyword with constructor, Instance Initialization Block and Static Initialization Block?
No. Constructor, Static Initialization Block, Instance Initialization Block and variables can not be abstract.

4) Why final and abstract can not be used at a time?

Because, final and abstract are totally opposite in nature. A final class or method can not be modified further where as abstract class or method must be modified further. “final” keyword is used to denote that a class or method does not need further improvements. “abstract” keyword is used to denote that a class or method needs further improvements.

5) Can we instantiate a class which does not have even a single abstract methods but declared as abstract?

No, We can’t instantiate a class once it is declared as abstract even though it does not have abstract methods.

6) Can we declare abstract methods as private? Justify your answer?

No. Abstract methods can not be private. If abstract methods are allowed to be private, then they will not be inherited to sub class and will not get enhanced.

7) We can’t instantiate an abstract class. Then why constructors are allowed in abstract class?

It is because, we can’t create objects to abstract classes but we can create objects to their sub classes. From sub class constructor, there will be an implicit call to super class constructor. That’s why abstract classes should have constructors. Even if you don’t write constructor for your abstract class, compiler will keep default constructor.

8) Can we declare abstract methods as static?
No, abstract methods can not be static.

9) Can a class contain an abstract class as a member?
Yes, a class can have abstract class as it's member.

10) Can abstract method declaration include throws clause?
Yes. Abstract methods can be declared with throws clause.

THANK YOU

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OBJECT ORIENTED PROGRAMMING WITH JAVA

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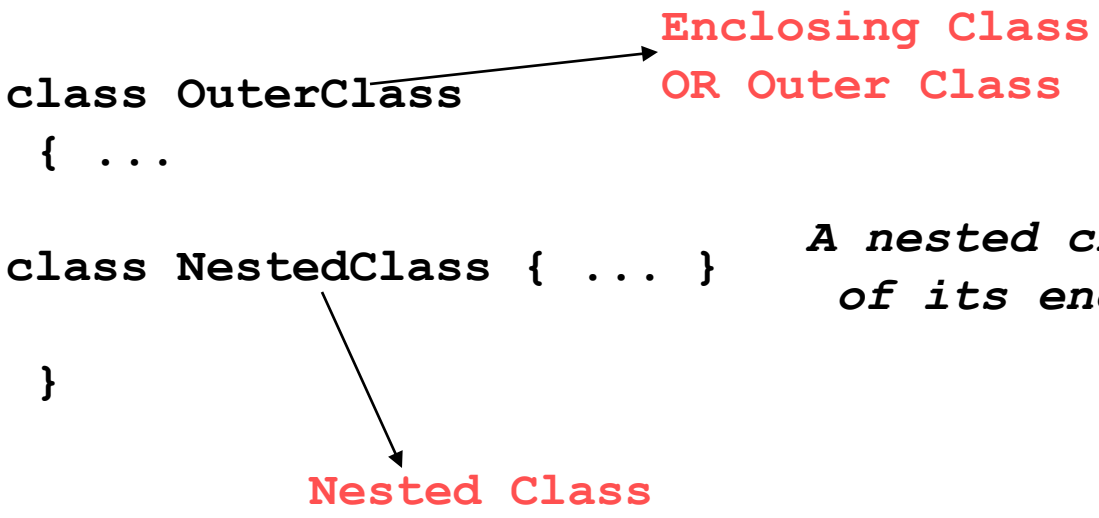
Nested Classes

Java programming language allows you to define a class within another class



A nested class is a member of its enclosing class

1. Nested has access to other members of the enclosing class, even if they are declared private

2. Can be private, public, protected or friendly access

Nested Class Types

- Static nested classes

1. Static keyword applied for class declaration
2. Static nested class can use the instance fields/methods of the outer class only through object reference.
3. Static nested class can be accessed

   OuterClass.StaticNestedClass

4. To create an object for the static nested class, use this syntax:

OuterClass.StaticNestedClass nestedObject = new OuterClass.StaticNestedClass();

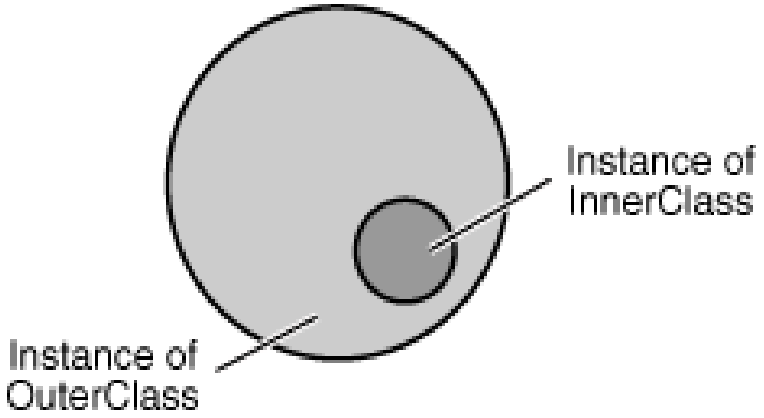
Nested Class Types cont..

- Non-Static nested classes

1. These nested classes do not have ***static*** keyword applied
2. Non-Static nested class can use the instance fields/methods of the outer class directly.
3. *To create an object for the non-static nested class, use this syntax:*

OuterClass.NestedClass nestedObject = Outerobjectreference. new innerclass();

Inner class instance can only exists inside Outer class instance.



Example 1 [Non-static Nested Class]

```
class A
{
private int a;
A(int a)
{
this.a =a;
}
void print()
{
System.out.println("a="+a);
}
class B
{
int b;
B(int b)
{
int c = b+10;
this.b = c;
}
void show()
{
print();
System.out.println("b="+b);
}
} // End of class B
} // End of class A
```

Outer Class

Nested class with friendly access

Call to print() of outer class

Example 1 [Non-static Nested Class] cont….

```
class innertest1
{
public static void main(String args[])
{
A a1 = new A(10);

A.B b1 = a1.new B(100);

b1.show();
}
}
```

Inner class Name

Outer class Reference

To create an inner class instance for non-static classes you need an outer class reference.

Inner class Reference

Outer class Name

If class B is Private then it is not visible in main().

A.B b1 = a1.new B(100); is WRONG/INVALID

Example 2

```
class A
{
private int a;
private int b=10;

A(int a)
{
this.a=a;
}
```

Outer class

Nested Inner class [Non-static Type]

```
class B
{
private int b;
B(int b)
{
this.b =b;
}
void show()
{
int b=20;
System.out.println("a="+a);
System.out.println("b="+b);
System.out.println("this.b="+this.b);
System.out.println("Outer b="+A.this.b);
}
} // End of B inner class
```

Instance Field of B

Outer Class A's a

Local b

B's instance Field b

A's instance Field b

```
void show()
{
B b1 = new B(30);
b1.show();
}
} // End of Outer class A
```

```
class innerTest
{
public static void main(String args[])
{
// Create an inner class B's instance
// Call show() method

// STEP 1
// Create an Outer Instance first

A a1 = new A(20);
A.B b1 = a1.new B(-30);
b1.show();

// inner class object instantiation thru anonymous outer
// reference
A.B b2 = new A(30).new B(-40);
b2.show();
}
}
```

```
a=20
b=20
this.b=-30
Outer b=10
```

```
a=30
b=20
this.b=-40
Outer b=10
```

Static Inner class / Static Nested class Exampl

```
class A
{
private int a;
A(int a)
{
this.a =a;
}
void print()
{
System.out.println("a="+a);
}
```

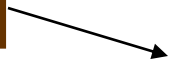
```
static class B
{
int b;
B(int b)
{
int c = b+10;
this.b = c;
}
void show()
{
// print();  INVALID
A a1 = new A(10);
a1.print();
System.out.println("b="+b);
}
} // End of class B
} // End of class A
```

Static inner class

Static nested class can refere to outer members only through outer reference

Example cont....

```
class innertest10
{
public static void main(String args[])
{
A.B b1 = new A.B(100);
b1.show();
}
}
```



Instance of static Inner class

Static Nested class Example 2


```
class A
{
private int a;
protected static int b=10;
A(int a)
{
this.a=a;
}
public void show()
{
System.out.println("a="+a);
display();
}
public static void display()
{
System.out.println("b="+b);
}
```

Example 2 cont....

```
static class B
{
private int a;
protected static int b=100;
B(int a)
{
this.a=a;
}
void show()
{
// A.this.show(); // Won't work show() is non-static in outer
display(); // Will work as method is static in outer
System.out.println("a="+a);
// System.out.println("a="+A.this.a);
// Won't work a is non-static in outer
System.out.println("b="+b); // Will refer to its own b
System.out.println("A'sb="+A.b);  // will refer to outer class B

new A(40).show();
// This is how you can call non static methods of outer

}
} // End of inner class B
} // End of class A
```

Example 2 cont….

```
class innerTest1
{
public static void main(String args[])
{
A.B b1 = new A.B(-30);
b1.show();
}
}
```

```
D:\jdk1.3\bin>java innerTest1
b=10
a=-30
b=100
A'sb=10
a=40
b=10
```

Local Inner classes [Classes Within method body]

```
class A
{
private int a;
protected static int b=10;
A(int a)
{
this.a=a;
}
void show()
{
        class B
        {}
}
}
```

Class declared within a method body.
Here method is show()
Local inner classes Can not be declared as public,private or protected

1. Class B is visible only in method show().
2. It can be used within this show() method only
3. Local inner classes can only use final variables from its enclosing method.
4. However inner classes can refer to its fields of enclosing class.

```
class A
{
private int a;
protected static int b=10;
A(int a)
{
this.a=a;
}
void show()
{
int x=10;
      class B
      {
      private int b;
      B(int b)
      {
      this.b=b;
      }
      void display()
      {
      System.out.println("a="+a);
      System.out.println("b="+b);
      System.out.println("x="+x);
      }
      } // End of class B
} // End of show() method
} // End of A class
```

```
D:\jdk1.3\bin>javac
innerTest2.java
innerTest2.java:23: local
variable x is accessed from
within inner class;
to be declared final
System.out.println("x="+x);
                       ^
1 error
```

Reference for A's a

Reference for B's b

Reference is wrong / errorneous

'x' is local variable inside the local method. Local classes can use only final fields from enclosing method

```
class innertest
{
public static void main(String
args[])
{
final int a1=10;
```

```
new A(20).show();
print();
}// End of main
static void print()
{
/*
A a1 = new A(30);
a1.show();
*/
System.out.println("Hello");
}
}
```

```
class A
{
private int a;
private int b;
int c;
A(int a)
{
this.a =a;
b = a+20;
c = a+40;
}
void show()
{
System.out.println("a1="+a1)
;
System.out.println("a="+a);
System.out.println("b="+b);
System.out.println("c="+c);
}
} //End of A
```

OUTPUT

E:\oop>java innertest
a1=10
a=20
b=40
c=60
Hello

Anonymous Inner classes

- ***Another category of local inner classes***
- ***Classes without any name i.e classes having no name***
- ***Can either implements an interface or extends a class.***
- ***Can not have more than one instance active at a time.***
- ***Whole body of the class is declared in a single statement ending with ;***

Cont…

- Syntax [If extending a class]

[variable_type_superclass =] new superclass_name() {
// properties and methods
} [;]

- Syntax [If implementing an interface]

[variable_type_reference =] new reference_name() {
// properties and methods
} [;]

Anonymous Inner Class Example


```
class A
{
private int a;
A(int a)
{
this.a =a;
}
void show()
{
System.out.println("a="+a);
} // End of show()
}// End of class A
```

```
class innertest1
{
public static void main(String args[])
{
```

Anonymous inner class extending super class A

```
A a1 = new A(20){
        public void show()
        {
        super.show();
        System.out.println("Hello");
        }
        public void display()
        {
        System.out.println("Hi");
        }
        };
a1.show();
// a1.display();
}
}
```

Calling show from inner class

```
interface X
{
int sum(int a,int b);
int mul(int x,int y);
}
class innertest2
{
public static void main(String args[])
{
```

Anonymous inner class implementing an interface

```
X x1 = new X()
        {
        public int sum(int a,int b)
        {
        return a+b;
        }
        public int mul(int a,int b)
        {
        return a*b;
        }
    };
System.out.println(x1.sum(10,20));
System.out.println(x1.mul(10,20));
}// End of main
}// End of innertest2
```

Home Exercise

- Write 5 BOX Comparator classes using anonymous inner classes.

THANK YOU

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