Unit-3

Packages:
Definition, types of packages, Creating and importing a user defined package.

Introduction to I/O programming:
DataInputStream, DataOutputStream, FileInputStream, FileOutputStream, BufferedReader.

Collections:
interfaces, Implementation classes, and Algorithms (such as sorting and searching).

Packages

- The main feature of OOP is its ability to support the reuse of code:
  - Using the classes (directly)
  - Extending the classes (via inheritance)
  - Extending interfaces
- The features in basic form limited to reusing the classes within a program

- What if we want to reuse your classes in other programs without physically copying them ?

- In Java, this is achieved by using “packages”, a concept similar to “class libraries” in other languages

- Package is a group of classes, interfaces and other packages

Creating and importing a user defined package

1. Pick a name for your package

Ex : 1. mypackage

2. mypackage.util

- java recommends lower case letters to the package names

2. Choose a directory on your hard drive as the root of your class library

- You need a place on your hard drive to store your classes
- I suggest you create a directory such as ***c:\javaclasses***
- This folder becomes the ***root directory*** for your Java packages

3. Create subdirectories within the package root directory for your package name

-- For example, for the package named **mypackage.util**, create a directory named **mypackage** in the **c:\javaclasses**. Then, in the **mypackage** directory, create a directory named **util**. Thus, the complete path to the directory that contains the classes for the **mypackage.util** package is **c:\javaclasses\mypackage\util**

4. Add the root directory for your package to the **classpath** environment variable

- Do not disturb any directories already listed in the classpath

  – For example, suppose your classpsath is already set to this:

  C:\Program Files\Java\jdk1.5.0_05\lib;

  – Then, you modify it to look like this:

  C:\Program Files\Java\jdk1.5.0_05\lib;c:\javaclasses;

5. Add a package statement at the beginning of each source file

- The package statement creates a package with specified name
- For example: **package mypackage.util**;
- All classes declared within that file belong to the specified package
- The package statement must be the first non-comment statement in the file

6. Save the files for any classes you want to be in a particular package in the directory for that package

-- For example, save the files for a class that belongs to the **mypackage.util** package in **c:\javaclasses\mypackage\util**

Ex:

```
package mypackage.util;
public class Sum
{
    public int sumInt(int a[])
    {

        int s=0;

        for(int i=0;i<a.length;i++)
        {
                s = s+a[i];
        }

        return s;
    }
}
```

```
import mypackage.util.Sum;
class PackageDemo
{
    public static void main( String args[])
    {
        int x[] = {1,2,3,4,5};
        Sum s = new Sum();
        System.out.println(s.sumInt(x));
    }
}
```

Note: This file can be compiled and executed from any place

- In general, a Java source file can contain any (or all) of the following four internal parts:

  - A single package statement (optional).
  - Any number of import statements (optional).
  - A single public class declaration (required).
  - Any number of classes private to the package (optional).

Accessing Classes from Packages

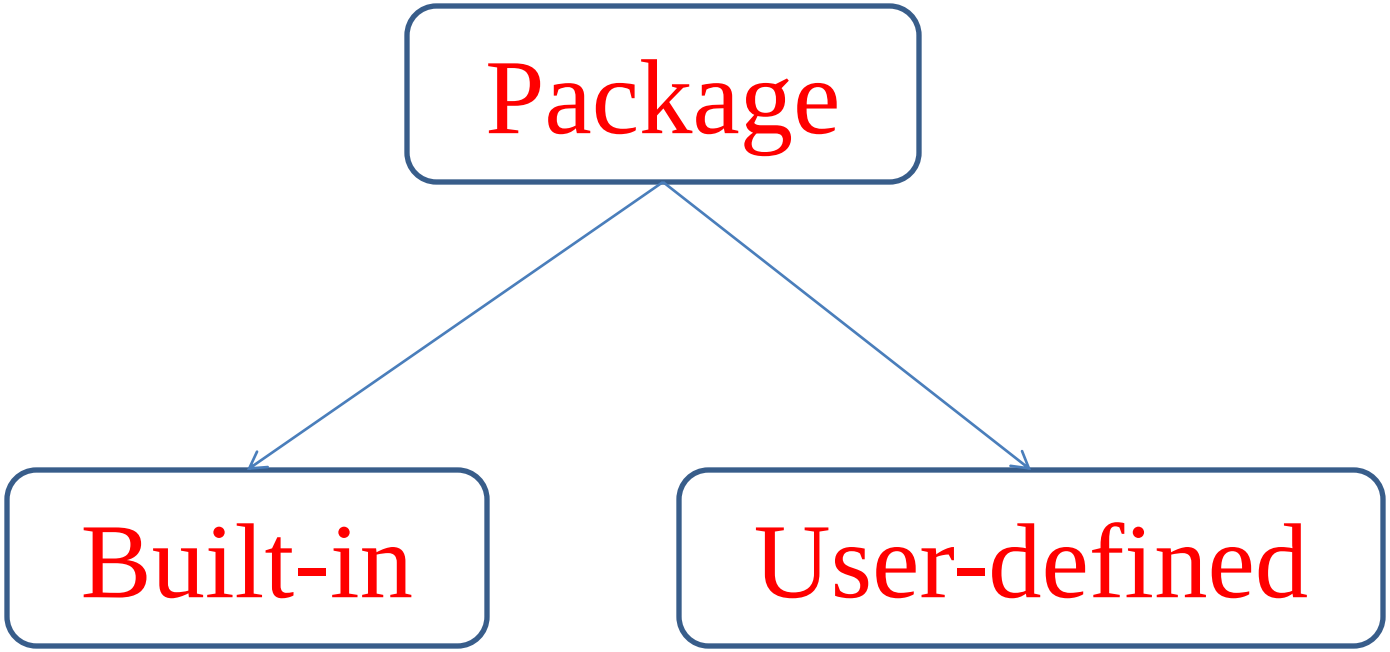
- There are two ways of accessing the classes stored in packages:

1. Using fully qualified class name
   - java.lang.Math.sqrt(x);

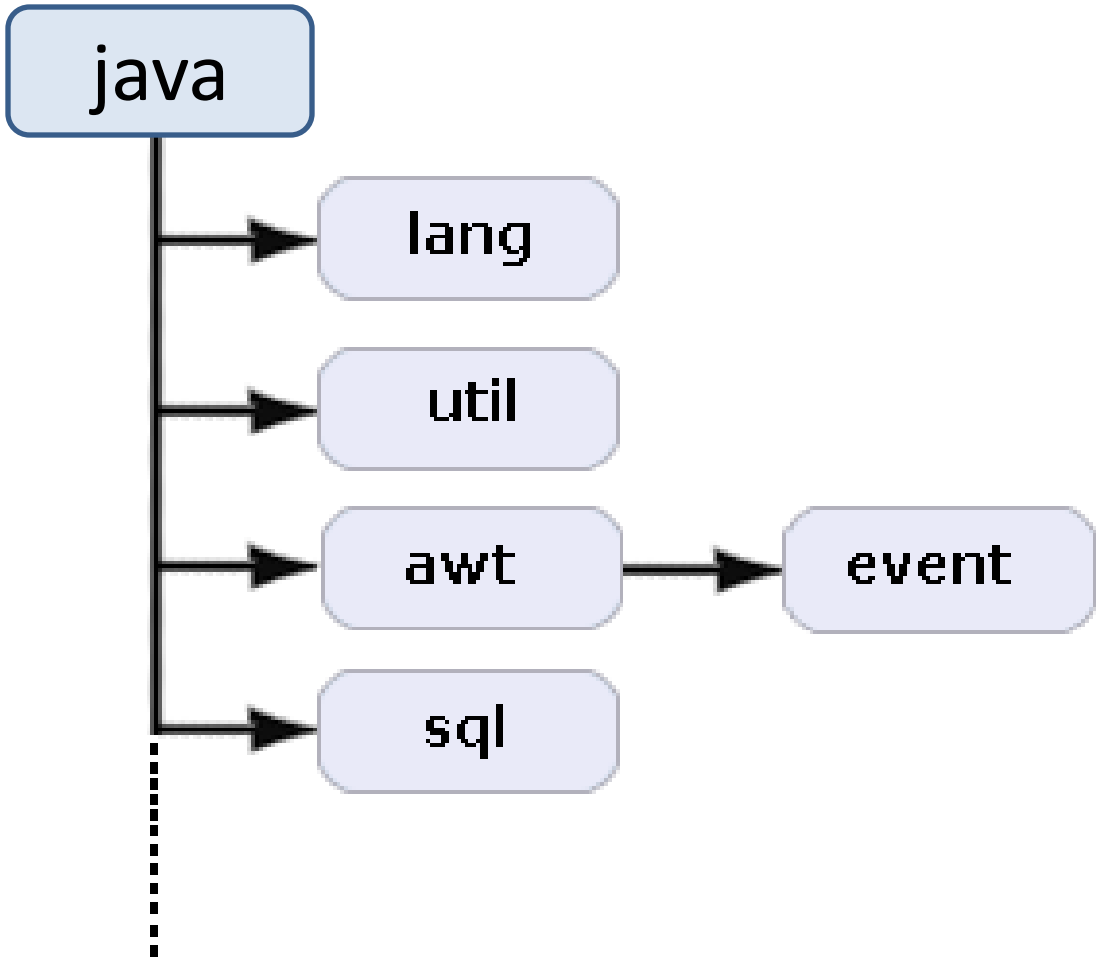
2. Import package and use class name directly
   - import java.lang.Math;
   - Math.sqrt(x);

- Selected classes or all classes in packages can be imported:
  - import package.ClassName;
  - import package.*;

Types of Packages



Built-In Packages



Built-in examples

- import java.util.Scanner;

  --java.util package contains Scanner class (has methods nextInt(), next(),…)

- import java.lang.Math;

  --java.lang package contains Math class (has methods sqrt(), floor(), …)

User-defined examples

- import mypackage.util.Sum;

  --user defined package mypackage.util contains Sum class

Accessing Classes in the same package (under same directory)

-Assume all files are stored in util package

```
class Add
{
   int addition(int a,int b)
   {
      return a+b;
   }
}
```

-Save file with Add.java

-Accessing Add.class in the following program:

```
class ExDemo
{
  public static void main(String args[])
  {
    Add ad = new Add();
    System.out.println("Sum is "+ad.addition(100,200));
  }
}
```

-Save file with ExDemo.java

-The output of ExDemo.java is 300

Note: access specifier for class and method in Add.java is default

Accessing Classes from other Packages

default access modifier

```
package abcpackage;

public class Addition {
   /* Since we didn't mention any access modifier here, it would
    * be considered as default.
    */
   int addTwoNumbers(int a, int b){
         return a+b;
   }
}
```

-Assume the following file is stored in D:\src folder

```
/* We are importing the abcpackage
 * but still we will get error because the
 * class we are trying to use has default access
 * modifier.
 */
import abcpackage.*;
public class Test {
   public static void main(String args[]){
        Addition obj = new Addition();
        /* It will throw error because we are trying to access
         * the default method in another package
         */
        obj.addTwoNumbers(10, 21);
   }
}
```

-It gives the error because **no access specifier (default)** is used with the method in **Addition** class.

protected access modifier

```
package abcpackage;
public class Addition {

   protected int addTwoNumbers(int a, int b){
        return a+b;
   }
}
```

-Assume the following file is stored in D:\src folder

```
import abcpackage.*;
class Test extends Addition{
   public static void main(String args[]){
        Test obj = new Test();
        System.out.println(obj.addTwoNumbers(11, 22));
   }
}
```

-It gives 33 as output.

public access modifier

```
package abcpackage;

public class Addition {

   public int addTwoNumbers(int a, int b){
         return a+b;
   }
}
```

-Assume the following file is stored in D:\src folder

```
import abcpackage.*;
class Test{
   public static void main(String args[]){
      Addition obj = new Addition();
      System.out.println(obj.addTwoNumbers(100, 1));
   }
}
```

-It prints 101 as output.

Collections

- A **collection** is a group of objects

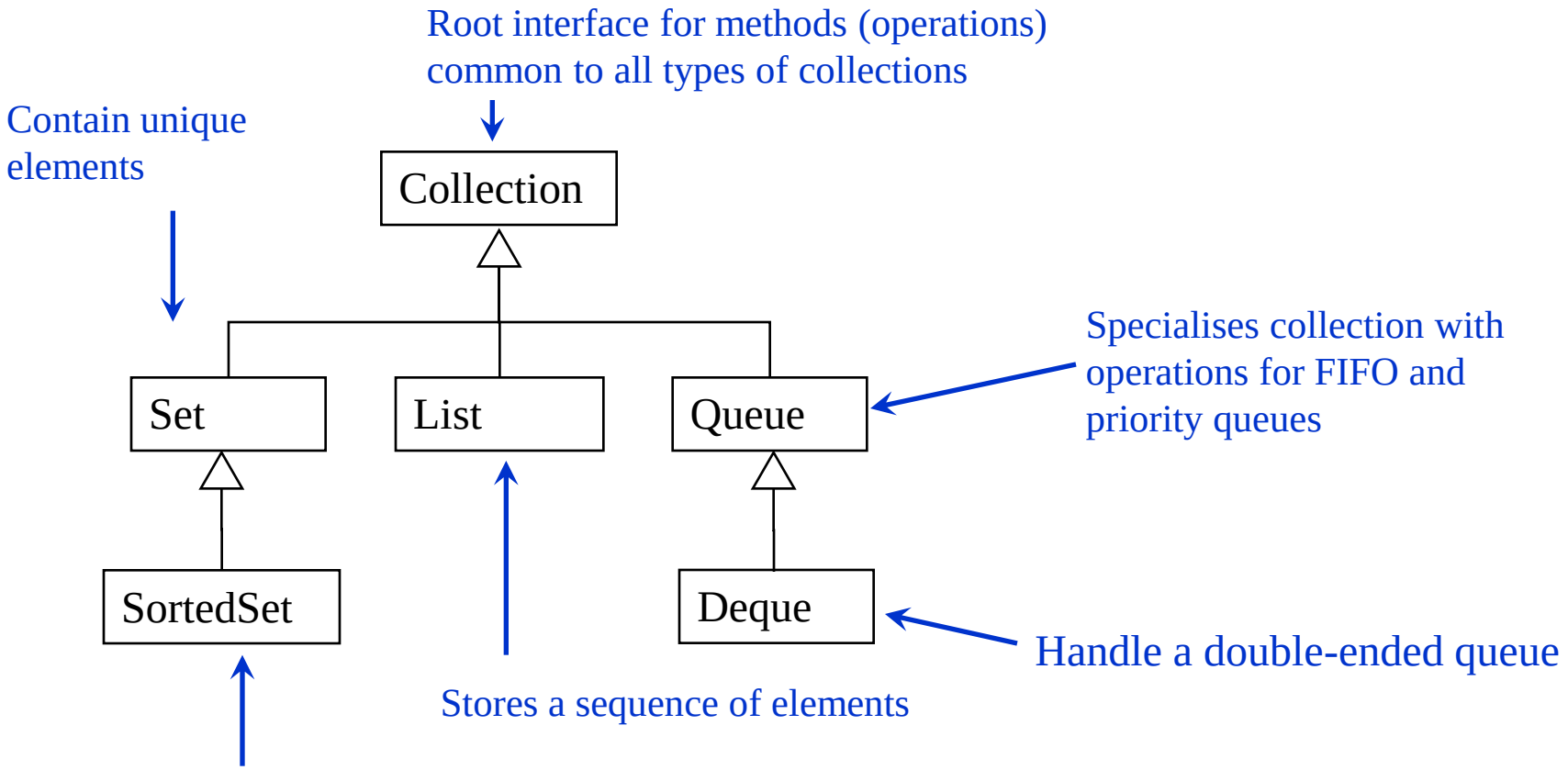
- The classes and interfaces of the **collections framework** are in package **java.util**

Collections frame work contains the following

- **Interfaces**
- **Implementations -**These are the classes
- **Algorithms -**These are the methods that perform useful computations, such as searching and sorting, on objects that implement collection interfaces

Interfaces

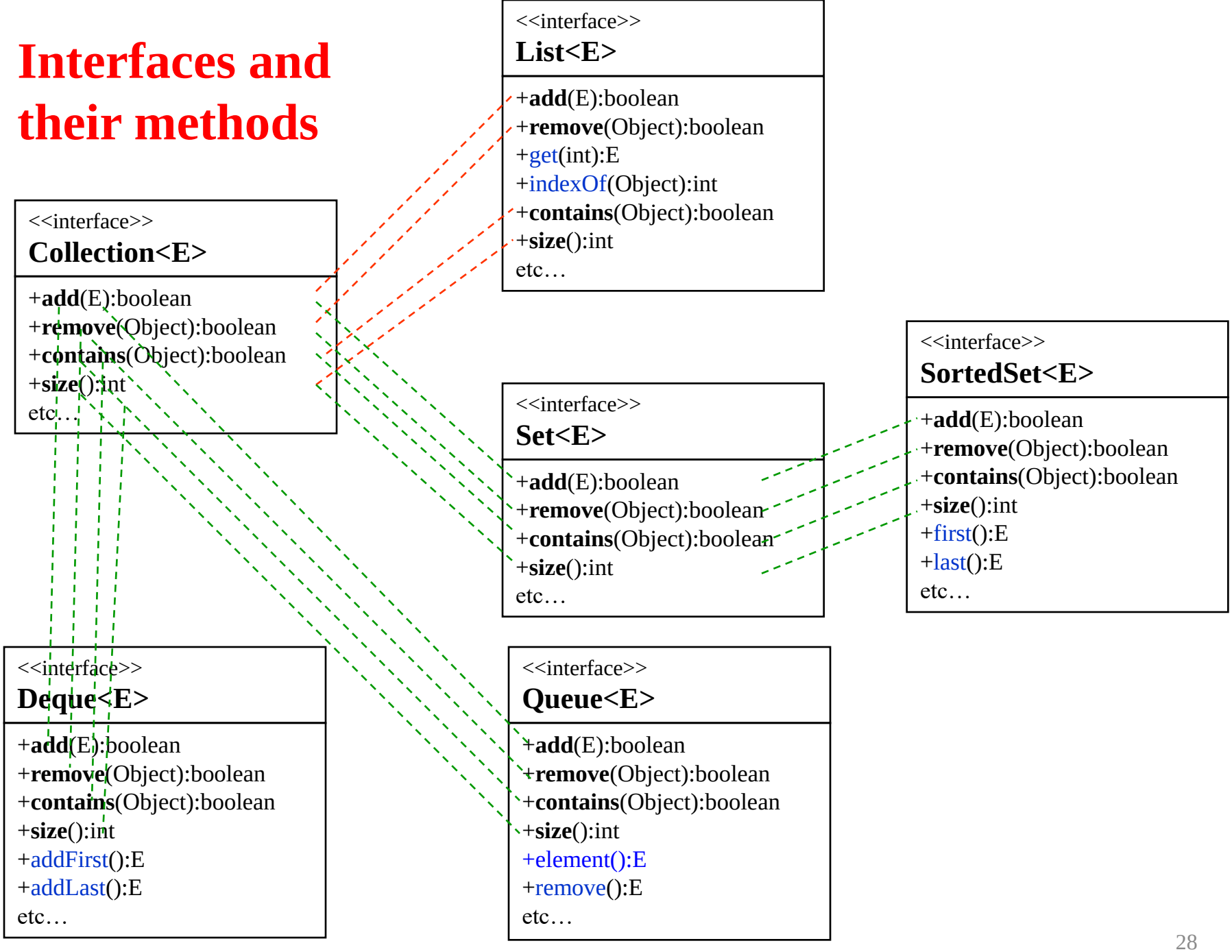
Generalisation



Specialisation

Interface	Description
Collection	Enables you to work with groups of objects; it is at the top of the collections hierarchy
List	Extends **Collection** to handle sequences (lists of objects)
Set	Extends **Collection** to handle sets, which must contain unique elements
Queue	Extends **collection** to handle special types of lists in which elements are removed only from the head
Deque	Extends **Queue** to handle a double-ended queue
SortedSet	Extends **Set** to handle sorted sets

Interfaces and their methods



The Collection Interface

- The **Collection** interface is the foundation upon which the collections framework is built

- It must be implemented by any class that defines a collection

- **Collection** is a generic interface that has this declaration:

  interface Collection<E>

  here E specifies the type of objects that the collection will hold

The methods defined by Collection

Method	Description
boolean add(E obj)	Adds *obj* to the invoking collection. Returns **true** if *obj* was added to the collection. Returns **false** if *obj* is already a member of the collection, and the collection does not allow duplicates
Boolean remove(Object obj)	Removes one instance of *obj* from collection . Returns true if the element was removed. Otherwise returns false
void clear( )	Removes all elements from the invoking collection
Boolean isEmpty()	Returns true if the collection is empty. Otherwise, returns false
int size()	Returns the number of elements held in the collection

The List Interface

- The **List** interface extends **Collection** and declares the behavior of a collection that stores a sequence of elements
- Elements can be inserted or accessed by their position in the list, using a zero-based index
- A list may contain duplicate elements
- **List** is a generic interface that has this declaration:

  interface List<E>

  here E specifies the type of objects that the list will hold

The methods defined by List

Method	Description
void add(int index, E obj)	Inserts *obj* into the invoking list at the index passed in *index*. Any preexisting elements at or beyond the point of insertion are shifted up. Thus, no elements are overwritten
E get(int *index*)	Returns the object stored at the specified index within the invoking collection
int indexOf(Object *obj*)	Returns the index of the first instance of *obj* in the invoking list. If *obj* is not an element of the list, –1 is returned
int lastIndexOf(Object *obj*)	Returns the index of the last instance of *obj* in the invoking list. If *obj* is not an element of the list, –1 is returned
E remove(int *index*)	Removes the element at position *index* from the invoking list and returns the deleted element. The resulting list is compacted. That is, the indexes of subsequent elements are decremented by one

The Set Interface

- The **Set** extends **Collection** and declares the behavior of a collection that does not allow duplicate elements
- Therefore, the **add( )** method returns **false** if an attempt is made to add duplicate elements to a set.
- It does not define any additional methods of its own
- **Set** is a generic interface that has this declaration:

  interface Set<E>

  here E specifies the type of objects that the Set will hold

The SortedSet Interface

- The **SortedSet** interface extends **Set** and declares the behavior of a set sorted in ascending order
- **SortedSet** is a generic interface that has this declaration:

interface SortedSet<E>

here E specifies the type of objects that the set will hold

The methods defined by SortedSet

Method	Description
E first()	Returns the first element in the invoking sorted set
E last()	Returns the last element in the invoking sorted set
SortedSet<E> subSet(E start, E end)	Returns SortedSet that includes those elements between start and end. Elements in the returned collection are also referenced by the invoking object

The queue interface

- The queue interface extends Collection and declares the behavior of a queue, which is often first-in, first-out list
- Queue is a generic interface that has this declaration:

  interface Queue<E>

  here E specifies the type of objects that the queue will hold

Methods defined by a queue

Method	Description
E element()	Returns the element at the head of the queue. The element is not removed. It throws **NoSuchElementException** if the queue is empty
E remove()	Removes the element at the head of the queue and returns that element. It throws **NoSuchElementException** if the queue is empty
E peek()	Returns the element at the head of the queue. It returns null if the queue is empty. The element is not removed
E poll()	Returns the element at the head of the queue. The element is removed. It returns null if the queue is empty

The deque interface

- It was added by Java SE 6
- It extends **queue** and declares the behavior of a double ended queue
- Double ended queue can function as first-in, first-out queues or as last-in, first-out stacks

Methods defined by deque

Method	Description
void addFisrt(E obj)	Adds obj to the head of the deque. Throws an **IllegalStateException** if a capacity-restricted deque is out of space
void addLast(E obj)	Adds obj to the tail of the deque. Throws an **IllegalStateException** if a capacity-restricted deque is out of space
E getFirst()	Returns the first element in the deque. The object is not removed from the deque. It throws **NoSuchElementException** if the deque is empty
E getLast()	Returns the last element in the deque. The object is not removed from the deque. It throws **NoSuchElementException** if the deque is empty
E removeFirst()	Returns and removes the first element. It throws **NoSuchElementException** if the deque is empty
E removeLast()	Returns and removes the last element. It throws **NoSuchElementException** if the deque is empty

The Collection Classes

- Collection classes are classes that implement collection interfaces
- Some of the classes provide full implementations that can be used as-it-is
- Others are abstract classes

Class	description
AbstractCollection	Implements most of the **Collection** interface
AbstractList	Extends **AbstractCollection** and implements most of the **List** interface
AbstractSet	Extends **AbstractCollection** and implements most of the **Set** interface
AbstractQueue	Extends **AbstractCollection** and implements most of the **Queue** interface
AbstractSequentialList	Extends **AbstractList** for use by a collection that uses sequential rather than random access of its elements
LinkedList	Implements a linked list by extending **AbstractSequentialList**
ArrayList	Implements a dynamic array by extending **AbstractList**

The ArrayList Class

- The **ArrayList** class extends **AbstractList** and implements the **List** interface
- Arraylist is a generic class that has this declaration:

  class ArrayList<E>

  here E specifies type of objects that the list will hold
- **ArrayList** has the constructors shown here:

  ArrayList( )

  ArrayList(Collection *c*)

  ArrayList(int *capacity*)

Ex:-

```
// Demonstrate ArrayList.
import java.util.*;
class ArrayListDemo {
    public static void main(String args[]) {
ArrayList<String> al = new ArrayList<String>();
    System.out.println("Initial size of al: " + al.size());
    al.add("C");
    al.add("A");
    al.add("E");
    al.add("B");
    al.add("D");
    al.add("F");
    al.add(1, "A2");
    System.out.println("Size of al after additions: " + al.size());
    System.out.println("Contents of al: " + al);
    al.remove("F");
    al.remove(2);
    System.out.println("Size of al after deletions: " + al.size());
    System.out.println("Contents of al: " + al);
  }
}
```

Output:

```
Initial size of al: 0
Size of al after additions: 7
Contents of al: [C, A2, A, E, B, D, F]
Size of al after deletions: 5
Contents of al: [C, A2, E, B, D]
```

The LinkedList Class

- The **LinkedList** class extends **AbstractSequentialList** and implements the **List , Deque,** and **Queue** interfaces
- LinkedList Class is a generic class that has this declaration:

  class LinkedList<E>

  here E specifies type of objects that the list will hold
- It provides a linked-list data structure
- It has the two constructors, shown here:

  LinkedList( )

  LinkedList(Collection *c*)
- The first constructor builds an empty linked list. The second constructor builds a linked list that is initialized with the elements of the collection *c*

Ex:-

```
// Demonstrate LinkedList.
import java.util.*;
class LinkedListDemo {
public static void main(String args[]) {
// create a linked list
LinkedList<String> llist = new LinkedList<String>();
llist.add("F");
llist.add("B");
llist.add("D");
llist.add("E");
llist.add("C");
llist.addLast("Z");
llist.addFirst("A");
llist.add(1, "A2");
System.out.println("Original contents of llist: " + llist);
// remove elements from the linked list
llist.remove("F");
llist.remove(2);
System.out.println("Contents of llist after deletion: " + llist);
```

```
// remove first and last elements
llist.removeFirst();
llist.removeLast();
System.out.println("llist after deleting first and last: "+ llist);
}
}
```

Output:

```
Original contents of llist: [A, A2, F, B, D, E, C, Z]
Contents of llist after deletion: [A, A2, D, E, C, Z]
llist after deleting first and last: [A2, D, E, C]
```

The Collection Algorithms

- The Collections Framework defines several algorithms
- These algorithms are defined as static methods within the **Collections** class

Method	Description
static int binarySearch(List *list*, Object *value*)	Searches for *value* in *list*. The list must be sorted. Returns the position of *value* in *list*,or−1 if *Value* is not found
static void sort(List *list*)	Sorts the elements of *list* as determined by their natural Ordering
static Object max(Collection *c*)	Returns the maximum element in *c* as determined by natural ordering. The collection need not be sorted

Method	Description
static Object min(Collection *c*)	Returns the minimum element in *c* as determined by natural ordering
static void reverse(List *list*)	Reverses the sequence in *list*

Example: (binary search)

```
import java.util.*;

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

   ArrayList<String> arlst=new ArrayList<String>();

    arlst.add("PROVIDES");
    arlst.add("QUALITY");
    arlst.add("TP");
    arlst.add("TUTORIALS");

  int index=Collections.binarySearch(arlst, "QUALITY");

    System.out.println("'QUALITY' is available at index: "+index);
    }
}
```

Example: (sort)

```
import java.util.*;

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

   ArrayList<String> arlst=new ArrayList<String>();

   arlst.add("QUALITY");
   arlst.add("PROVIDES");
   arlst.add("TUTORIALS");
   arlst.add("TP");

   System.out.println("List value before: "+arlst);

   Collections.sort(arlst);

   System.out.println("List value after sort: "+arlst);
   }
}
```

Example: (max, min and reverse)

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

   arlst.add(10);
   arlst.add(20);
   arlst.add(30);
   arlst.add(40);
   arlst.add(50);

   System.out.println("List values: "+arlst);
   System.out.println("Minimum is :"+Collections.min(arlst));
   System.out.println(“Maximum is :"+Collections.max(arlst));

   Collections.reverse(arlst);

   System.out.println("List values after reverse: "+arlst);
   }
}
```