



JAVA Programming

TOPICS to be discussed

- Introduction to Java Collection Framework
- Collection Framework Hierarchy
- Collection Interface
- Iterator and Iterable Interface
- List Interface
- Different List Traversal techniques
 - ❑ ArrayList
 - ❑ LinkedList
 - ❑ Vector
 - ❑ Stack

Let's START!!!



Collection and Framework

- A **Collection** represents a single unit of **objects**, i.e., a group.
- The **Collection** in **Java** is a framework that provides an architecture to store and manipulate the group of **objects**.
- **Java Collections** can achieve all the operations that you perform on a data such as searching, sorting, insertion, manipulation, and deletion.

What is a Framework in Java?

A **Framework** provides a ready-made structure of **classes** and **interfaces** for building software applications efficiently.

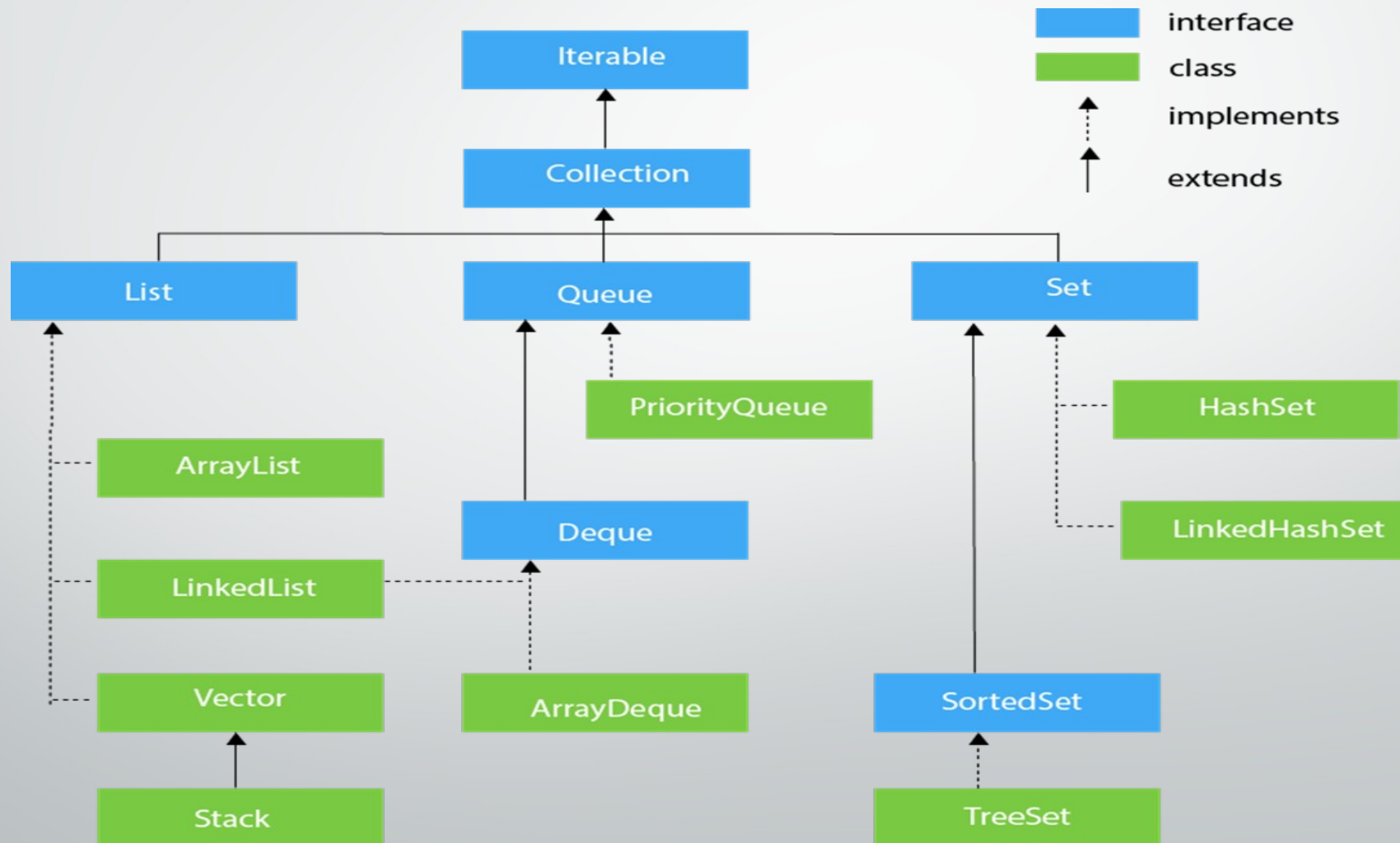
Java Collection Framework

- The **Collection framework** represents a unified architecture for storing and manipulating a group of **objects**.
- It enhances code efficiency and readability by offering various **data structures**, including arrays, linked lists, trees, and hash tables, tailored to different programming needs.

Why Collection Framework?

- Before **JDK 1.2**, **Java**'s approach to **collections** relied on Arrays, Vectors, and Hash tables.
- Each type of **collection** had its own set of **methods**, **syntax**, and **constructors**, without any standardization.
- Developers had to remember different **methods** and **syntax** for each **collection**, making the code harder to work with.
- This lack of cohesion emphasized the need for a unified **Collection Framework** to simplify and standardize **collection** operations.

Collection Framework Hierarchy



Collection Interface

- The **Collection interface** is the root **interface** of the **collection framework** hierarchy.
- **Java** does not provide direct implementations of the **Collection interface** but provides implementations of its **sub-interfaces** like List, Set, and Queue.

Method	Description
<code>public boolean add(E e)</code>	It is used to insert an element in this collection.
<code>public boolean addAll(Collection<? extends E> c)</code>	It is used to insert the specified collection elements in the invoking collection.
<code>public boolean remove(Object element)</code>	It is used to delete an element from the collection.
<code>public boolean removeAll(Collection<?> c)</code>	It is used to delete all the elements of the specified collection from the invoking collection.
<code>default boolean removeIf(Predicate<? super E> filter)</code>	It is used to delete all the elements of the collection that satisfy the specified predicate.
<code>public boolean retainAll(Collection<?> c)</code>	It is used to delete all the elements of invoking collection except the specified collection.
<code>public int size()</code>	It returns the total number of elements in the collection.
<code>public void clear()</code>	It removes the total number of elements from the collection.
<code>public boolean contains(Object element)</code>	It is used to search an element.
<code>public boolean containsAll(Collection<?> c)</code>	It is used to search the specified collection in the collection.

Iterable and Iterator Interface

- The **Iterable** and **Iterator** interfaces are part of the **Java Collections Framework**, providing a way to traverse or iterate over elements in a collection.
- While they are related, they have distinct purposes and roles.

Iterable Interface

The Iterable interface is present in java.lang package and is the root interface for all collection classes. It allows an object to be the target of the **for-each loop**.

Key Points:

- It has only one method: `iterator()`, which returns an Iterator.
- Implementing `Iterable<T>` allows the collection to be iterated using an enhanced for loop.
- Common collections like `ArrayList`, `HashSet`, and `LinkedList` implement `Iterable`.

Iterable (Example)

```
IterableExample.java x
1  import java.util.*;
2
3  class IterableExample {
4      public static void main(String[] args) {
5          List<String> names = new ArrayList<>();
6          names.add("Apple");
7          names.add("Banana");
8          names.add("Cat");
9
10         // Using for-each loop (internally calls iterator())
11         for (String name : names) {
12             System.out.println(name);
13         }
14     }
15 }
```

Apple
Banana
Cat

Iterable and Iterator Interface

Iterator Interface

The Iterator interface is present in Java.util package, provides methods to iterate over a collection.

Key Methods:

- `hasNext()`: Returns true if more elements exist.
- `next()`: Returns the next element.
- `remove()`: Removes the last element returned by `next()`.

Iterator (Example)

IteratorExample.java

```
1  import java.util.*;
2
3  class IteratorExample {
4      public static void main(String[] args) {
5          List<Integer> numbers = new ArrayList<>();
6          numbers.add(10);
7          numbers.add(20);
8          numbers.add(30);
9
10         Iterator<Integer> itr = numbers.iterator();
11
12         while (itr.hasNext()) {
13             System.out.println(itr.next());
14         }
15     }
16 }
```

10
20
30

Iterator (Example 2)

IteratorMethodsExample.java

```
1  import java.util.*;
2  class IteratorMethodsExample {
3      public static void main(String[] args) {
4          // Creating a list of integers
5          List<Integer> numbers = new ArrayList<>();
6          numbers.add(10);
7          numbers.add(20);
8          numbers.add(30);
9          numbers.add(40);
10         numbers.add(50);
11         // Getting an iterator for the list
12         Iterator<Integer> itr = numbers.iterator();
13         // Using hasNext() to check if elements are available
14         while (itr.hasNext()) {
15             // Using next() to get the next element
16             int num = itr.next();
17             System.out.println("Current Element: " + num);
18
19             // Using remove() to remove elements that meet a condition
20             if (num == 30) {
21                 itr.remove(); // Removes the last returned element (30)
22                 System.out.println("Element 30 removed");
23             }
24         }
25         System.out.println("Final List: " + numbers);
26     }
```

```
Current Element: 10
Current Element: 20
Current Element: 30
Element 30 removed
Current Element: 40
Current Element: 50
Final List: [10, 20, 40, 50]
```

List Interface

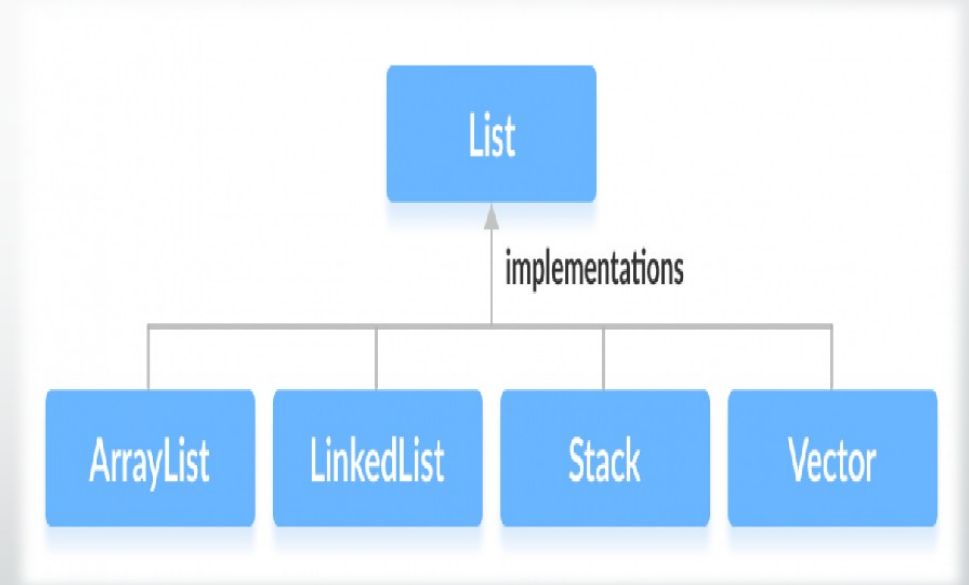
- In **Java**, the **List interface** is an ordered **collection** that allows us to store and access elements sequentially.
- It extends the **Collection interface**.
- Since **List** is an **interface**, we cannot create **objects** from it.
- To use the functionalities of the **List interface**, we can use these **classes**:

❑ **ArrayList**

❑ **Vector**

❑ **LinkedList**

❑ **Stack**



List implementation:

```
List<String> list1 = new ArrayList<>(); //Using ArrayList
```

```
List<String> list2 = new LinkedList<>(); //Using LinkedList
```

Methods of List Interface

Methods	Description
<code>add()</code>	adds an element to a list
<code>addAll()</code>	adds all elements of one list to another
<code>get()</code>	helps to randomly access elements from lists
<code>iterator()</code>	returns iterator object that can be used to sequentially access elements of lists
<code>set()</code>	changes elements of lists
<code>remove()</code>	removes an element from the list
<code>removeAll()</code>	removes all the elements from the list
<code>clear()</code>	removes all the elements from the list (more efficient than <code>removeAll()</code>)
<code>size()</code>	returns the length of lists
<code>toArray()</code>	converts a list into an array
<code>contains()</code>	returns true if a list contains specific element

ArrayList

- In **Java**, we need to declare the size of an **array** before we can use it. Once the size of an **array** is declared, it's hard to change it.
- To handle this issue, we can use the **ArrayList class**. It allows us to create **resizable arrays**.
- Unlike **arrays**, **arraylists** can automatically adjust their capacity when we add or remove elements from them. Hence, **arraylists** are also known as **dynamic arrays**.

Properties:

1. Fast access to elements
2. Slow insertion, deletion of elements
3. Best suited for frequent access, less modification scenarios



ArrayList (Example)

```
import java.util.List;
import java.util.ArrayList;
class ArrayListDemo {
    public static void main(String[] args) {
        //Creating an ArrayList of Strings
        ArrayList<String> ltrs = new ArrayList<>();
        //Adding elements
        ltrs.add("A");    ltrs.add("B");
        List<String> list = new ArrayList<>();
        list.add("C");    list.add("D");
        ltrs.addAll(2, list);
        System.out.println("letters: "+ ltrs);
        //Access elements
        System.out.println("Element-2: "+ ltrs.get(1));
        //Changing element
        ltrs.set(2, "X");
        System.out.println("letters: "+ ltrs);
        //Removing element
        ltrs.remove(2);
        System.out.println("letters: "+ ltrs);
    }
}
```

Output:

letters: [A, B, C, D]

Element-2: B

letters: [A, B, X, D]

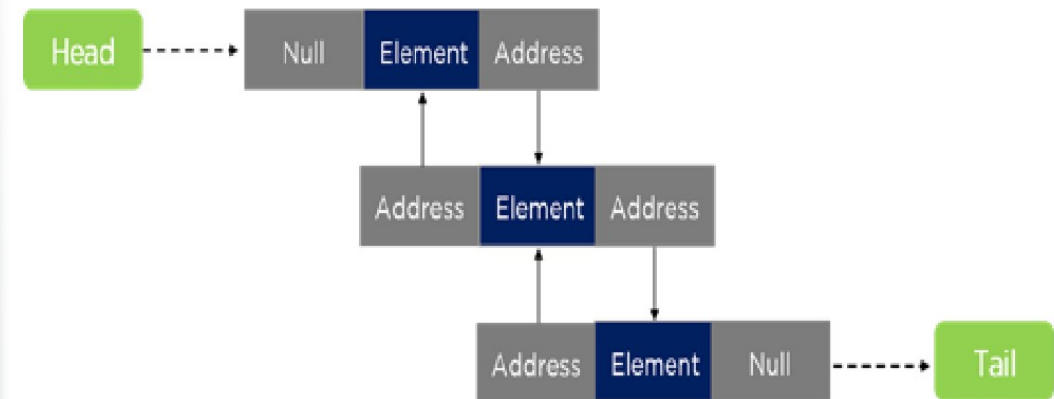
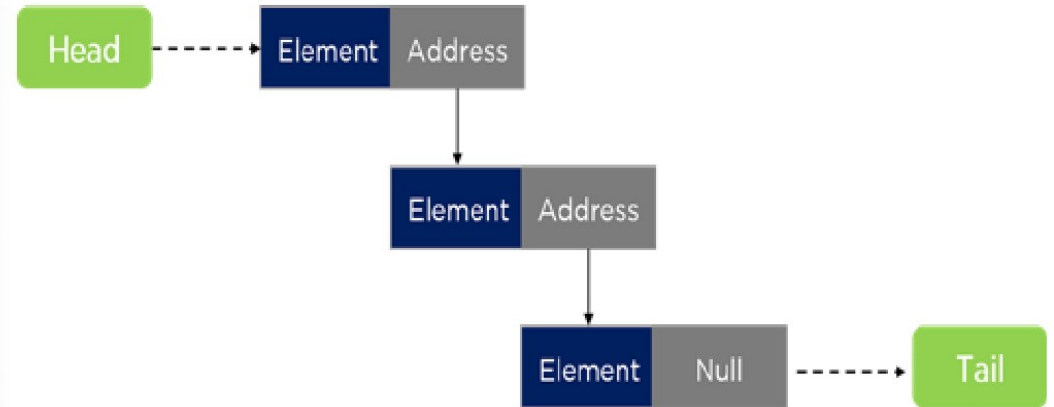
letters: [A, B, D]

LinkedList

- **LinkedList** is a doubly-linked list implementation of the **List** and the **Deque** interface.
- It allows duplicates and maintains insertion order.

Properties:

1. Slower access to elements
2. Fast insertion, deletion of elements
3. Best suited for frequent modification (insertion/deletion) scenarios



LinkedList (Example)

```
import java.util.List;
import java.util.LinkedList;
class LinkedListDemo {
    public static void main(String[] args) {
        //Creating an LinkedList of Strings
        LinkedList<String> ltrs = new LinkedList<>();
        //Adding elements
        ltrs.add("A");    ltrs.add("B");
        List<String> list = new LinkedList<>();
        list.add("C");    list.add("D");
        ltrs.addAll(2, list);
        System.out.println("letters: "+ ltrs);
        //Access elements
        System.out.println("Element-2: "+ ltrs.get(1));
        //Changing element
        ltrs.set(2, "X");
        System.out.println("letters: "+ ltrs);
        //Removing element
        ltrs.remove(2);
        System.out.println("letters: "+ ltrs);
    }
}
```

Output:

letters: [A, B, C, D]

Element-2: B

letters: [A, B, X, D]

letters: [A, B, D]

Vector

- A **Vector** is a **dynamic array** that can grow or shrink in size as needed.
- It is part of **java.util** and implements the **List interface**, making it compatible with most **collection** operations.
- Unlike an **ArrayList**, **Vector** is **synchronized**, meaning it is **thread-safe** and can be used in **multi-threaded environments**.

```
import java.util.Vector;
class VectorDemo {
    public static void main(String[] args) {
        //Creating a Vector of Strings
        Vector<String> ltrs = new Vector<>();
        //Adding and Accessing elements
        ltrs.add("A"); ltrs.add("B"); ltrs.add("C");
        System.out.println("letters: " + ltrs);
        System.out.println("Element-2: " + ltrs.get(1));
        ltrs.set(2, "X"); //Changing element
        System.out.println("letters: " + ltrs);
        ltrs.remove(2); //Removing element
        System.out.println("letters: " + ltrs);
        //Capacity of the vector
        System.out.println("Capacity: " + ltrs.capacity());
    }
}
```

Output: letters: [A, B, C]
Element-2: B
letters: [A, B, X]
letters: [A, B]
Capacity: 10

Stack

- A **Stack** is a **last-in, first-out (LIFO)** data structure.
- It is part of **java.util** and extends the **Vector class**.

Stack-Specific Methods:

- **push(E element):** Adds an element to the top of the stack.
- **pop():** Removes and returns the top element.
- **peek():** Returns the top element without removing it.
- **empty():** Checks if the stack is empty.
- **search(Object o):** Returns the 1-based position of an element.

```
import java.util.Stack;
class StackDemo {
    public static void main(String[] args) {
        //Creating a Stack of Integers
        Stack<Integer> stack = new Stack<>();
        //Pushing elements onto the stack
        stack.push(10); stack.push(20); stack.push(30);
        System.out.println("Stack: "+stack);
        //Peek at the top element
        System.out.println("Top element: "+stack.peek());
        //Pop elements from the stack
        System.out.println("Popped Element: "+stack.pop());
        System.out.println("Stack: "+ stack);
        //Searching for an element
        System.out.println("Position of 10: " +
                                stack.search(10));
    }
}
```

Output: Stack: [10, 20, 30]
Top element: 30
Popped Element: 30
Stack: [10, 20]
Position of 10: 2

Traversing through a List

- Suppose, in **Java**, we have a **List** of fruits as

```
List<String> list = Arrays.asList("Apple", "Banana", "Cherry");
```

- We have different available techniques for traversal through the **collection**.

Using enhanced for loop:

```
for(String item: list)
    System.out.println(item);
```

Using for loop with index:

```
for(int i=0; i<list.size(); i++) {
    System.out.println(list.get(i));
}
```

Using an Iterator:

```
Iterator<String> iterator =
    list.iterator();
while(iterator.hasNext())
    System.out.println(iterator.next());
```

Using a ListIterator:

```
ListIterator<String> listiterator =
    list.listiterator();
while(listiterator.hasNext())
    System.out.println(listiterator.next());
```

Using forEach+Lambda: (Java8 & above)

```
list.forEach(item ->
    System.out.println(item));
```

Using Stream API: (Java8 and above)

```
list.stream()
    .forEach(System.out::println);
```

Advantages and Disadvantages of different Traversal Techniques

Technique	Advantages	Disadvantages
Enhanced for Loop	Simple syntax, works with any Iterable	No modification, forward-only
Iterator	Supports safe removal, works with any Iterable	More code required, forward-only
ListIterator	Bidirectional traversal, supports modification	Limited to List collections, more complex syntax
forEach + Lambda	Concise, functional, suitable for processing	No modification, requires Java 8+
for Loop with Index	Supports random access and modification, useful when index needed	Limited to List/arrays, more error-prone and less readable
Stream API	Powerful functional operations, parallel processing support	Read-only, can be complex for simple tasks, requires Java 8+



Thank You!