JAVA Programming

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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.

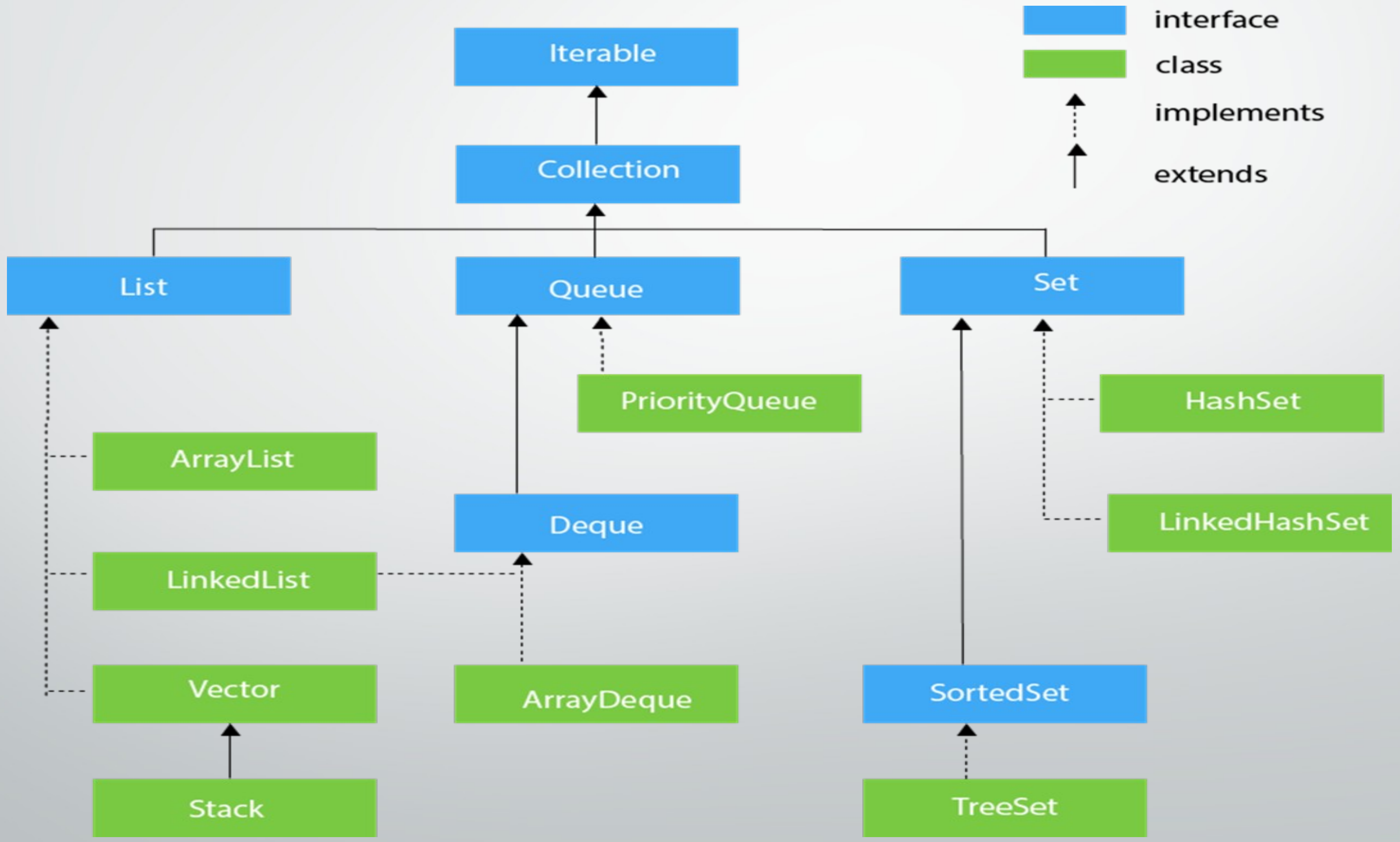
Java Collection Framework

- 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?

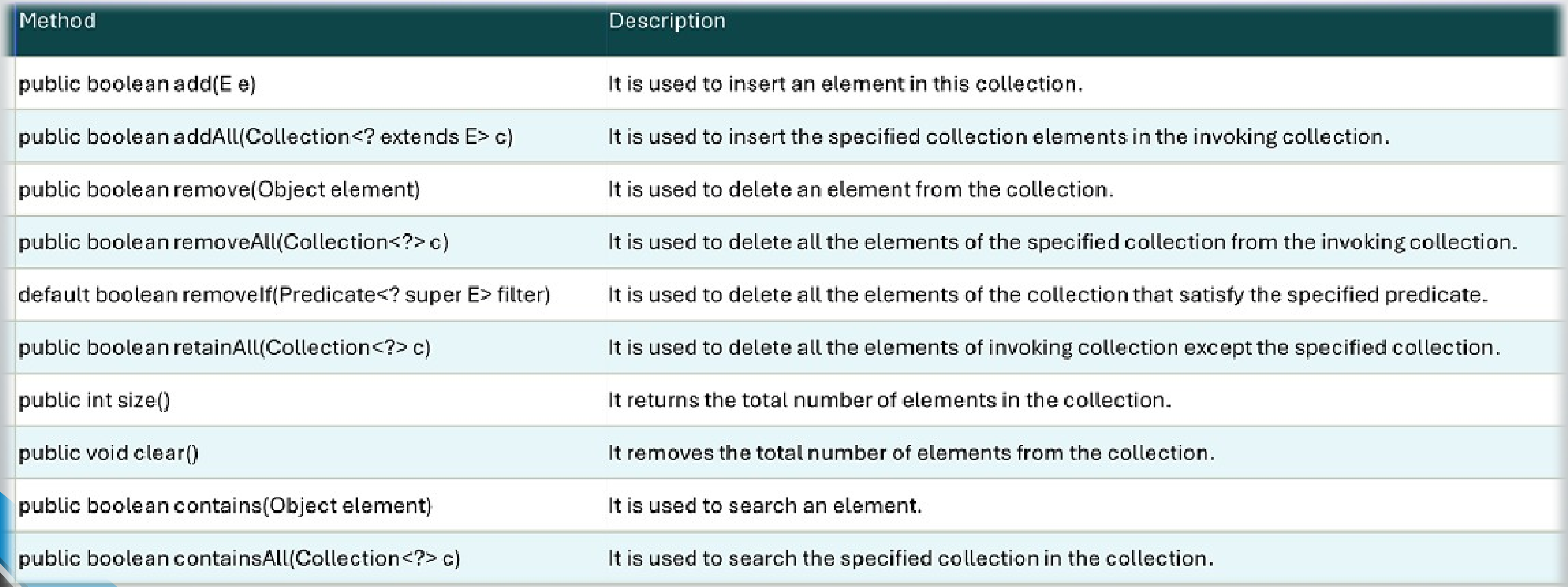
- Before **JDK 1.2**, **Java**’s approach to collections relied on Arrays, Vectors, and Hash tables.
- Each type of collection had its own set of methods, syntax, and constructors, without any standardization.
- Developers had to remember different methods and syntax for each collection, making the code 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
public boolean add(E e)	It is used to insert an element in this collection.
public boolean addAll(Collection<? extends E> c)	It is used to insert the specified collection elements in the invoking collection.
public boolean remove(Object element)	It is used to delete an element from the collection.
public boolean removeAll(Collection<?> c)	It is used to delete all the elements of the specified collection from the invoking collection.
default boolean removeIf(Predicate<? super E> filter)	It is used to delete all the elements of the collection that satisfy the specified predicate.
public boolean retainAll(Collection<?> c)	It is used to delete all the elements of invoking collection except the specified collection.
public int size()	It returns the total number of elements in the collection.
public void clear()	It removes the total number of elements from the collection.
public boolean contains(Object element)	It is used to search an element.
public boolean containsAll(Collection<?> c)	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

- part of the java.lang package and represents a collection of elements that can be iterated over.
- root interface for all collections that can provide an Iterator.
- implemented by all collection classes in **Java**, such as List, Set, and Queue.
- has a single abstract method:

```
Iterator<T> iterator();
```

Iterator Interface

- part of the java.util package, provides methods to traverse a collection one element at a time.
- It is obtained by calling the **iterator()** method of an Iterable object.
- has the following methods:

```
- boolean hasNext();
- T next();
- void remove();
```

Iterable and Iterator (Example)

```
import java.util.ArrayList;
import java.util.List;
class MainClass {
   public static void main(String[] args) {
      List<String> list = new ArrayList<>();
      list.add("A");
      list.add("B");
      list.add("C");

      //Using for-each loop(Iterable feature)
      for(String item : list){
         System.out.print(item + " ");
      }
   }
}
```

Output:

```
A  B  C
```

```
import java.util.ArrayList;
import java.util.Iterator;
import java.util.List;
class MainClass {
   public static void main(String[] args) {
      List<String> list = new ArrayList<>();
      list.add("A");  list.add("B"); list.add("C");

      //Using Iterator
      Iterator<String> iterator = list.iterator();
      while(iterator.hasNext()){
         String item = iterator.next();
         System.out.print(item + " ");
         //Remove an element
         if("B".equals(item)){ iterator.remove(); }
      }
      System.out.println("\nUpdated List: " + list);
   }
}
```

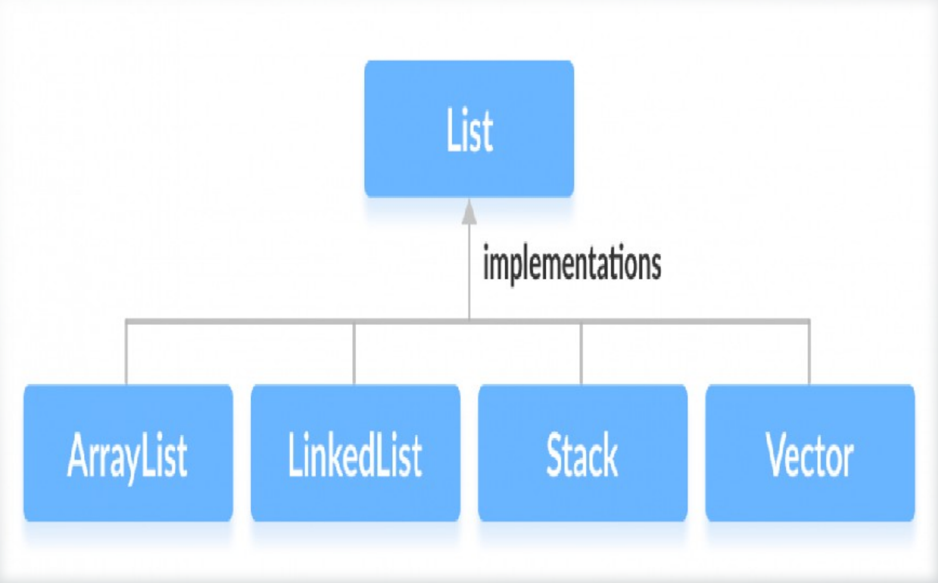
Output:

```
A B C
Updated List: [A, C]
```

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:

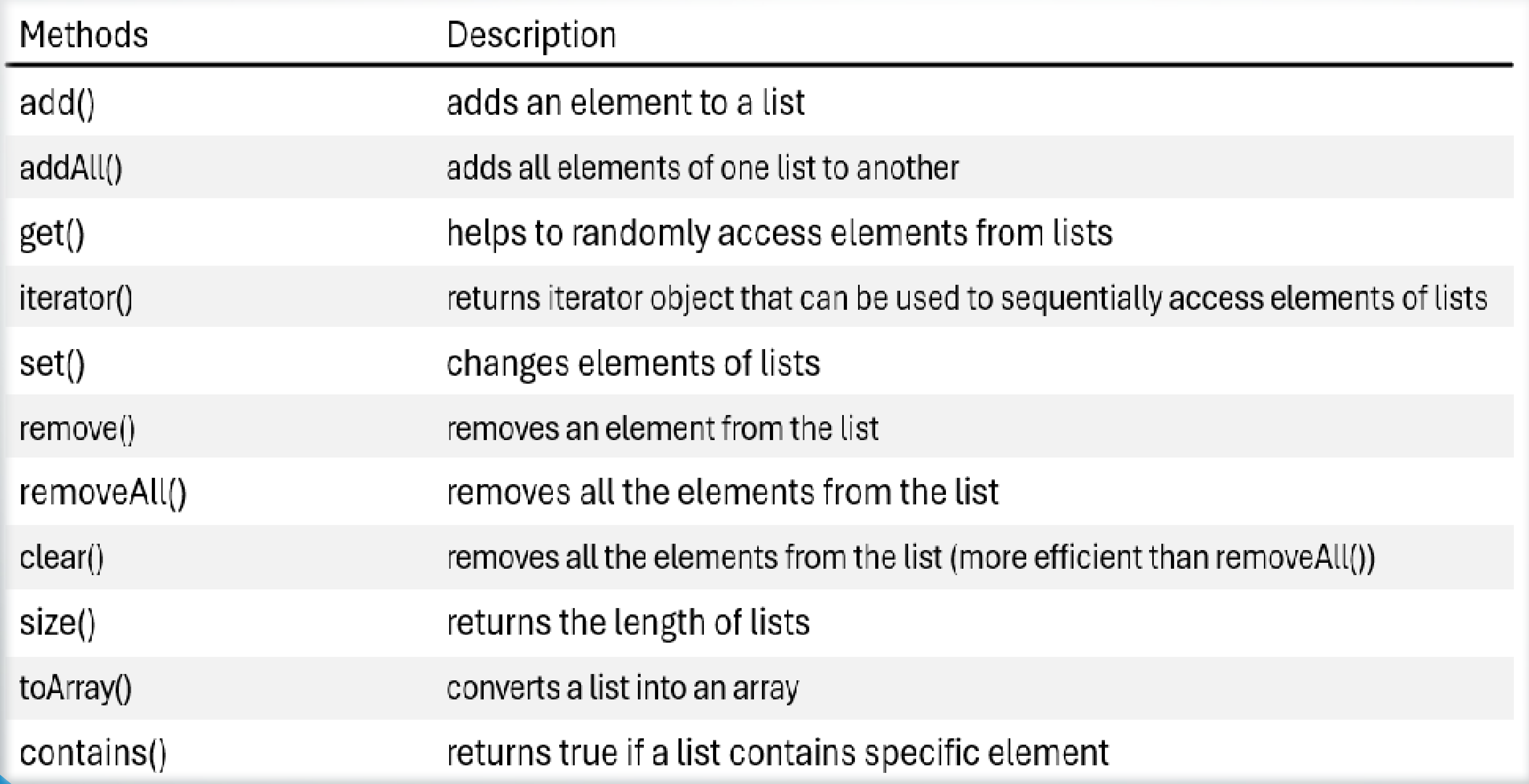
❑**ArrayList** ❑ **Vector**
❑**LinkedList** ❑ **Stack**



List implementation:

```
List<String> list1 = new ArrayList<>();    //Using ArrayList
List<String> list2 = new LinkedList<>();   //Using LinkedList
```

Methods of List Interface



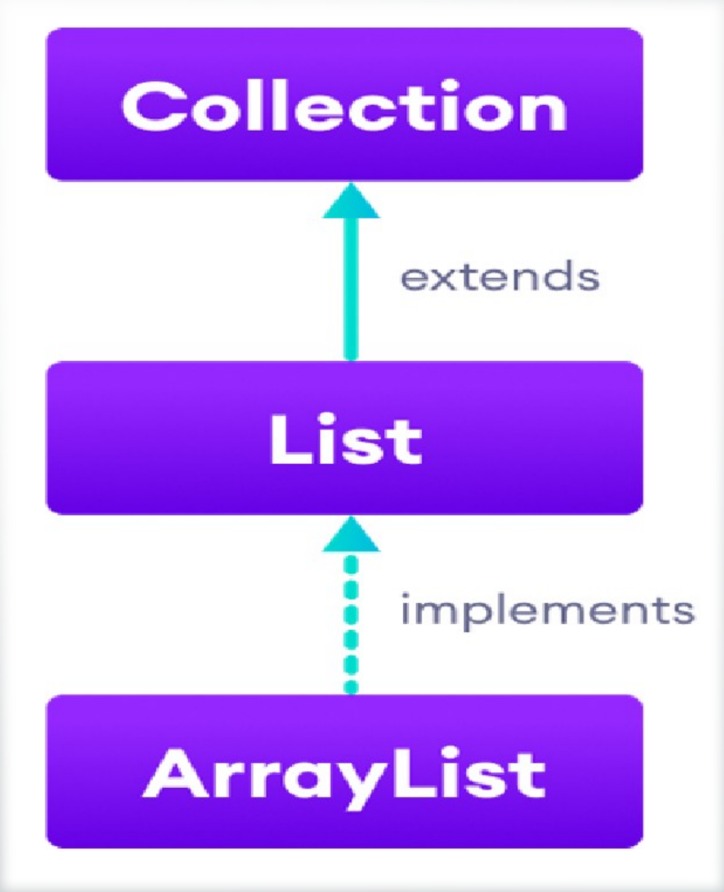
Methods	Description
add()	adds an element to a list
addAll()	adds all elements of one list to another
get()	helps to randomly access elements from lists
iterator()	returns iterator object that can be used to sequentially access elements of lists
set()	changes elements of lists
remove()	removes an element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

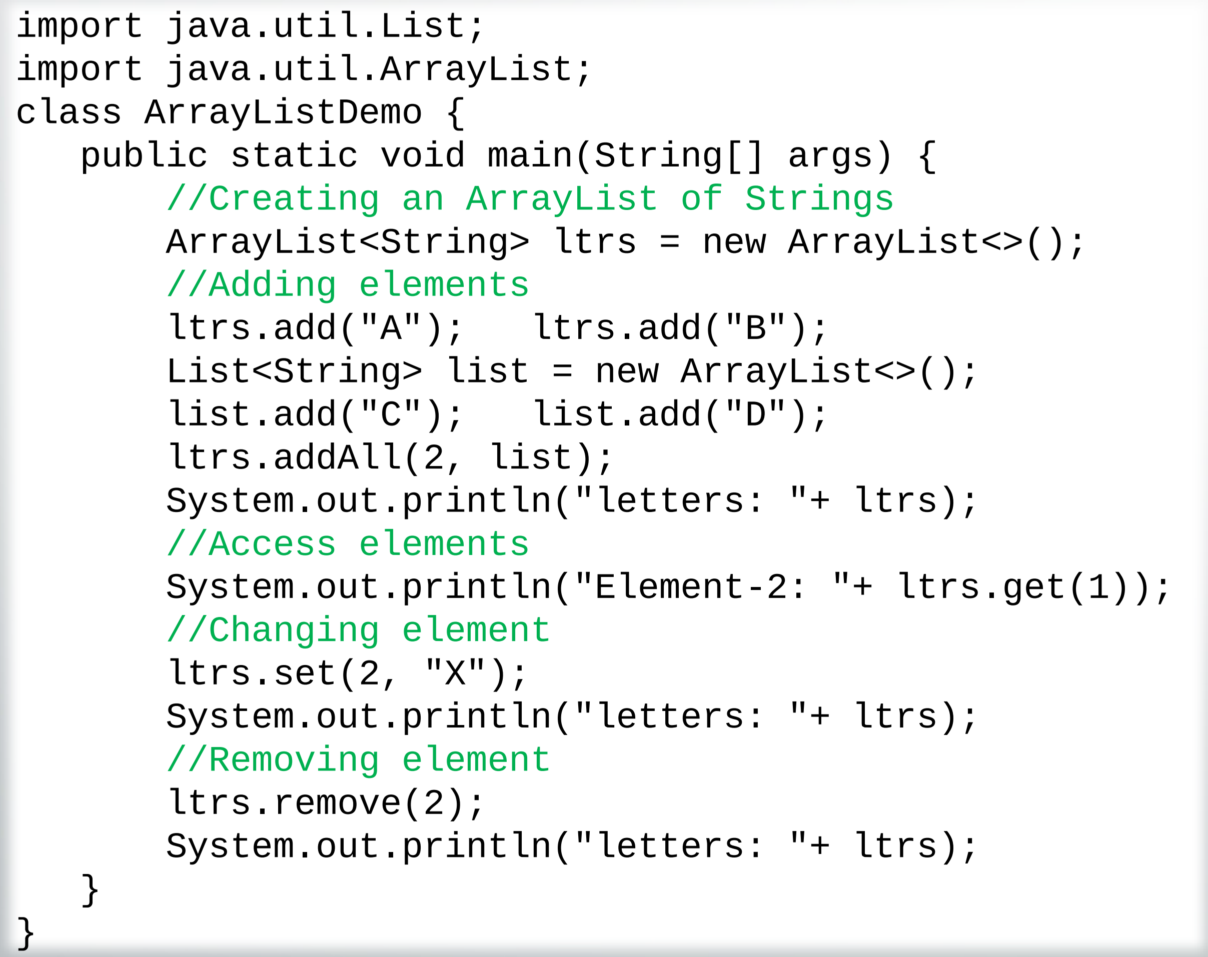
- Unlike arrays, arraylists can automatically adjust their capacity when we add or remove elements from them. Hence, arraylists are also known as dynamic arrays.



Properties:

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

ArrayList (Example)



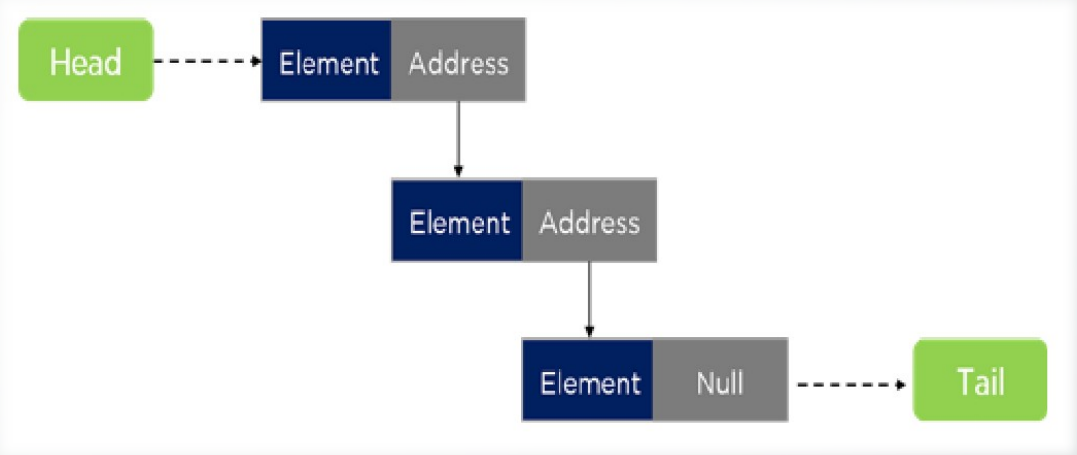
```
import java.util.List;
import java.util.ArrayList;
class ArrayListDemo {
   public static void main(String[] args) {
       //Creating an ArrayList of Strings
       ArrayList<String> ltrs = new ArrayList<>();
       //Adding elements
       ltrs.add("A");   ltrs.add("B");
       List<String> list = 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]
```

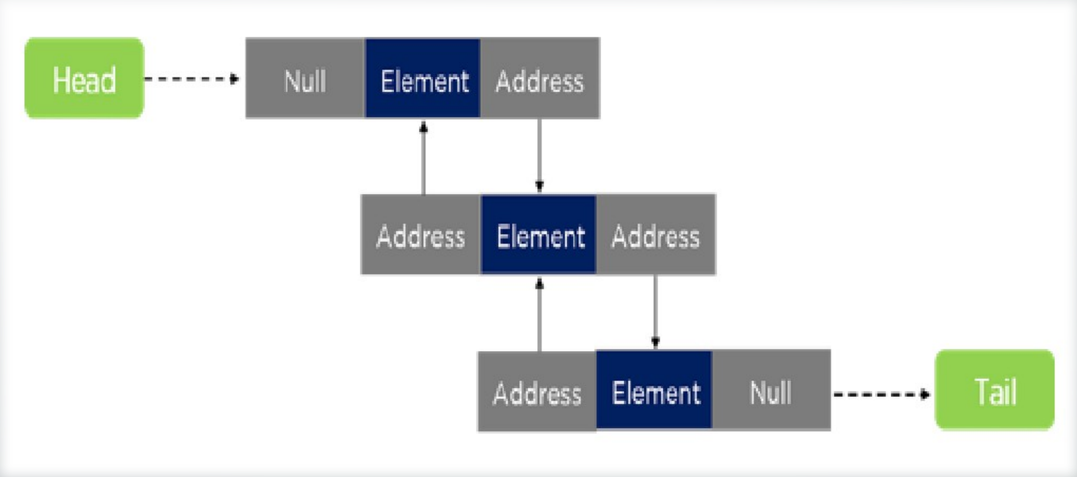
LinkedList

- 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)

```java
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());
```

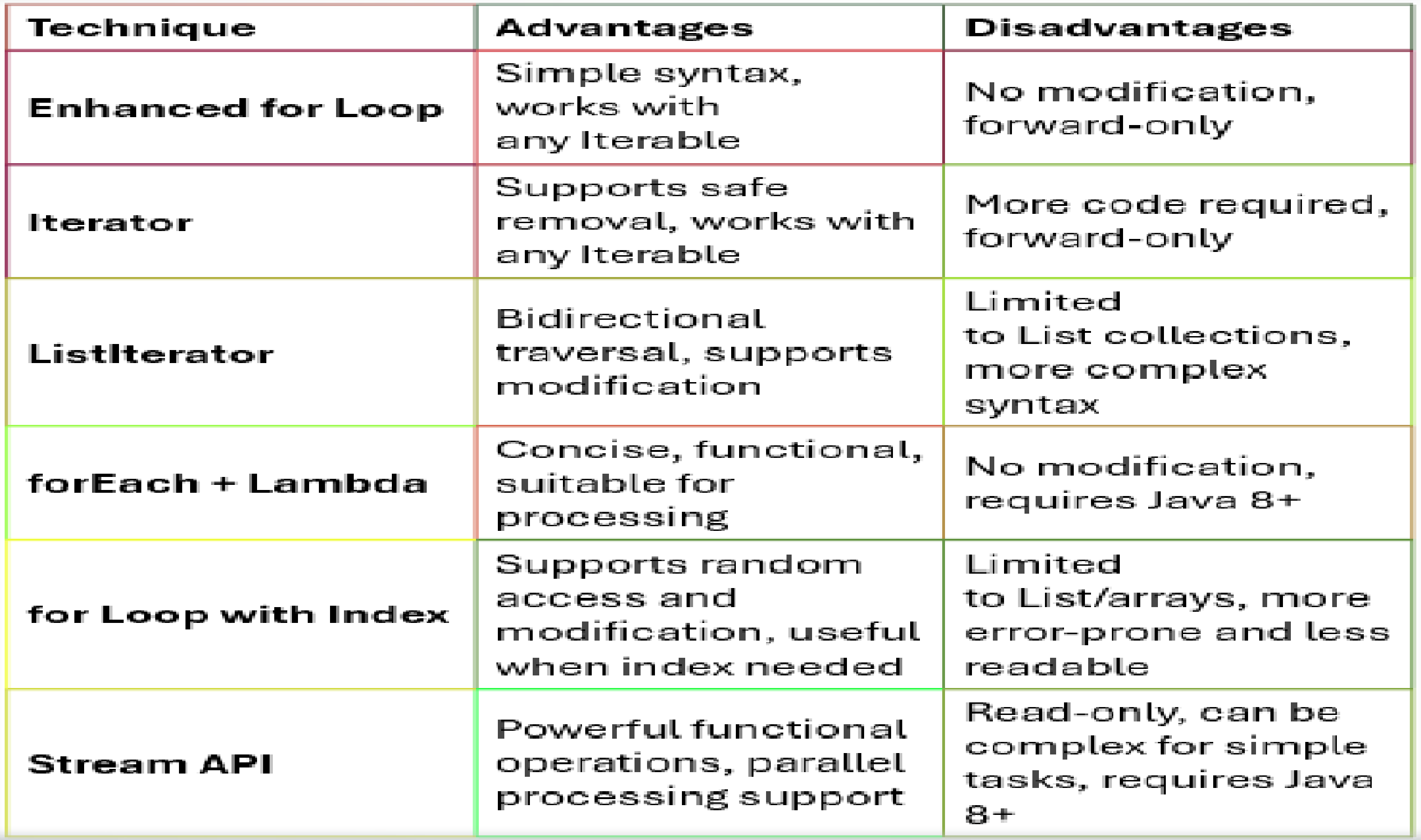
Using forEach+Lambda: (Java8 & above)

```
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+

Summary

Today, we learned about

- Introduction to Java Collections
- Collection Framework Hierarchy
- Collection interface
- Iterable and Iterator interface
- List interface (ArrayList, LinkedList, Vector, and Stack)
- Different List Traversal techniques

Thank You!