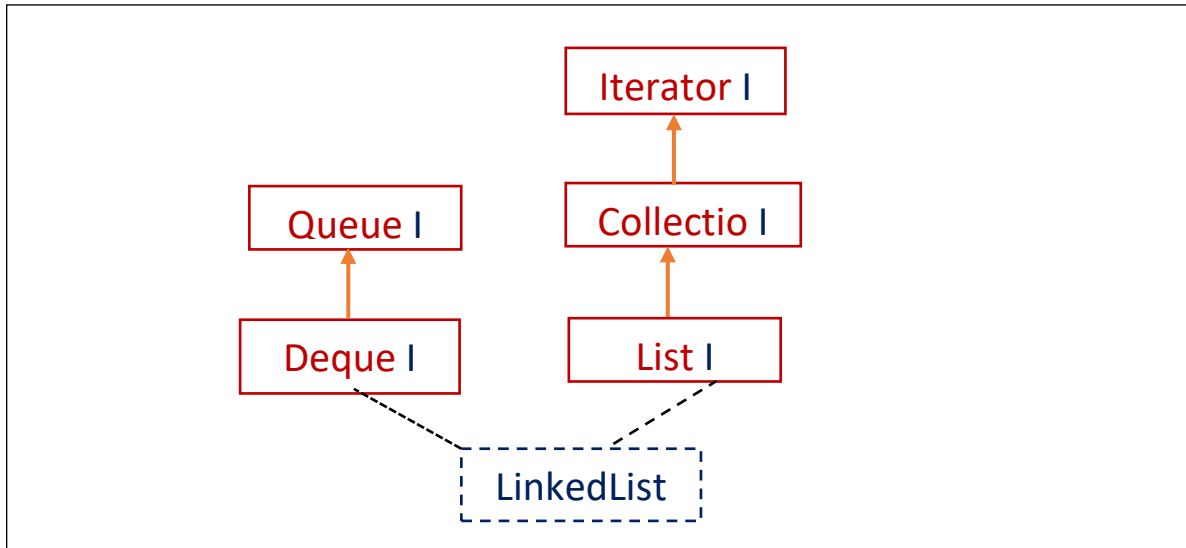


# LinkedList



## Methods()

1. `add(x)` ----->  $\theta(1)$
2. `add(index, x)` ----->  $\theta(\text{index})$
3. `contains(x)` ----->  $O(n)$
4. `add(x)` ----->  $\theta(\text{index})$
5. `remove(x)` ----->  $O(n)$
6. `get(index)` ----->  $\theta(\text{index})$
7. `set(index, x)` ----->  $\theta(\text{index})$
8. `indexOf(x)` ----->  $O(n)$
9. `lastIndexOf(x)` ----->  $O(n)$

## Warning ⚠

Remove any mid-element from `LinkedList` using “`forEach()`” method, it must be throws an “*`ConcurrentModificationException`*” Exception.

```
public class Main {
    no usages
    public static void main(String[] args) {
        LinkedList<Integer> ll = new LinkedList<>(Arrays.asList(2, 3, 5, 8, 10, 11, 10, 13, 10, 17));
        System.out.println(ll);

        ll.forEach(x->{
            if (x.equals(10)){
                ll.remove(x);
            }
        });
        System.out.println(ll);
    }
}

Main x
"C:\Program Files\Java\jdk-19\bin\java.exe" "-javaagent:M:\IntelliJ IDEA 2022.3.1\lib\idea_rt.jar=57142:M
.encoding=UTF-8 -Dsun.stdout.encoding=UTF-8 -Dsun.stderr.encoding=UTF-8 -classpath "S:\Client
Help\Collection-Framework\out\production\Collection-Framework" Main
[2, 3, 5, 8, 10, 11, 10, 13, 10, 17]
Exception in thread "main" java.util.ConcurrentModificationException Create breakpoint
    at java.base/java.util.LinkedList$ListItr.checkForComodification(LinkedList.java:970)
    at java.base/java.util.LinkedList$ListItr.next(LinkedList.java:892)
    at java.base/java.lang.Iterable.forEach(Iterable.java:74)
    at Main.main(Main.java:12)
```

Safe Way 

Remove any mid-element from the LinkedList use "iterator()".

```
public class Main {
    no usages
    public static void main(String[] args) {
        LinkedList<Integer> ll = new LinkedList<>(Arrays.asList(2, 3, 5, 8, 10, 11, 10, 13, 10, 17));
        System.out.println(ll);

        Iterator it = ll.iterator();
        while (it.hasNext()){
            if((int)it.next()==10){
                it.remove();
            }
        }
        System.out.println(ll);
    }
}

Main x
"C:\Program Files\Java\jdk-19\bin\java.exe" "-javaagent:M:\IntelliJ IDEA 2022.3.1\lib\idea_rt.jar=5715
.encoding=UTF-8 -Dsun.stdout.encoding=UTF-8 -Dsun.stderr.encoding=UTF-8 -classpath "S:\Client
Help\Collection-Framework\out\production\Collection-Framework" Main
[2, 3, 5, 8, 10, 11, 10, 13, 10, 17]
[2, 3, 5, 8, 11, 13, 17]
```

Queue:

add(x), remove(), element()

offer(), poll(), peek()

Deque:

addFirst(x), removeFirst(), getFirst()

addLast(x), removeLast(), getLast()

offerFirst(), pollFirst(), peekFirst()

offerLast(), pollLast()

#### Equivalent Methods

add()	addLast()
offer()	offerLast()
remove()	removeFirst()
pollFirst()	pollFirst()
element()	getFirst()
peek()	peekFirst()