Core Java

Java Collection Framework

List interface

- Ordered/sequential collection.
- List can contain duplicate elements.
- List can contain multiple null elements.
- Elements can be accessed sequentially (bi-directional using Iterator) or randomly (index based).
- List enable searching (in the list)
- Implementations: ArrayList, Vector, Stack, LinkedList, etc.
- Abstract methods
  - void add(int index, E element)
  - E get(int index)
  - E set(int index, E element)
  - E remove(int index)
  - boolean addAll(int index, Collection<? extends E> c)
  - int indexOf(Object o)
  - int lastIndexOf(Object o)
  - String toString()
  - ListIterator listIterator()
  - ListIterator listIterator(int index)
  - List subList(int fromIndex, int toIndex)
- To store objects of user-defined types in the list, you must override equals() method for the objects. It is mandetory while searching operations like conatains(), indexOf(), lastIndexOf().

Iterator vs Enumeration

- Enumeration
  - Since Java 1.0
  - Methods
    - boolean hasMoreElements()
    - E nextElement()
  - Example

    ```
    Enumeration<E> e = v.elements();
    while(e.hasMoreElements()) {
        E ele = e.nextElement();
        System.out.println(ele);
    }
    ```

  - Enumeration behaves similar to fail-safe iterator.
- Iterator
  - Part of collection framework (1.2)

- Methods
  - boolean hasNext()
  - E next()
  - void remove()
- Example

```
Iterator<E> e = v.iterator();
while(e.hasNext()) {
    E ele = e.next();
    System.out.println(ele);
}
```

- ListIterator
  - Part of collection framework (1.2)
  - Inherited from Iterator
  - Bi-directional access
  - Methods
    - boolean hasNext()
    - E next()
    - int nextIndex()
    - boolean hasPrevious()
    - E previous()
    - int previousIndex()
    - void remove()
    - void set(E e)
    - void add(E e)

Traversal

- Using Iterator

```
Iterator<Integer> itr = list.iterator();
while(itr.hasNext()) {
    Integer i = itr.next();
    System.out.println(i);
}
```

- Using for-each loop

```
for(Integer i:list)
    System.out.println(i);
```

- Gets converted into Iterator traversal

```
    for(Iterator<Integer> itr = list.iterator(); itr.hasNext();)  {
        Integer i = itr.next();
        System.out.println(i);
    }
```

- Enumeration -- Traversing Vector (Java 1.0)

```
    // v is Vector<Integer>
    Enumeration<Integer> e = v.elements();
    while(e.hasMoreElements()) {
        Integer i = e.nextElement();
        System.out.println(i);
    }
```

LinkedList class

- Internally LinkedList is doubly linked list.
- Elements can be traversed using Iterator, ListIterator, or using index.
- Primary use
    - Add/remove elements (anywhere)
    - Less contiguous memory available
- Limitations:
    - Slower random access
- Inherited from List<>, Deque<>.

ArrayList class

- Internally ArrayList is dynamic array (can grow or shrink dynamically).
- When ArrayList capacity is full, it grows by half of its size.
- Elements can be traversed using Iterator, ListIterator, or using index.
- Primary use
    - Random access
    - Add/remove elements (at the end)
- Limitations
    - Slower add/remove in between the collection
    - Uses more contiguous memory
- Inherited from List<>.

Vector class

- Internally Vector is dynamic array (can grow or shrink dynamically).
- Vector is a legacy collection (since Java 1.0) that is modified to fit List interface.
- Vector is synchronized (thread-safe) and hence slower.
- When Vector capacity is full, it doubles its size.
- Elements can be traversed using Enumeration, Iterator, ListIterator, or using index.
- Primary use

- Random access
- Add/remove elements (at the end)
- Limitations
  - Slower add/remove in between the collection
  - Uses more contiguous memory
  - Synchronization slow down performance in single threaded environment
- Inherited from List<>.

Fail-fast vs Fail-safe Iterator

- If state of collection is modified (add/remove operation other than iterator methods) while traversing a collection using iterator and iterator methods fails (with ConcurrentModificationException), then iterator is said to be Fail-fast.
  - e.g. Iterators from ArrayList, LinkedList, Vector, ...
- If iterator allows to modify the underlying collection (add/remove operation other than iterator methods) while traversing a collection (NO ConcurrentModificationException), then iterator is said to be Fail-safe.
  - e.g. Iterators from CopyOnWriteArrayList, ...

Synchronized vs Unsynchronized collections

- Synchronized collections are thread-safe and sync checks cause slower execution.
- Legacy collections were synchronized.
  - Vector
  - Stack
  - Hashtable
  - Properties
- Collection classes in collection framework (since 1.2) are non-synchronized (for better performance).
- Collection classes can be converted to synchronized collection using Collections class methods.
  - syncList = Collections.synchronizedList(list)
  - syncSet = Collections.synchronizedSet(set)
  - syncMap = Collections.synchronizedMap(map)

Collections class

- Helper/utility class that provides several static helper methods
- Methods
  - List reverse(List list);
  - List shuffle(List list);
  - void sort(List list, Comparator cmp)
  - E max(Collection list, Comparator cmp);
  - E min(Collection list, Comparator cmp);
  - List synchronizedList(List list);

Collection vs Collections

- Collection interface
  - All methods are public and abstract. They implemented in sub-classes.

- Since all methods are non-static, must be called on object.

```
Collection<Integer> list = new ArrayList<>();
//List<Integer> list = new ArrayList<>();
//ArrayList<Integer> list = new ArrayList<>();
list.remove(new Integer(12));
```

- Collections class
    - Helper class that contains all static methods.
    - We never create object of "Collections" class.

```
Collections.methodName(...);
```

Assignments

1. Store book details in a library in a list -- ArrayList.
    - Book details: isbn(string), price(double), authorName(string), quantity(int)
    - Write a menu driven program to
        1. Add new book in list
        2. Display all books in forward order
        3. Display all books in reverse order
        4. Delete a book at given index.
        5. Sort all books by price in desc order -- list.sort();