

Collections Framework: Part 2

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Lecture 18

Map & Collection Hierarchies

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→ extends

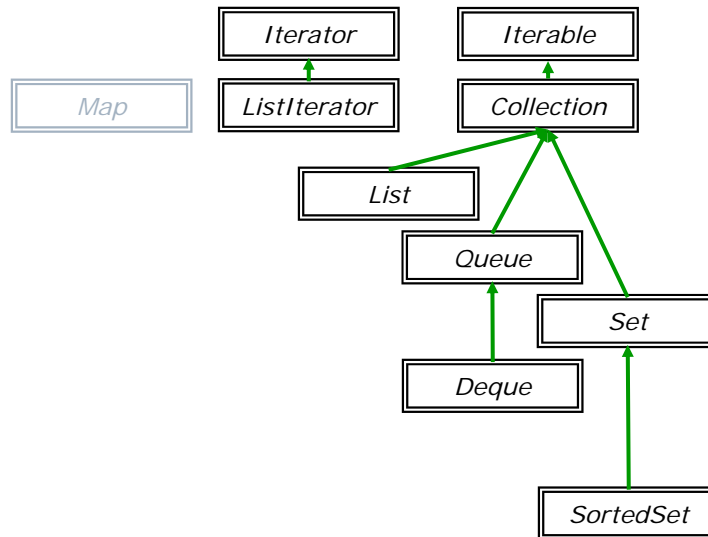
Map

Collection

Iterable Collection Hierarchy

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→ extends



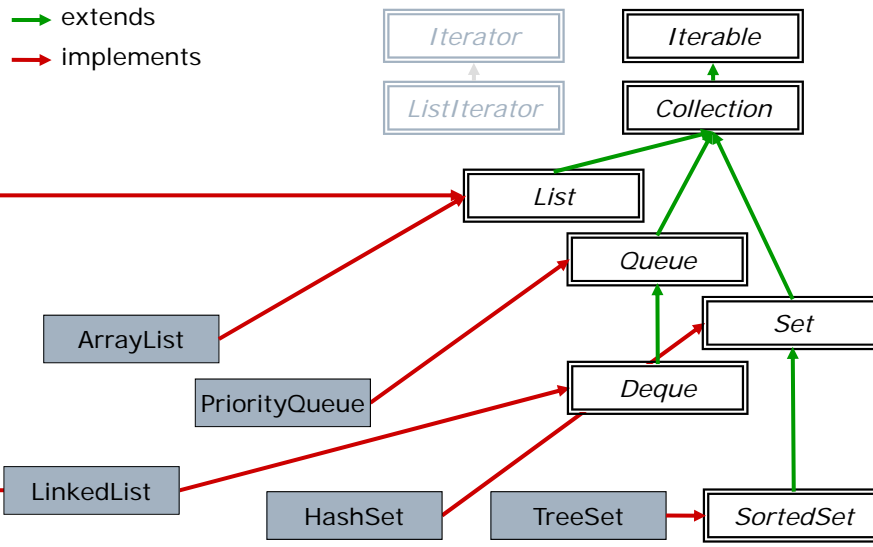
Collection Implementations

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- Java SDK provides several implementations of Collection subinterfaces
 - List
 - ArrayList, LinkedList
 - Queue (and Deque)
 - PriorityQueue, LinkedList
 - Set (and SortedSet)
 - HashSet, TreeSet, LinkedHashSet, EnumSet
- These differ in concrete implementation
 - Differences in algorithmic complexity
 - Different refinements of interface semantics

Iterable Collection Hierarchy

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List Implementations

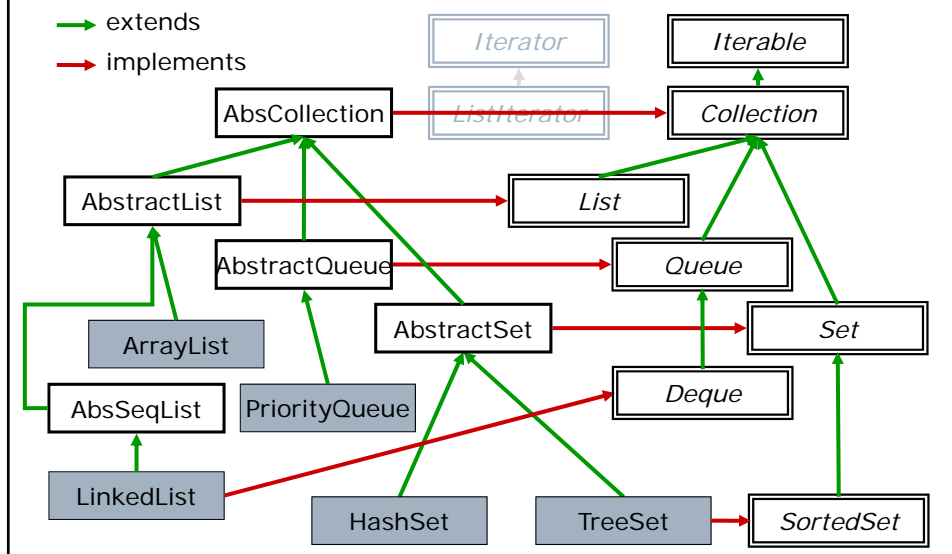
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- ArrayList: a resizable-array
 - Adding or removing elements at the end, or getting an element at a specific position is fast – $O(1)$
 - Adding or removing elements from the middle is more expensive – $O(n-i)$
 - Can be efficiently scanned (using indices) without creating an Iterator object
 - Good for: lists that are scanned frequently, lists where most additions/removals are at the ends
- LinkedList: a doubly-linked list
 - Getting an element at position i is more expensive – $O(i)$
 - But once you are there, addition/removal is fast – $O(1)$
 - Good for: lists where most of additions/removals are not at the ends

Customizing Collections

- To support creation of new collection classes, SDK provides several abstract classes
 - Skeleton implementation of base functionality
 - Can not be instantiated directly
 - Can be extended, providing appropriate implementation details
 - Example: add method throws exception unless overridden
 - Example: implementation of equals and hashCode

Iterable Collection Hierarchy



Maps

- While Collections contain individual elements, Maps contain key-value pairs
 - A map can not contain duplicate keys
 - It maps each key to at most one value
 - Recall Resolve's *Partial_Map*
- Provided as a generic interface

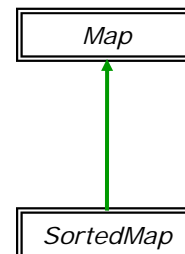
```
interface Map<K, V>
```

 - K: type of key, V: type of value
 - Example

```
Map<String, PhoneNumber> phoneBook
```
- SortedMap further guarantees that keys are in ascending order

Map Hierarchy

- extends
- implements



Map Interface

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□ Methods for working with Map

■ Modifying contents

```
public V get(Object key)
public V put(K key, V value)
public V remove(Object key)
public void clear()
```

■ Statistics and searching

```
public int size()
public boolean isEmpty()
public boolean containsKey(Object key)
public boolean containsValue(Object value)
```

Map Interface Cont'd

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□ Three views of contents

- Set of keys
- Collection of values
- Set of key-value pairs (ie mappings)

□ Main methods for obtaining these views

```
public Set<K> keySet()
public Collection<V> values()
public Set<Map.Entry<K,V>> entrySet()
```

□ These views are backed by the actual Map

- Removing element from one of these views removes the key-value pair from the Map
- Adding an element to one of these views is not allowed
- Recall: While iterating, make such modifications only through the iterator

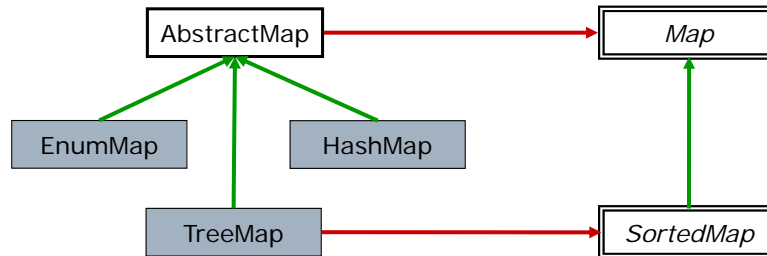
□ Arbitrary iteration order

- Independent order for keys / values in same Map
- Subinterface SortedMap provides this guarantee

Map Hierarchy

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- extends
- implements



Utility Class: java.util.Collections

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- Static methods for many common tasks
 - Ordering and permuting
 - `public void sort(List list)`
 - `public void shuffle(List list)`
 - `public void reverse(List list)`
 - `public void rotate(List list, int distance)`
 - `public void swap(List list, int i, int j)`
 - Modifying contents
 - `public <T> void fill(List<T> list, T obj)`
 - `public <T> void copy(List<T> src, List<T> dst)`
 - Statistics and searching
 - `public int frequency(Collection c, Object o)`
 - `public boolean disjoint(Collection c1, Collection c2)`
 - `public <T> T min(Collection<T> c)`
 - `public <T> T max(Collection<T> c)`

Utility Class: java.util.Arrays

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- Static methods for common tasks:
 - Ordering

```
public void sort(int[] a)
public void sort(int[] a, int i, int j)
```
 - Modifying contents

```
public void fill(int[] a, int val)
public void fill(int[] a, int i, int j, int v)
```
 - Statistics and searching

```
public int binarySearch(int[] a, int key)
```
 - Core methods

```
public boolean equals(int[] a1, int[] a2)
public int hashCode(int[] a)
public String toString(int[] a)
```
- All are overloaded (for primitives and Object)

Good Practice: Avoid Legacy Types

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- java.util has been around since 1.0
 - “Collections Framework” since 1.2
- For backwards compatibility, it still contains some classes that have been superseded
 - The use of these older classes is deprecated
 - The only reason for using them is to interface with legacy code
- The “legacy collections” are:
 - Enumeration – prefer Iterator interface
 - Stack – prefer Deque (a subinterface of Queue)
 - Dictionary – prefer Map interface
 - Hashtable – prefer HashMap class*
 - Vector – prefer ArrayList class*

*Aside: Vector and Hashtable are still used today, but *only* for multithreaded code

Good Practice: Know the Libraries

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- Bloch Item #47
- Example: Print (contents of) an array

```
int[] a = . . .  
System.out.println(a); //gibberish  
System.out.println(Arrays.toString(a));
```

- Example: Find identical entries in two phone books

```
Map tmp = new HashMap(h1);  
tmp.entrySet().retainAll(h2.entrySet());  
Set result = tmp.keySet();
```

Supplemental Reading

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- Sun “Collections Framework” trail
- For Collections utility class, see “Algorithms” section of collections trail

Summary

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- ❑ Collection Implementations
 - ArrayList, LinkedList, PriorityQueue, HashSet
- ❑ Maps
 - Key/value pairs, with unique keys
 - Interfaces: Map, SortedMap
 - Classes: HashMap, EnumMap, TreeMap
- ❑ Utility Classes
 - Collections, Arrays