Sets and Maps

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Sets

- Properties
  - Collection of elements without duplicates
  - No ordering (i.e., no front or back)
  - Order in which elements added doesn’t matter

- Implementation goal
  - Offer the ability to find / remove element quickly
  - Without searching through all elements
How Do Sets Work in Java?

- Finding matching element is based on `equals()`
- To build a collection for a class
  - Need to define your own `equals(Object)` method
  - Default `equals()` uses reference comparison
    - I.e., `a.equals(b) \rightarrow a == b`
    - `a, b` equal only if reference to same object
  - Many classes have predefined `equals()` methods
    - `Integer.equals( ) \rightarrow` compares value of integer
    - `String.equals( ) \rightarrow` compares text of string
Set Concrete Classes

• HashSet
  • Elements must implement hashCode() method

• LinkedHashSet
  • HashSet supporting ordering of elements
  • Elements can be retrieved in order of insertion

• TreeSet
  • Elements must be comparable
    • Implement Comparable or provide Comparator
  • Guarantees elements in set are sorted
Map Definition

- Map (associative array)
  - Unordered collection of keys
  - For each key, an associated object
  - Can use key to retrieve object
- Can view as array indexed by any (key) value
  - Example
    
    ```
    A["key1"] = ...
    ```
Map Interface Methods

- Methods
  - void put(K key, V value) // inserts element
  - V get(Object key) // returns element
  - V remove(Object key) // removes element
  - int size() // key-value mappings
  - void clear() // clears the map
  - boolean containsKey(Object key) // looks for key
  - boolean containsValue(Object value) // looks for value
  - boolean isEmpty() // empty map?
  - Set<K> keySet() // entire set of keys
  - Collection<V> values() // values in the map
Map Concrete Classes

- HashMap
  - Elements must implement hashCode() method
- LinkedHashMap
  - HashMap supporting ordering of elements
  - Elements can be retrieved in order of insertion
- TreeMap
  - Elements must be comparable
    - Implement Comparable or provide Comparator
  - Elements can be retrieved in sorted order
Map Properties

• Map keys & map objects
  • Can also treat keys & values as collections
    • Access using keySet( ), values( )
  • Aliasing
    • Each key refers only a single object
    • But object may be referred to by multiple keys
• Keys & values may be of complex type
  • Map<Object Type1, Any Object Type2>
  • Including other collections, maps, etc…
Map Implementation

- Implementation approaches
  - Two parallel arrays
    - Unsorted
    - Sorted
  - Linked list
  - Binary search tree
  - Hash table
- Java Collections Framework
  - TreeMap → uses red-black (balanced) tree
  - HashMap → uses hash table
Map Hierarchy

SortedMap

AbstractMap

TreeMap

HashMap

LinkedHashMap

Red ➔ Interface
Black ➔ Class