CMSC 132: OBJECT-ORIENTED PROGRAMMING II

Sets and Maps

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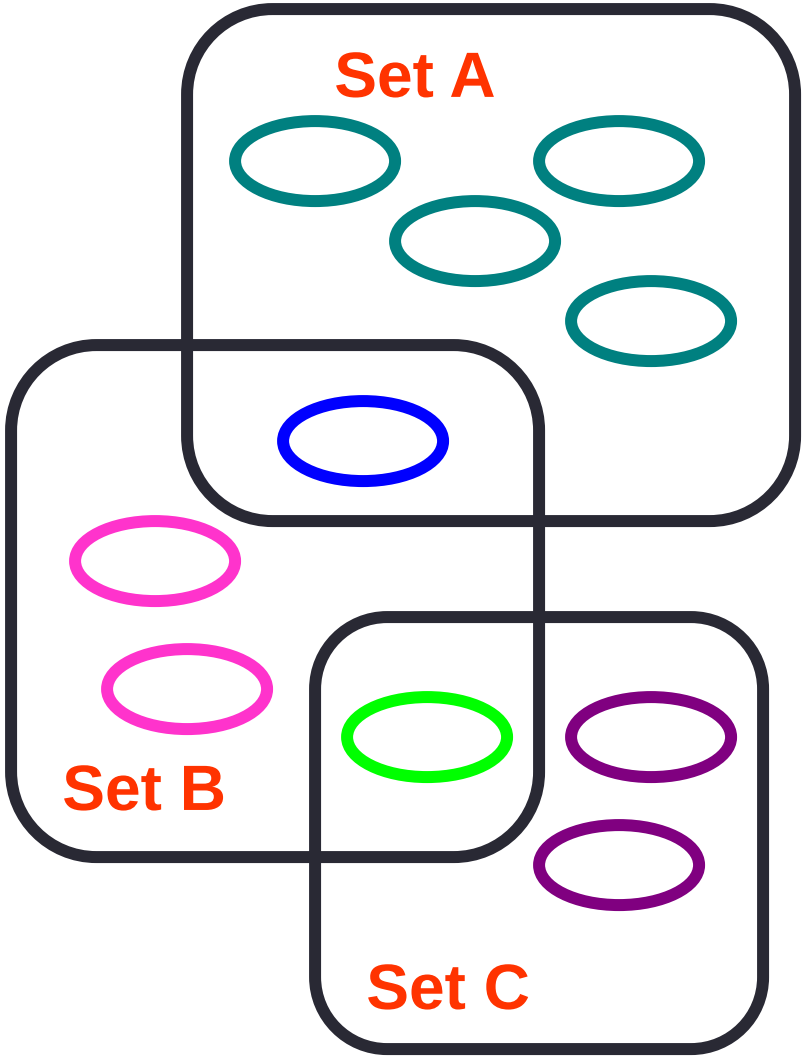
Sets

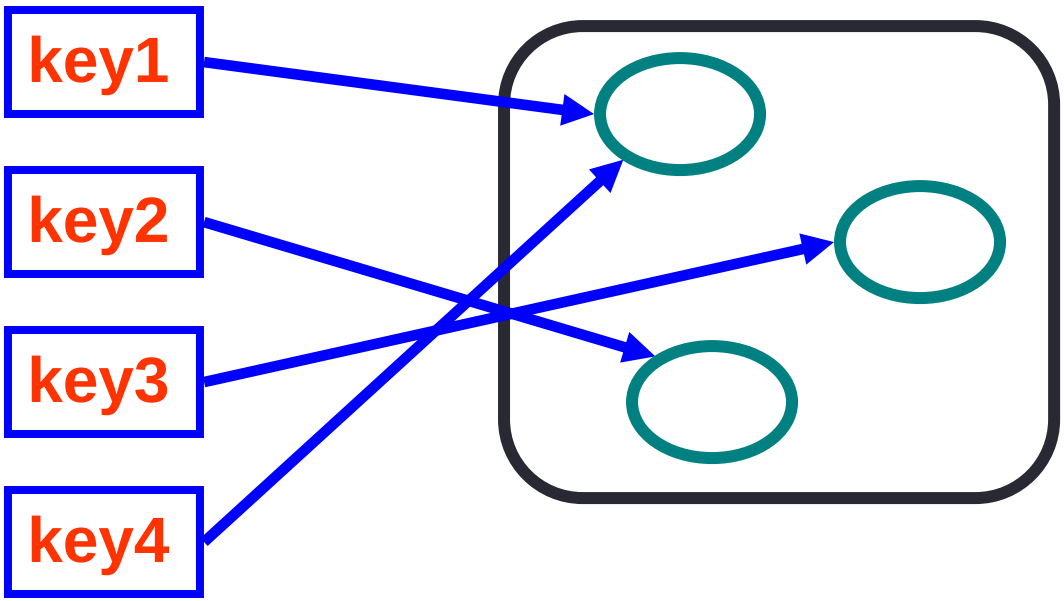
- **Properties**
  - Collection of elements without duplicates
  - No ordering (i.e., no front or back)
  - Order in which elements added doesn't matter
- **Implementation goal**
  - Offer the ability to find / remove element quickly
  - Without searching through all elements



Map Definition

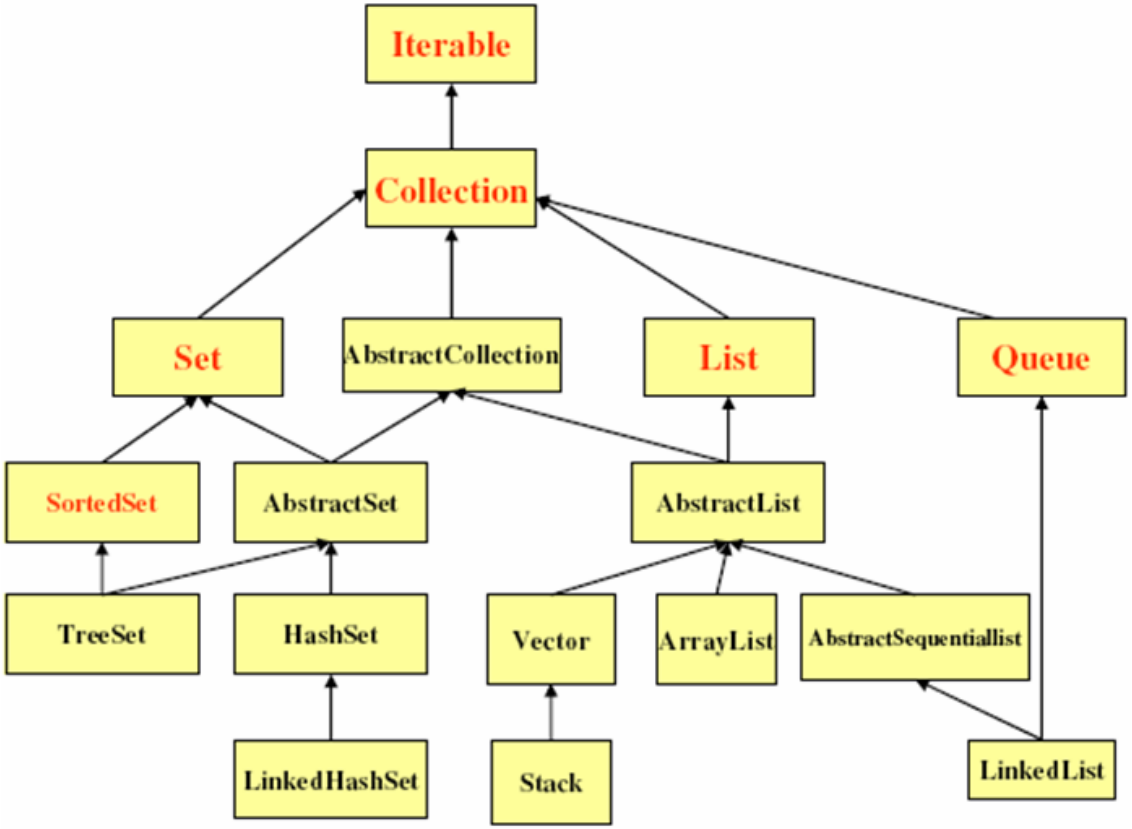
- Map (associative array)
  - Unordered collection of keys
  - For each key, an associated object
  - Can use key to retrieve object
- Can view as array indexed by any (key) value
  - Example

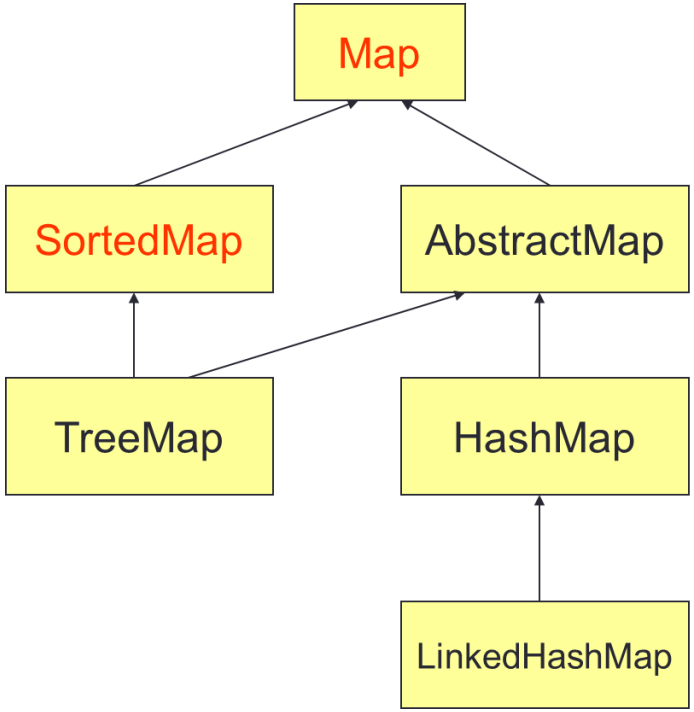
    A[“key1”] = …



Collection & Map Hierarchies

In Java a map is not a Java Collection (e.g., TreeMap does not implement Iterable)





Interface (red)
Class (black)

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 and you need to make sure the **Java Hash Code Contract** is satisfied
  - Default equals( ) uses reference comparison
    - I.e., a.equals(b) → a == b
    - a, b equal only if reference to same object
  - Many classes have predefined equals( ) methods
    - Integer.equals( ) → compares value of integer
    - String.equals( ) → compares text of string

Set Concrete Classes

- HashSet
  - Elements must satisfy the Java Hash Code Contract
- 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
- **You can create one type of set of out of another type**
  - For example, a sorted set out of a HashSet
    - After processing data efficiently (hashSet) you would like to print values in sorted order
- **Example:** SetsMapsCode

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
  - Set<Map.Entry<K,V>> entrySet() // set view of the mapping
    - Map.Entry<K,V> is a nested class

Map Concrete Classes

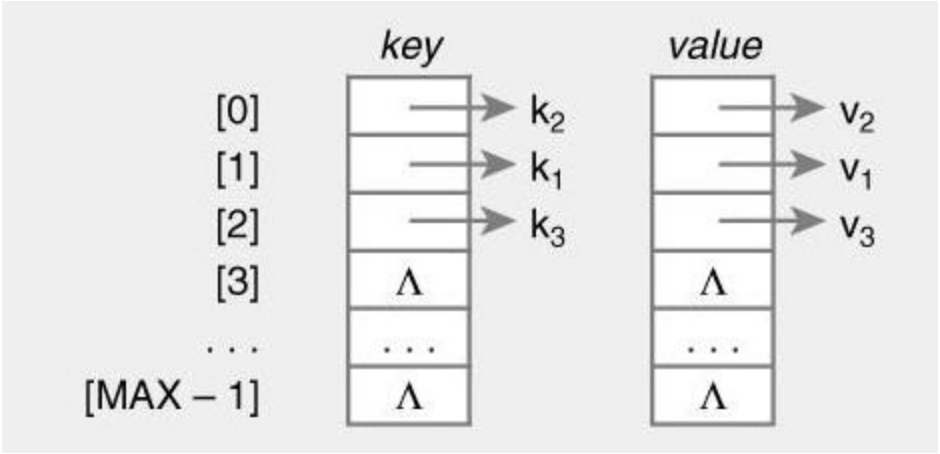
- HashMap
  - Elements must implement Java Hash Code Contract
- LinkedHashMap
  - HashMap supporting ordering of elements
  - Elements can be retrieved in order of insertion
- TreeMap
  - Elements must be comparable
    - Implement Comparable or provide Comparator
  - Elements can be retrieved in sorted order
- **Example:** SetsMapsCode
- Every class provides a constructor that allows you to create a Map out of another kind of map:
  - **Example:** new TreeMap(hashMap)

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