CMSC 132:
Object-Oriented Programming II

Sets and Maps

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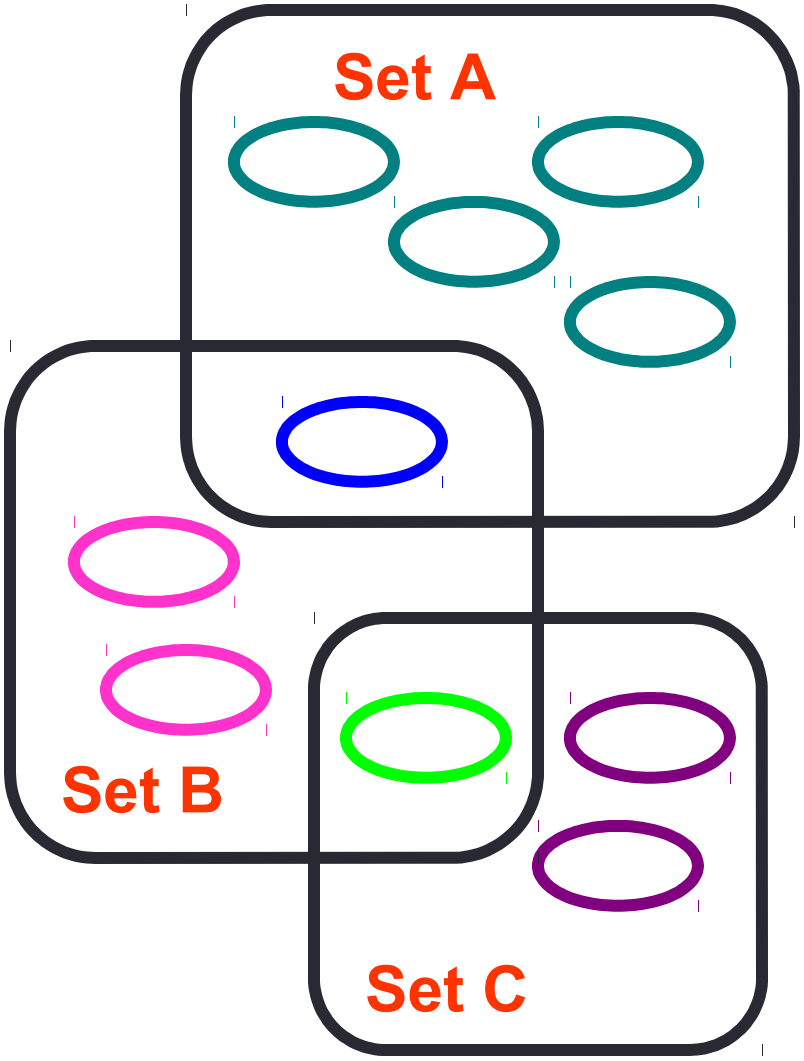
Sets

- 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



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) ⇔ 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

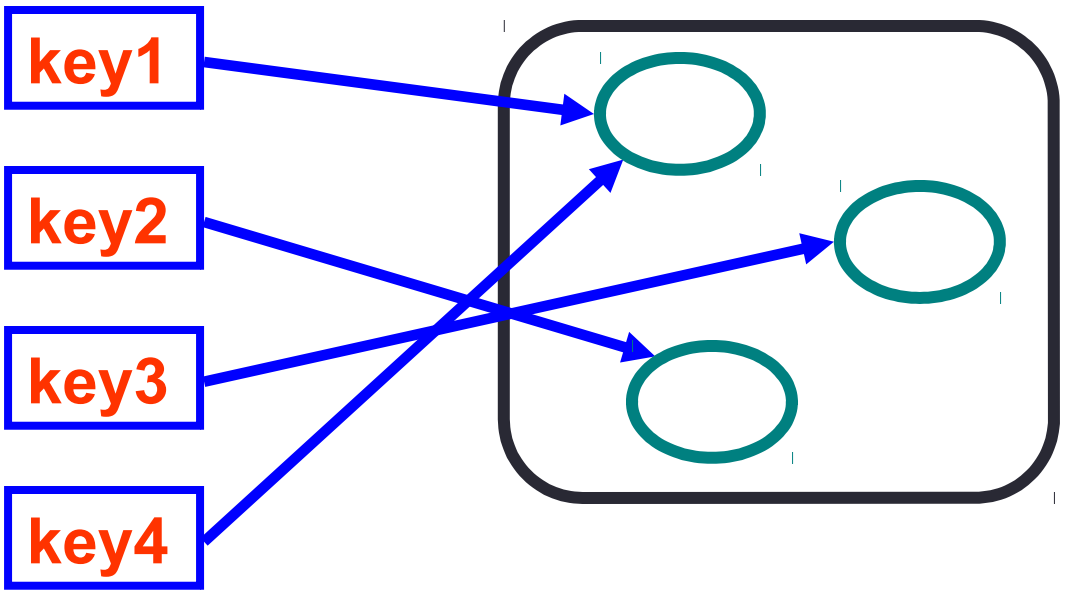
Set Concrete Classes

- HashSet
  - Elements must 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
- **Example:** See SetsMapsCode

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

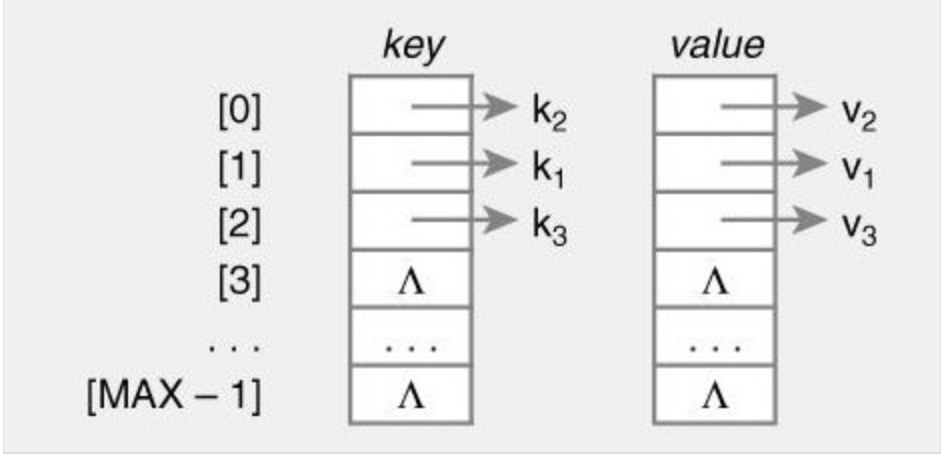
- HashMap
  - Elements must implement hashCode( ) method
- LinkedHashMap
  - HashMap supporting ordering of elements
  - Elements can be retrieved in order of insertion
- TreeMap
  - Elements must be comparable
    - Implement Comparable or provide Comparator
  - Elements can be retrieved in sorted order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

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…

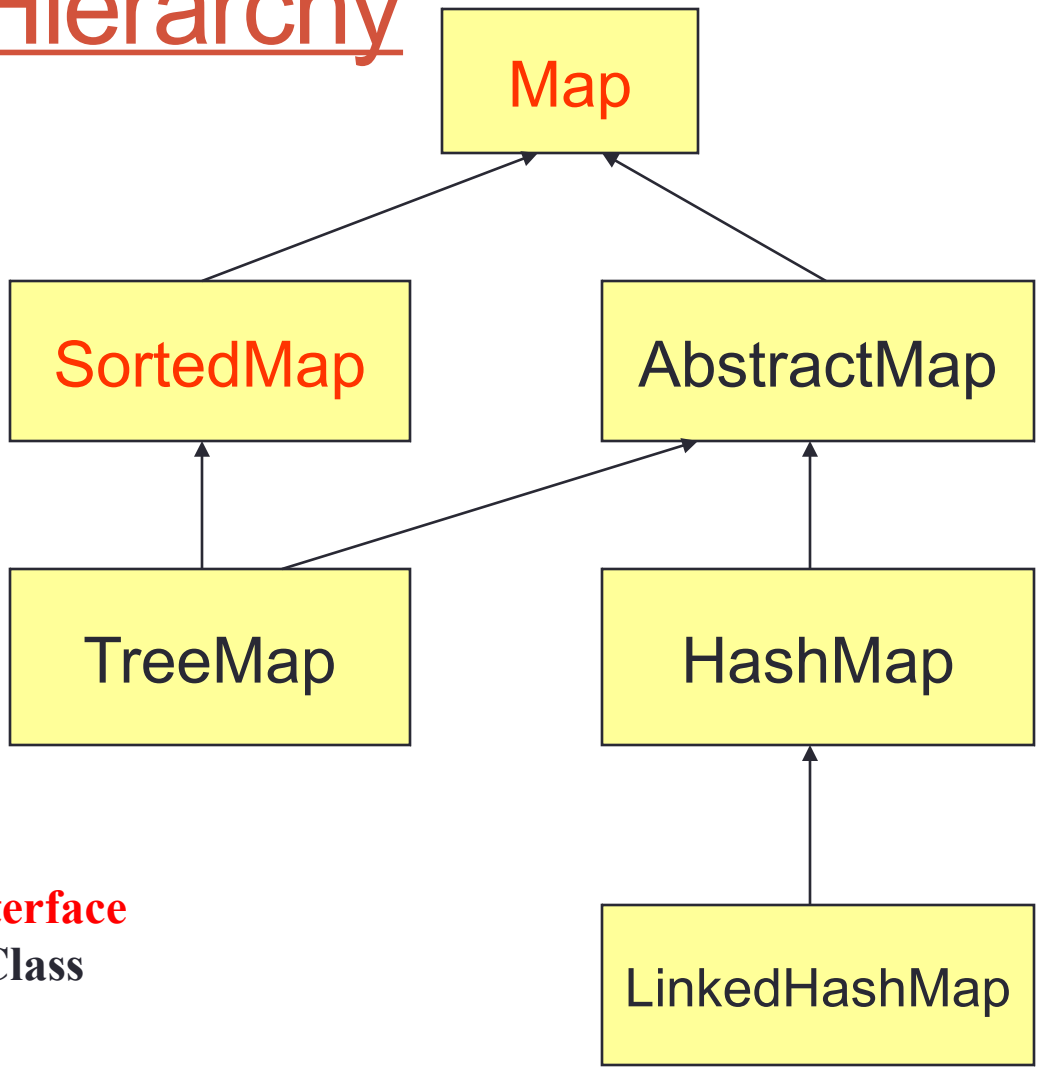
Map Implementation

- Implementation approaches
  - Two parallel arrays
    - Unsorted
    - Sorted
  - Linked list
  - Binary search tree
  - Hash table



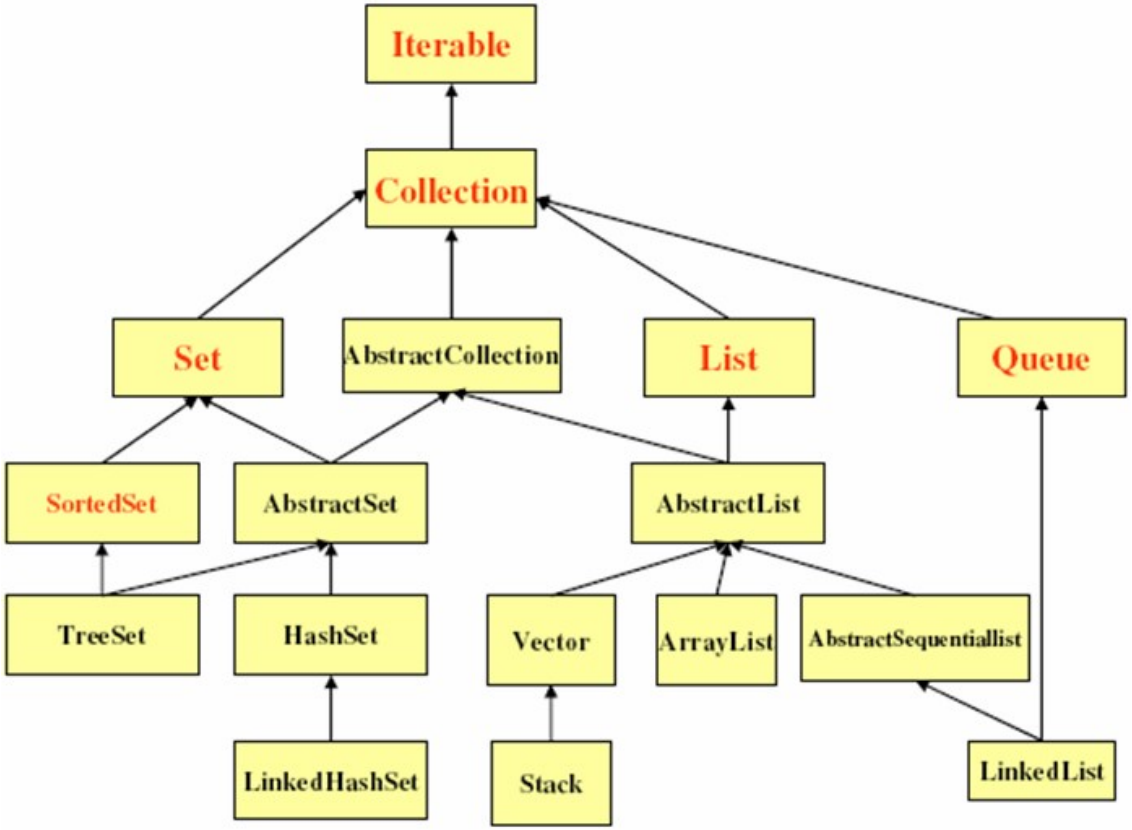
- Java Collections Framework
  - TreeMap → uses red-black (balanced) tree
  - HashMap → uses hash table

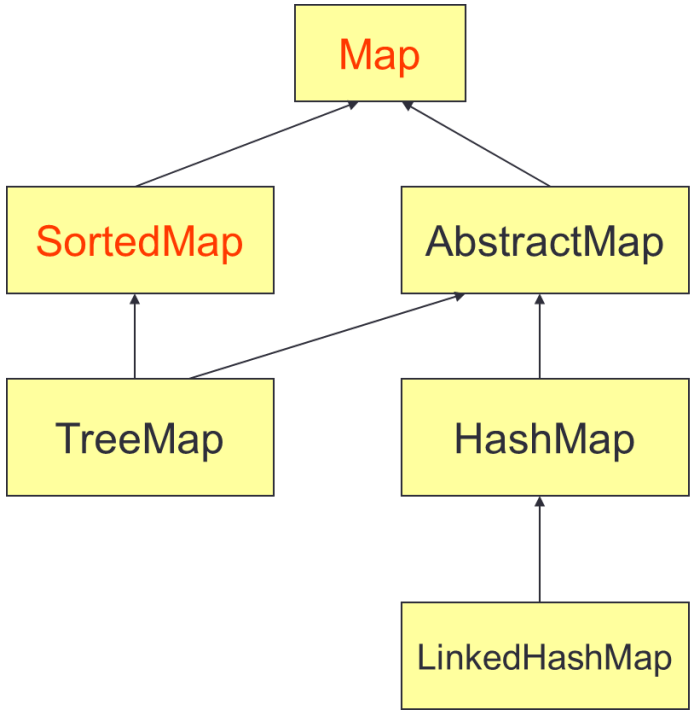
Map Hierarchy



Red □ Interface
Black □ Class

Collection & Map Hierarchies





Interface (red)
Class (black)