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
Collection & Map Hierarchies

Interface (red)
Class (black)