CMSC 132: OBJECT-ORIENTED PROGRAMMING II

Sets and Maps

Department of Computer Science
University of Maryland, College Park
**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
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

Map

- SortedMap
  - TreeMap
- AbstractMap
  - HashMap
  - LinkedHashMap

Red → Interface
Black → Class
Collection & Map Hierarchies

Interface (red)
Class (black)