

CMSC 132: Object-Oriented Programming II

Sets and Maps



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Set Data Structures

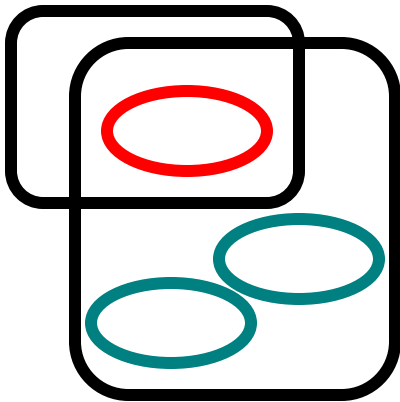
- No relationship between elements

- Types of sets

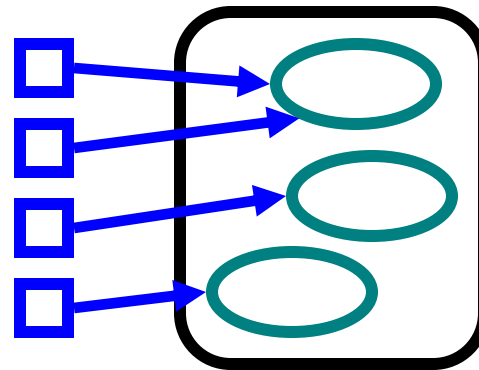
- Set

- Map

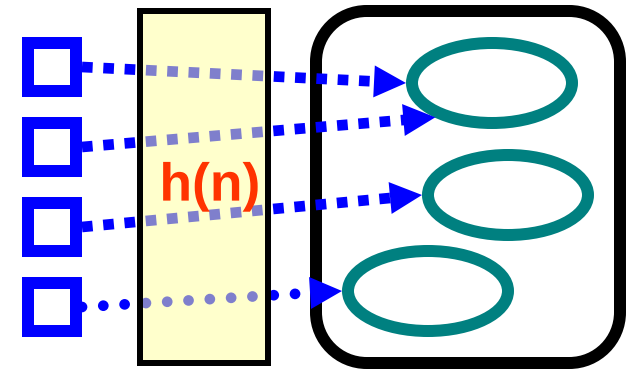
- Hash Table



Set



Map



Hash Table

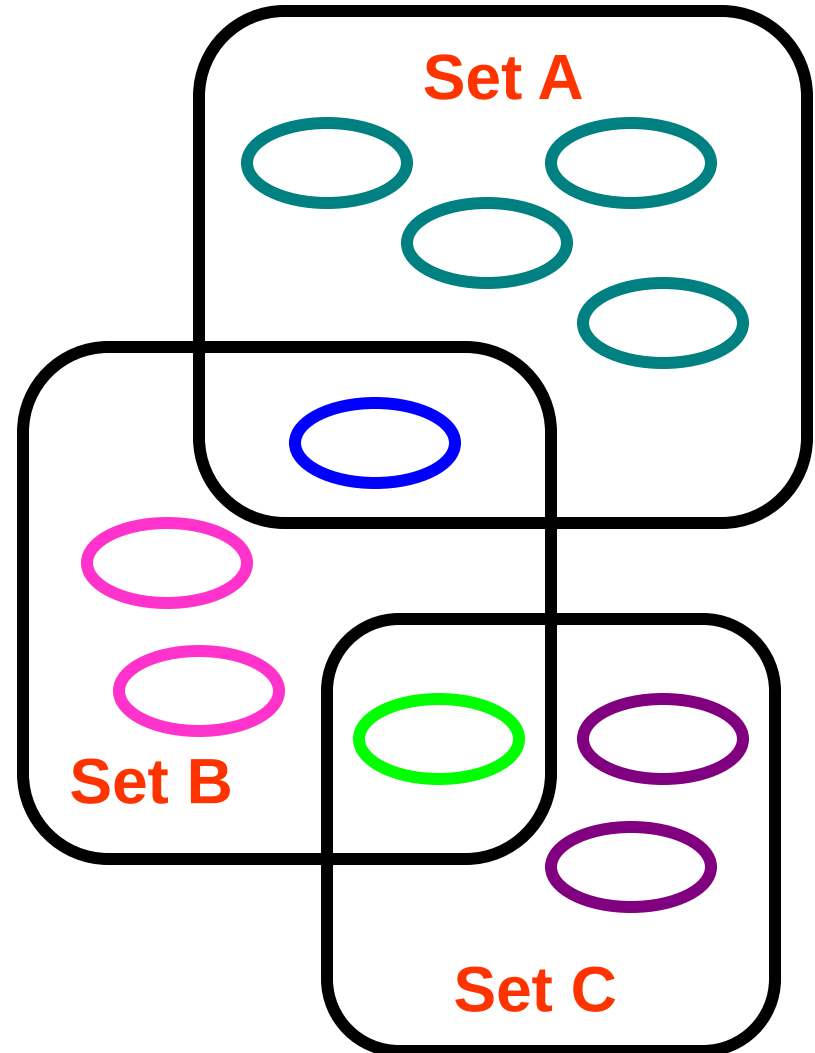
Sets

■ 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

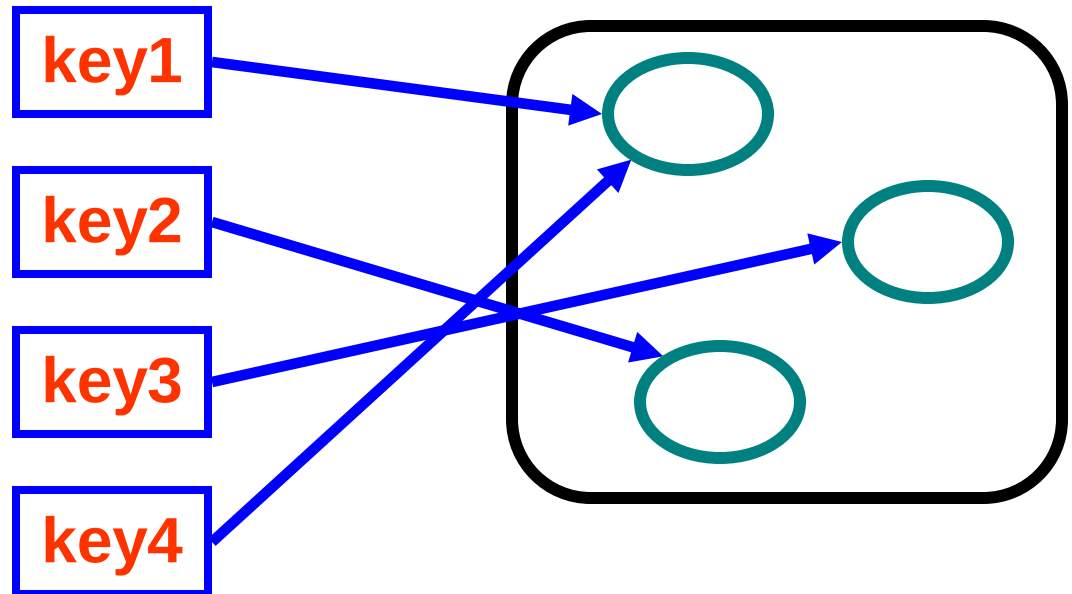
- Elements must be comparable
 - Implement Comparable or provide Comparator
- Guarantees elements in set are sorted

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

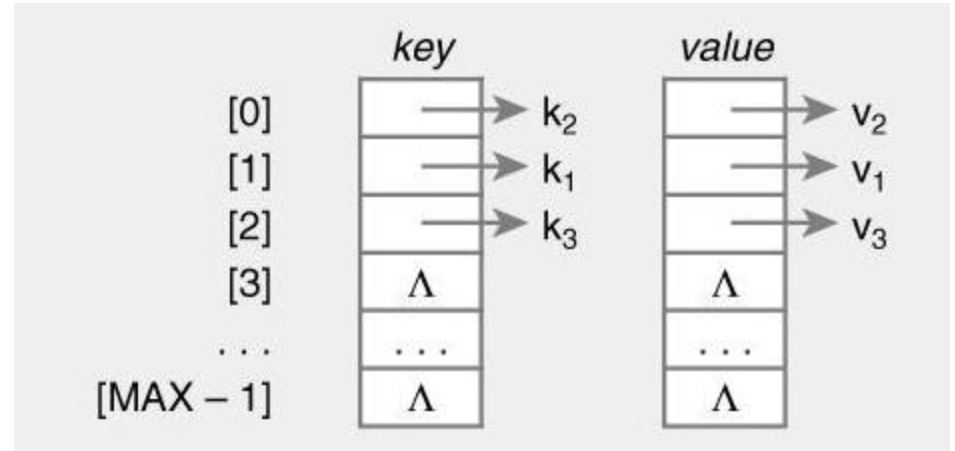
■ Unsorted

■ Sorted

■ Linked list

■ Binary search tree

■ Hash table



■ Java Collections Framework

■ TreeMap → uses red-black (balanced) tree

■ HashMap → uses hash table

Map Hierarchy

