More on the Java Collections Framework

CS211
Fall 2000

java.util.SortedSet (an interface)

- SortedSet *extends* Set
- For a SortedSet, the iterator( ) returns the elements in sorted order
- Methods (in addition to those inherited from Set):
  - public Object first ( );
    Returns the first (lowest) object in this set
  - public Object last ( );
    Returns the last (highest) object in this set
  - public Comparator comparator ( );
    Returns the Comparator being used by this sorted set if there is one; returns null if the natural order is being used
  - …

java.lang.Comparable (an interface)

public int compareTo (Object x);
Returns a value (< 0), (= 0), or (> 0)
- ▲(< 0) implies *this* is before x
- ▲(= 0) implies *this*.equals(x) is true
- ▲(> 0) implies *this* is after x

- Many existing classes implement Comparable
  - String, Double, Integer, Char, java.util.Date,…
  - If a class implements Comparable then that is considered to be the class's *natural ordering*

java.util.Comparator (an interface)

public int compare (Object x1, Object x2);
Returns a value (< 0), (= 0), or (> 0)
- ▲(< 0) implies x1 is before x2
- ▲(= 0) implies x1.equals(x2) is true
- ▲(> 0) implies x1 is after x2

- Can often use a Comparator when a class's natural order is not the one you want
  - String.CASE_INSENSITIVE_ORDER is a predefined Comparator
  - java.util.Collections.reverseOrder( ) returns a Comparator that reverses the *natural order*

SortedSet Implementations

- java.util.TreeSet
  - This is the only class that implements SortedSet
  - TreeSet's constructors
    public TreeSet ( );
    public TreeSet (Collection c);
    public TreeSet (Comparator comp);
    public TreeSet (SortedSet set);
    (uses the same sorting order as that used by set)
- Write a method that prints out a SortedSet of words in order
- Write a method that prints out a Set of words in order

java.util.List (an interface)

- List *extends* Collection
- Items in a list can be accessed via their index (position in list)
- The add( ) method always puts an item at the end of the list
- The iterator( ) returns the elements in list-order
- Methods (in addition to those inherited from Collection)
  - public Object get (int index);
    Returns the item at position index in the list
  - public Object set (int index, Object x);
    Places x at position index, replacing previous item; returns the previous item
  - public void add (int index, Object x);
    Places x at position index, shifting items to make room
  - public Object remove (int index);
    Remove item at position index, shifting items to fill the space; returns the removed item
  - public int indexOf (Object x);
    Return the index of the first item in the list that equals x (x.equals())
  - …

List Implementations

- java.util.ArrayList (an array; expands via array-doubling)
  - Constructors
    public ArrayList ( );
    public ArrayList (int initialCapacity);
    public ArrayList (Collection c);
- java.util.LinkedList (a doubly-linked list)
  - Constructors
    public LinkedList ( );
    public LinkedList (Collection c);
- Both include some additional useful methods specific to that class
- Both are Cloneable

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Efficiency Depends on Implementation

- Object x = list.get(k);
  - O(1) time for ArrayList
  - O(k) time for LinkedList
- list.remove(0);
  - O(n) time for ArrayList
  - O(1) time for LinkedList
- If (set.contains(x))…
  - O(1) *expected* time for HashSet
  - O(log n) for TreeSet
- Write a Stack class
- Write a Queue class
- Write a PriorityQueue class that works on Comparable objects

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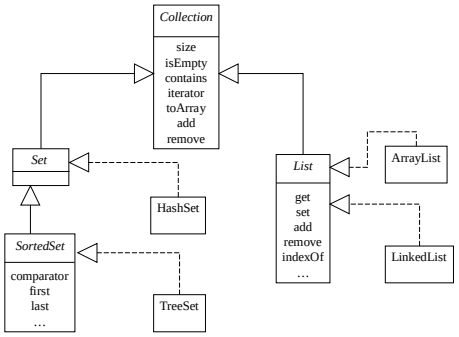
Summary



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java.util.Map (an interface)

- Map does *not* extend Collection
- A Map contains key/value pairs instead of individual elements
- Methods
  public Object put (Object key, Object value);
  Associates value with key in the map; returns the old value associated with key or null if the key did not previously appear in the map
  public Object get (Object key);
  Returns the object to which this key is mapped or null if there is no such key
  public boolean containsKey (Object key);
  True iff Map contains a pair using the given key
  public boolean containsValue (Object value);
  True iff there is at least on pair with this value
  public Object remove (Object key);
  Removes any mapping for the key; returns old value associated with key if there was one (null otherwise)

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More Map Methods

- Other methods
  public int size ( );
  Return the number of key/value pairs in the Map
  public boolean isEmpty ( );
  True iff Map holds no pairs
- Bulk methods
  public void putAll (Map otherMap);
  Puts all the mappings from otherMap into this map
  public void clear ( );
  Removes all mappings
- Sets/Collections derived from a Map
  public Set keySet ( );
  Returns a Set whose elements are the keys of this map
  public Collection values ( );
  Returns a Collection whose elements are all the values of this map
  public Set entrySet( );
  Returns a Set of Map.Entry objects (can use getKey() and getValue())

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java.util.SortedMap (an interface)

- Extends the Map contract: requires that keys are sorted
- The iterators for keySet( ), values( ), and entrySet( ) all return items in order of the keys
- Methods (in addition to those inherited from Map):
  public Comparator comparator ( );
  Returns the comparator used to compare keys for this map; null is returned if the natural order is being used
  public Object firstKey ( );
  Returns the first (lowest value) key in this map
  public Object lastKey ( );
  Returns the last (highest value) key in this map
  …

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Set and SortedSet Implementations

- java.util.HashMap (a class; implements Map)
  - Constructors

    public HashMap ( );
    public HashMap (Map map);
    public HashMap (int initialCapacity);
    public HashMap (int initialCapacity, float loadFactor);
- java.util.TreeMap (a class; implements SortedMap)
  - Constructors

    public TreeMap ( );
    public TreeMap (Map map);
    public TreeMap (Comparator comp);
    public TreeMap (SortedMap map);

Efficiency & Some Comments

- Both TreeMap and HashMap are meant to be accessed via keys
  - get, put, containsKay, remove are all fast
    - O(1) expected time for HashMap
    - O(log n) worst-case time for TreeMap
  - containsValue is slow
    - O(n) for both HashMap and TreeMap
- Both HashSet and TreeSet are actually implemented by building a HashMap and a TreeMap, respectively
- Given a Map that maps student ID number to student name, print out a list of students sorted by ID number and another list sorted by name (assume no duplicate names)

The java.util.Arrays Utility Class

- Provides useful static methods for dealing with arrays
  - sort
    - Mostly uses QuickSort
    - Uses MergeSort for Object[ ] (it's *stable*)
  - binarySearch
  - equals
  - fill
- These methods are overloaded to work with
  - arrays of each primitive type
  - arrays of Objects
- Methods sort and binarySearch can use the natural order or there is a version of each that can use a Comparator
- There is also a method for viewing an array as a List:

  static List asList (Object[ ] a);
  - Note that the resulting List is *backed by* the array (i.e., changes in the array are reflected in the List and vice versa)

Unmodifiable Collections

- Dangerous version:

public final String suits[ ] = { "Clubs", "Diamonds", "Hearts", "Spades" };

- The final modifier means that suits always refers to the same array, but the array's elements can be changed
  - suits[0] = "Leisure";
- Safe version:

private final String theSuits[ ] = { "Clubs", "Diamonds", "Hearts", "Spades" };
public final List suits = Collections.unmodifiableList(Arrays.asList(theSuits));

- The Collections class provides *unmodifiable wrappers*; any methods that would modify the collection throw an UnsupportedOperationException
  - unmodifiableCollection, unmodifiableSet, unmodifiableSortedSet, unmodifiableList
  - unmodifiableMap, unmodifiableSortedMap

The java.util.Collections Utilities

```
public static Object min (Collection c);
public static Object min (Collection c, Comparator comp);
public static Object max (Collection c);
public static Object max (Collection c, Comparator comp);

public static Comparator reverseOrder ( );     // Reverse of natural order

public static void reverse (List list);        // Reverse the list
public static void shuffle (List list);        // Randomly shuffle the list
public static void fill (List list, Object x); // List is filled with x's

public static void sort (List list);           // Sort using natural order
public static void sort (List list, Comparator comp);
public static void binarySearch (List list, Object key);
public static void binarySearch (List list, Object key, Comparator comp);
…
```


Summary