Collections types

Collections Class in Theory

* prebuilt data structure(s) that handle ANY custom object we (create) give it
  + why write the same data structure that other people use over and over
* data structures covered today
  + Linked Lists
  + Arrays of Objects (not simple data type arrays)
* data structures covered later
  + Queues
  + Sets
  + Maps
* each data structure has it’s pros and cons
* import java.util.LinkedList

Collections Class details

* The class is a huge help to experienced programmer that know what some data structures are.
  + why we cover AFTER Linked Lists and Stacks/Queues
* the Collections class is a SUPER class, so it itself can do many options to the lower data structures it creates
* all functions and sub-classes (as of 1.5) ARE NOW GENERIC
  + does not matter the object, will work with it

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| **The Collection Class and SubClasses** |
| Queue <Integer> crap = **new** Queue<Integer>(); // didn’t work!!  Queue <String> crap2 = **new** Queue<String>(); // didn’t work!!    // ONly Lined lIsts and Priority Lists |

from <https://slideplayer.com/slide/9085017/>

The bad side of Collections

* only works with NON-simple data types
  + Integer // int != Integer
  + Double // double != Double
* ***ANY*** CREATED DATA TYPES (like NODE)
  + ***THAT’S WHY GENERIC!!! WORKS WITHOUT A LOT CHANGES!!***
* have to “downcast” to type cast when retrieving objects for the data structures
* have to redo (add) a NEW compareTo that works with general Objects

The Collections version of compareTo

* collections deals with “Objects”
  + Object is a **very** general complex data type
* Old compareTo is used for comparing two items
* COLLECTIONS compareTo is used for sorting MASSIVE AMOUNTS

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| **Overloading the CompareTo (numeric) operator** | |
| To Use between same objects | To use for Collections |
| **public** **int** compareTo(Employee x)  {  **if (this.age == x.age)**  **{ return 0; }**  **else if (this.age < x.age)**  **{ return -1; }**  **else // (this.age == x.age)**  **{ return 1; }**  } | **public** **int** compareTo(Object that)  {  Employee x = (Employee) that; // casting  **if (this.age == x.age)**  **{ return 0; }**  **else if (this.age < x.age)**  **{ return -1; }**  **else // (this.age == x.age)**  **{ return 1; }**  } |

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| **Overloading the CompareTo (String) operator** |
| Function |
| **public** **int** compareTo(Employee x)  { **return** **this**.getlastName().compareTo(x.getlastName()); } |

The Array List Data structure

* ArrayList is creating an array of objects (INDEXCARDS in this example)

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| INDEXCARD |
| **name** |
| **tele** |
| **zip** |

* + we give it the BASE object
  + ArrayList<OBJECT> **anyname** = new ArrayList<OBJECT>();
* uses an iterator to traverse the array
* must import
  + java.util.ArrayList;

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| **name** | **name** | **name** | **name** | **name** | **name** | **name** | **name** | **name** |
| **tele** | **tele** | **tele** | **tele** | **tele** | **tele** | **tele** | **tele** | **tele** |
| **zip** | **zip** | **zip** | **zip** | **zip** | **zip** | **zip** | **zip** | **zip** |

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| **Example Object (incomplete) for the ArrayList** |
| class INDEXCARD  {  private String name;  private String tele;  private int zip;  INDEXCARD(String x, String t, int z) { name = x; tele = t zip = z; }  public String getName() { return name; }  public String getTele() { return tele; }  public int getZip() { return zip; }  **// rest of complete class profile methods**  public String toString() { return (name + “ “ + tele + “ “ + zip); }  } |

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| **Use of ArrayList in the Driver** |
| public static void main(String args[])  {  ArrayList<INDEXCARD> greetings = new ArrayList<INDEXCARD>();  INDEXCARD x = new INDEXCARD("Prof. Lupoli", “1800SUPERMAN”, 21117);  greetings.add(x); // inserts “x” into the array list |

Draw what the ArrayList would look like at this moment

Difference between size & capacity

* the **size** is the number of elements in the list
* the **capacity** is how many elements the list can potentially accommodate without reallocating its internal structures
* so we would need to add default values in order to start messing with them individually

// size is a parameter in this function

ArrayList <T> table = **new** ArrayList<T>();

**while**(table.size() < size) { table.add(**new** BSTree()); }

Commonly used ArrayList(Vector) Functions

* there are more, you can check Java’s website for info

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| **ArrayList Constructor Summary** |
| [**ArrayList**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#ArrayList%28%29)()            Constructs an empty list with an initial capacity of ten. |
| **ArrayList<TEACHER> Staff\_Roster = new ArrayList<TEACHER>();** |
| [**ArrayList**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#ArrayList%28java.util.Collection%29)([Collection](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collection.html)<? extends [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html)> c)            Constructs a list containing the elements of the specified collection, in the order they are returned by the collection's iterator. |
| [**ArrayList**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#ArrayList%28int%29)(int initialCapacity)            Constructs an empty list with the specified initial capacity. |

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| **ArrayList Method Summary** | |
| boolean | [**add**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#add%28E%29)([E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html) o)            Appends the specified element to the ***end*** of this list. |
| **TEACHER t1 = new TEACHER(“Prof.”, “Lupoli”, 30); // constructor created for TEACHER**  **Staff\_Roster.add(t1); // create the object first, then place into the ArrayList** | |
| void | [**add**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#add%28int,%20E%29)(int index, [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html) element)            Inserts the specified element at the specified position in this list. |
| **same as above, with an index** | |
| boolean | [**addAll**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#addAll%28java.util.Collection%29)([Collection](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collection.html)<? extends [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html)> c)            Appends all of the elements in the specified Collection to the end of this list, in the order that they are returned by the specified Collection's Iterator. |
| **TEACHER AACC1 = new TEACHER(“Janice”, “Gilbert”, 30);**  **TEACHER AACC2 = new TEACHER(“Bud”, “Brengle”, 54);**  **TEACHER AACC3 = new TEACHER(“Karen”, “Hommel”, 30);**  **TEACHER AACC4 = new TEACHER(“Mary Jane”, “Blasi”, 45);**  **AACC\_Staff\_Roster.add(AACC1); // AACC\_Staff\_Roster already established (code not shown)**  **AACC\_Staff\_Roster.add(AACC2);**  **AACC\_Staff\_Roster.add(AACC3);**  **AACC\_Staff\_Roster.add(AACC4);**  **Staff\_Roster.addAll(AACC\_Staff\_Roster); // adds all AACC teachers to Staff Roster** | |
| boolean | [**addAll**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#addAll%28int,%20java.util.Collection%29)(int index, [Collection](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collection.html)<? extends [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html)> c)            Inserts all of the elements in the specified Collection into this list, starting at the specified position. |
| **same as above, with an index** | |
| void | [**clear**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#clear%28%29)()            Removes all of the elements from this list. |
| **Staff\_Roster.clear();** | |
| [Object](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Object.html) | [**clone**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#clone%28%29)()            Returns a shallow copy of this ArrayList instance. |
| **ArrayList Staff\_Roster2 = (ArrayList) Staff\_Roster.clone();**  **// creates a copy of the original ArrayList** | |
| boolean | [**contains**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#contains%28java.lang.Object%29)([Object](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Object.html) elem)            Returns true if this list contains the specified element. |
| **TEACHER t1 = new TEACHER(“Prof.”, “Lupoli”, 30);**  **if(Staff\_Roster.contains(t1))** | |
| [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html) | [**get**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#get%28int%29)(int index)            Returns the element at the specified position in this list. |
| **System.out.println(Staff\_Roster.get(i)); // USES OVERLOADED TOSTRING!!! (if created)**  **// prints the object’s data in a line // MORE ON THIS LATER!!!** | |
| int | [**indexOf**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#indexOf%28java.lang.Object%29)([Object](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Object.html) elem)            ***Searches*** for the first occurrence of the given argument, testing for equality using the equals method. |
| **TEACHER t1 = new TEACHER(“Prof.”, “Lupoli”, 30); *// MUST CREATE TARGET NODE TO MATCH!!!***  **Staff\_Roster.indexOf(t1)**  **OR // MORE ON THIS LATER!!!**  **Staff\_Roster.indexOf(new TEACHER(“Prof.”, “Lupoli”, 30)) // SUGGESTED**  ***RETURNS a -1 IF NOTHING IS FOUND!!!*** | |
| boolean | [**isEmpty**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#isEmpty%28%29)()            Tests if this list has no elements. |
| **while(!Staff\_Roster.isEmpty())** | |
| int | [**lastIndexOf**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#lastIndexOf%28java.lang.Object%29)([Object](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Object.html) elem)            Returns the index of the last occurrence of the specified object in this list. |
| **TEACHER t2 = new TEACHER(“Jack”, “McLaughlin”, 70);**  **Staff\_Roster.lastIndexOf(t2);** | |
| [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html) | [**remove**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#remove%28int%29)(int index)             Removes the element at the specified position in this list. |
| **Staff\_Roster.remove(0); // removes object at index 0** | |
| boolean | [**remove**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#remove%28java.lang.Object%29)([Object](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Object.html) o)            Removes a **single** instance of the specified element from this list, if it is present (optional operation). **Searches through the array to find the object.** |
| **TEACHER t2 = new TEACHER(“Jack”, “McLaughlin”, 70);**  **Staff\_Roster.remove(t2);**  **OR *// MUST CREATE TARGET NODE TO MATCH!!!***  **Staff\_Roster.remove(new TEACHER(“Jack”, “McLaughlin”, 70)); // SUGGESTED** | |
| [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html) | [**set**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#set%28int,%20E%29)(int index, [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html) element)            Replaces the element at the specified position in this list with the specified element. |
| **TEACHER t2 = new TEACHER(“Jack”, “McLaughlin”, 70);**  **Staff\_Roster.set(2, t2);** | |
| int | [**size**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html#size%28%29)()            Returns the number of elements in this list. |
| **for(int i = 0; i < Staff\_Roster.size(); i++)** | |

“get” function from the Method Summary

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| INDEXCARD |
| **name** |
| **tele** |
| **zip** |

* retrieves a literal OBJECT back at that index
  + this is a problem
  + because in our case the Object is REALLY an INDEXCARD

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| **“Getting” to gather info** |
| ArrayList <INDEXCARD> TAMU = new ArrayList <INDEXCARD>();  INDEXCARD newProfessor = new INDEXCARD("Prof. L", "1800SUPERMAN", 21117);  INDEXCARD dean = new INDEXCARD("Jack", "1800THEDEAN", 26751);  INDEXCARD oldProfessor = new INDEXCARD("Peter", "1900THEPROF", 28178);  TAMU.add(newProfessor);  TAMU.add(dean);  TAMU.add(oldProfessor);  **//Complex Method Calling**  String target\_name = "Prof. L";  if(target\_name.equals(TAMU.get(0).getname()))  {}  **//Simple Method Calling**  String newguy; // will get from retrieval  String target\_name = "Prof. L";  newguy = TAMU.get(0).getname();  if(target\_name.equals(newguy)) |

ArrayList’s indexOf method

* The indexOf requires the use of the OVERLOADED equals method
  + ***WHICH YOU SHOULD ALREADY HAVE!!!***
  + uses complete class profile
* used for other classes in Collections as well
* ***returns a literal OBJECT back so you can FIND an object in an ArrayList***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| Prof. L | Jack | Peter | **name** | **name** | **name** | **name** | **name** | **name** |
| **…** | **…** | **…** | **tele** | **tele** | **tele** | **tele** | **tele** | **tele** |
| 21117 | 26751 | 28178 | **zip** | **zip** | **zip** | **zip** | **zip** | **zip** |

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| **Overloading the “equals” operator** |
| |  |  |  | | --- | --- | --- | | **THIS** |  | **THAT** | | Jack | name | Jack | | 1800THEDEAN | tele | 1800THEDEAN | | 26751 | zip | 26751 | |

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| **Finding a value in an ArrayList** |
| ArrayList <INDEXCARD> TAMU = new ArrayList <INDEXCARD>();  INDEXCARD newProfessor = new INDEXCARD("Prof. L", "1800SUPERMAN", 21117);  INDEXCARD dean = new INDEXCARD("Jack", "1800THEDEAN", 26751);  INDEXCARD oldProfessor = new INDEXCARD("Peter", "1900THEPROF", 28178);  TAMU.add(newProfessor);  TAMU.add(dean);  TAMU.add(oldProfessor);  // Find Jack!  // This identifies that the item is at least in the ArrayList  if(TAMU.indexOf(new INDEXCARD("Jack", "1800THEDEAN", 26751)) > -1) // But why -1???  **// this returns the index number it WAS found in.**  int indexFound = TAMU.indexOf(new INDEXCARD("Jack", "1800THEDEAN", 26751);  **if(** indexFound > -1) // change something  {}  else // was never found  **{}**  ***BUT!!! INDEX OF USES THE OLD EQUALS (string) to compare!!!***  ***They aren’t STRINGS!!!*** |

Vectors in Theory

* can be thought of as an arrays that shrinks and grows
* can change while your program is running, called dynamic (ever changing)
* adds NEW items in the next available spot starting from 0
  + increments/decrements itself

One already established in vector

|  |  |  |
| --- | --- | --- |
| [0] | (only one segment of memory used) | |
|  |  | |
| Added one more data element to the vector | | |
| [0] | [1] | (only two segments of memory used) |
|  |  |  |
| Erased one data element in the vector | | |
| [0] | (back to one) | |
|  |  | |

Vectors for Real

* are almost EXACTLY like ArrayList
  + same methods!!
  + Also inherits Collection features/behaviors
* there are battles online between developers which is faster, better, etc…
* the difference by JAVA is:

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| ArrayList |
| Resizable-array implementation of the List interface. Implements all optional list operations, and permits all elements, including null. In addition to implementing the List interface, this class provides methods to manipulate the size of the array that is used internally to store the list. (This class is roughly equivalent to Vector, except that it is unsynchronized.) If multiple threads access an ArrayList instance concurrently, and at least one of the threads modifies the list structurally, it *must* be synchronized externally. |
| Vector |
| The Vector class implements a growable array of objects. Like an array, it contains components that can be accessed using an integer index. However, the size of a Vector can grow or shrink as needed to accommodate adding and removing items after the Vector has been created. Unlike the new collection implementations, Vector is synchronized. |

Iterators in Array/Vector/Linked Lists

* The iterator is a common item used to ***traverse a collection***
  + must
    - import java.util.Iterator;
  + an iterator of the same type as the Collection must be created
  + a Collection must be created
    - Iterator <OBJECT> x = COLLECTION.iterator();
* think of it as CURSOR

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| name | |  | [2] | [3] | [4] | [5] | [6] | [7] | … | … | … | … | … | … | … | … |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Iterators |  | | | | | | | | | | | | | | | |

* The iterator has two important functions
  + hasNext()
    - checks to see if at the end of the Collection
  + next()
    - moves to next element in the Collection

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| **Example of an iterator in use** |
| Iterator <Employee> Radford = TAMU.iterator(); // TAMU was the orig. list  // list of Radford Employees  while (Radford.hasNext())  {  Employee aPerson = Radford.next();  System.out.print(aPerson.firstname + " ");  System.out.println(aPerson.lastname);  OR  System.*out*.println(aPerson); // if we have a toString()  } |

Editing using Iterators or get()

* remember, an iterator is the ONLY way we can gain access to a Collection
* next() gives us access to a **specific** element in the Collection
* we need to retrieve the value next() returns
  + that will give us direct access
  + that will give us the ability to change a value within the collection

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| Iterator Version #1 |
| // a collection of BST was set up within an ArrayList named table  // the table itself was full of <BinarySearchTree<Node>> (s)  Iterator <BinarySearchTree<Node>> list = table.iterator();  **while** (list.hasNext())  {  Node x = **new** Node("Lupoli");  Node y = **new** Node("Jensen");  BinarySearchTree retreived = list.next();  retreived.insert(x);  retreived.printTree();  retreived.insert(y);  retreived.printTree();  **break**; // I only wanted to add to ONE element in the entire ArrayList  } |

The Linked List Data Structure

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **(node)** |  | **(node)** |  | **(node)** |  | **(node)** |  |
|  |  |  |  |  |  |  |  |
|  | (link) |  | (link) |  | (link) |  | null |

* Collections will handle:
  + all Objects
    - using Generics
  + all links NAMED “next”
* must
  + import java.util.LinkedList;
  + create the BASE OBJECT for the linked list

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| **Example (incomplete BASE object)** |
| public class Employee  {  private String first;  private String last;  private int age;  // create other useful methods  } |

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| **Example Driver** |
| LinkedList <Employee> TAMU = **new** LinkedList <Employee>();  Employee adjunct = **new** Employee("Prof. L", "Lupoli", 30);  Employee dean = **new** Employee("Jack", "McLaughlin", 90);  Employee professor = **new** Employee("Peter", "Joyce", 60);  TAMU.add(adjunct);  TAMU.add(dean);  TAMU.add(professor); |

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| **Linked List Constructor Summary** |
| [**LinkedList**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#LinkedList%28%29)()            Constructs an empty list. |
| [**LinkedList**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#LinkedList%28java.util.Collection%29)([Collection](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collection.html)<? extends [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html)> c)            Constructs a list containing the elements of the specified collection, in the order they are returned by the collection's iterator. |

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| --- | --- |
| **Linked List Method Summary** | |
| boolean | [**add**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#add%28E%29)([E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) o)            Appends the specified element to the ***end*** of this list. |
| void | [**add**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#add%28int,%20E%29)(int index, [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) element)            Inserts the specified element at the specified position in this list. |
| boolean | [**addAll**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#addAll%28java.util.Collection%29)([Collection](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collection.html)<? extends [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html)> c)            Appends all of the elements in the specified collection to the end of this list, in the order that they are returned by the specified collection's iterator. |
| boolean | [**addAll**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#addAll%28int,%20java.util.Collection%29)(int index, [Collection](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collection.html)<? extends [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html)> c)            Inserts all of the elements in the specified collection into this list, starting at the specified position. |
| void | [**addFirst**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#addFirst%28E%29)([E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) o)            Inserts the given element at the ***beginning*** of this list. |
| void | [**addLast**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#addLast%28E%29)([E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) o)            Appends the given element to the ***end*** of this list. |
| void | [**clear**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#clear%28%29)()            Removes all of the elements from this list. |
| [Object](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Object.html) | [**clone**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#clone%28%29)()            Returns a shallow copy of this LinkedList. |
| boolean | [**contains**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#contains%28java.lang.Object%29)([Object](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Object.html) o)            Returns true if this list contains the specified element. |
| [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) | [**element**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#element%28%29)()            Retrieves, but does not remove, the head (first element) of this list. |
| (any data type the List is made up of) [***E***](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) | [**get**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#get%28int%29)(int index)            Returns the element at the specified position in this list. |
| [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) | [**getFirst**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#getFirst%28%29)()            Returns the first element in this list. |
| [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) | [**getLast**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#getLast%28%29)()            Returns the last element in this list. |
| int | [**indexOf**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#indexOf%28java.lang.Object%29)([Object](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Object.html) o)            Returns the index in this list of the first occurrence of the specified element, or -1 if the List does not contain this element. |
| int | [**lastIndexOf**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#lastIndexOf%28java.lang.Object%29)([Object](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Object.html) o)            Returns the index in this list of the last occurrence of the specified element, or -1 if the list does not contain this element. |
| [ListIterator](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ListIterator.html)<[E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html)> | [**listIterator**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#listIterator%28int%29)(int index)            Returns a list-iterator of the elements in this list (in proper sequence), starting at the specified position in the list. |
| boolean | [**offer**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#offer%28E%29)([E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) o)            Adds the specified element as the tail (last element) of this list. |
| [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) | [**peek**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#peek%28%29)()            Retrieves, but does not remove, the head (first element) of this list. |
| [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) | [**poll**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#poll%28%29)()            Retrieves and removes the head (first element) of this list. |
| [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) | [**remove**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#remove%28%29)()            Retrieves and removes the ***head*** (first element) of this list. |
| [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) | [**remove**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#remove%28int%29)(int index)            Removes the element at the specified position in this list. |
| boolean | [**remove**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#remove%28java.lang.Object%29)([Object](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Object.html) o)            Removes the first occurrence of the specified element in this list. |
| [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) | [**removeFirst**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#removeFirst%28%29)()            Removes and returns the first element from this list. |
| [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) | [**removeLast**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#removeLast%28%29)()            Removes and returns the last element from this list. |
| [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) | [**set**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#set%28int,%20E%29)(int index, [E](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html) element)            Replaces the element at the specified position in this list with the specified element. |
| int | [**size**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/LinkedList.html#size%28%29)()            Returns the number of elements in this list. |

Peek vs. Get First

* thanks to Corbin Crockett F’14
* the difference between the two is getFirst can throw an exception

|  |
| --- |
| getFirst throwing an exception |
| import java.util.LinkedList; import java.util.NoSuchElementException; public class PeekVsGetFirst {      public static void main(String [] args){         LinkedList<Car> cars = new LinkedList<Car>();         try{             cars.getFirst();         }         catch(NoSuchElementException e){             e.printStackTrace();         }          System.out.println(cars.peekFirst());     } } |
|  |

1. Create a base object “Car” that contains nickname, license, and MPG.
2. Create a driver to:
   1. Create an instance of a Collection Linked List
   2. Add a few instances of Car(s) to the Linked List

Answerb:

The Collection Class and it’s functions

* Collection is the super class of all collections and data structure covered above
* so the functions can be used on the ArrayList, LinkedList, and Queue
* HAS VERY POWERFUL AND USEFUL methods!!
  + sorting!!!

Commonly used Collection Functions

|  |  |
| --- | --- |
| **Collections Method Summary** | |
| static   |  | | --- | | <T> int | | [**binarySearch**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#binarySearch%28java.util.List,%20T,%20java.util.Comparator%29)([List](http://java.sun.com/j2se/1.5.0/docs/api/java/util/List.html)<? extends T> list, T key, [Comparator](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Comparator.html)<? super T> c)            Searches the specified list for the specified object using the binary search algorithm.  <NEEDS TO BE SORTED FIRST> |
| static boolean | [**disjoint**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#disjoint%28java.util.Collection,%20java.util.Collection%29)([Collection](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collection.html)<?> c1, [Collection](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collection.html)<?> c2)            Returns true if the two specified collections have no elements in common. |
| static   |  | | --- | | <T> [List](http://java.sun.com/j2se/1.5.0/docs/api/java/util/List.html)<T> | | [**emptyList**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#emptyList%28%29)()            Returns the empty list (immutable). |
| static   |  | | --- | | <T> void | | [**fill**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#fill%28java.util.List,%20T%29)([List](http://java.sun.com/j2se/1.5.0/docs/api/java/util/List.html)<? super T> list, T obj)            Replaces all of the elements of the specified list with the specified element. |
| static int | [**frequency**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#frequency%28java.util.Collection,%20java.lang.Object%29)([Collection](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collection.html)<?> c, [Object](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Object.html) o)            Returns the number of elements in the specified collection equal to the specified object. |
| static int | [**indexOfSubList**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#indexOfSubList%28java.util.List,%20java.util.List%29)([List](http://java.sun.com/j2se/1.5.0/docs/api/java/util/List.html)<?> source, [List](http://java.sun.com/j2se/1.5.0/docs/api/java/util/List.html)<?> target)            Returns the starting position of the first occurrence of the specified target list within the specified source list, or -1 if there is no such occurrence. |
| static int | [**lastIndexOfSubList**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#lastIndexOfSubList%28java.util.List,%20java.util.List%29)([List](http://java.sun.com/j2se/1.5.0/docs/api/java/util/List.html)<?> source, [List](http://java.sun.com/j2se/1.5.0/docs/api/java/util/List.html)<?> target)            Returns the starting position of the last occurrence of the specified target list within the specified source list, or -1 if there is no such occurrence. |
| static   |  | | --- | | <T> [ArrayList](http://java.sun.com/j2se/1.5.0/docs/api/java/util/ArrayList.html)<T> | | [**list**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#list%28java.util.Enumeration%29)([Enumeration](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Enumeration.html)<T> e)            Returns an array list containing the elements returned by the specified enumeration in the order they are returned by the enumeration. |
| static   |  | | --- | | <T extends [Object](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Object.html) & [Comparable](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Comparable.html)<? super T>>  T | | [**max**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#max%28java.util.Collection%29)([Collection](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collection.html)<? extends T> coll)            Returns the maximum element of the given collection, according to the *natural ordering* of its elements. |
| static   |  | | --- | | <T> T | | [**max**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#max%28java.util.Collection,%20java.util.Comparator%29)([Collection](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collection.html)<? extends T> coll, [Comparator](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Comparator.html)<? super T> comp)            Returns the maximum element of the given collection, according to the order induced by the specified comparator. |
| static   |  | | --- | | <T extends [Object](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Object.html) & [Comparable](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Comparable.html)<? super T>>  T | | [**min**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#min%28java.util.Collection%29)([Collection](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collection.html)<? extends T> coll)            Returns the minimum element of the given collection, according to the *natural ordering* of its elements. |
| static   |  | | --- | | <T> T | | [**min**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#min%28java.util.Collection,%20java.util.Comparator%29)([Collection](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collection.html)<? extends T> coll, [Comparator](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Comparator.html)<? super T> comp)            Returns the minimum element of the given collection, according to the order induced by the specified comparator. |
| static   |  | | --- | | <T> [List](http://java.sun.com/j2se/1.5.0/docs/api/java/util/List.html)<T> | | [**nCopies**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#nCopies%28int,%20T%29)(int n, T o)            Returns an immutable list consisting of n copies of the specified object. |
| static   |  | | --- | | <T> boolean | | [**replaceAll**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#replaceAll%28java.util.List,%20T,%20T%29)([List](http://java.sun.com/j2se/1.5.0/docs/api/java/util/List.html)<T> list, T oldVal, T newVal)            Replaces all occurrences of one specified value in a list with another. |
| static void | [**reverse**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#reverse%28java.util.List%29)([List](http://java.sun.com/j2se/1.5.0/docs/api/java/util/List.html)<?> list)            Reverses the order of the elements in the specified list. |
| static   |  | | --- | | <T> [Comparator](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Comparator.html)<T> | | [**reverseOrder**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#reverseOrder%28%29)()            Returns a comparator that imposes the reverse of the *natural ordering* on a collection of objects that implement the Comparable interface. |
| static   |  | | --- | | <T> [Comparator](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Comparator.html)<T> | | [**reverseOrder**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#reverseOrder%28java.util.Comparator%29)([Comparator](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Comparator.html)<T> cmp)            Returns a comparator that imposes the reverse ordering of the specified comparator. |
| static void | [**shuffle**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#shuffle%28java.util.List%29)([List](http://java.sun.com/j2se/1.5.0/docs/api/java/util/List.html)<?> list)            Randomly permutes the specified list using a default source of randomness. |
| static void | [**shuffle**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#shuffle%28java.util.List,%20java.util.Random%29)([List](http://java.sun.com/j2se/1.5.0/docs/api/java/util/List.html)<?> list, [Random](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Random.html) rnd)            Randomly permute the specified list using the specified source of randomness. |
| static   |  | | --- | | <T extends [Comparable](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Comparable.html)<? super T>>  void | | [**sort**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#sort%28java.util.List%29)([List](http://java.sun.com/j2se/1.5.0/docs/api/java/util/List.html)<T> list)            Sorts the specified list into ascending order, according to the *natural ordering* of its elements. |
| static   |  | | --- | | <T> void | | [**sort**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#sort%28java.util.List,%20java.util.Comparator%29)([List](http://java.sun.com/j2se/1.5.0/docs/api/java/util/List.html)<T> list, [Comparator](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Comparator.html)<? super T> c)            Sorts the specified list according to the ***order induced by*** the specified comparator. |
| static void | [**swap**](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Collections.html#swap%28java.util.List,%20int,%20int%29)([List](http://java.sun.com/j2se/1.5.0/docs/api/java/util/List.html)<?> list, int i, int j)            Swaps the elements at the specified positions in the specified list. |

Theory of a Comparable/Comparator

* if the data type was simple, a <, >, ==, would simply do
* but how do we compare or order ***OBJECTS BY CERTAIN DATA***
  + by age
  + by name
  + etc…
* we would have to pick a certain part of that object(s) in order to compare
* there are different ways of comparing Strings and integer values
  + Strings uses the compareTo function covered in Strings
  + Integers can use <, >, = =, etc…

Comparables

* introspective – using own custom built compareTo function
  + can be used to compare **both** homogeneous and heterogeneous objects
  + usually the compareTo method’s design has some type or natural ordering
    - by name
    - by income
    - etc…
  + shortcomings
    - can only have ***one*** compareTo function
      * can then use Comparators if you need more sorting options

Deciding between comparable & comparator

* designing how you will use either is important

|  |
| --- |
| Gameplan with given code |
|  |

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| --- |
| Compara*ble* for a String |
| Option #1 |
| **public** **class** Employee **implements** Comparable<Object> {  **private** String first;  **private** String last;  **private** **int** age;    **public** Employee(String first, String last, **int** i) {  **this**.first = first;  **this**.last = last;  **this**.age = i;  }  **public** String getFirst() { **return** first; }  **public** String getLast() { **return** last; }  **public** **int** getAge() { **return** age; }    **public** **int** compareTo(Object x)  {  **if**(x **instanceof** Employee)  {  Employee e = (Employee) x;  **if**(**this**.getLast().equals(e.getLast()))  **return** **this**.getFirst().compareTo(e.getFirst());  **else**  **return** **this**.getLast().compareTo(e.getLast());  }  **else** **if** (x **instanceof** IndexCard)  {  IndexCard e = (IndexCard) x;  **if**(**this**.getLast().equals(e.getLast()))  // comparing Employee first to IndexCard first  **return** **this**.getFirst().compareTo(e.getFirst());  **else**  **return** **this**.getLast().compareTo(e.getLast());  }  **else** { **return** -1; } // not a match  }  **public** String toString() {  **return** "Employee [first=" + first + ", last=" + last + "]";  }  } |

|  |
| --- |
| 2nd option for compareTo |
| **public** **class** Employee **implements** Comparable<Employee> {  … // same as above    **public** **int** compareTo(Employee e) {  **if**(**this**.getLast().equals(e.getLast()))  **return** **this**.getFirst().compareTo(e.getFirst());  **else**  **return** **this**.getLast().compareTo(e.getLast());  …  } |

|  |
| --- |
| Using a comparable |
| **import** java.util.ArrayList;  **import** java.util.Collections;  **import** java.util.Iterator;  **public** **class** Driver {  **public** **static** **void** main(String args[])  {  ArrayList<Employee> x = **new** ArrayList<Employee>();  Employee adjunct = **new** Employee("Dan", "Malesko", 30);  Employee dean = **new** Employee("Jack", "McLaughlin", 90);  Employee professor = **new** Employee("Peter", "Joyce", 60);  IndexCard lupoli = **new** IndexCard("Prof", "Lupoli", "1800SUPERMAN", 21117);    // comparing an Employee to an Employee  System.***out***.println(adjunct.compareTo(dean));  // comparing an Employee to an IndexCard  System.***out***.println(adjunct.compareTo(lupoli));  x.add(adjunct);  x.add(dean);  x.add(professor);  Iterator<Employee> before = x.iterator();  **while** (before.hasNext())  {  Employee aPerson = before.next();  System.***out***.print(aPerson.getFirst() + " ");  System.***out***.println(aPerson.getLast());  }  Collections.*sort*(x); // Comparable Option  Iterator<Employee> after = x.iterator();  **while** (after.hasNext())  {  Employee aPerson = after.next();  System.***out***.print(aPerson.getFirst() + " ");  System.***out***.println(aPerson.getLast());  }  }  } |
| -2  1  Dan Malesko  Jack McLaughlin  Peter Joyce  Peter Joyce  Dan Malesko  Jack McLaughlin |

Comparators

* uses an interface
  + info on Comparator available methods [here](https://docs.oracle.com/javase/7/docs/api/java/util/Comparator.html)
  + no code given, just the function header ***compare***
    - ***basically same as compareTo***
  + requires a class to implement compare
    - usually a very simple class to create
* used to compare HOMOGENOUS objects that the Comparator didn’t cover
  + gives you options if you want to sort the Object in another fashion

|  |
| --- |
| Compara*tor* Setup Example |
| Base Object (incomplete) |
| class Employee  {  private String firstname, lastname;  private int age;  Employee(String f, String l, int a)  {  firstname = f;  lastname = l;  age = a;  }  public String getfirstName() { return firstname; }  public String getlastName() { return lastname; }  public int getAge() { return age; }  } |

|  |  |
| --- | --- |
| Comparator for a String | |
| import java.util.\*;  //http://leepoint.net/notes-//java/data/collections/comparators.html  **class** FULLNAME **implements** **Comparator**<Employee>  {  // Comparator interface requires defining compare method.  **public** **int** compare(Employee **a**, Employee **b**)  {  **if(a**.getlastName().equals(**b**.getlastName())  { **return** **a**.getfirstName().compareTo(**b**.getfirstName()); }  else { **return** **a**.getlastName().compareTo(**b**.getlastName()); }  }// What values can CompareTo return?? | |
| Comparator for an Int (Ascending) | |
| import java.util.\*;  **class** AGE **implements** Comparator<Employee>  {  // Comparator interface requires defining compare method.  **public** **int** compare(Employee a, Employee b)  { //... Sort the age of the Objects  **if**(a.getAge() < b.getAge()) {**return** -1;}  **else** **if**(a.getAge() > b.getAge()) {**return** 1;}  **else** { **return** 0; }  }  } | * Compare/compareTo ALWAYS needs three responses   + -1   + 0 (identical)   + 1 |

|  |
| --- |
| Full Example |
| ArrayList<Employee> x = **new** ArrayList<Employee>();  Employee adjunct = **new** Employee("Prof. L", "Lupoli", 30);  Employee dean = **new** Employee("Jack", "McLaughlin", 90);  Employee professor = **new** Employee("Peter", "Joyce", 60);  x.add(adjunct);  x.add(dean);  x.add(professor);   |  |  |  | | --- | --- | --- | | **0** | **1** | **2** | | Jack | Peter | Prof. L | | **…** | **…** | **…** | |  |  |  |   Iterator<Employee> y = x.iterator();  **while** (y.hasNext())  {  Employee aPerson = y.next();  System.out.print(aPerson.getfirstName() + " ");  System.out.println(aPerson.getfirstName());  }  // Comparator Option  // comparable for LASTNAME/FULLNAME of Employee  **FULLNAME** fullname = **new** FULLNAME();  Collections.sort(x, fullname);   |  |  |  | | --- | --- | --- | | **0** | **1** | **2** | | Prof. L | Jack | Peter | | **Lupoli** | **McL** | **Joyce** | |  |  |  |   y = x.iterator();  **while** (y.hasNext())  {  Employee aPerson = y.next();  System.out.print(aPerson.getfirstName() + " ");  System.out.println(aPerson.getfirstName());  }  AGE age = **new** AGE();  Collections.sort(x, age); |

With the Car class, create a compara***tor*** that will order cars by MPG. Then:

1. Create at least 3 instances of Cars
2. Display the list **nicely** BEFORE you sort it
3. Display the list **nicely** AFTER you sort it

Using a Collection as a parameter

void printList(ArrayList<Employee> x)

{

Iterator <Employee> student = x.iterator();

while (student.hasNext())

{

System.out.println(student.next());

}

}

Polymorphism in Lists

* Lists
  + ArrayList
  + Vector
  + LinkedList
  + Stack (covered later)

|  |
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| **Polymorphism Example for Lists** |
| **import** java.util.List;  **import** java.util.ArrayList;  **import** java.util.LinkedList;  **import** java.util.Stack;  **import** java.util.Vector;  **public** **class** test  {    **public** **static** **void** main(String args[])  {  List <Employee> listA = **new** ArrayList();  List <Employee> listB = **new** LinkedList();  List <Employee> listC = **new** Vector();  List <Employee> listD = **new** Stack();  }    } |

Answer Section

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| Creating a Car |
| **public** **class** Car {    **private** String nickname;  **private** String license;  **private** **int** MPG;      **public** String getNickname() { **return** nickname; }  **public** **void** setNickname(String nickname) { **this**.nickname = nickname; }  **public** String getLicense() { **return** license; }  **public** **void** setLicense(String license) { **this**.license = license; }  **public** **int** getMPG() { **return** MPG; }  **public** **void** setMPG(**int** mPG) { MPG = mPG; }    @Override  **public** String toString() {  **return** "Car [nickname=" + nickname + ", license=" + license + ", MPG="  + MPG + "]";  }  @Override  **public** **boolean** equals(Object obj) {  **if** (**this** == obj) { **return** **true**; }  **if** (obj == **null**) { **return** **false**; }  **if** (getClass() != obj.getClass()) { **return** **false**; }  Car other = (Car) obj;  **if** (MPG != other.MPG) { **return** **false**; }  **if** (license == **null**)  {  **if** (other.license != **null**) { **return** **false**; }  }  **else** **if** (!license.equals(other.license)) { **return** **false**; }  **if** (nickname == **null**) {  **if** (other.nickname != **null**)  **return** **false**;  } **else** **if** (!nickname.equals(other.nickname))  **return** **false**;  **return** **true**;  }  } |
| **import** java.util.ArrayList;  **import** java.util.Collections;  **public** **class** Driver {    **public** **static** **void** main(String args[])  {  //Creating the ArrayList  ArrayList<Car> cars = **new** ArrayList<Car> ();    //Creating different cars  Car tesla = **new** Car();  tesla.setLicense("ANISHAN");  tesla.setMPG(50);  tesla.setNickname("Stella");    Car porsche = **new** Car();  porsche.setLicense("CYF1234");  porsche.setNickname("Cayenne");  porsche.setMPG(25);    Car bmw = **new** Car();  bmw.setLicense("HHX1234");  bmw.setMPG(30);  bmw.setNickname("525i");    //Adding to the list  cars.add(tesla);  cars.add(porsche);  cars.add(bmw);    //Printing elements in list  **for** (Car car : cars) {  System.***out***.println(car);  }    MPG mpg = **new** MPG();  Collections.*sort*(cars,mpg);  System.***out***.println();  **for** (Car car : cars) {  System.***out***.println(car);  }  }  } |
| **import** java.util.Comparator;  **public** **class** MPG **implements** Comparator<Car> {  @Override  **public** **int** compare(Car o1, Car o2) {  **if**(o1.getMPG() < o2.getMPG()) { **return** -1; }  **else** **if**(o1.getMPG() > o2.getMPG()) { **return** 1; }  **return** 0;  }  } |

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| Car and Comparable |
| **public** **class** Car **implements** Comparable <Car>{  **private** String nickname;  **private** String license;  **private** **int** mpg;    Car(String n, String l, **int** m){  nickname = n;  license = l;  mpg = m;  }  **public** String print(){ **return** nickname + " " + license + " " + mpg; }  **public** **int** compareTo(Car c){  **if** (**this**.mpg > c.mpg){ **return** 1; }  **else** **if** (**this**.mpg < c.mpg){ **return** -1; }  **else** { **return** 0; }  }  } |
| //Benjamin M. Yankowski (Spidey)  //Nathaniel Dorr  **import** java.util.Collections;  **import** java.util.LinkedList;  **public** **class** NewJunkDriver {  **public** **static** **void** main(String[] args) {  LinkedList<Car> list = **new** LinkedList<Car>();    list.add(**new** Car("Camery", "111III01", 25));  list.add(**new** Car("Porche", "2FAST4U", 3));  list.add(**new** Car("Bike", "[INSERT CENSORSHIP]", 9000000));    **for**(**int** n=0; n < list.size(); n++){  System.*out*.println(list.get(n).print());  }  Collections.*sort*(list);  **for**(**int** n=0; n < list.size(); n++){  System.*out*.println(list.get(n).print());  }  }  } |

Sources:

Comparable vs. Comparator

<http://stackoverflow.com/questions/1440134/java-what-is-the-difference-between-implementing-comparable-and-comparator>

Parameterized Generic Classes

<http://javahowto.blogspot.com/2008/06/java-generics-examples-parameterized.html>

<http://docs.oracle.com/javase/tutorial/java/generics/types.html>