CS206

Generics

ArrayList

Lab Feb 23

```
/**
 * Removes the element at the specified position in this
 * list. Shifts any subsequent elements to the left
 * (subtracts one from their indices).
 *
 * @param index the index of the element to be removed
 */

public void remove(int index) throws IndexOutOfBoundsException{
   if(index > count){
      throw new IndexOutOfBoundsException("Can only get where
there are already items");
   }
   if(index < 0){
      throw new IndexOutOfBoundsException("Cannot retrieve from
negative location");
   }
   arra[index]=null;
   for(int i=index; i<count; i++){
      arra[i]=arra[i+1];
   }
   count--;
}
```

Reading from Files

- In, StdIn classes are not part of Java 11
  - do not use them
- Scanner
  - could use for reading files
    - DO NOT
  - DO USE for reading from keyboard
- BufferedReader
  - Use this for reading from files (lab 2, EchoCount)

Generics

- A way to write classes and methods that can operate on a variety of data types without being locked into specific types at the time of definition
  - When objects are created, they are locked to a class
    - Allows for code checking at compile time
    - Automatic casting to appropriate types
- General Idea: Write definitions & implementations with "Generic" parameters

Generic Alternative

- ArraList class from Tuesday
  - It is defined to store Object
  - So it can store anything

- It is generally a BAD idea to store different types of data in a single data structure.

Generic Methods

```
import java.util.Random;
/************************
 * @author gTowell
 * Created: August 28, 2019
 * Modified: Jan 24, 2019
 * Purpose:
 * Generic Methods
 ************************/
public class NormalClassWithGenericMethod {
    public static void main(String[] args) {
        Integer[] jj = { 1, 2, 3, 4, 5, 6, 7, 8, 9 }; // NOTE AUTOBOXING!!!
        new GenericMethod().randomize(jj);
        for (int j : jj)
            System.out.println(j);
        String[] ss = { "A", "B", "c", "d", "E", "F" };
        new GenericMethod().randomize(ss);
        for (String s : ss)
            System.out.println(s);
    }

    // The Fisher-Yates shuffle
    public <T> void randomize(T[] data) {
        Random r = new Random();
        for (int i = data.length; i>0; i--) {
            int tgt = r.nextInt(data.length);
            T temp = data[i];
             data[i]=data[tgt];
             data[tgt]=temp;
        }}}
```

— generic swap method??

Generic Class

```
/**
 * Simple generic class example
 * @author gtowell
 *
 * @param <A>
 */
public class GenericClass<A> {
    /** A non-generic value */
    private double amount;
    /** A generic value */
    private A otherValue;
    /**
     * Constructor.
     * @param other the generic value
     * @param amt a double value.
     */
    public GenericClass(A other, double amt) {
        this.otherValue = other;
        this.amount = amt;
    }
    public static void main(String[] args) {
        GenericClass<String> gString = new GenericClass<String>("ASDF", 24.5);
        System.out.println(gString);
        GenericClass<Double> gDouble = new GenericClass<Double>(99.5, 44.5);
        System.out.println(gDouble);
        GenericClass<BufferedReader> gBR = new GenericClass<BufferedReader>(
                new BufferedReader(new StringReader("When in the course")), 99.8);
        System.out.println(gBR);
    }}
```

write a toString function for this class

Generics Restrictions

- No instantiation with primitive types
  - `Genre<Double>` ok, but `Genre<double>` is NOT
- Can not declare static instance variables of a parameterized type
- Can not create arrays of parameterized types
  - but you can create an array of `Object` then cast
    - ~~`T[] array = new T[10]`~~
    - `T[] array = (T[])new Object[10]`

Creation with Type Parameters

- When constructing an class with generics, you must specify the type of elements via <>

```
ArraList<String> l1 = new ArraList<>(100);
ArraList<Integer> l2 = new ArraList<>();
```

Reimplementation of ArrayList

- Mostly, just change "Object" to "T"

```
public interface ArraListInterface<T> {
   boolean add(T t);
   boolean add(int index, T t) throws IndexOutOfB
   void remove(int index) throws IndexOutOfBounds
   T get(int index) throws IndexOutOfBoundsExcept
   boolean set(int index, T t) throws IndexOutOfB
   int size();
   int indexOf(T t);
   void clear();
}
```

ArraList indexOf(T t)

- Problem … how can you compare equality of two generics
  - The only functions you can assume exist for a generic are those with Object.

- Solution: Override Equals!!!

Generics and Equals

```
public class Place {
    private String zip, city, state;
    public String getZip() { return zip; }
    // Other stuff not shown
    @Override
    public boolean equals(Object o) {
        if (o instanceof Place) {
            return zip.equals(((Place) o).getZip());
        }
        return super.equals(o);  // return false;
    }
    public static void main(String[] args) {
        Place p1 = new Place("19380", "a", "b");
        Place p2 = new Place("19380", "aaaa", "bbbb");
        Place p3 = new Place("19385", "a", "b");
        Integer ii = 10;
        System.out.println("p1 p2: " + p1.equals(p2));
        System.out.println("p1 p3: " + p1.equals(p3));
        System.out.println("p1 ii: " + p1.equals(ii));
        System.out.println("p2 p3: " + p2.equals(p3));
    }}
```

Groups

- For the ArraList class write:

```
/**
 * Returns the index of the first occurrence of the specified element in this
 * list, or -1 if this list does not contain the element. More formally, returns
 * the lowest index i such that (o==null ? get(i)==null : o.equals(get(i))), or
 * -1 if there is no such index.
 *
 * @param t the item to be found
 * @return the index of the first occurrence of the specified element in this
 *         list, or -1 if this list does not contain the element
 */
int indexOf(T t);
```

A toString method that returns a print representation of every object in the ArraList.

2d ArraList

```
public class AL2d {
    public static void main(String[] args) {
        ArraList<ArraList<String>> al2d = new ArraList<>();
        al2d.add(new ArraList<String>());
        // etc
        al2d.get(0).add("Hello");
        al2d.get(0).add(1);
    }
}
```

a real mouthful!

Add an AL to the "outer" AL

add a string to the inner AL

Not legal!

Using an ArrayList

- Problem: Write a program to collect then print all unique words in a file
- Difficulty: you do not know the number of distinct words!
  - Solutions
    - Bad: allocate a really big array
    - Use ArraList!

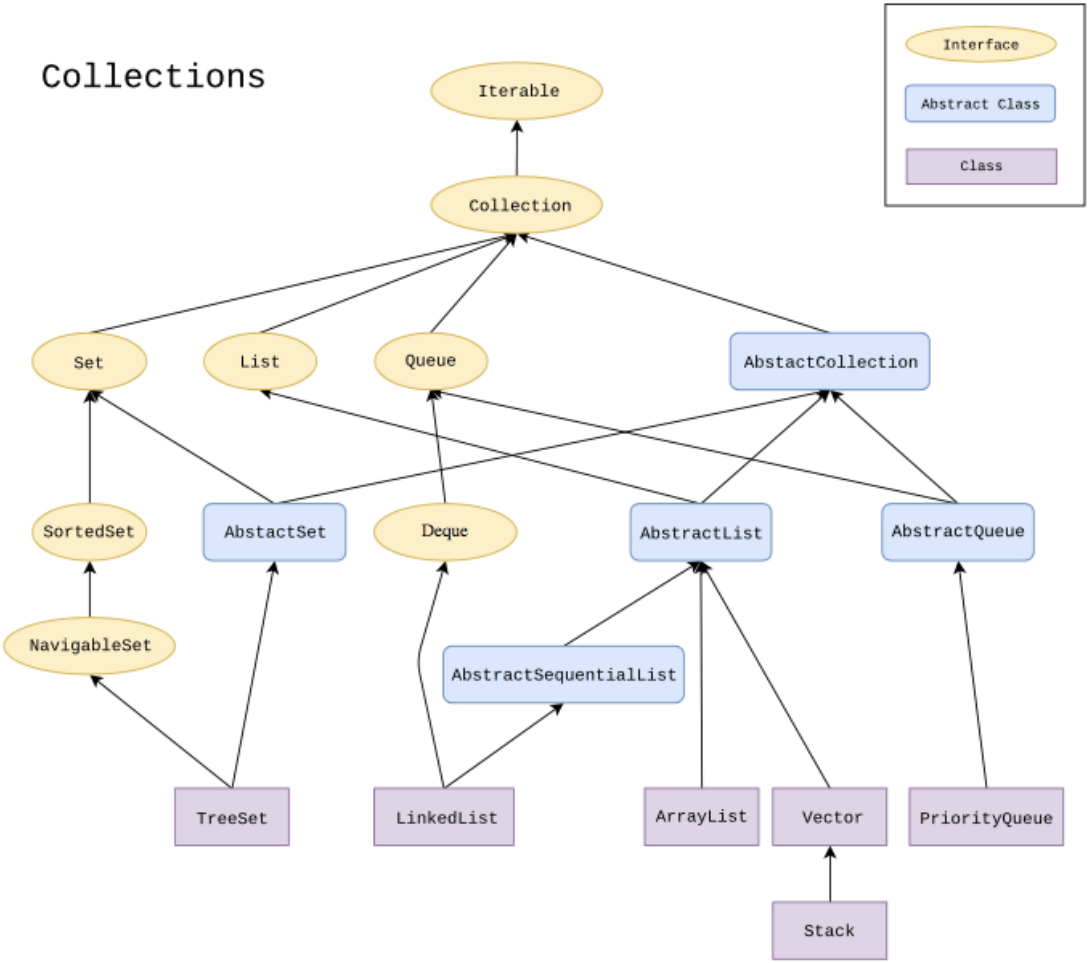
WordCounter — Count the unique words in file!

WordCounter.java

java.util.ArrayList

- Implements much the same interface as ours
  - Their implementation has a few more functions
- Theirs is probably more more efficient.
- Part of Java collections framework
- import java.util.ArrayList
- Use ArrayList rather than ArraList (ours) for Homework 3.

Collections



Lab

- Go to Park 231 (The CS computer labs!!!!)
  - read my document about using the computers in the lab (link near the top of class web page).
- Log into a Unix machine (You may do this in pairs) but there should be just about enough to work solo in the two rooms.
- Start a terminal
- execute ls in the terminal
- take a picture of your screen
- send me the picture
- log out