Points off	1	2	3	4A	4B		Total off	Net Score

CS 307 – Midterm 1 – Fall 2010

Your Name_____

Your UTEID _____

Circle yours TA's name: Harsh Yi-Chao

Instructions:

1. There are **4** questions on this test.
2. You have 2 hours to complete the test.
3. You may not use a calculator or any other electronic devices while taking the test.
4. When writing a method assume the preconditions of the method are met.
5. When writing a method you may add helper methods if you wish.
6. When you complete the test show the proctor your UTID and give them the test and any scratch paper. Please leave the room quietly.

1. (2 points each, 30 points total) Short answer questions. Place your answers on the attached answer sheet. For code samples state the output. If the code would cause a syntax error then answer "syntax error". If it would cause a runtime exception then answer "exception". If it would result in an infinite loop answer "infinite loop".

A. What is output by the following code when the client code is executed?

```
public int a(int y){
     y--;
     int x = y * 2 - 1;
     return x;
}

// client code
int x = 4;
int y = a(x);
System.out.print(x + " " + y);
```

B. What is output by the following code?

```
ArrayList<Integer> vals = new ArrayList<Integer>();
ArrayList<Integer> other = vals;
other.add(4);
vals.add(2);
vals.add(5);
System.out.println(other);
```

C. What is output by the following code when the client code is executed?

```
public void c(int[] list){
     list[list.length - 1] += 2;
     list[0]--;
}

// client code
int[] data = {3, 5, 2};
c(data);
System.out.println(Arrays.toString(data));
```

D. What is output by the following code?

```
ArrayList<String> names = new ArrayList<String>();
System.out.println(names.size());
```

E. Briefly explain why the following code will not compile.

```
Object obj = new ArrayList<String>();
obj.add("Kelly");
System.out.println( obj.toString() );
System.out.println( obj.equals(obj) );
```

F. Does the following code result in syntax error, a runtime error (exception), or neither?

```
int k = 10;
String[] titles = new String[k + 2];
System.out.println( titles[ titles.length / 2 ].length() );
```

For questions G - N consider the following classes.

```
public abstract class IPod {
      private int memory;

      public IPod() { memory = 40; }

      // pre: m > 0
      public IPod(int m) { memory = m; }

      public abstract String memoryType();

      public String toString() { return memoryType() + " " + memory; }
}


public class Touch extends IPod {

      public Touch() {}

      public Touch(int s) {
            super(s);
      }

      public String memoryType() { return "flash"; }

      public boolean hasTouchScreen() { return true; }
}


public class Classic extends IPod {

      public Classic(int s) {    super(s);  }

      public String memoryType() { return "hard drive"; }

      public int numColors() { return 2; }
}


public class HP extends Classic {

      public HP(int s) { super(s); }

      public int numColors() { return 1; }
}
```

G. Briefly explain why the following code will not compile:

```
IPod p = new IPod(-20);
```

H. What is output by the following code?

```
Touch t = new Touch(30);
System.out.println( t.toString() );
```

I. What is output by the following code?

```
IPod[] ps = new IPod[3];
ps[0] = new Touch();
ps[1] = new Classic(20);
ps[2] = new HP(30);
for(IPod p : ps)
     System.out.println(p);
```

J. State if the following declarations are valid or invalid (meaning they cause a syntax error). 1 point each

```
Classic c2 = new Touch(20);
Classic c3 = new HP(20);
```

K. State if the following declarations are valid or invalid (meaning they cause a syntax error). 1 point each

```
Object obj = new HP(20);
HP h1 = new Classic(30);
```

L. What is output by the following code?

```
Object obj2 = new Touch(30);
System.out.println(obj2);
```

M. What is output by the following code?

```
Classic c2 = new HP(30);
System.out.println( c2.memoryType() + " " + c2.numColors() );
```

N. What is output by the following code?

```
IPod i2 = new Classic(30);
System.out.println( i2.memoryType() + " " +
                        ((Classic) i2).numColors() );
```

O. How many interfaces can a class in Java implement?

2. The `GenericList` class. (25 points) In lecture, to demonstrate encapsulation and the syntax for building a class in Java, we developed a `GenericList` class to represent a list of objects. As discussed in class the internal storage container may have extra capacity.

Complete a method for the `GenericList` class named `interleave`. This is an instance method in the `GenericList` class that creates and returns a new `GenericList` object that has the elements of the calling `GenericList` and another `GenericList` sent as an explicit parameter interleaved.

The method header is:

```
/*
pre: other != null

post: return a new GenericList that has the elements of this GenericList
and other interleaved.
The size of the returned list equals 2 times the minimum of the size of
this list and other.
The elements of the returned list alternate between the values of this
list, then other, then this list, then other, and so forth.
Neither this nor other is altered as a result of this method call.
*/
public GenericList interleave(GenericList other) {
```

Examples of calls to `interleave`: (Assume values shown are Strings.)

```
[A, B, C].interleave([Q, M, P]) -> [A, Q, B, M, C, P]

[].interleave([Q, M, P]) -> []

[A, B, C].interleave([]) -> []

[A, A, B, A, B].interleave([P, M, P]) -> [A, P, A, M, B, P]

[A, B, C, D, E, F].interleave([Q, M, P]) -> [A, Q, B, M, C, P]

[A, B, C].interleave([Q, M, P, Z, X, Y, K]) -> [A, Q, B, M, C, P]

[A, B, C, D, E, F].interleave([B, A, M]) -> [A, B, B, A, C, M]

[].interleave([]) -> []

[A].interleave([]) -> []

[A].interleave([Q]) -> [A, Q]
```

You may not use any other methods in the `GenericList` class except the default constructor unless you define and implement them yourself. Recall that the `interleave` method is in the `GenericList` class so you have access to all `GenericList` objects' private instance variables.

You may not use objects or methods from other Java classes other than native arrays and the Math class. If you want to use any other `GenericList` methods, other than the default constructor, you must define and implement them yourself.

Recall the `GenericList` class:

```
public class GenericList{

      private Object[] container;
      private int size;

      public GenericList() {
            container = new Object[10];
            size = 0;
}
```

Complete the following instance method for the `GenericList` class.

```
/*
pre: other != null

post: return a new GenericList that has the elements of this GenericList
and other interleaved.
The size of the returned list equals 2 times the minimum of the size of
this list and other.
The elements of the returned list alternate between the values of this
list, then other, then this list, then other, and so forth.
Neither this nor other is altered as a result of this method call.
*/
public GenericList interleave(GenericList other) {
```

Complete on next page

Complete on next page

Complete on next page

Complete on next page

Complete on next page

Complete on next page

```
public GenericList interleave(GenericList other) {
     assert other != null;
```

3. (20 points total) 2D Arrays. Write a method to determine the number of `Color` objects in a neighborhood of a 2D array of `Color` objects that have a greater intensity of green **and** blue than a `Color` object at a given location at the center of the neighberhood.

```
/*
pre: grid != null, no elements in grid are null,
     grid is a rectangular matrix, 0 <= row < grid.length,
     0 <= col < grid[0].length, size > 0
post: return the number of Color objects in grid that have a greater
     intensity of green and blue than the Color at location
     grid[row][col] and that are in the neighborhood of the given size
     centered around the cell at location row, col.
*/
public int numGreaterBlueGreen(Color[][] grid, int row, int col, int
                                    size) {
```

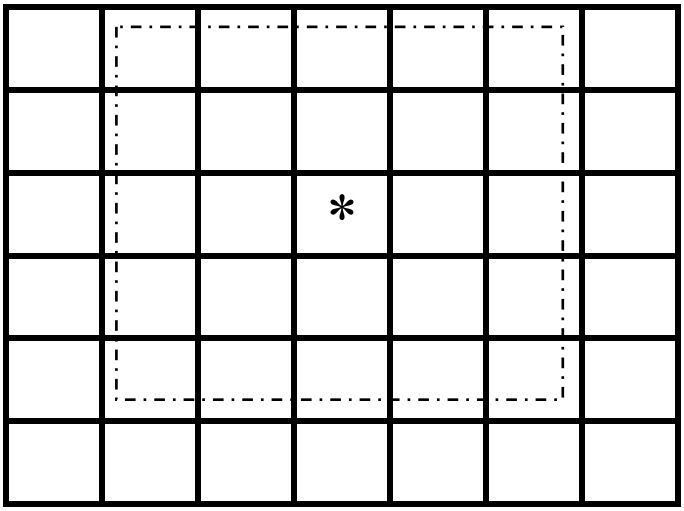
`Color` objects store the intensity of the red, green, and blue components of a color. The intensity varies between 0 and 255. The methods for the `Color` class are:

```
public class Color {

     // All three of these methods will
     // return a value between 0 and 255.
     // The larger the value, the greater the intensity.

     public int getRed() // return red intensity of this Color
     public int getGreen() // return green intensity of this Color
     public int getBlue() // return blue intensity of this Color
}
```

The `size` parameter specifies how large an area to search around the cell at location `row, col`. For example if the array is 6 by 7, `row = 2, col = 3`, and `size = 2,` the neighborhood to search is shown below. The asterisk marks the center cell.



Note, based on row, column, and size there may be cells in the neighborhood that do not exist. Your methods must ignore these cells.

You may not use any other Java classes except the `Color` and `Math` classes and native arrays.

```
/*
pre: grid != null, no elements in grid are null,
     grid is a rectangular matrix, 0 <= row < grid.length,
     0 <= col < grid[0].length, size > 0
post: return the number of Color objects in grid that have a greater
     intensity of green and blue than the Color at location
     grid[row][col] that are in the neighborhood of the given size
     centered around the cell at location row, col.
*/
public int numGreaterBlueGreen(Color[][] grid, int row, int col, int
                                    size) {
     // DO NOT CHECK THE PRECONDITIONS. ASSUME THEY ARE MET.
```

4 Working with objects (25 points total) This question involves the `NameRecord` and `Names` classes from Assignment 4, the NameSurfer assignment. The question has 2 parts.

A. (15 points) Complete an instance method in the `NameRecord` class that returns `true` if the ranks for two `NameRecord` objects (the calling object and the explicit parameter) differ by no more than some max value for **every** decade.

```
// pre: other != null, this.numDecades() == other.numDecades(),
//      maxDiff >= 0
// post: return true if the ranks for this NameRecord and other differ by
//       no more than maxDiff in their rank for every decade,
//       false otherwise.
//       A rank of 0 (unranked) is treated as a rank of 1001.
private boolean inSync(NameRecord other, int maxDiff) {
```

Recall the first integer is the rank for the decade 1900 - 1909, the second integer is the rank for the decade from 1910 - 1919, and so forth. Recall a lower number (except for 0's) means a name was more popular. A value of 0 indicates the name had a rank greater than 1000 for the decade. For this question you will assume a 0 indicates a rank of 1001.

Consider the following example:

The ranks for the name Margaret are: 3 4 5 8 14 23 54 101 95 107 112
The ranks for the name David are: 29 30 22 11 6 5 2 4 5 11 13

The absolute values of the difference between the ranks for each decade are:
26 26 17 3 8 18 52 97 90 96 99

If the max allowed difference were 100 the method would return `true` for those two `NameRecord` objects. If the max allowed difference were 50 the method would return `false` for those two `NameRecord` objects.

If a name is unranked for a decade the `getRank` method from the `NameRecord` class returns a 0. For this problem you will treat all 0's as a rank of 1001. So for example, if one `NameRecord` has a rank of 950 and the other is unranked. The difference is calculated to be 51. (1001 - 950 = 51)

The `NameRecord` class you will use on this question is as follows:

```
public class NameRecord {

     private String name;
     private ArrayList<Integer> ranks;
     // ranks.size() always equals numDecades()

     // returns this NameRecords name
     public String getName()

     // Return the number of decades of data for this NameRecord.
     // Includes decades the name was not in the top 1000.
     public int numDecades()
```

```
     // NameRecord class continued

     // get the rank of this NameRecord for the given decade
     // first decade of data is 0, next is 1, and so forth
     // pre: 0 <= decade < numDecades()
     public int getRank(int decade){
```

From the `ArrayList` class:

`public int size() - returns the number of elements in this ArrayList`

`public E get(int pos) - returns the element at the specified position in this list. pre: 0 <= pos < size()`

You are not allowed to use any other methods from the `NameRecord` or `ArrayList` classes other than those shown above and the `Math` class. You may not use any other Java classes. (You may use native arrays if you would like.)

Complete the `inSync` method from the `NameRecord` class.

```
// pre: other != null, this.numDecades() == other.numDecades(),
//      maxDiff >= 0
// post: return true if the ranks for this NameRecord and other differ by
//       no more than maxDiff in their rank for every decade,
//       false otherwise.
//       A rank of 0 (unranked) is treated as a rank of 1001.
private boolean inSync(NameRecord other, int maxDiff) {
     assert other != null && this.numDecades() == other.numDecades()
          && maxDiff > 0 : "failed precondition, method inSync";
```

`// More room for inSync if necessary on next page`

4B(10 points) Complete an instance method in the `Names` class that returns an `ArrayList<String>` of all the names that are in sync with a given name based on a maximum allowed difference.

```
// pre: name != null, maxDiff >= 0
// post: return an ArrayList<String> of names that are in sync with
// the name. If name is not in this Names database return an empty
// ArrayList.
// The returned ArrayList will NOT contain name.
public ArrayList<String> getNamesInSync(String name, int maxDiff) {
```

For example given a maximum allowed difference of 100 per decade, the name Margaret is in sync with these names (Note, the list does NOT contain Margaret, the original name.):

Anna, Catherine, Charles, David, Edward, Edwin, Frank, George, Henry, Jack, James, John, Katherine, Laura, Martin, Mary, Paul, Peter, Raymond, Richard, Robert, Samuel, Thomas

The `Names` class you will use on this question is as follows:

```
public class Names {

     // the NameRecods in this Names object.
     private ArrayList<NameRecord> nameList;

     // return the NameRecord associated with name, ignoring case
     // if there is no NameRecord based on name, return null
     public NameRecord getName(String name)

}
```

From the `ArrayList` class:

```
public ArrayList() - construct an empty ArrayList

public int size() - returns the number of elements in this ArrayList

public E get(int pos)  - returns the element at the specified position in
this list. pre: 0 <= pos < size()

public boolean add(E obj) - add obj to the end of this ArrayList. Always
returns true.
```

You are not allowed to use any other methods from the `NameRecord`, `Names`, `String`, or `ArrayList` classes other than those shown above and on part A of the question. You may not use any other Java classes. (You may use native arrays if you would like.)

Complete the method on the next page.

Complete the following instance method for the `Name` class.

```
// pre: name != null, maxDiff >= 0
// post: return an ArrayList<String> of names that are in sync with
// the name. If name is not in this Names database return an empty
// ArrayList.
// The returned ArrayList will NOT contain name.
public ArrayList<String> getNamesInSync(String name, int maxDiff) {
     assert name != null && maxDiff >= 0 : "Failed precondition, "
          + "method getNamesInSync.";
```

Question 1 answer Sheet

Name_____

A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

G. _____

H. _____

I. _____

1.

2.

J. _____

1.

2.

K. _____

L. _____

M. _____

N. _____

O. _____