CISC 3115
Final Exam

Please complete the exam and submit it as a plain text email with the subject "CISC 3115 Final" to nzhou@brooklyn.cuny.edu by midnight on Monday, December 14.

Question 1 (25 points)

Does each of the following programs compile and run? If no, explain the reason. If yes, give the output.

1.
```
class P1 {
    public static void main(String[] args){
        String[] s = "hello";
        System.out.println(s);
    }
}
```

2.
```
class SuperP2 {
    void m(){
        System.out.println("m of SuperP2");
    }
}

class P2 extends SuperP2 {
    void m(){
        System.out.println("m of P2");
    }

    public static void main(String[] args){
        SuperP2 e = new SuperP2();
        e.m();
    }
}
```

3.
```
import java.util.*;

class P3 {
    ArrayList<Object> lst;

    public void add(Object obj){
        if (!lst.contains(obj))
            lst.add(obj);
    }

    public static void main(String[] args){
        P3 d = new P3();
        d.add(1); d.add(1);
        d.add(2); d.add(2);
    }
}
```

4.
```
class P4 {
    public static void main(String[] args){
        Integer[] a = {1,2,3};
        int s = 3;
        for (int e : a){
            s += e;
        }
        System.out.println(s);
    }
}
```

5.
```
public class P5 {
    static void pretty_print(String s){
        int n = s.length();
        if ( n <= 3) {
            System.out.print(s);
        } else {
            pretty_print(s.substring(0, n-3));
            System.out.print("," + s.substring(n-3));
        }
    }

    public static void main(String[] args){
        pretty_print("1234567890");
    }
}
```

Question 2 (20 points)

Assume the availability of a class named `Container` containing integer elements:

```
class Container {
    public Container();
    public boolean contains(int val);
    public boolean add(int val);
    public int getSize();
    public toString();
}
```

- The `contains` method returns `true` if `val` is in the container, and returns `false` otherwise.
- The `add` method adds a value to the container. This method always returns true.
- The `getSize` method returns the number of elements in the container.
- The `toString` method returns a string consisting of the elements of the container separated by commas.

Base on the above class, write a class named `Set`, which has the following API:

```
class Set extends Container {
    public Set();
    public boolean add(int val);
    public boolean isEmpty();
    public toString();
}
```

- The `add` method returns true if the value was added to the set, and false otherwise (note that a set does not allow duplicates).
- The `isEmpty` method returns true if the set is empty, and false otherwise.
- The `toString` method returns a string consisting of the elements of the container separated by commas, and surrounded by braces.

Question 3 (20 points)

Assume the availability of the following class `Rational`. Write a class named `ComparableRational` that extends the `Rational` class and implements the `Comparable` interface. The `compareTo` method compares `this` object with a given `ComparableRational` object mathmatically. For example, $1/3 < 1/2$.

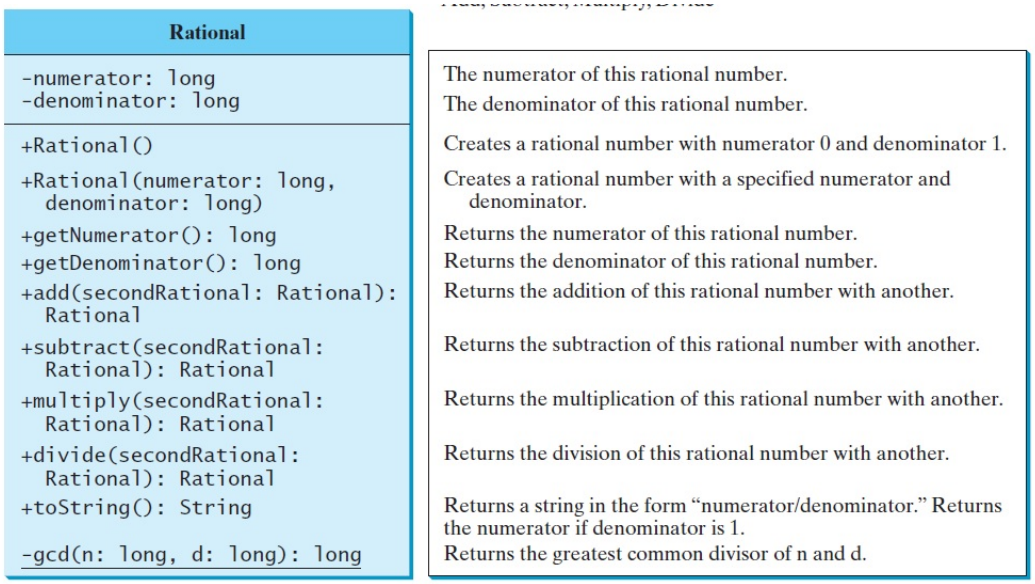

Figure 1: The `Rational` class

Question 4 (20 points)

In order to write a program to detect broken links, you need a function of the following specification:

```
public static ArrayList<String> hyperLinks(Scanner sc)
```

which takes a scanner that is linked to an HTML document, and returns a list of hyperlinks contained in the document. A hyperlink is defined by the HTML tag `<a>` with the following syntax:

```
<a href="url">link text</a>
```

For example, for the following document

```
<H3> Resources </H3>
<UL>
  <LI> <a href="http://docs.oracle.com/javase/tutorial/"> Java Online Tutorials</a>
  <LI> <a href="https://en.wikipedia.org/wiki/Object-oriented_programming"> OOP Wiki</a>
  <LI> <a href="https://www.courseduck.com/programming/java/"> CourseDuck's Java page</a>
</UL>
```

The returned list contains the following three hyperlinks:

```
"http://docs.oracle.com/javase/tutorial/",
"https://en.wikipedia.org/wiki/Object-oriented_programming"
"https://www.courseduck.com/programming/java/"
```

Implement the `hyperLinks` function.

Question 5 (15 points)

Consider the function:

```
public static long string_to_int(String s)
```

which converts a string to an integer. For example, for the string "123", it returns the integer 123. Give two different implementations of the function, one using recursion and the other using iteration.

There are several methods available in the Java library for the purpose. For example, the `valueOf(String)` method in the `Integer` class returns an `Integer` object, and the the `parseInt(String)` method in the `String` class returns a primitive integer value. You must not use any of these methods in the library. You are free to introduce auxiliary functions, if necessary.

Question 6 (extra 10 points)

Consider strings over the alphabet $\Sigma = \{a, b\}$. Write a function of the following specification:

```
int ArrayList<String> gen(int n)
```

which returns a list of all possible strings that contain the same number of a's as b's. For example, for `n = 3`, the returned list is empty, and for `n = 4`, the returned list is `["aabb", "abab", "abba", "baab", "baba", "bbaa"]`. The order of the strings in the list is not important.