Project 6— Implementation of Banker's Algorithm in Dealing with Deadlocks -**120 points**

(**Due date: 12/1/2010/Wednesday Midnight at Moodle**)

Your name:	Date:

In Chapter 7 (Deadlocks), we described the Banker's algorithm as one of the methods used for deadlock avoidance. In this project, we will write a Java program that implements the banker's algorithm: customers request and release resources from the bank and the banker will grant a request *only if it leaves the system in a safe state*. A request is denied if it leaves the system in an unsafe state.

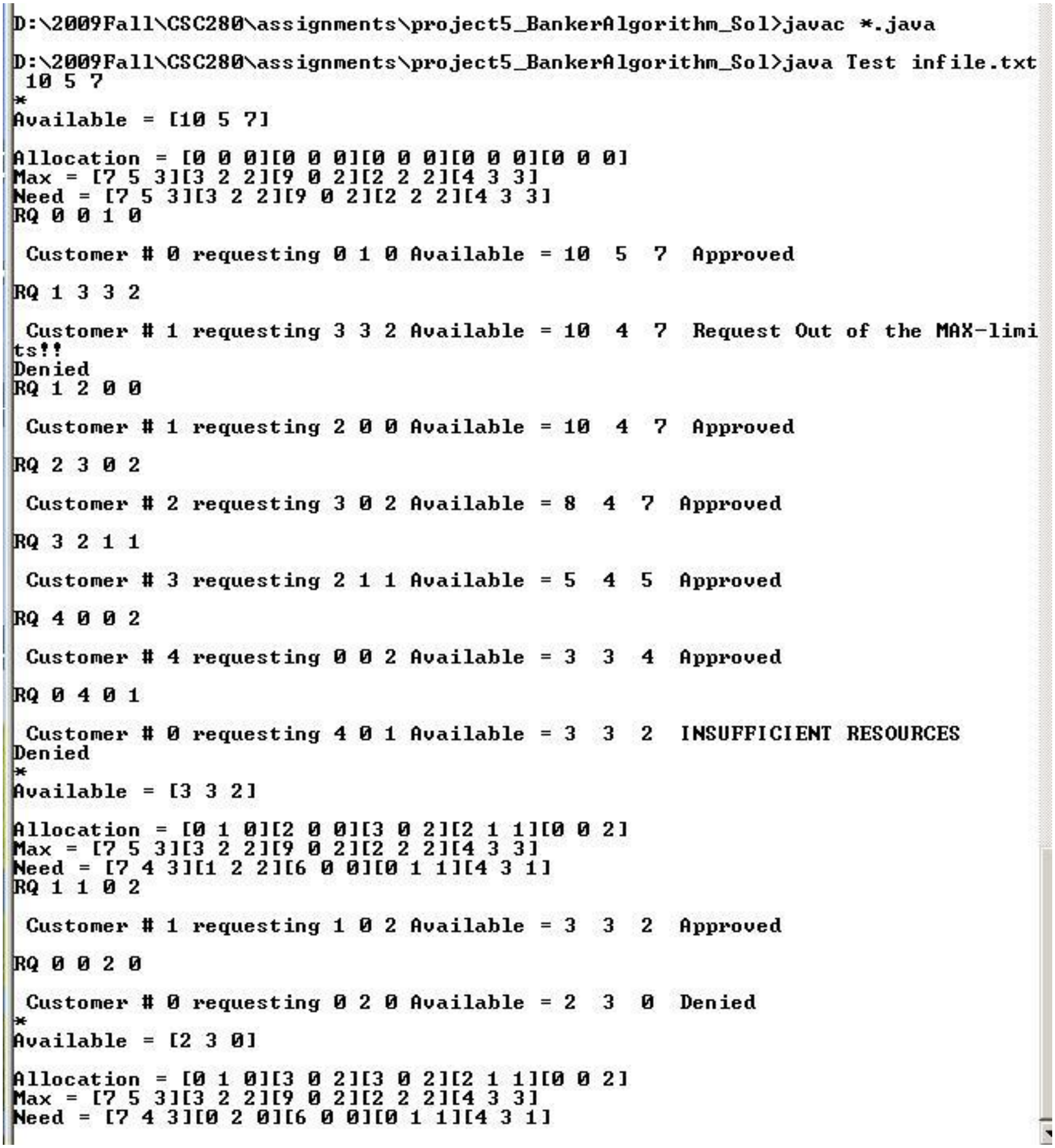
- The bank will employ the strategy outlined in the textbook whereby it will consider requests from ***n*** customers for ***m*** resources. The bank will keep track of the resources using the following data structures:
    - int [] available; //the available amount of each resource
    - int [] [] maximum; //the maximum demand of each customer
    - int [][] allocation; //the amount currently allocated to each customer
    - int [][] need; //the remaining needs of each customer
- The functionality of the bank appears in the interface defined in "**Bank.java**" file.
    - The implementation of this interface (in a Java file called "**BankImpl.java**", which you are required to complete) will require adding a *constructor* that is passed the number of resources initially available. For example,
        - Suppose we have three resource types with 10, 5, and 7 resource instances initially available. In this case, we can create an implementation of the interface using the following technique:
            - Bank theBank = new BankImpl(10, 5, 7);
    - The bank will grant a request if the request satisfies *the safety algorithm* outlined in the textbook; if granting the request does not leave the system in a safe state, the request is denied.
- Testing your implementation:
    - There is a test input data file called "**infile.txt**" that contains the maximum demand for each customer. The file appears as follows:

```
7,5,3
3,2,2
9,0,2
2,2,2
4,3,3
```

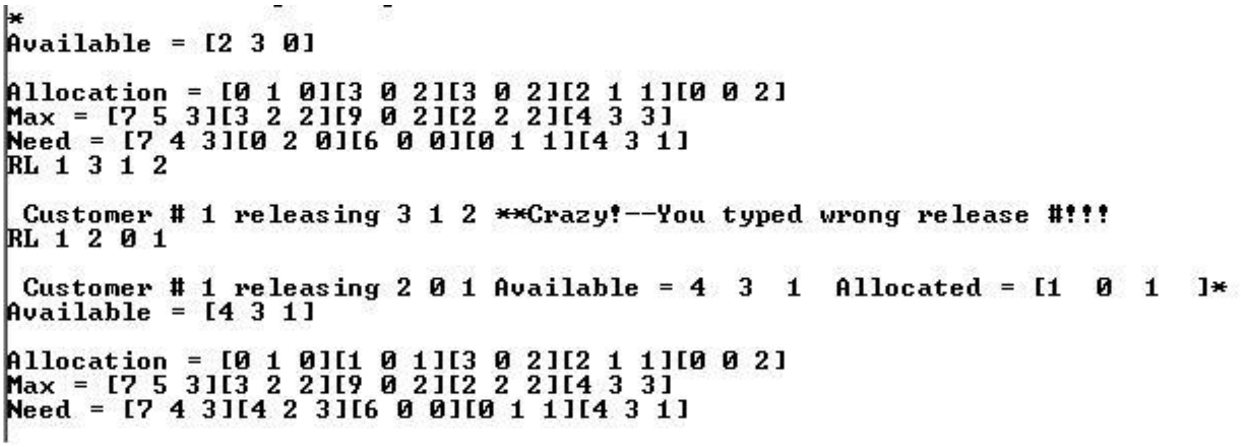
- This means the maximum demand for customer0 is 7, 5, 3; for customer1, 3, 2, 2; and so forth.
- Since each line of the input file represents a separate customer, the ***addCustomer***() method is to be invoked as each line is read in, initializing the value of maximum for each customer:
    - maximum[0][] is initialized to 7, 5, 3,
    - maximum[1][] is initialized to 3, 2, 2,
    - … …

- Furthermore, **Test.java** also requires the initial number of resources available in the bank. For example, if there are initially 10, 5, and 7 resources available, we invoke Test.java as follows:
  - **java Test infile.txt 10 5 7**

- The following shows the process on how to run this process, provide inputs and read the outputs from the program:



```
D:\2009Fall\CSC280\assignments\project5_BankerAlgorithm_Sol>javac *.java

D:\2009Fall\CSC280\assignments\project5_BankerAlgorithm_Sol>java Test infile.txt
 10 5 7
*
Available = [10 5 7]

Allocation = [0 0 0][0 0 0][0 0 0][0 0 0][0 0 0]
Max = [7 5 3][3 2 2][9 0 2][2 2 2][4 3 3]
Need = [7 5 3][3 2 2][9 0 2][2 2 2][4 3 3]
RQ 0 0 1 0

 Customer # 0 requesting 0 1 0 Available = 10  5  7  Approved

RQ 1 3 3 2

 Customer # 1 requesting 3 3 2 Available = 10  4  7  Request Out of the MAX-limi
ts!!
Denied
RQ 1 2 0 0

 Customer # 1 requesting 2 0 0 Available = 10  4  7  Approved

RQ 2 3 0 2

 Customer # 2 requesting 3 0 2 Available = 8  4  7  Approved

RQ 3 2 1 1

 Customer # 3 requesting 2 1 1 Available = 5  4  5  Approved

RQ 4 0 0 2

 Customer # 4 requesting 0 0 2 Available = 3  3  4  Approved

RQ 0 4 0 1

 Customer # 0 requesting 4 0 1 Available = 3  3  2  INSUFFICIENT RESOURCES
Denied
*
Available = [3 3 2]

Allocation = [0 1 0][2 0 0][3 0 2][2 1 1][0 0 2]
Max = [7 5 3][3 2 2][9 0 2][2 2 2][4 3 3]
Need = [7 4 3][1 2 2][6 0 0][0 1 1][4 3 1]
RQ 1 1 0 2

 Customer # 1 requesting 1 0 2 Available = 3  3  2  Approved

RQ 0 0 2 0

 Customer # 0 requesting 0 2 0 Available = 2  3  0  Denied
*
Available = [2 3 0]

Allocation = [0 1 0][3 0 2][3 0 2][2 1 1][0 0 2]
Max = [7 5 3][3 2 2][9 0 2][2 2 2][4 3 3]
Need = [7 4 3][0 2 0][6 0 0][0 1 1][4 3 1]
```



```
*
Available = [2 3 0]

Allocation = [0 1 0][3 0 2][3 0 2][2 1 1][0 0 2]
Max = [7 5 3][3 2 2][9 0 2][2 2 2][4 3 3]
Need = [7 4 3][0 2 0][6 0 0][0 1 1][4 3 1]
RL 1 3 1 2

 Customer # 1 releasing 3 1 2 **Crazy!--You typed wrong release #!!!
RL 1 2 0 1

 Customer # 1 releasing 2 0 1 Available = 4  3  1  Allocated = [1  0  1  ]*
Available = [4 3 1]

Allocation = [0 1 0][1 0 1][3 0 2][2 1 1][0 0 2]
Max = [7 5 3][3 2 2][9 0 2][2 2 2][4 3 3]
Need = [7 4 3][4 2 3][6 0 0][0 1 1][4 3 1]
```

- After you typed “java Test infile.txt 10 5 7” with an Enter key, you may:
  - Type “*” key for the program to show the current state information;
  - Provide Request with “RQ customer# r1 r2 r3”
    - For example: “RQ 0 2 1 3” means “customer0 requests resources 2 1 3”.
  - Release resources with “RL customer# r1 r2 r3”
    - For example, “RL 2 3 0 2” means “customer2 releases resources 3 0 2”
  - At anytime, you can type “*” to display the current state of the system.

What you need to do in this project:

1. Download the accompanied zipped file and expand it and you will find the following files:
   a. “Bank.java”—the interface that you will implement upon
   b. “infile.txt”—input data file that gives the maximum demand for each customer
   c. “Test.java”—used for testing your implementation
   d. “**BankImpl.java**”—the ***only java program that you will need to complete***. This program is supposed to implement the interface “Bank.java”. At this time, only a skeleton is provided and it is your job to complete and test it.
2. Complete the “**BankImpl.java**” based on the “Bank.java” interface and the data structures mentioned above (*available, maximum, allocation,* and *need* arrays at the beginning).
3. You will definitely use “Test.java” to test your implementation:
   a. Read this program thoroughly. You will get some ideas on how to implement “BankImpl.java.”
   b. Don’t change to code.
4. You must use Test.java to test you program by using:

   java Test infile.txt 10 5 7
5. Provide some requests and releases to the program and record the results by taking a screenshot (use the sample output shown in the previous page).
6. You **must use Bank.java, Test.java, infile.txt** ***without changing*** their contents for this project.
7. You must ***do necessary boundary checks*** when requesting and releasing resources as shown in the second screenshot above.
8. In addition to completing **BankImpl.java**, a **readme** file (PDF or Doc or DOCX format) is required for your submission. Check the following on how to submit your project.

   a. In the sample code, the “thread” name, in fact, means a “customer”. To use “thread”, this sample code can be readily modified to a multithreaded program which is NOT required in this project. Synchronized method is NOT required.

9. At least **two screenshots** are required in your **readme** file to show a comprehensive input/output procedure including boundary checks.

====================How To Submit—Read Carefully, Pease!!============

1. Create a directory “**project6_YourLastName**” (you must use this format for the directory name for this project; **Use Your Last Name.**
2. When having finished your project, copy **all the source files (*.java)** to these subdirectories, respectively—you should keep this folders clean: ***only source code*** files included.
3. **A “readme” file is required** for the project write-up that tells how to compile/run the programs and result screenshots … *keep this readme simple*!
4. Compress directory “**project6_YourLastName**” and its contents into a **zip** or **rar** file with same name.
5. Submit the compressed file at Moodle.
6. **Penalty** for NOT following these submission instructions (10% ~100%).