



COMP 6231

Distributed System Design

Assignment 1 Report

Distributed Class Management System (DCMS) using Java RMI

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By

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Technique used

- We used **Java RMI (Remote Method Invocation)** to implement the communication between Manager/Clients and servers (MTL, LVL and DDO).
- We used **UDP** to implement the communication between servers for counting Records on each server
- We used **HashMap** to store the records of teachers and students.
- We used **multithreading** technique so that multiple clients can act simultaneously.
- We used **synchronization and semaphore** technique to keep the integrity of data while modifying it, so the server can maximize the concurrency.

Design architecture

CenterServer

Main interface file that defines all the operations that can be used by the managers(Clients of this system).

- createTRecord
- createSRecord
- getRecordCounts
- editRecord
- displayAllRecords
- displayRecord

MTL/LVL/DDOClass

These files implement the CenterServer and extend `java.rmi.server.UniCastRemoteObject`. All the functions defined in the CenterServer are implemented here. Some other functions are also defined here, i.e. `validRecordID()`, `dateFormatChecker()` (Date format checker for attribute `statusDate` of Student Record), `setUpHashMap()` (initialising HashMap here) and `findRecord()`.

MTL/LVL/DDOSever

These files are responsible for getting the server up and running.

Server name, number and port are assigned here. The specific `<server>Class's` object is created here and binding of registry takes place.

As a starting point, some records are created here (by some default managerID like MTL/LVL/DDO0000) to fill the initial database. There are direct method invocations here, so we have also put validations in the MTL/LVL/DDOClass files.

MTL/LVL/DDOClient

These files contain client specific code. Here choices are provided to the user (manager) for which operation is to be performed. Validation of inputs is provided in these files.

ManagerClient

This file is the starting point of the application. This file asks for the mangerID whose prefix (first 3 characters) are used to run the server. If the managerID is MTL1234, then MTL Server will be up and running and so on for other two servers. Here, validation of managerID takes place, if it is not in the format MTL/LVL/DDO followed by four digits, then it won't work.

Record

Record class used to create TeacherRecord and StudentRecord (subclasses). It has two main attributes of Record, RecordID and Name. Also, a toString() method is defined to appropriately format and print the data for the Client.

TeacherRecord

This class is used for storing various details of Teachers. It stores the following details of a student: First Name, Last Name, Address, Phone number, Specialization, Location. Similar to the Record class, Student Record class has a toStringT() method which formats and prints the data for the client.

StudentRecord

This class is used for storing various details of Students. It stores the following details of a student: First Name, Last Name, Courses he is registered in, status, status date. Similar to the Record class, Student Record class has a toStringS() method which formats and prints the data for the client.

Log

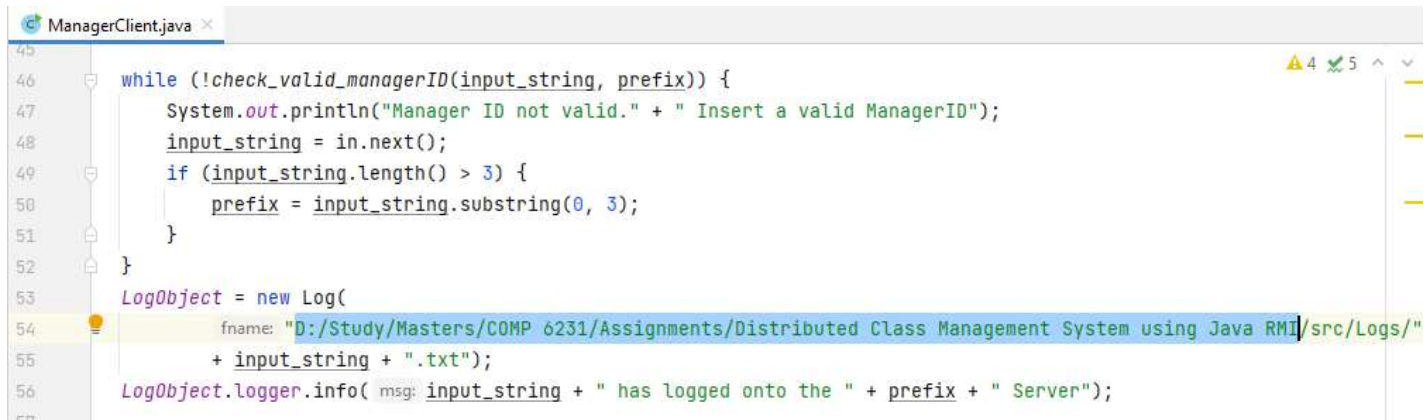
This file is used to create log files and add information of all activities taking place in the application.

Server logs are named as MTL.txt, LVL.txt, DDO.txt and are saved in the root folder (src). Client logs are saved as per the managerID used and are saved in the folder of "Logs". The path to the Logs folder has to be set in the ManagerClient file before running the application.

Before starting the application

We have used IntelliJ IDEA Community edition for development of this application.

Open ManagerClient.java file. Replace the log file location that is **exactly highlighted in blue (till /Logs/)** in the image below to the location (path) where you have extracted the folder in your computer.



```

45
46 while (!check_valid_managerID(input_string, prefix)) {
47     System.out.println("Manager ID not valid." + " Insert a valid ManagerID");
48     input_string = in.next();
49     if (input_string.length() > 3) {
50         prefix = input_string.substring(0, 3);
51     }
52 }
53 LogObject = new Log(
54     fname: "D:/Study/Masters/COMP 6231/Assignments/Distributed Class Management System using Java RMI/src/Logs/"
55     + input_string + ".txt");
56 LogObject.logger.info( msg: input_string + " has logged onto the " + prefix + " Server");
57

```

Starting the application

- 1) Open command prompt
- 2) cd into the folder extracted
- 3) Run "javac ManagerClient.java"
- 4) start rmiregistry
- 5) run "java ManagerClient"

Data structures

Array List

All the details of students and teachers are stored in an array list

HashMap

It consists of an id (string type) as the key and values are Array Lists that contain the records of students and teachers itself.

Test Scenarios

The ManagerClient is used to start the application. According to the ManagerID provided, the server will run (prefix of the ID).

After this, the manager will be allowed to use the operations displayed to him in a menu based way.

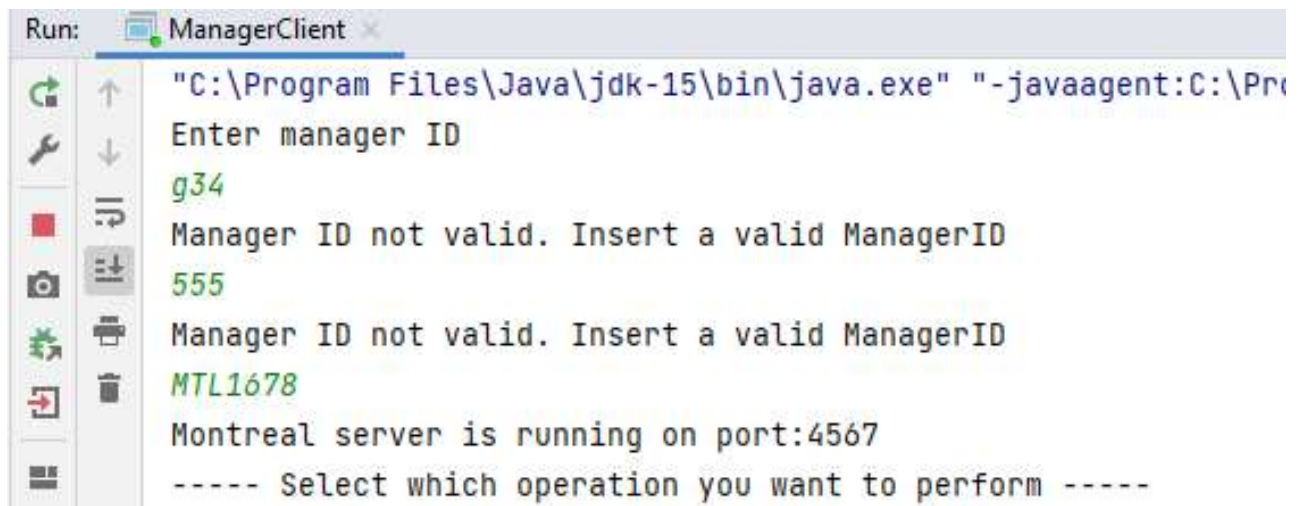
For the entire application we have created functions that test several inputs:

- validRecordID()
- hasNumbers()
- dateFormatChecker()
- hasAlpha()

These functions test the conditions on the input provided by the user to the system.

Some examples are as follows:

- Manager ID only valid in the format (MTL/LVL/DDO followed by four digits)



```
Run: ManagerClient x
"C:\Program Files\Java\jdk-15\bin\java.exe" "-javaagent:C:\Pro
Enter manager ID
g34
Manager ID not valid. Insert a valid ManagerID
555
Manager ID not valid. Insert a valid ManagerID
MTL1678
Montreal server is running on port:4567
----- Select which operation you want to perform -----
```

- First Name and Last name are validated in the same way. (Both can not be empty and can't contain numbers)

Enter First name:

St12

A name can not contain numbers, please insert valid input.

Stallone

Enter Last name:

we12

A name can not contain numbers, please insert valid input.

Mecwan

Enter Address:

.

- Phone number must be in this format only, otherwise it would not be accepted

Enter Phone number in the format (514-888-9999):

8866429090

Invalid phone number

Try another

514-898-0000

Specialization courses:

|

- Only these values in status are accepted: (active, Active, Inactive, inactive)

Enter Status of the student:

act

Status inserted is not accepted, please enter (active or inactive).

inactive

Enter status date: (format - dd/mm/yyyy)

|

- Status date would be only accepted in this format dd/mm/yyyy:

Enter status date: (format - dd/mm/yyyy)

4/4/98

Invalid date format, please insert again in this format dd/mm/yyyy

04/16/1998

Invalid date format, please insert again in this format dd/mm/yyyy

The first case representing that 04/04/1998 is not provided

The second case representing that month (mm) cannot exceed 12.

- Location can be only MTL or LVL or DDO.

Enter Location:

Either of them (MTL, LVL, DDO)

mtl

Invalid location entered

Try another

edr

Invalid location entered

Try another

MTL

- Record ID must be in the format (TR/SR followed by five numbers)

3

Enter the recordID of the record you want to edit:

TR100

Invalid recordID, insert a valid ID

TR10TR10

Invalid recordID, insert a valid ID

TR10000

Enter name of the field you want to change:

Enter in this format: address, phone, specialization, location

,

- Below is a demonstration of creating teacher record with its log created

1

Enter First name:

ABC

Enter Last name:

XYZ

Enter Address:

Montreal, QC

Enter Phone number in the format (514-888-9999):

514-898-1234

Specialization courses:

DSD

Enter Location:

Either of them (MTL, LVL, DDO)

DDO

Enter the recordID of the record to display:

TR10003

Record ID: TR10003 Name: ABC XYZ

Address: Montreal, QC Phone: 514-898-1234

Specialization: DSD Location: DDO

INFO: MTL1212 created a teacher record ID:TR10003

Jun. 13, 2021 7:29:35 P.M. ServerImplementation.MTLClass displayAllRecords

INFO: MTL1212 has displayed all records

Jun. 13, 2021 7:29:42 P.M. ServerImplementation.MTLClass displayRecord

INFO: MTL1212 has displayed record TR10003

- Below is a demonstration of edit record function with its log created:

3

Enter the recordID of the record you want to edit:

TR10003

Enter name of the field you want to change:

Enter in this format: address, phone, specialization, location

address

What value you want to change to:

Toronto, ON

5

Enter the recordID of the record to display:

TR10003

Record ID: TR10003 Name: ABC XYZ

Address: Toronto, ON Phone: 514-898-1234

Specialization: DSD Location: DDO

Jun. 13, 2021 7:33:15 P.M. ServerImplementation.MTLClass editRecord

INFO: MTL1212 edited a Teacher record ID:TR10003

Jun. 13, 2021 7:33:23 P.M. ServerImplementation.MTLClass displayRecord

INFO: MTL1212 has displayed record TR10003

- Below is a demonstration of creating student record with its log created

2

Enter First name:

LMN

Enter Last name:

OPQ

Name courses the student is registered in:

Algorithms

Enter Status of the student:

active

Enter status date: (format - dd/mm/yyyy)

12/12/2020

4

Record ID: TR10001

Name: Zeal Agrawal

Record ID: SR10000

Name: Stallone Mecwan

Record ID: SR10004

Name: LMN OPQ

Record ID: SR10002

Jun. 13, 2021 7:34:36 P.M. ServerImplementation.MTLClass createSRecord

INFO: MTL1212 created a student record ID:SR10004

Jun. 13, 2021 7:36:31 P.M. ServerImplementation.MTLClass displayAllRecords

INFO: MTL1212 has displayed all records

- Below is the demonstration of displayAllRecords function:

```
4. Display all records
5. Displaying a record
6. Display total Record count of all servers.
7. Exit.
```

```
4
```

```
Record ID: TR10001
Name: Zeal Agrawal
Record ID: SR10000
Name: Stallone Mecwan
Record ID: SR10002
Name: Meet Patel
Record ID: SR10003
Name: Bhoomi Sehra
Record ID: TR10000
Name: Teja Sehra
Record ID: TR10002
Name: Pavit Singh
Record ID: SR10001
Name: Vandit Thakkar
```

```
Jun. 13, 2021 7:23:52 P.M. ServerImplementation.MTLClass displayAllRecords
INFO: MTL1212 has displayed all records
```

- This is how we can get total number of records of ever server:

```
6. Display total Record count of all servers.
7. Exit.
```

```
6
```

```
Laval Server was not running, so running it now to get the record count.
Laval server is running on port:4568
DDO Server was not running, so running it now to get the record count.
Dollard des server is running on port:4569
MTL 7, LVL 12, DDO 12.
```

```
Jun. 13, 2021 7:22:03 P.M. ServerImplementation.MTLClass getRecordCounts
INFO: MTL1212 has retrieved the total record count
```

The application requires all the servers to start before getRecordCount method is used due to which if only one server is running, and client tries to retrieve the count, all the remaining servers are started.

Important part/ Difficulty

We initially used `HashMap<Character, ArrayList>` due to which everytime during creation of records, `NullPointerExceptions` were thrown.

This was solved by using a `HashMap<String, ArrayList>`.

The application uses synchronized methods for some operations, while using semaphore alongside. This was due to the fact that removing semaphore and replacing with synchronized blocks made the application run into infinite loop and the console hanged. This was the most difficult part to figure out.