



Concordia University
Department of Computer Science and Software Engineering
Comp 5461 – Operating Systems
Summer 2025

Programming Assignment 1
Submission through Moodle
Due Date: 29 June 2025 @ 23:59.

Objectives

This is an introductory assignment to operating systems and Java. You will simply use Java while grasping concurrency and atomicity concepts.

Tools

You will use Java 1.5 or later for this assignment. You can work on the assignment on any machine you wish (i.e., personal laptop) as long as you use Java 1.5 or a later version, and the assignment works in the lab as expected. You can also use any source code editing & compiling tools, such as TextPad, vim, Emacs, Eclipse, JBuilder, NetBeans, etc. All these tools have easy configurable convenient syntax highlighting. You can use whichever you prefer but you need to make sure that your programs run as expected at the Concordia lab before you submit them.

Setting Up Your Environment

To work in the labs, you will need to set up your environment first, which will be explained in the first tutorial. If you require help - don't hesitate to ask your lab instructor for it!

Source Code

There are four files provided with the assignment. You will need these files to work on the assignment. A soft copy of the needed code is available for download from the course web site.

File Checklist

- Account.java
- AccountManager.java
- Depositor.java
- Withdrawer.java

Background

To begin, realize that this assignment is “a bit” artificial in a sense, and should only be considered for learning purposes. In this assignment, we deal with concurrent execution of multiple threads operating on a shared data structure (Accounts). You will be learning more of Java along the way.

An array of accounts hold 10 account information (imagine like OS resources of the same type). The account array has a valid state once it is initialized. We will employ 10 threads for deposit and 10 threads for withdrawal; each thread is bound to a specific account. There will be one *depositor* thread and one *withdrawer* thread that are bound to one specific account. The depositor is responsible for depositing X amount to the account and the withdrawer is responsible for withdrawing the same X amount from the same account. As a result of running 20 threads the final accounts’ balance/state should be the same as initial accounts’ balance/state. The main goal is to maintain the accounts’ state valid regardless of the number of the concurrent threads accessing them, and regardless of their order.

E.g.: of consistent run

Print initial account balances

Account: 1234	Name: Mike	Balance:	1000.0
Account: 2345	Name: Adam	Balance:	2000.0
Account: 3456	Name: Linda	Balance:	3000.0
Account: 4567	Name: John	Balance:	4000.0
Account: 5678	Name: Rami	Balance:	5000.0
Account: 6789	Name: Lee	Balance:	6000.0
Account: 7890	Name: Tom	Balance:	7000.0
Account: 8901	Name: Lisa	Balance:	8000.0
Account: 9012	Name: Sam	Balance:	9000.0
Account: 4321	Name: Ted	Balance:	10000.0

Depositor and Withdrawal threads have been created

Print final account balances after all the child thread terminated...

Account: 1234	Name: Mike	Balance:	1000.0
Account: 2345	Name: Adam	Balance:	2000.0
Account: 3456	Name: Linda	Balance:	3000.0
Account: 4567	Name: John	Balance:	4000.0
Account: 5678	Name: Rami	Balance:	5000.0
Account: 6789	Name: Lee	Balance:	6000.0
Account: 7890	Name: Tom	Balance:	7000.0
Account: 8901	Name: Lisa	Balance:	8000.0
Account: 9012	Name: Sam	Balance:	9000.0
Account: 4321	Name: Ted	Balance:	10000.0

Elapsed time in milliseconds 13900

Elapsed time in seconds is 13.9

E.g.: of non-consistent run

Print initial account balances

Account: 1234	Name: Mike	Balance:	1000.0
Account: 2345	Name: Adam	Balance:	2000.0
Account: 3456	Name: Linda	Balance:	3000.0
Account: 4567	Name: John	Balance:	4000.0
Account: 5678	Name: Rami	Balance:	5000.0
Account: 6789	Name: Lee	Balance:	6000.0

Account: 7890	Name: Tom	Balance: 7000.0
Account: 8901	Name: Lisa	Balance: 8000.0
Account: 9012	Name: Sam	Balance: 9000.0
Account: 4321	Name: Ted	Balance: 10000.0

Depositor and Withdrawal threads have been created
 Print final account balances after all the child thread terminated...

Account: 1234	Name: Mike	Balance: -9180.0
Account: 2345	Name: Adam	Balance: 2000.0
Account: 3456	Name: Linda	Balance: -9.953971E7
Account: 4567	Name: John	Balance: 1.00004E8
Account: 5678	Name: Rami	Balance: -3.682011E7
Account: 6789	Name: Lee	Balance: 6000.0
Account: 7890	Name: Tom	Balance: -6.951315E7
Account: 8901	Name: Lisa	Balance: -9.087615E7
Account: 9012	Name: Sam	Balance: 1.00009E8
Account: 4321	Name: Ted	Balance: -9.631527E7

Elapsed time in milliseconds 139
 Elapsed time in seconds is 0.139

There are 20 threads accessing the accounts concurrently. One depositor threads deposit into account # 1234 the amount 10 CAD * 10000000 iterations. On the other side, one withdrawer thread withdraws from account # 1234 the same amount 10 CAD * 10000000 iterations. The rest 9 depositor threads and 9 withdrawer threads perform the same operations over the other 9 accounts.

Tasks

Task 1: Atomicity Bug Hunt

Compile and run the Java app given to you as it is. Explain why the main requirement above (i.e. consistent state of the account array) is not met. What atomicity problem does it pose? Find the bug that causes it. In no more than three sentences, explain what went wrong.

Task 2: Starting Order

Explain, in about one sentence, what determines the start order of the threads. Also, very briefly, explain the lifetime of a thread: its creation, execution, and termination. Experiment with the start order of any of the threads. Is the consistency of the accounts preserved?

Task 3: Method level synchronization

Create a package and name it task3 and copy the provided java files into that new package. Use synchronized technology (method level synchronization) in order to introduce a solution to the problem at hand.

Task 4: Block level synchronization

Create a package and name it task4 then copy the java files from task 3 into that new package. Use synchronized technology (block level synchronization) in order to improve the solution to the problem at hand.

Task 5: synchronized block vs synchronized method

Considering the results of task 3 and task 4, what is the advantage of synchronized block over synchronized method?

Deliverables

IMPORTANT: You are allowed to work on a team of 2 students at most (including yourself!). You and your teammate must be in the same section. Any teams of 3 or more students will result in 0 marks for all team members. If your work on a team, ONLY one copy of the assignment is to be submitted for both members. You must make sure that you upload the assignment to the correct link of **Programming Assignment 1** using Moodle.

Naming convention for uploaded file: Create one zip file, containing all needed files for your assignment using the following naming convention:

The zip file should be called *a#_studentID*, where # is the number of the assignment *studentID* is your student ID(s) number. For example, for the first assignment, student 1234567 would submit a zip file named *a1_1234567.zip*. If you work on a team and your IDs are 1234567 and 4567890, you would submit a zip file named *a1_1234567_4567890.zip*.

Submit your assignment electronically via Moodle based on the instruction given above. **Please see course outline for submission rules and format, as well as for the required demo of the assignment.** A working copy of the code and a sample output should be submitted for the tasks that require them. A text file with answers to tasks 1 to 3 should be provided. Put it all in a file layout as explained below, archive it with any archiving and compressing utility, such as WinZip. **You must keep a record of your submission confirmation.** This is your proof of submission; which you may need should a submission problem arises.

Finally, please notice that a demo, for about 10 minutes, is required with the marker. Both team members must be present for the demo. Failing to demo your assignment will result in zero mark regardless of your submission.

Possible file layout:

pa1.txt	-- Tasks 1, 2 and 5 theory components (can be .doc as well)
task3/	
*.java	-- Fixed Java code
before.out	-- Buggy output
after.out	-- Output after the code has been fixed
task4/	
*.java	-- Fixed Java code
before.out	-- Output after the code has been fixed in task 3
after.out	-- Output after the code has been improved for exceptions

Zip all files into a file called *pa1.zip*, and submit that file electronically using Moodle system. If you work on a team, only one of the members should submit the assignment. Do not submit two copies.

Grading Scheme

Grading Scheme:

T#	MX	MK

1	/1	
2	/1	
3	/3	
4	/3	
5	/1	
General	/1	

Total:

(T# - task number, MX - max (out of), MK - your mark)

References

API: <http://java.sun.com/j2se/1.3/docs/api/>