008

Threads Synchronization

Operating Systems

Lab008 Threads Synchronization

(Multi-Threaded Banking System)

Objective

The goal of this lab is to introduce students to **thread synchronization** using **locks (mutexes) and joins**. By simulating a **banking system**, students will learn how to handle **data consistency** and prevent **race conditions** when multiple threads access shared resources.

Scenario: Multi-Threaded Banking System (Account Transactions with Multiple ATMs)

A bank has multiple ATM machines that allow customers to deposit or withdraw money from their accounts. These ATMs operate simultaneously and process transactions in parallel.
However, since multiple ATMs may access the same account at the same time, race conditions could occur, leading to inconsistent balances (e.g., an account going negative or transactions being lost).
To ensure data consistency, we need to:

- Use locks (mutexes) to protect the shared bank account balance.
- Use thread joins to ensure all transactions are completed before printing the final balance.

Assignment Tasks

1. Implement a Shared Bank Account

- Create a global bank account structure that stores:
  - The account balance.
  - A mutex (lock) to protect balance updates.
  - The system needs to handle more than one account.

2. Simulate ATM Machines as Threads

- Each ATM machine runs in a separate thread.
- Each ATM processes random transactions (deposits and withdrawals).
- Each transaction can affect one of the many accounts available.

3. Implement Thread Synchronization

- Use locks (mutexes) to prevent race conditions when modifying the balance.
- Use thread joins to ensure all ATMs finish processing before displaying the final account balance.

4. Login system and error handling

- Implement a thread-safe logging system where each transaction is logged to a shared file.
- Handler for transaction failures (e.g., insufficient funds, account does not exist).
- Log file output format:

```
[Fri Mar 14 10:40:19 2025] Withdrew $47.00 from Account 0 | New Balance: $1051.00
[Fri Mar 14 10:40:19 2025] Withdrew $51.00 from Account 2 | New Balance: $1047.00
[Fri Mar 14 10:40:19 2025] Deposited $21.00 to Account 1 | New Balance: $1051.00
[Fri Mar 14 10:40:19 2025] Transferred $14.00 from Account 1 to Account 0
[Fri Mar 14 10:40:19 2025] Deposited $72.00 to Account 2 | New Balance: $1119.00
[Fri Mar 14 10:40:20 2025] Transaction Failed: Insufficient funds | Account 2
```

5. Final report

- At the end, display the total balance per account.