Your task is to simulate a shopping service by synchronizing the product sales, reservations and cancellations.

There are customers and sellers who can make the following operations:

- Buy product
- Reserve product
- Cancel reservation

At the end of the simulation, the shopping system should give a summary of the operations on the products by all customers and sellers, so that you can check whether there are inconsistencies. During a specified period, operations will be simulated. The operations consist of buying products, reserving products and canceling reservations. The customers can only see their accounts and do all the operations on their accounts. On the other hand, the sellers can see all customers' accounts and also, can make all the operations. The important point is to preserve the consistency in customer accounts during concurrent access to the accounts with the operations using suitable synchronization primitives.

You are asked to implement such a shooping service simulation performed during a period, using PThreads library primitives. Each customer and seller of the company should be implemented as a separate thread. At the end of the service simulation, the initial thread prints out the transactions for each customer, number of transactions of each customer and seller, and total products, reserved and cancelled of the company.

Details:

- You should implement each customer and seller as a separate thread. The initial main thread is responsible for creating customer/seller threads, managing them, and displaying the final results as soon as the simulation completes.

- Note that, shared resources among multiple threads are products (i.e., number of instances of each product) and *preserving consistency* and *preventing deadlocks* are major issues.
- We suggest you to pick the number of operations and operation types to be performed by each customer/seller in *random* manner in your simulation.
- When the customer cancels a reservation, it can tell the seller either the transaction id of the reservation to be canceled or give the reservation details to be canceled. Cancellation can only be made if both the reservation and cancellation are done on the same day.
- The total simulation time is D days. All the transactions within that period will be logged in a file.
- There are C customers and S sellers with unique IDs used by the shopping system. Customer accounts also have unique IDs like the products.
- Number of simulation days, customers, sellers and product information would be taken from the input file. Input file format is described below.
- Assume that 10 seconds correspond to one simulation day.
- All sellers know the IDs of all the customers. These sellers have all access rights on the accounts of the all customers.
- A customer can only access to her/his own account for viewing/buying/reserving/canceling.
- The company has a limitation for the products that can be reserved from each account. However, there is no such limit for buying products. Customers cannot reserve more than a total of R products on a day.
- There can be a maximum of T operations from each customer account during a day. Each customer can have a different membership, so T may vary from customer to customer. Similarly, R may vary as well. (See the input file description). There is no limit on the number of operations done by a seller.
- In your implementation of buy/reserve (multiple) products operations, make sure that a solution for *deadlock prevention* is taken into account.
- All operations should be performed in a *mutually exclusive* way.
- When the simulation is finished for the given number of days, the following should be available in a log file:
  - For each transaction, there should be a line of information in the log file in the following format:

      C_ID Operation   Simulation_Day

- o Number of transactions performed by each customer and seller.
- o Total number of products sold/reserved and reservations canceled.

    Ex: Product #1   20   40   10

           ....

          Product #N   20   40   10

Input File Format: (input.txt)

6 Number of customers

5 Number of sellers

5 Number of simulation days

8 Number of products

22

33

18

17

24

34

23

15

1 5 6

2 8 10

3 3 4

4 5 6

5 3 5

6 4 5

Lines 5 – 12 shows the number of instances of product 1 – product 8.

Lines 13 – 18 shows customer information described below:

Customer ID   # of operations allowed   # of reservable products

# of operations allowed (T): How many operations this customer can make during a day.

# of reservable products (R): How many products in total this customer can reserve during a day.