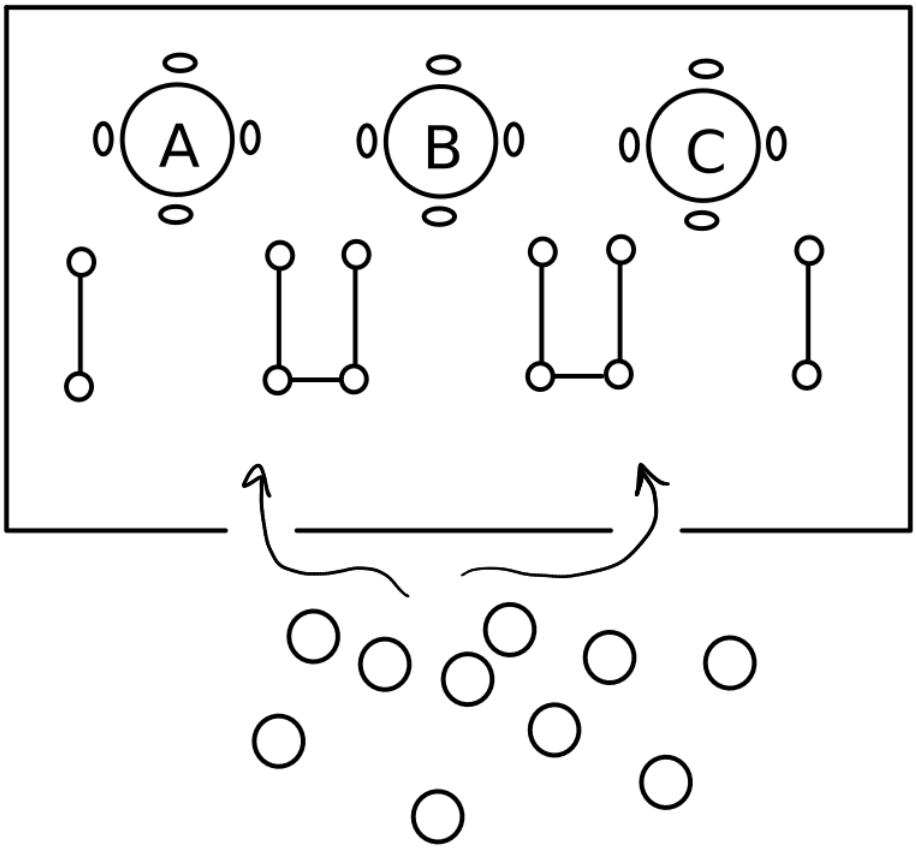
Computer Systems Overview

Due: Friday, October 22nd 11:59pm

1 Description

Imagine there is a restaurant with three tables. Table A serves seafood, table B serves steak, and table C serves pasta. Each table can fit four people. Everyone must choose the table they want to eat at, and stand in its line. Each customer has an idea of which table they want to eat at, and may have a backup choice in case it is too busy. When the customer enters the restaurant through one of it's two doors (which fit one person at a time) they look at the lines for the tables they want. If their first choice has a long line (7 or more) they will choose their second choice (if they have one) if it is not also long. Otherwise they will always choose their first choice. Once their table is chosen, the customers stand in line for that table getting one of the four seats when it is their turn. After the customer sits at the table, they will call the waiter. The waiter will go to the table to take the order, go to the kitchen to deliver the order, and after some time will bring the order back to the table. The customers at the table will then eat, leave the table, pay, and then leave the restaurant.



2 Details

You should program a single application in c,c++, java, or python. The program will simulate the restaurant using threads for the waiters and customer. If you program in c or c++, use pthreads and POSIX semaphores. If you program in java use the Thread and Semaphore classes. If you use python, use the threading module, and threading.Semaphore for synchronization.

You should set-up the simulation and then launch 3 waiter threads followed by 40 customer threads. At creation each thread will be given an id that uniquely distinguishes it from other threads of the same type (waiter or customer). You will need some shared variables to exchange information and synchronization. In particular, several semaphores must be used to synchronize the behavior of the threads.

Both the waiter and the customer will have times it will wait. The wait time is given as a range. You should randomly select a time within the range when you reach that step.

2.1 The Waiter

1. The waiter chooses a table. Only one waiter can wait each table.
2. The waiter waits for a customer from his table to call him.
3. Once called, the waiter goes to the customer, and informs the customer he is ready to take the order
4. The waiter gets the customer's id (represents getting the order)
5. The waiter goes to the kitchen. Only one waiter can use the kitchen at a time. He will spend 100 to 500 milliseconds in the kitchen to deliver the order.
6. The waiter waits outside the kitchen for the order to be ready (this will be between 300 milliseconds to 1 second)
7. The waiter will go to the kitchen to get the order. He will spend 100 to 500 milliseconds in the kitchen.
8. The waiter will bring the customer the order
9. The waiter will wait for the next customer
10. When the last customer leaves the restaurant, the waiter will clean the table, and leave the restaurant.

2.2 The Customer

1. The customer chooses a table to eat at
2. The customer may choose a backup table to eat at (randomly decide this)
3. The customer enters the restaurant through one of the two doors. Each door allows one customer to enter at a time.

4. The customer looks at the lines for the chosen tables.
    - A line is long if there are 7 or more customers in it. You will need to keep a shared counter.
    - If the first choice's line is long, but the second choice's line is not, then the customer will go to the second choice table
    - Otherwise, the customer will go to the first choice table
    - If there is no second choice, the customer will always go to the first choice table
5. Once the table is chosen, the customer will stand in the corresponding line to wait for an empty seat
6. There are four seats. Whenever a seat is empty the next customer in line leave the line to sit down.
    - The seats will start empty. So, the first four customers in line will not need to wait.
7. When the customer sits down, it will call the waiter for this table, and wait.
8. When the waiter comes to take the order, the customer will give the waiter its id (representing giving the order), and wait for the order
9. When the waiter brings the order, the customer will eat the food. This will take 200 milliseconds to 1 second.
10. Afterwards the customer will leave the table. This means the seat has now become empty.
11. The customer will then pay the bill. Only one customer can pay at a time.
12. The customer leaves the restaurant. The client thread will then exit.

2.3 Output

Every thread should print out what it is doing as it does it. Each step listed in the above subsections needs a line printed. Each line should contain what type of thread it is (waiter or customer) and its id (within its type). If the action is an interaction with the other type of thread it should also print out that information. As an example, when the waiter takes the customer's order, your program may print out something like:

```
Waiter 0 takes Customer 7's order.
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When the customer gives its order to the waiter your program may print out something like:

```
Customer 7 gives the order to Waiter 0.
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The order of the message are only restricted by the order the actions must take place in, given in the previous two subsections. Due do the nature of threads, without using a synchronization mechanism like semaphores, we cannot control the order these actions will happen in. So, the waiter should not take an order before going to the table, but it is ok if waiter 2 takes customer 30's order before waiter 0 takes customer 7's.

3 What to Turn in

Upload your submission as a zip archive containing the following:

- Source code (c, c++, java, or python files)
  - Source code should not require a particular IDE to compile and run.
  - Should work on the cs1 and cs2 machines
- Readme (Plain text document)
  - List the files included in the archive and their purpose
  - Explain how to compile and run your project
  - Include any other notes that the TA may need
- Write-up (Microsoft Word or pdf format)
  - How did you approach the project?
  - How did you organize the project? Why?
  - What problems did you encounter?
  - How did you fix them?
  - What did you learn doing this project?
  - If you did not complete some feature of the project, why not?
    - What unsolvable problems did you encounter?
    - How did you try to solve the problems?
    - Where do you think the solution might lay?
      - What would you do to try and solve the problem if you had more time?

4 Grading

The grade for this project will be out of 100, and broken down as follows:

Followed Specifications	50
Use of Semaphores	20
Correct Output	10
Write-up	20

If you were not able to complete some part of the program discussing the problem and potential solutions in the write-up will reduce the points deducted for it. For example, suppose there is a bug in your code that sometimes allows two customers to approach the same worker, and could not figure out the problem before the due date. You can write 2-3 paragraphs in the write-up to discuss this issue. Identify the error and discuss what you have done to try to fix it/find the problem point, and discuss how you would proceed if you had more time. Overall, inform me and the TA that you know the problem exists and you seriously spend time trying to fix the problem. Normally you may lose 5 points (since it is a rare error) but with the write-up you only lose 2. These points can make a large difference if the problem is affecting a larger portion of the program.