



**TEMA 2**  
la disciplina  
**TEHNICI DE PROGRAMARE**  
  
**- SIMULATOR COZI-**

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# 1. Obiectivul temei

## 1.1 Obiectivul principal

Obiectivul acestei teme de laborator este să proiectăm și să implementăm o aplicație Java care urmărește să analizeze sistemele bazate pe cozi, pentru a determina și minimiza timpul de așteptare al clienților.

Cozile sunt folosite, de obicei, pentru a modela multe domenii din lumea reală. Scopul principal al unei cozi este să confere un spațiu în care un client așteaptă deservirea unui serviciu. În acest sistem bazat pe cozi suntem interesați să micșorăm timpul în care clienții stau în așteptare în coadă.

Aplicația va simula o serie de  $N$  clienți care sosesc pentru un anumit serviciu (de exemplu plasarea la o casă la un supermarket, unde clienții așteaptă să platească produsele), și intra în una dintre cele  $Q$  cozi. Clientul așteaptă până ajunge în fața cozii, unde este servit și mai apoi părăsește coada. Clienții vor fi generați la pornirea simulării și au ca atribute: id-ul (un număr între 1 și  $N$ ),  $t_{arrival}$  (timpul de simulare când clientul se pune la coadă) și  $t_{service}$  (timpul în care clientul este procesat de coadă). La finalul simulării se dorește ora de varf (adică momentul când au fost cei mai mulți clienți în cozi), timpul mediu de așteptare (timpul mediu în care un client din coadă ajunge în fața cozii pentru a fi procesat) și timpul mediu de procesare.

## 1.2 Obiectivele secundare

Dezvoltarea de use case-uri – capitolul doi

Use case-urile reprezintă un set de scenarii legate de modul în care este utilizat sistemul. Dacă le utilizăm putem să descoperim:

- entități de sistem
- actori de sistem (roluri)
- comportament
- atribute
- cum interacționează actorii cu resursele sistemului

- Dezvoltarea de diagrame UML pentru pachete și clase – capitolul trei

Vom utiliza diagrama de pachete pentru a asigura un „good practice”. Cele trei părți ale acestei arhitecturi fiind separate în câte un pachet. Vom utiliza diagramele UML de obiecte pentru a obține clasele necesare pentru rezolvarea obiectivului principal.

- Dezvoltarea algoritmilor – capitolul trei

Pentru a ne atinge obiectivul principal, avem nevoie să dezvoltăm algoritmi sau să căutăm algoritmi ce realizează funcționalitatea dorită. Specific pentru acest proiect va fi algoritmul de plasare a unui client în coadă cu timpul de așteptare minim.

- Implementarea soluției – capitolul patru

Vom descrie clasele și interfața, și motivele pentru alegerea acestei implementări.

- Testarea – capitolul cinci

Vom prezenta rezultatele a trei simulări și conținutul fișierului Log.txt

## 2. Analiza problemei, modelare, scenarii, cazuri de utilizare

Se dorește o soluție capabilă să simuleze corect și eficient funcționarea paralelă a sistemului de cozi. Deci cu siguranță programul va conține mai multe fire de procesare, respectiv un fir pentru fiecare coadă și un fir principal capabil să gestioneze simularea de la început până la sfârșit. Interfața grafică va fi gestionată, de asemenea, de firul principal. Programul poate fi predispus erorilor, datorate caracterului concurent, dar și a celor din partea utilizatorului.

Modelarea problemei este extrem de importantă pentru a ajunge la soluția dorită. Structura aleasă fiind detaliată în capitolele trei și patru.

Caz de utilizare: simularea sistemului de cozi

Actor principal: utilizator calculator

Scenariul principal de succes:

1. Utilizatorul introduce în câmpurile corespunzătoare datele corecte ce definesc parametrii simulării (introducerea de întregi în câmpuri, și condițiile de min și max sunt respectate)
2. Utilizatorul apasă butonul de start
3. Datele despre sistemul de cozi sunt afișate într-un mod vizual pentru fiecare moment din timpul de simulare
4. Se afișează datele finale, precum timpul mediu de așteptare, de procesare și ora de varf.

Secvențe alternative:

Nu au fost introduse datele corecte în câmpurile corespunzătoare

- utilizatorul primește un mesaj de eroare

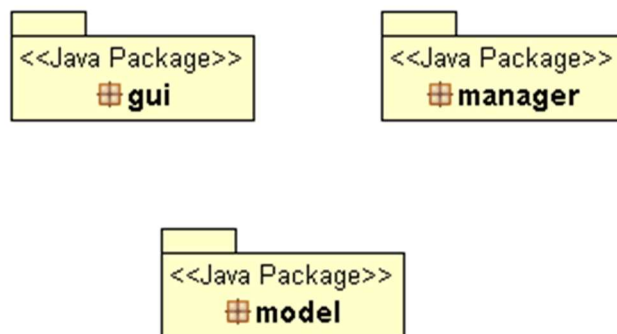
### 3. Proiectare (decizii de proiectare, diagrame UML, structuri de date, proiectare clase, interfețe, relații, packages, algoritmi, interfață utilizator)

Am ales sa divizam aplicati in pachete pentru ca este un „good practice”, facand aplicatia mult mai structurata si usor de inteles.

#### 3.1 Diagrame UML

- Diagrama de pachete

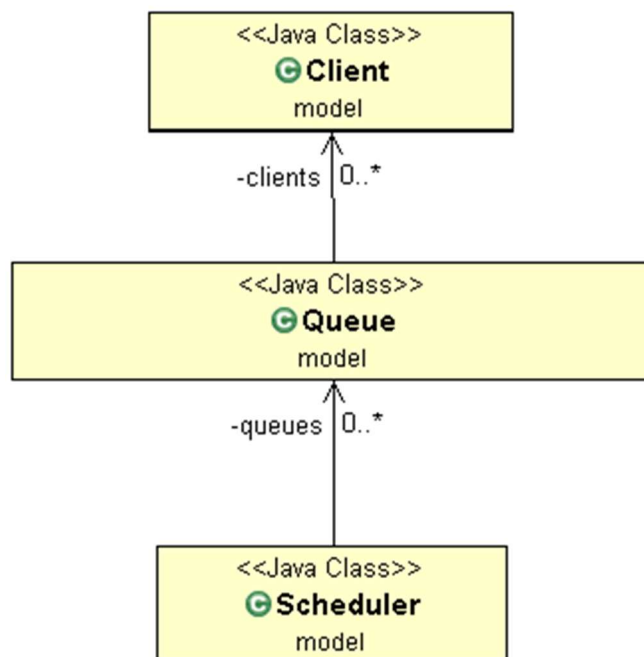
Diagramele de pachete ne ajută să decompunem sistemul în subsisteme, astfel descompunem sistemul nostru în trei pachete gui, manager si model. Deși nu sunt reprezentate în imagine, există relații de asociere între cele trei pachete.



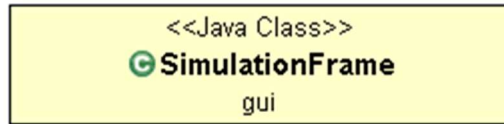
- Diagrama de clase

Diagrama de clase descrie clasele din sistem și relațiile dintre ele, ce pot fi asocieri, generalizari, de realizare, de dependenta. Clasele vor fi doar enumerate în această capitol, detaliile despre câmpuri și metode se vor dezvolta în capitolul cinci.

Clasele din pachetul model: Client, Queue, Scheduler



Clasa din pachetul gui( practic interfața acestei aplicații): SimulationFrame



Clasa din pachetul manager: SimulationManager



### 3.2 Structuri de date folosite

Singura structura folosita este cea de coada. Coada (queue) este o lista liniara in care inserarile se fac doar in capul listei, iar extragerile doar din capul listei. Politica cozilor este FIFO.

In acest program lucram in domeniul concurent, deci vom folosi structuri care sunt sigure pentru threaduri precum `BlockingQueue`, `AtomicInteger`, `AtomicBoolean`.

Interfața Java `BlockingQueue` face parte din cadrul colecțiilor Java. Java oferă mai multe implementări pentru `BlockingQueue`, cum ar fi `ArrayBlockingQueue`, `LinkedBlockingQueue`, `PriorityBlockingQueue`, `SynchronousQueue` etc. În implementăm acestei aplicații am ales să folosesc implementarea `ArrayBlockingQueue`. Toate metodele specifice cozilor sunt de natură atomică și utilizează lock-uri interne sau alte forme de control al concurenței.

O acțiune atomică este una care se realizează ca un total. O acțiune atomică nu se poate opri la mijloc: fie se întâmplă complet, fie nu se întâmplă deloc. Nu sunt vizibile efecte secundare ale unei acțiuni atomice până când acțiunea nu este finalizată.

Variabile atomice utilizate des în Java sunt `AtomicInteger`, `AtomicLong`, `AtomicBoolean` și `AtomicReference`.

### 3.3 Algoritmi utilizați

Singurul algoritm utilizat este cel de plasare a clienților în una dintre cele  $Q$  cozi, care se bazează pe politica de cel mai scurt timp.

```
placeClient (Client c)
    min=inifinty
    for Queue q: queues
        if q.waitingPeriod <min
            min=s.waitingPeriod
    for Queue q:queues)
        if q.waitingPeriod==min) {
            q.addClient(c)
            return
```

## 4. Implementare

### 4.1 Clasele din pachetul model

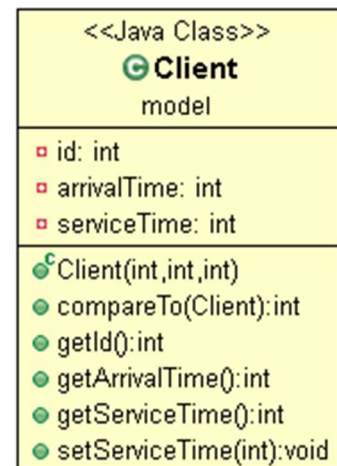
- Clasa Client

Modeleaza clientii ce vor fi generati random si attributele acestora, ce au importanta in cadrul simularii.

Campurile clasei sunt id, care identifica unic un client, arrivalTime, timpul la care clientul este pregatit sa se aseze intr-o coada si serviceTime, timpul necesar unui client pentru a fi procesat de coada, cand acesta ajunge in fata.

Clasa implementeaza interfata Comparable, pentru a putea fi facuta sortarea clientilor in functie de timpul de sosire.

Metodele clasei sunt doar settersi si getteri.

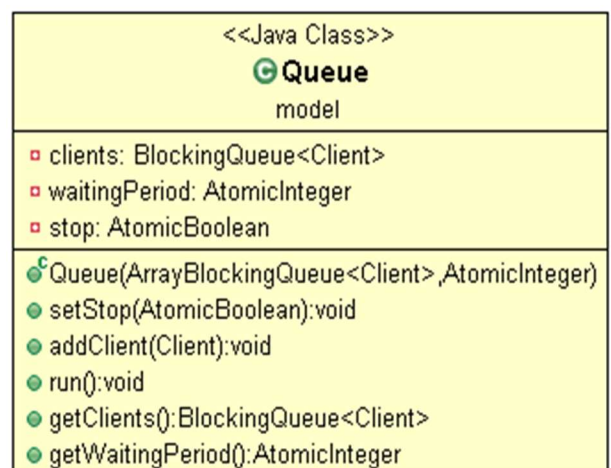


- Clasa Queue

Modeleaza cozile in care vor fi plasati clientii.

Campurile clasei sunt clients, care reprezinta efectiv clientii ce sunt in acel moment la coada, waitingPeriod, care reprezinta timpul de asteptare din acea coada, adica suma tuturor timpilor de servire a clientilor aflati in acel moment la coada si stop.

Toate campurile au tipuri care sunt sigure pentru threaduri, pentru clients folosim BlockingQueue, pentru waitingPeriod AtomicInteger si pentru stop AtomicBoolean.



Clasa Queue implementeaza interfata Runnable. Runnable este o interfață care urmează să fie implementată de o clasă ale cărei instanțe sunt facute sa fi executate de un thread. Trebuie sa implementam metoda run(), care va descrie secventa de cod pe care dorim sa o execute threadul.

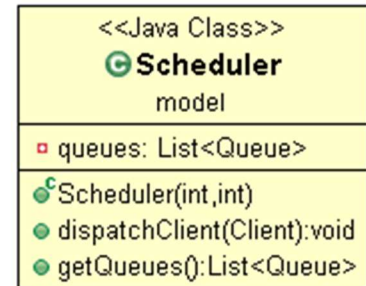
Metoda run() trebuie sa verifice in mod continuu daca este vreun client in coada, si daca este, sa il proceseze ( mai exact sa scadem din timpul de procesare al clientului din fata cozii o secunda). Daca clientul din fata cozii se termina de procesat ( are serviceTime-ul 0) atunci putem sa-l scoatem din coada. Threadul este adormit pentru o secunda pentru a simula un serviciu efectiv ce trebui indeplinit.

Campul stop este initial setat pe valoare booleana false, atunci cand acesta va fi setat pe true ( de catre managerul simularii), atunci conditia de verificare continua a cozii nu va mai fi valabila si vom iesi din While, iar metoda run() se va termina.

- Clasa Scheduler

Clasa Scheduler grupeaza toate cozile pe care le are aplicatie si cum se deduce din nume, are rolul de a planifica, mai exact de a distribui clientii generati aleator, urmarind politica de cel mai scurt timp.

In constructorul clasei se creeaza cele Q cozi si threadurile corespunzatoare fiecareia, si se pornesc cele Q threaduri. Metoda cea mai importanta din aceasta clasa este dispatchClient care face plasarea propriu-zisa a clientului in coada care are cel mai mic waitingPeriod. O alta metoda este getterul getQueues.



## 4.2 Clasa din pachetul manager

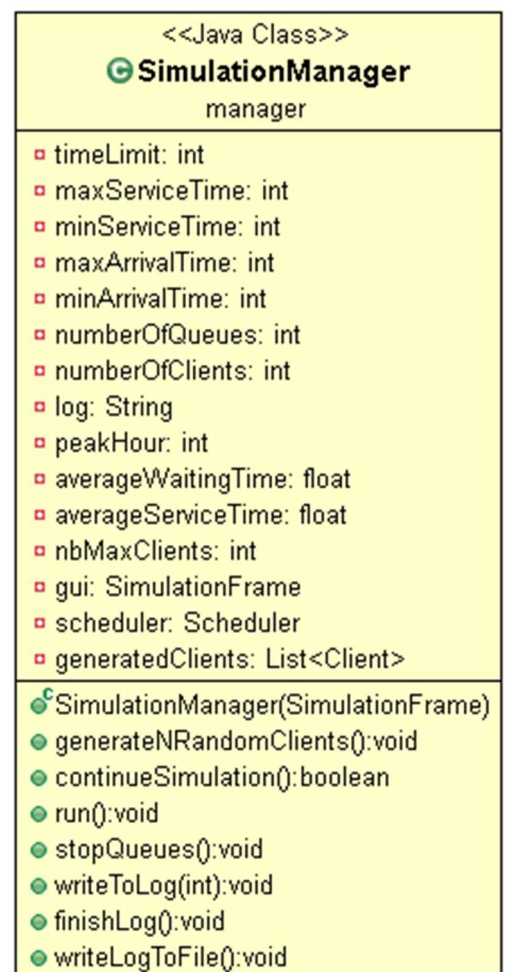
- Clasa SimulationManager

Este clasa care gestioneaza toata simularea, dar si interfata grafica.

Campurile clasei sunt cele necesare pentru simulare timeLimit (timpul maxim pentru care se poate desfasura simularea), minServiceTime si maxServiceTime (intervalul valabil din care se alege aleator timpul de servire al unui client), minArrivalTime si maxArrivalTime (intervalul valabil din care se alege aleator momentul de timp la care un client este gata sa intre intr-o coada), numberOfQueues, numberOfClients. Pe langa acestea mai avem campurile ce au legatura cu rezultatele simularii precum peakHour, averageWaitingTime, averageServiceTimes si log (reprezinta jurnalul evenimentelor).

De asemenea, managerul are un Scheduler (care contine cozile si se ocupa de adaugarea unui client la coada cu cel mai mic waitingTime) si un SimulationFrame care este interfata in care vom afisa simularea grafic. Mai avem si campul generatedClients care contine clientii generati aleator cu ajutorul metodei generateNRandom.

Clasa SimulationManger implementeaza interfata Runnable, si deci prin urmare trebuie sa implementeze metoda run(), care va descrie ce secventa de cod trebuie sa execute threadul.



Metoda run() ne spune ce face threadul principal. Acesta nu continua atat timp cat timpul de simulare nu este egal cu timeLimit si cat functia continueSimulation returneaza true (acesta metoda verifica daca mai sunt clienti care n-au intrat in cozi si daca in cozi mai avem clienti ce nu au terminat procesarea). Daca conditiile de mai sus sunt adevarate verificam daca in generatedClients avem clientii care au arrivalTime egal cu timpul actual al simularii, daca sunt atunci acestia vor fi adaugati in cozi si mai apoi eliminati din generatedClients. Starea actuala a cozilor va fi consemnata in log si va fi afisata in interfata grafica. Threadul va fi adormit pentru o secunda pentru a consemna trecerea timpului, iar timpul se va incrementa.



Inainte de terminarea metodei, se scriu in log si interfata rezultatele obtinute in urma simularii, iar threadurile pentru corespunzatoare fiecarei cozi va fi oprit.


### 4.3 Clasa din pachetul gui

- Clasa SimulationFrame

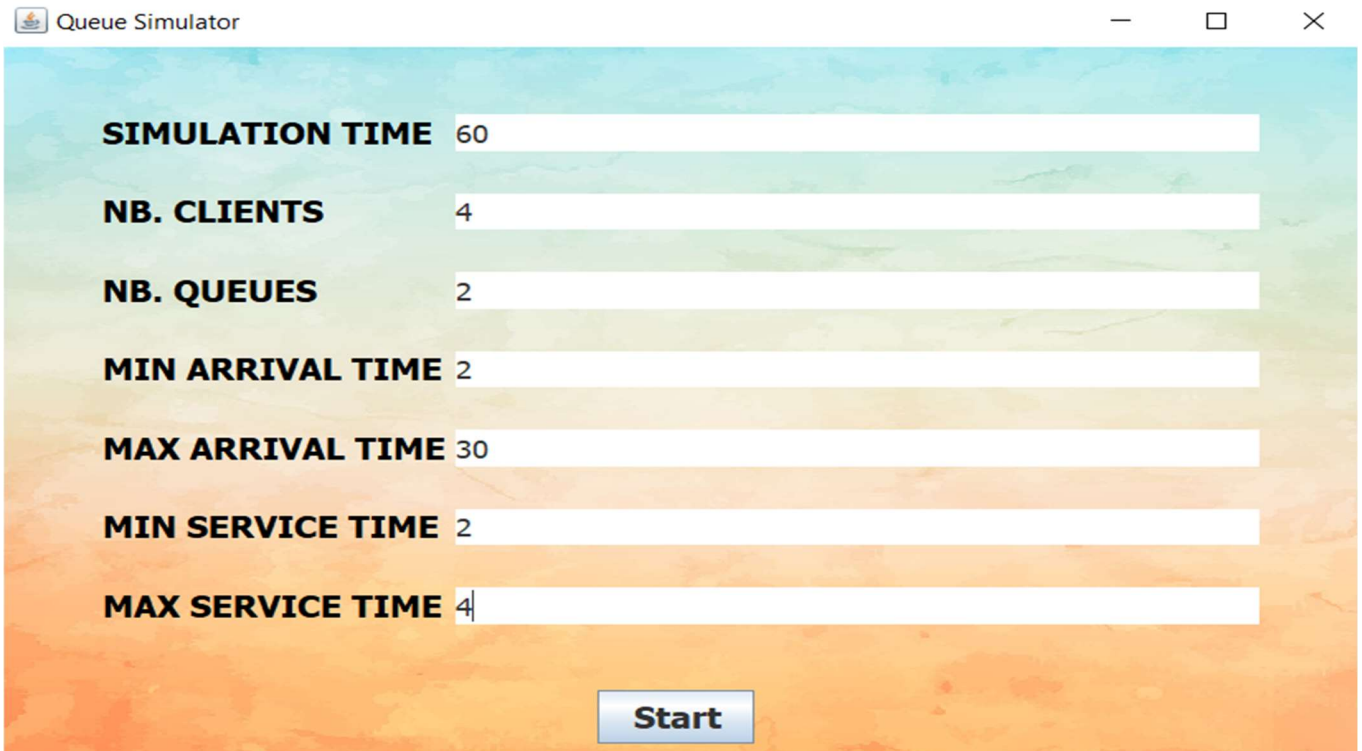
Campurile clasei sunt cele sapte casete unde utilizatorul va introduce datele necesare simularii (care mai apoi vor fi trimise managerului), care sunt de tipul JTextField si alte paneluri principale precum panelButon, panel, panelText si panelLabels.

O componenta importanta este lblCurrentSim in care vor fi afisate toate datele despre cum arata sistemul de cozi in fiecare secunda si datele finale obtinute dupa simulare.

Alta componenta este butonul de start caruia ii vom adauga un ActionListener. Apasare acestui buton determina crearea managerului de simulare si pornirea threadului principal, deci prin urmare determina inceperea simularii. De asemenea, vizibilitatea panel-urilor se schimba, facandu-se vizibila eticheta lblCurrentSim.

<<Java Class>>	
 <b>SimulationFrame</b>	
gui	
<ul style="list-style-type: none"> <li>▣ simulationTime: JTextField</li> <li>▣ nbClients: JTextField</li> <li>▣ nbQueues: JTextField</li> <li>▣ minArrivalTime: JTextField</li> <li>▣ maxArrivalTime: JTextField</li> <li>▣ minServiceTime: JTextField</li> <li>▣ maxServiceTime: JTextField</li> <li>▣ content: JPanel</li> <li>▣ panelButon: JPanel</li> <li>▣ panel: JPanel</li> <li>▣ panelText: JPanel</li> <li>▣ panelLabels: JPanel</li> <li>▣ img: Image</li> <li>▣ lblCurrentSim: JLabel</li> </ul>	
<ul style="list-style-type: none"> <li>🟢 SimulationFrame()</li> <li>🟢 updateSimulation(List&lt;Queue&gt;,int):void</li> <li>🟢 updateFinished(float,float,int):void</li> <li>🟢 getNbQueues():int</li> <li>🟢 getSimulationTime():int</li> <li>🟢 getNbClients():int</li> <li>🟢 getMinArrivalTime():int</li> <li>🟢 getMaxArrivalTime():int</li> <li>🟢 getMinServiceTime():int</li> <li>🟢 getMaxServiceTime():int</li> </ul>	

Prezentarea interfetei aplicatiei:



Queue Simulator

**SIMULATION TIME** 60

**NB. CLIENTS** 4

**NB. QUEUES** 2

**MIN ARRIVAL TIME** 2

**MAX ARRIVAL TIME** 30

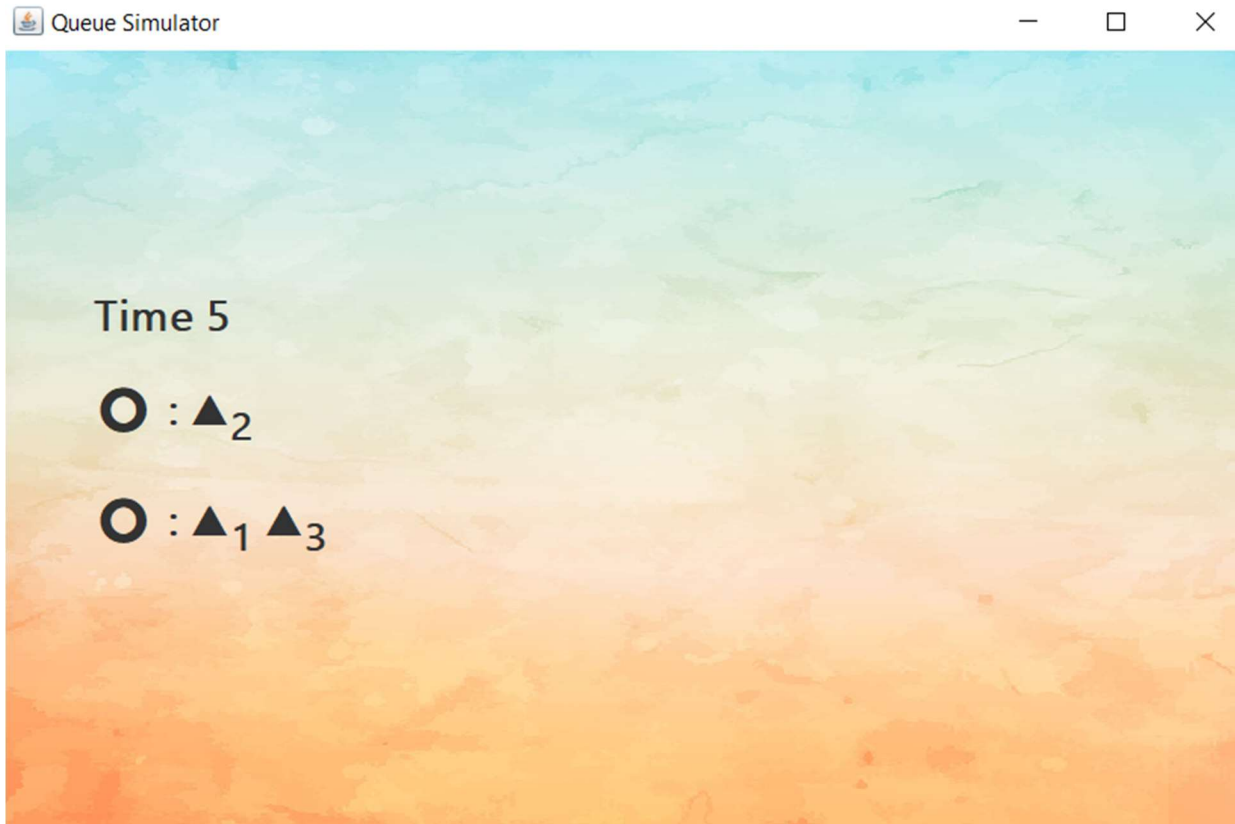
**MIN SERVICE TIME** 2

**MAX SERVICE TIME** 4

**Start**

Frame-ul de initializare a datelor corespunzatoare simularii. Trebuie sa se introduca intregi in cele sapte casute, iar conditiile de minim si maxim pentru intervalul arrivalTime si serviceTime.

Un screenshot din timpul simularii pentru secunda 5, unde avem se observa ca avem 2 cozi, in prima avem un client care are timpul de procesare egal cu 2, iar in a doua coada avem 2 clienti, primul este cel care este procesat, iar cel de-al doilea asteapta sa ajunga in fata ca sa fie servit.



## 5. Rezultate

Pentru a ne asigura că programul functioneaza cum ne dorim vom efectua trei teste, cu diferiti timpi de simulare si numar diferit de cozi. Vom examina fisierle log generate pentru a determina daca programul funtioneaza corect.

Primul test cu urmatoarele date de intrare:

$N = 4$

$Q = 2$

$T_{simulation} = 60$  secunde

$[T_{minArrival}, T_{maxArrival}] = [2, 30]$

$[T_{minService}, T_{minService}] = [2, 4]$

---

Time 0

Waiting clients: (2,2,2); (1,9,2); (4,19,3); (3,30,3);

Queue 1: closed

Queue 2: closed

Time 1

Waiting clients: (2,2,2); (1,9,2); (4,19,3); (3,30,3);

Queue 1: closed

Queue 2: closed

Time 2

Waiting clients: (1,9,2); (4,19,3); (3,30,3);

Queue 1: (2,2,2);

Queue 2: closed

Time 3

Waiting clients: (1,9,2); (4,19,3); (3,30,3);

Queue 1: (2,2,1);

Queue 2: closed

Time 4

Waiting clients: (1,9,2); (4,19,3); (3,30,3);

Queue 1: closed

Queue 2: closed

Time 5

Waiting clients: (1,9,2); (4,19,3); (3,30,3);

Queue 1: closed

Queue 2: closed

Time 6

Waiting clients: (1,9,2); (4,19,3); (3,30,3);

Queue 1: closed

Queue 2: closed

Time 7

Waiting clients: (1,9,2); (4,19,3); (3,30,3);

Queue 1: closed

Queue 2: closed

Time 8

Waiting clients: (1,9,2); (4,19,3); (3,30,3);

Queue 1: closed

Queue 2: closed

Time 9  
Waiting clients: (4,19,3); (3,30,3);  
Queue 1: (1,9,2);  
Queue 2: closed

Time 10  
Waiting clients: (4,19,3); (3,30,3);  
Queue 1: (1,9,1);  
Queue 2: closed

Time 11  
Waiting clients: (4,19,3); (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 12  
Waiting clients: (4,19,3); (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 13  
Waiting clients: (4,19,3); (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 14  
Waiting clients: (4,19,3); (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 15  
Waiting clients: (4,19,3); (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 16  
Waiting clients: (4,19,3); (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 17  
Waiting clients: (4,19,3); (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 18  
Waiting clients: (4,19,3); (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 19  
Waiting clients: (3,30,3);  
Queue 1: (4,19,3);  
Queue 2: closed

Time 20  
Waiting clients: (3,30,3);  
Queue 1: (4,19,2);  
Queue 2: closed

Time 21  
Waiting clients: (3,30,3);  
Queue 1: (4,19,1);  
Queue 2: closed

Time 22  
Waiting clients: (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 23  
Waiting clients: (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 24  
Waiting clients: (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 25  
Waiting clients: (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 26  
Waiting clients: (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 27  
Waiting clients: (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 28  
Waiting clients: (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 29  
Waiting clients: (3,30,3);  
Queue 1: closed  
Queue 2: closed

Time 30  
Waiting clients:  
Queue 1: (3,30,3);  
Queue 2: closed

Time 31  
Waiting clients:  
Queue 1: (3,30,2);  
Queue 2: closed

Time 32  
Waiting clients:  
Queue 1: (3,30,1);  
Queue 2: closed

Simulation finished  
Average waiting time : 0.0  
Average service time : 2.5  
Peak Hour : 2

Al doilea test cu urmatoarele date de intrare:

N = 50

Q = 5

Tsimulation = 60 secunde

[TminArrival, TmaxArrival] = [2, 40]

[TminService, TmaxService] = [1, 7]

---

Time 0

Waiting clients: (10,4,5); (30,4,6); (2,5,5); (18,5,1); (32,5,6); (25,6,7); (6,7,6); (9,7,3); (14,8,3); (22,8,4); (29,8,7); (40,8,1); (3,9,5); (38,9,7); (20,11,1); (36,11,2); (48,12,6); (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: closed

Queue 2: closed

Queue 3: closed

Queue 4: closed

Queue 5: closed

Time 1

Waiting clients: (10,4,5); (30,4,6); (2,5,5); (18,5,1); (32,5,6); (25,6,7); (6,7,6); (9,7,3); (14,8,3); (22,8,4); (29,8,7); (40,8,1); (3,9,5); (38,9,7); (20,11,1); (36,11,2); (48,12,6); (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: closed

Queue 2: closed

Queue 3: closed

Queue 4: closed

Queue 5: closed

Time 2

Waiting clients: (10,4,5); (30,4,6); (2,5,5); (18,5,1); (32,5,6); (25,6,7); (6,7,6); (9,7,3); (14,8,3); (22,8,4); (29,8,7); (40,8,1); (3,9,5); (38,9,7); (20,11,1); (36,11,2); (48,12,6); (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: closed

Queue 2: closed

Queue 3: closed

Queue 4: closed

Queue 5: closed

Time 3

Waiting clients: (10,4,5); (30,4,6); (2,5,5); (18,5,1); (32,5,6); (25,6,7); (6,7,6); (9,7,3); (14,8,3); (22,8,4); (29,8,7); (40,8,1); (3,9,5); (38,9,7); (20,11,1); (36,11,2); (48,12,6); (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: closed

Queue 2: closed

Queue 3: closed

Queue 4: closed

Queue 5: closed

Time 4

Waiting clients: (2,5,5); (18,5,1); (32,5,6); (25,6,7); (6,7,6); (9,7,3); (14,8,3); (22,8,4); (29,8,7); (40,8,1); (3,9,5); (38,9,7); (20,11,1); (36,11,2); (48,12,6); (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (10,4,5);

Queue 2: (30,4,6);

Queue 3: closed  
Queue 4: closed  
Queue 5: closed

Time 5

Waiting clients: (25,6,7); (6,7,6); (9,7,3); (14,8,3); (22,8,4); (29,8,7); (40,8,1); (3,9,5); (38,9,7); (20,11,1); (36,11,2); (48,12,6); (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (10,4,4);

Queue 2: (30,4,5);

Queue 3: (2,5,5);

Queue 4: (18,5,1);

Queue 5: (32,5,6);

Time 6

Waiting clients: (6,7,6); (9,7,3); (14,8,3); (22,8,4); (29,8,7); (40,8,1); (3,9,5); (38,9,7); (20,11,1); (36,11,2); (48,12,6); (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (10,4,3);

Queue 2: (30,4,4);

Queue 3: (2,5,4);

Queue 4: (25,6,7);

Queue 5: (32,5,5);

Time 7

Waiting clients: (14,8,3); (22,8,4); (29,8,7); (40,8,1); (3,9,5); (38,9,7); (20,11,1); (36,11,2); (48,12,6); (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (10,4,2); (6,7,6);

Queue 2: (30,4,3); (9,7,3);

Queue 3: (2,5,3);

Queue 4: (25,6,6);

Queue 5: (32,5,4);

Time 8

Waiting clients: (3,9,5); (38,9,7); (20,11,1); (36,11,2); (48,12,6); (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (10,4,1); (6,7,6);

Queue 2: (30,4,2); (9,7,3); (29,8,7);

Queue 3: (2,5,2); (14,8,3); (40,8,1);

Queue 4: (25,6,5);

Queue 5: (32,5,3); (22,8,4);

Time 9

Waiting clients: (20,11,1); (36,11,2); (48,12,6); (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (6,7,6);

Queue 2: (30,4,1); (9,7,3); (29,8,7);

Queue 3: (2,5,1); (14,8,3); (40,8,1); (38,9,7);

Queue 4: (25,6,4); (3,9,5);

Queue 5: (32,5,2); (22,8,4);

Time 10

Waiting clients: (20,11,1); (36,11,2); (48,12,6); (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (6,7,5);  
Queue 2: (9,7,3); (29,8,7);  
Queue 3: (14,8,3); (40,8,1); (38,9,7);  
Queue 4: (25,6,3); (3,9,5);  
Queue 5: (32,5,1); (22,8,4);

#### Time 11

Waiting clients: (48,12,6); (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);  
Queue 1: (6,7,4); (20,11,1);  
Queue 2: (9,7,2); (29,8,7);  
Queue 3: (14,8,2); (40,8,1); (38,9,7);  
Queue 4: (25,6,2); (3,9,5);  
Queue 5: (22,8,4); (36,11,2);

#### Time 12

Waiting clients: (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);  
Queue 1: (6,7,3); (20,11,1); (48,12,6);  
Queue 2: (9,7,1); (29,8,7);  
Queue 3: (14,8,1); (40,8,1); (38,9,7);  
Queue 4: (25,6,1); (3,9,5);  
Queue 5: (22,8,3); (36,11,2);

#### Time 13

Waiting clients: (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);  
Queue 1: (6,7,2); (20,11,1); (48,12,6);  
Queue 2: (29,8,7);  
Queue 3: (40,8,1); (38,9,7);  
Queue 4: (3,9,5);  
Queue 5: (22,8,2); (36,11,2);

#### Time 14

Waiting clients: (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);  
Queue 1: (6,7,1); (20,11,1); (48,12,6);  
Queue 2: (29,8,6);  
Queue 3: (38,9,7);  
Queue 4: (3,9,4);  
Queue 5: (22,8,1); (36,11,2);

#### Time 15

Waiting clients: (35,16,2); (39,16,1); (42,16,7); (46,16,1); (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);  
Queue 1: (20,11,1); (48,12,6);  
Queue 2: (29,8,5);  
Queue 3: (38,9,6);  
Queue 4: (3,9,3);  
Queue 5: (36,11,2);

#### Time 16

Waiting clients: (43,17,1); (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);  
Queue 1: (48,12,6);  
Queue 2: (29,8,4);  
Queue 3: (38,9,5);  
Queue 4: (3,9,2); (39,16,1); (42,16,7);



Queue 5: (36,11,1); (35,16,2); (46,16,1);

Time 17

Waiting clients: (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (48,12,5);

Queue 2: (29,8,3); (43,17,1);

Queue 3: (38,9,4);

Queue 4: (3,9,1); (39,16,1); (42,16,7);

Queue 5: (35,16,2); (46,16,1);

Time 18

Waiting clients: (5,19,7); (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (48,12,4);

Queue 2: (29,8,2); (43,17,1);

Queue 3: (38,9,3);

Queue 4: (39,16,1); (42,16,7);

Queue 5: (35,16,1); (46,16,1);

Time 19

Waiting clients: (19,20,1); (31,20,4); (41,20,6); (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (48,12,3);

Queue 2: (29,8,1); (43,17,1);

Queue 3: (38,9,2);

Queue 4: (42,16,7);

Queue 5: (46,16,1); (5,19,7);

Time 20

Waiting clients: (26,21,4); (50,21,5); (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (48,12,2); (41,20,6);

Queue 2: (43,17,1); (19,20,1);

Queue 3: (38,9,1); (31,20,4);

Queue 4: (42,16,6);

Queue 5: (5,19,7);

Time 21

Waiting clients: (12,22,2); (16,22,1); (21,22,7); (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (48,12,1); (41,20,6);

Queue 2: (19,20,1); (26,21,4);

Queue 3: (31,20,4); (50,21,5);

Queue 4: (42,16,5);

Queue 5: (5,19,6);

Time 22

Waiting clients: (28,23,7); (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (41,20,6);

Queue 2: (26,21,4); (12,22,2);

Queue 3: (31,20,3); (50,21,5);

Queue 4: (42,16,4); (16,22,1); (21,22,7);

Queue 5: (5,19,5);

Time 23

Waiting clients: (7,24,4); (15,24,6); (24,24,7); (47,24,1); (49,24,6); (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (41,20,5);

Queue 2: (26,21,3); (12,22,2);  
Queue 3: (31,20,2); (50,21,5);  
Queue 4: (42,16,3); (16,22,1); (21,22,7);  
Queue 5: (5,19,4); (28,23,7);

Time 24

Waiting clients: (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);  
Queue 1: (41,20,4); (7,24,4); (47,24,1); (49,24,6);  
Queue 2: (26,21,2); (12,22,2); (15,24,6);  
Queue 3: (31,20,1); (50,21,5); (24,24,7);  
Queue 4: (42,16,2); (16,22,1); (21,22,7);  
Queue 5: (5,19,3); (28,23,7);

Time 25

Waiting clients: (37,26,6); (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);  
Queue 1: (41,20,3); (7,24,4); (47,24,1); (49,24,6);  
Queue 2: (26,21,1); (12,22,2); (15,24,6);  
Queue 3: (50,21,5); (24,24,7);  
Queue 4: (42,16,1); (16,22,1); (21,22,7);  
Queue 5: (5,19,2); (28,23,7);

Time 26

Waiting clients: (34,27,3); (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);  
Queue 1: (41,20,2); (7,24,4); (47,24,1); (49,24,6);  
Queue 2: (12,22,2); (15,24,6); (37,26,6);  
Queue 3: (50,21,4); (24,24,7);  
Queue 4: (16,22,1); (21,22,7);  
Queue 5: (5,19,1); (28,23,7);

Time 27

Waiting clients: (27,28,6); (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);  
Queue 1: (41,20,1); (7,24,4); (47,24,1); (49,24,6);  
Queue 2: (12,22,1); (15,24,6); (37,26,6);  
Queue 3: (50,21,3); (24,24,7);  
Queue 4: (21,22,7); (34,27,3);  
Queue 5: (28,23,7);

Time 28

Waiting clients: (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);  
Queue 1: (7,24,4); (47,24,1); (49,24,6);  
Queue 2: (15,24,6); (37,26,6);  
Queue 3: (50,21,2); (24,24,7);  
Queue 4: (21,22,6); (34,27,3);  
Queue 5: (28,23,6); (27,28,6);

Time 29

Waiting clients: (1,30,5); (23,30,3); (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);  
Queue 1: (7,24,3); (47,24,1); (49,24,6);  
Queue 2: (15,24,5); (37,26,6);  
Queue 3: (50,21,1); (24,24,7);  
Queue 4: (21,22,5); (34,27,3);  
Queue 5: (28,23,5); (27,28,6);

Time 30

Waiting clients: (17,31,3); (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);  
Queue 1: (7,24,2); (47,24,1); (49,24,6);  
Queue 2: (15,24,4); (37,26,6);  
Queue 3: (24,24,7); (1,30,5);  
Queue 4: (21,22,4); (34,27,3); (23,30,3);  
Queue 5: (28,23,4); (27,28,6);

Time 31

Waiting clients: (44,32,5); (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (7,24,1); (47,24,1); (49,24,6); (17,31,3);

Queue 2: (15,24,3); (37,26,6);

Queue 3: (24,24,6); (1,30,5);

Queue 4: (21,22,3); (34,27,3); (23,30,3);

Queue 5: (28,23,3); (27,28,6);

Time 32

Waiting clients: (4,33,2); (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (47,24,1); (49,24,6); (17,31,3);

Queue 2: (15,24,2); (37,26,6); (44,32,5);

Queue 3: (24,24,5); (1,30,5);

Queue 4: (21,22,2); (34,27,3); (23,30,3);

Queue 5: (28,23,2); (27,28,6);

Time 33

Waiting clients: (13,34,2); (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (49,24,6); (17,31,3);

Queue 2: (15,24,1); (37,26,6); (44,32,5);

Queue 3: (24,24,4); (1,30,5);

Queue 4: (21,22,1); (34,27,3); (23,30,3); (4,33,2);

Queue 5: (28,23,1); (27,28,6);

Time 34

Waiting clients: (8,35,1); (33,36,2); (45,38,3); (11,40,7);

Queue 1: (49,24,5); (17,31,3);

Queue 2: (37,26,6); (44,32,5);

Queue 3: (24,24,3); (1,30,5);

Queue 4: (34,27,3); (23,30,3); (4,33,2);

Queue 5: (27,28,6); (13,34,2);

Time 35

Waiting clients: (33,36,2); (45,38,3); (11,40,7);

Queue 1: (49,24,4); (17,31,3); (8,35,1);

Queue 2: (37,26,5); (44,32,5);

Queue 3: (24,24,2); (1,30,5);

Queue 4: (34,27,2); (23,30,3); (4,33,2);

Queue 5: (27,28,5); (13,34,2);

Time 36

Waiting clients: (45,38,3); (11,40,7);

Queue 1: (49,24,3); (17,31,3); (8,35,1);

Queue 2: (37,26,4); (44,32,5);

Queue 3: (24,24,1); (1,30,5); (33,36,2);

Queue 4: (34,27,1); (23,30,3); (4,33,2);

Queue 5: (27,28,4); (13,34,2);

Time 37

Waiting clients: (45,38,3); (11,40,7);

Queue 1: (49,24,2); (17,31,3); (8,35,1);

Queue 2: (37,26,3); (44,32,5);

Queue 3: (1,30,5); (33,36,2);

Queue 4: (23,30,3); (4,33,2);

Queue 5: (27,28,3); (13,34,2);

Time 38

Waiting clients: (11,40,7);

Queue 1: (49,24,1); (17,31,3); (8,35,1);

Queue 2: (37,26,2); (44,32,5);

Queue 3: (1,30,4); (33,36,2);

Queue 4: (23,30,2); (4,33,2); (45,38,3);

Queue 5: (27,28,2); (13,34,2);

Time 39

Waiting clients: (11,40,7);

Queue 1: (17,31,3); (8,35,1);

Queue 2: (37,26,1); (44,32,5);

Queue 3: (1,30,3); (33,36,2);

Queue 4: (23,30,1); (4,33,2); (45,38,3);

Queue 5: (27,28,1); (13,34,2);

Time 40

Waiting clients:

Queue 1: (17,31,2); (8,35,1);

Queue 2: (44,32,5);

Queue 3: (1,30,2); (33,36,2);

Queue 4: (4,33,2); (45,38,3);

Queue 5: (13,34,2); (11,40,7);

Time 41

Waiting clients:

Queue 1: (17,31,1); (8,35,1);

Queue 2: (44,32,4);

Queue 3: (1,30,1); (33,36,2);

Queue 4: (4,33,1); (45,38,3);

Queue 5: (13,34,1); (11,40,7);

Time 42

Waiting clients:

Queue 1: (8,35,1);

Queue 2: (44,32,3);

Queue 3: (33,36,2);

Queue 4: (45,38,3);

Queue 5: (11,40,7);

Time 43

Waiting clients:

Queue 1: closed

Queue 2: (44,32,2);

Queue 3: (33,36,1);

Queue 4: (45,38,2);

Queue 5: (11,40,6);

Time 44

Waiting clients:

Queue 1: closed

Queue 2: (44,32,1);

Queue 3: closed

Queue 4: (45,38,1);

Queue 5: (11,40,5);

Time 45

Waiting clients:

Queue 1: closed

Queue 2: closed

Queue 3: closed

Queue 4: closed

Queue 5: (11,40,4);

Time 46

Waiting clients:

Queue 1: closed

Queue 2: closed

Queue 3: closed

Queue 4: closed

Queue 5: (11,40,3);

Time 47  
Waiting clients:  
Queue 1: closed  
Queue 2: closed  
Queue 3: closed  
Queue 4: closed  
Queue 5: (11,40,2);

Time 48  
Waiting clients:  
Queue 1: closed  
Queue 2: closed  
Queue 3: closed  
Queue 4: closed  
Queue 5: (11,40,1);

Simulation finished  
Average waiting time : 3.88  
Average service time : 4.06  
Peak Hour : 24

Al treilea test cu urmatoarele date de intrare:

N = 1000  
Q = 20  
Tsimulation = 200 secunde  
[TminArrival, TmaxArrival] = [10, 100]  
[TminService, TmaxService] = [3, 9]

---

Time 0

Waiting clients: (19,10,4); (42,10,9); (90,10,6); (256,10,8); (259,10,9); (312,10,3); (320,10,5); (368,10,6); (485,10,6); (584,10,6); (648,10,7); (715,10,7); (720,10,9); (803,10,5); (985,10,3); (53,11,6); (180,11,9); (387,11,3); (406,11,3); (438,11,4); (616,11,8); (629,11,5); (700,11,8); (833,11,3); (903,11,7); (147,12,4); (270,12,8); (322,12,4); (482,12,3); (596,12,8); (732,12,8); (932,12,9); (148,13,6); (191,13,8); (192,13,8); (261,13,6); (498,13,4); (731,13,4); (835,13,4); (960,13,8); (5,14,7); (50,14,8); (115,14,3); (391,14,3); (467,14,6); (529,14,3); (545,14,3); (632,14,4); (644,14,8); (671,14,6); (678,14,6); (730,14,8); (770,14,6); (787,14,6); (806,14,7); (857,14,3); (873,14,4); (80,15,4); (332,15,9); (473,15,9); (517,15,9); (553,15,3); (602,15,6); (645,15,5); (716,15,8); (811,15,9); (952,15,3); (965,15,7); (127,16,4); (249,16,9); (292,16,3); (352,16,7); (408,16,4); (505,16,8); (555,16,5); (582,16,3); (655,16,9); (780,16,7); (792,16,5); (838,16,9); (972,16,8); (26,17,8); (118,17,5); (173,17,5); (187,17,6); (324,17,7); (384,17,3); (522,17,5); (565,17,4); (656,17,3); (694,17,7); (941,17,3); (989,17,7); (144,18,8); (176,18,4); (271,18,8); (300,18,5); (355,18,5); (385,18,6); (436,18,3); (711,18,5); (892,18,5); (995,18,9); (204,19,6); (239,19,4); (379,19,7); (383,19,5); (687,19,4); (691,19,7); (746,19,4); (107,20,5); (185,20,7); (209,20,8); (288,20,3); (331,20,6); (557,20,9); (600,20,7); (605,20,3); (634,20,5); (674,20,5); (675,20,5); (874,20,3); (897,20,3); (979,20,3); (982,20,4); (20,21,6); (62,21,8); (208,21,6); (231,21,5); (266,21,7); (639,21,8); (663,21,9); (861,21,5); (923,21,7); (4,22,5); (57,22,3); (68,22,5); (354,22,7); (357,22,7); (428,22,9); (502,22,7); (701,22,7); (723,22,9); (884,22,8); (926,22,7); (961,22,9); (45,23,6); (161,23,8); (223,23,3); (503,23,3); (523,23,5); (533,23,8); (640,23,4); (880,23,9); (109,24,5); (119,24,6); (138,24,3); (278,24,3); (305,24,8); (575,24,8); (702,24,7); (779,24,6); (805,24,7); (859,24,5); (888,24,9); (895,24,3); (914,24,9); (955,24,7); (962,24,7); (139,25,7); (152,25,8); (229,25,6); (304,25,8); (311,25,3); (367,25,3); (416,25,3); (423,25,4); (440,25,6); (619,25,8); (698,25,9); (717,25,5); (755,25,3); (785,25,4); (815,25,9); (866,25,5); (878,25,9); (922,25,6); (33,26,6); (75,26,9); (123,26,3); (228,26,9); (279,26,8); (335,26,3); (388,26,3); (606,26,4); (630,26,6); (902,26,8); (947,26,7); (76,27,4); (212,27,6); (273,27,9); (336,27,7); (430,27,3); (560,27,9); (610,27,9); (621,27,6); (821,27,4); (844,27,6); (849,27,3); (931,27,3); (101,28,9); (111,28,9); (314,28,6); (412,28,9); (492,28,4); (614,28,8); (625,28,7); (652,28,5); (827,28,3); (841,28,9); (883,28,7); (919,28,6); (946,28,4); (31,29,6); (175,29,9); (389,29,5); (462,29,7); (490,29,6); (520,29,9); (601,29,5); (647,29,6); (842,29,7); (864,29,7); (9,30,7); (96,30,3); (366,30,4); (395,30,3); (668,30,6); (757,30,8); (879,30,6); (40,31,7); (56,31,5); (157,31,6); (181,31,6); (468,31,9); (576,31,4); (617,31,8); (618,31,9); (646,31,5); (680,31,6); (809,31,6); (858,31,9); (943,31,4); (958,31,4); (997,31,7); (10,32,8); (14,32,9); (172,32,6); (197,32,4); (234,32,8); (277,32,5); (289,32,5); (710,32,7); (714,32,3); (748,32,6); (776,32,3); (920,32,7); (74,33,3); (83,33,9); (156,33,8); (603,33,6); (653,33,5); (665,33,4); (744,33,9); (777,33,9); (812,33,5); (24,34,3); (81,34,6); (106,34,4); (253,34,3); (338,34,6); (380,34,7); (788,34,4); (825,34,8); (927,34,6);

(15,35,7); (151,35,8); (254,35,6); (394,35,6); (453,35,7); (759,35,6); (862,35,7); (935,35,8); (28,36,6); (94,36,5); (166,36,7); (303,36,4); (337,36,6); (608,36,8); (773,36,8); (822,36,9); (867,36,5); (233,37,5); (334,37,5); (339,37,7); (376,37,5); (403,37,7); (420,37,3); (439,37,8); (479,37,4); (622,37,4); (623,37,8); (763,37,4); (910,37,9); (61,38,4); (97,38,6); (136,38,7); (200,38,7); (296,38,3); (452,38,5); (470,38,8); (512,38,5); (532,38,9); (620,38,9); (641,38,8); (719,38,7); (724,38,5); (772,38,3); (870,38,7); (877,38,3); (36,39,6); (143,39,6); (230,39,9); (260,39,3); (262,39,9); (401,39,4); (521,39,6); (524,39,4); (804,39,4); (814,39,6); (906,39,7); (25,40,5); (55,40,4); (121,40,5); (128,40,9); (316,40,9); (350,40,8); (378,40,9); (432,40,3); (590,40,9); (593,40,3); (669,40,3); (742,40,7); (760,40,5); (904,40,6); (3,41,3); (95,41,7); (153,41,8); (224,41,6); (274,41,8); (444,41,9); (577,41,5); (664,41,8); (749,41,6); (996,41,8); (130,42,3); (207,42,3); (306,42,9); (358,42,5); (374,42,8); (580,42,6); (696,42,3); (740,42,5); (933,42,8); (104,43,7); (205,43,6); (216,43,9); (240,43,5); (242,43,3); (404,43,7); (405,43,3); (488,43,6); (635,43,3); (758,43,6); (900,43,8); (986,43,8); (89,44,8); (281,44,3); (299,44,9); (466,44,3); (631,44,4); (750,44,9); (991,44,3); (142,45,4); (348,45,3); (448,45,8); (455,45,9); (480,45,6); (509,45,5); (572,45,3); (585,45,7); (612,45,5); (638,45,7); (893,45,6); (964,45,4); (63,46,6); (126,46,9); (244,46,7); (613,46,7); (756,46,5); (944,46,9); (2,47,5); (79,47,5); (268,47,9); (369,47,5); (540,47,3); (688,47,7); (940,47,3); (193,48,8); (284,48,7); (661,48,8); (765,48,6); (869,48,7); (911,48,6); (84,49,8); (102,49,4); (450,49,4); (454,49,4); (459,49,5); (477,49,6); (650,49,8); (737,49,5); (819,49,8); (924,49,4); (951,49,7); (100,50,9); (373,50,8); (526,50,7); (626,50,6); (643,50,5); (673,50,5); (705,50,6); (791,50,5); (816,50,9); (830,50,3); (865,50,5); (981,50,5); (27,51,8); (48,51,3); (186,51,4); (472,51,9); (491,51,6); (558,51,3); (563,51,7); (685,51,7); (810,51,8); (853,51,3); (896,51,5); (939,51,3); (34,52,7); (162,52,7); (213,52,4); (251,52,7); (319,52,5); (344,52,6); (345,52,7); (402,52,4); (422,52,6); (465,52,8); (478,52,5); (764,52,8); (934,52,5); (16,53,5); (98,53,7); (215,53,7); (221,53,3); (269,53,4); (435,53,5); (443,53,5); (501,53,4); (541,53,4); (549,53,9); (559,53,8); (718,53,5); (754,53,3); (846,53,4); (91,54,8); (392,54,5); (411,54,8); (552,54,9); (609,54,7); (667,54,9); (800,54,4); (807,54,3); (829,54,8); (860,54,9); (59,55,5); (194,55,4); (235,55,7); (789,55,8); (894,55,5); (70,56,9); (78,56,5); (85,56,5); (199,56,8); (211,56,9); (287,56,4); (298,56,3); (364,56,7); (382,56,3); (535,56,7); (588,56,4); (697,56,4); (726,56,9); (820,56,9); (58,57,9); (103,57,3); (133,57,8); (137,57,9); (145,57,9); (155,57,8); (163,57,9); (188,57,4); (214,57,8); (275,57,8); (399,57,6); (496,57,7); (508,57,4); (627,57,5); (695,57,5); (834,57,8); (839,57,5); (887,57,6); (953,57,8); (983,57,8); (226,58,3); (302,58,9); (341,58,9); (351,58,5); 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(658,64,9); (670,64,5); (743,64,7); (942,64,7); (225,65,6); (276,65,9); (280,65,4); (386,65,7); (516,65,9); (527,65,3); (561,65,6); (733,65,7); (767,65,6); (781,65,5); (848,65,3); (891,65,5); (1,66,6); (18,66,8); (179,66,5); (346,66,7); (484,66,7); (706,66,9); (774,66,5); (970,66,3); (6,67,6); (52,67,7); (202,67,9); (318,67,6); (518,67,7); (974,67,5); (12,68,6); (22,68,4); (110,68,4); (189,68,3); (245,68,7); (495,68,8); (513,68,8); (554,68,7); (786,68,8); (793,68,4); (916,68,7); (987,68,9); (250,69,7); (290,69,3); (301,69,7); (313,69,5); (414,69,3); (528,69,5); (581,69,4); (666,69,4); (707,69,3); (928,69,6); (977,69,4); (77,70,9); (141,70,5); (146,70,5); (196,70,9); (237,70,4); (310,70,7); (371,70,3); (419,70,4); (567,70,8); (637,70,7); (660,70,4); (708,70,3); (937,70,8); (990,70,3); (54,71,5); (164,71,8); (333,71,3); (361,71,9); (546,71,4); (556,71,4); (649,71,3); (936,71,6); (38,72,6); (92,72,3); (177,72,8); (206,72,4); (343,72,7); (775,72,9); (975,72,9); (30,73,7); (44,73,9); (46,73,4); 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Queue 1: closed  
Queue 2: closed  
Queue 3: closed  
Queue 4: closed  
Queue 5: closed  
Queue 6: closed  
Queue 7: closed  
Queue 8: closed  
Queue 9: closed  
Queue 10: closed  
Queue 11: closed  
Queue 12: closed  
Queue 13: closed  
Queue 14: closed  
Queue 15: closed  
Queue 16: closed  
Queue 17: closed  
Queue 18: closed  
Queue 19: closed  
Queue 20: closed

.....

Time 10

Waiting clients: (53,11,6); (180,11,9); (387,11,3); (406,11,3); (438,11,4); (616,11,8); (629,11,5); (700,11,8); (833,11,3); (903,11,7); (147,12,4); (270,12,8); (322,12,4); (482,12,3); (596,12,8); (732,12,8); (932,12,9); (148,13,6); (191,13,8); (192,13,8); (261,13,6); (498,13,4); (731,13,4); (835,13,4); (960,13,8); (5,14,7); (50,14,8); (115,14,3); (391,14,3); (467,14,6); (529,14,3); (545,14,3); (632,14,4); (644,14,8); (671,14,6); (678,14,6); (730,14,8); (770,14,6); (787,14,6); (806,14,7); (857,14,3); (873,14,4); (80,15,4); (332,15,9); (473,15,9); (517,15,9); (553,15,3); (602,15,6); (645,15,5); (716,15,8); (811,15,9); (952,15,3); (965,15,7); (127,16,4); (249,16,9); (292,16,3); (352,16,7); (408,16,4); (505,16,8); (555,16,5); (582,16,3); (655,16,9); (780,16,7); (792,16,5); (838,16,9); (972,16,8); (26,17,8); (118,17,5); (173,17,5); (187,17,6); (324,17,7); (384,17,3); (522,17,5); (565,17,4); (656,17,3); (694,17,7); (941,17,3); (989,17,7); (144,18,8); (176,18,4); (271,18,8); (300,18,5); (355,18,5); (385,18,6); (436,18,3); (711,18,5); (892,18,5); (995,18,9); (204,19,6); (239,19,4); (379,19,7); (383,19,5); (687,19,4); (691,19,7); (746,19,4); (107,20,5); (185,20,7); (209,20,8); (288,20,3); (331,20,6); (557,20,9); (600,20,7); (605,20,3); (634,20,5); (674,20,5); (675,20,5); (874,20,3); (897,20,3); (979,20,3); (982,20,4); (20,21,6); (62,21,8); (208,21,6); (231,21,5); (266,21,7); (639,21,8); (663,21,9); (861,21,5); (923,21,7); (4,22,5); (57,22,3); (68,22,5); (354,22,7); (357,22,7); (428,22,9); (502,22,7); (701,22,7); (723,22,9); (884,22,8); (926,22,7); (961,22,9); (45,23,6); (161,23,8); (223,23,3); (503,23,3); (523,23,5); (533,23,8); (640,23,4); (880,23,9); (109,24,5); (119,24,6); (138,24,3); (278,24,3); (305,24,8); (575,24,8); (702,24,7); (779,24,6); (805,24,7); (859,24,5); (888,24,9); (895,24,3); (914,24,9); (955,24,7); (962,24,7); (139,25,7); (152,25,8); (229,25,6); (304,25,8); (311,25,3); (367,25,3); (416,25,3); (423,25,4); (440,25,6); (619,25,8); (698,25,9); (717,25,5); (755,25,3); (785,25,4); (815,25,9); (866,25,5); (878,25,9); (922,25,6); (33,26,6); (75,26,9); (123,26,3); (228,26,9); (279,26,8); (335,26,3); (388,26,3); (606,26,4); (630,26,6); (902,26,8); (947,26,7); (76,27,4); (212,27,6); (273,27,9); (336,27,7); (430,27,3); (560,27,9); (610,27,9); (621,27,6); (821,27,4); (844,27,6); (849,27,3); (931,27,3); (101,28,9); (111,28,9); (314,28,6); (412,28,9); (492,28,4); (614,28,8); (625,28,7); (652,28,5); (827,28,3); (841,28,9); (883,28,7); (919,28,6); (946,28,4); (31,29,6); (175,29,9); (389,29,5); (462,29,7); (490,29,6); (520,29,9); (601,29,5); (647,29,6); (842,29,7); (864,29,7); (9,30,7); (96,30,3); (366,30,4); (395,30,3); (668,30,6); (757,30,8); (879,30,6); (40,31,7); (56,31,5); (157,31,6); (181,31,6); (468,31,9); (576,31,4); (617,31,8); (618,31,9); (646,31,5); (680,31,6); (809,31,6); (858,31,9); (943,31,4); (958,31,4); (997,31,7); (10,32,8); (14,32,9); (172,32,6); (197,32,4); (234,32,8); (277,32,5); (289,32,5); (710,32,7); (714,32,3); (748,32,6); (776,32,3); (920,32,7); (74,33,3); (83,33,9); (156,33,8); (603,33,6); (653,33,5); (665,33,4); (744,33,9); (777,33,9); (812,33,5); (24,34,3); (81,34,6); (106,34,4); (253,34,3); (338,34,6); (380,34,7); (788,34,4); (825,34,8); (927,34,6); (15,35,7); (151,35,8); (254,35,6); (394,35,6); (453,35,7); (759,35,6); (862,35,7); (935,35,8); (28,36,6); (94,36,5); (166,36,7); (303,36,4); (337,36,6); (608,36,8); (773,36,8); (822,36,9); (867,36,5); (233,37,5); (334,37,5); (339,37,7); (376,37,5); (403,37,7); (420,37,3); (439,37,8); (479,37,4); (622,37,4); (623,37,8); (763,37,4); (910,37,9); (61,38,4); (97,38,6); (136,38,7); (200,38,7); (296,38,3); (452,38,5); (470,38,8); (512,38,5); (532,38,9); (620,38,9); (641,38,8); (719,38,7); (724,38,5); (772,38,3); (870,38,7); (877,38,3); (36,39,6); (143,39,6); (230,39,9); (260,39,3); (262,39,9); (401,39,4); (521,39,6); (524,39,4); (804,39,4); (814,39,6); (906,39,7); (25,40,5); (55,40,4);

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(856,79,6); (1000,79,3); (66,80,3); (160,80,8); (168,80,3); (353,80,8); (591,80,7); (657,80,4); (722,80,3); (87,81,6); (241,81,4); (267,81,9); (418,81,5); (451,81,7); (689,81,6); (913,81,8); (959,81,6); (993,81,7); (999,81,6); (41,82,4); (170,82,3); (203,82,8); (210,82,4); (330,82,4); (500,82,6); (562,82,8); (808,82,3); (876,82,4); (881,82,4); (968,82,7); (71,83,7); (88,83,3); (178,83,5); (342,83,6); (407,83,8); (409,83,8); (461,83,4); (507,83,7); (514,83,4); (543,83,3); (654,83,8); (797,83,5); (174,84,5); (257,84,7); (297,84,9); (460,84,7); (548,84,3); (566,84,4); (679,84,3); (699,84,8); (728,84,3); (762,84,9); (845,84,4); (863,84,8); (917,84,4); (971,84,9); (135,85,4); (217,85,6); (363,85,4); (424,85,4); (427,85,7); (469,85,6); (579,85,6); (778,85,6); (930,85,6); (263,86,5); (321,86,7); (370,86,9); (390,86,3); (571,86,4); (597,86,3); (712,86,3); (817,86,3); (818,86,8); (843,86,8); (901,86,4); (474,87,8); (481,87,5); (534,87,9); (745,87,8); (840,87,6); (907,87,4); (65,88,6); (149,88,3); (220,88,8); (425,88,3); (499,88,4); (538,88,4); (583,88,9); (682,88,3); (847,88,7); (8,89,3); (64,89,6); (105,89,6); (150,89,7); (243,89,4); (247,89,9); (282,89,5); (286,89,6); (415,89,9); (564,89,9); (686,89,4); (734,89,7); (771,89,8); (885,89,5); (165,90,3); (184,90,8); (232,90,3); (574,90,7); (611,90,9); (642,90,7); (725,90,5); (736,90,5); (751,90,3); (826,90,8); (875,90,5); (992,90,3); (73,91,7); (171,91,5); (317,91,7); (375,91,7); (713,91,5); (752,91,9); (782,91,4); (886,91,4); (899,91,4); (908,91,7); (909,91,8); (969,91,5); (980,91,9); (17,92,5); (49,92,8); (377,92,3); (381,92,9); (486,92,8); (550,92,7); (684,92,9); (783,92,8); (798,92,9); (799,92,6); (11,93,8); (113,93,7); (158,93,5); (252,93,7); (595,93,6); (598,93,7); (604,93,9); (768,93,6); (769,93,3); (222,94,5); (293,94,3); (400,94,3); (434,94,9); (519,94,9); (607,94,8); (729,94,7); (813,94,8); (828,94,9); (890,94,8); (898,94,5); (929,94,9); (183,95,4); (283,95,3); (285,95,5); (398,95,8); (445,95,7); (475,95,9); (483,95,4); (570,95,4); (573,95,3); (589,95,5); (956,95,7); (984,95,6); (29,96,9); (35,96,8); (116,96,4); (140,96,3); (219,96,9); (307,96,4); (360,96,6); (393,96,9); (426,96,5); (463,96,9); (464,96,3); (536,96,4); (586,96,9); (693,96,5); (704,96,3); (739,96,8); (795,96,4); (889,96,3); (69,97,5); (72,97,4); (238,97,7); (328,97,6); (329,97,4); (442,97,5); (938,97,8); (950,97,9); (967,97,9); (988,97,9); (32,98,6); (60,98,5); (112,98,3); (340,98,5); (359,98,7); (544,98,5); (599,98,5); (672,98,4); (823,98,8); (837,98,4); (21,99,4); (82,99,8); (272,99,9); (327,99,7); (397,99,8); (447,99,8); (497,99,6); (676,99,7); (852,99,3); (868,99,3); (51,100,5); (93,100,9); (117,100,5); (182,100,3); (265,100,6); (458,100,7); (493,100,3); (515,100,8); (624,100,6); (651,100,8); (683,100,6); (957,100,9);

Queue 1: (19,10,4);

Queue 2: (42,10,9);

Queue 3: (90,10,6);



Queue 4: (256,10,8);  
 Queue 5: (259,10,9);  
 Queue 6: (312,10,3);  
 Queue 7: (320,10,5);  
 Queue 8: (368,10,6);  
 Queue 9: (485,10,6);  
 Queue 10: (584,10,6);  
 Queue 11: (648,10,7);  
 Queue 12: (715,10,7);  
 Queue 13: (720,10,9);  
 Queue 14: (803,10,5);  
 Queue 15: (985,10,3);  
 Queue 16: closed  
 Queue 17: closed  
 Queue 18: closed  
 Queue 19: closed  
 Queue 20: closed

.....  
 Time 100  
 Waiting clients:  
 Queue 1: (128,40,2); (933,42,8); (638,45,7); (102,49,4); (100,50,9); (478,52,5); (91,54,8); (588,56,4); (496,57,7); (125,59,9); (227,61,7); (578,62,6); (190,64,5); (516,65,9); (786,68,8); (54,71,5); (44,73,9); (236,77,8); (856,79,6); (993,81,7); (460,84,7); (390,86,3); (481,87,5); (282,89,5); (875,90,5); (49,92,8); (400,94,3); (570,95,4); (219,96,9); (672,98,4); (51,100,5);  
 Queue 2: (742,40,2); (104,43,7); (509,45,5); (369,47,5); (924,49,4); (865,50,5); (251,52,7); (392,54,5); (199,56,8); (834,57,8); (709,59,5); (854,60,6); (169,62,5); (295,63,8); (225,65,6); (6,67,6); (414,69,3); (146,70,5); (38,72,6); (851,74,4); (131,76,9); (537,79,4); (722,80,3); (999,81,6); (654,83,8); (571,86,4); (220,88,8); (611,90,9); (158,93,5); (434,94,9); (463,96,9); (327,99,7);  
 Queue 3: (358,42,5); (900,43,8); (2,47,5); (650,49,8); (563,51,7); (435,53,5); (194,55,4); (298,56,3); (145,57,9); (167,59,4); (429,60,6); (372,61,5); (487,62,4); (569,63,6); (658,64,9); (189,68,3); (987,68,9); (92,72,3); (46,73,4); (23,75,4); (594,76,5); (446,78,3); (692,79,8); (203,82,8); (762,84,9); (425,88,3); (150,89,7); (171,91,5); (486,92,8); (813,94,8); (464,96,3); (329,97,4); (823,98,8);  
 Queue 4: (274,41,5); (986,43,8); (79,47,5); (737,49,5); (981,50,5); (319,52,5); (443,53,5); (235,55,7); (155,57,8); (872,58,7); (753,60,8); (323,62,3); (86,63,5); (349,64,5); (527,65,3); (346,66,7); (250,69,7); (164,71,8); (973,74,6); (326,77,5); (966,78,6); (87,81,6); (881,82,4); (548,84,3); (917,84,4); (597,86,3); (534,87,9); (642,90,7); (550,92,7); (519,94,9); (536,96,4); (950,97,9); (493,100,3);  
 Queue 5: (306,42,8); (448,45,8); (661,48,8); (472,51,9); (501,53,4); (807,54,3); (211,56,9); (839,57,5); (255,59,3); (836,59,6); (347,61,3); (47,62,9); (963,63,6); (561,65,6); (318,67,6); (581,69,4); (660,70,4); (775,72,9); (246,76,4); (134,78,9); (241,81,4); (210,82,4); (507,83,7); (778,85,6); (499,88,4); (286,89,6); (317,91,7); (252,93,7); (183,95,4); (29,96,9); (359,98,7); (515,100,8);  
 Queue 6: (444,41,6); (299,44,9); (193,48,8); (27,51,8); (16,53,5); (667,54,9); (163,57,9); (294,59,8); (998,60,8); (633,62,3); (766,63,3); (476,64,3); (670,64,5); (484,66,7); (290,69,3); (977,69,4); (333,71,3); (975,72,9); (325,76,6); (741,78,7); (267,81,9); (797,83,5); (363,85,4); (817,86,3); (538,88,4); (415,89,9); (908,91,7); (769,93,3); (828,94,9); (739,96,8); (397,99,8);  
 Queue 7: (378,40,3); (404,43,7); (893,45,6); (765,48,6); (673,50,5); (939,51,3); (764,52,8); (789,55,8); (275,57,8); (309,59,8); (114,61,7); (539,62,3); (396,63,9); (733,65,7); (245,68,7); (196,70,9); (218,74,5); (13,76,3); (421,77,9); (66,80,3); (689,81,6); (342,83,6); (971,84,9); (847,88,7); (725,90,5); (909,91,8); (293,94,3); (283,95,3); (956,95,7); (442,97,5); (837,98,4); (265,100,6);  
 Queue 8: (577,41,2); (205,43,6); (455,45,9); (450,49,4); (373,50,8); (422,52,6); (411,54,8); (697,56,4); (508,57,4); (226,58,3); (456,59,8); (122,61,8); (662,62,9); (743,64,7); (52,67,7); (666,69,4); (708,70,3); (177,72,8); (659,75,3); (945,76,3); (159,78,5); (735,79,8); (330,82,4); (514,83,4); (845,84,4); (321,86,7); (8,89,3); (686,89,4); (992,90,3); (782,91,4); (783,92,8); (285,95,5); (307,96,4); (72,97,4); (544,98,5); (93,100,9);  
 Queue 9: (904,40,1); (374,42,8); (572,45,3); (944,46,9); (526,50,7); (344,52,6); (549,53,9); (726,56,9); (302,58,9); (871,60,9); (882,62,4); (824,63,8); (781,65,5); (518,67,7); (77,70,9); (264,73,6); (43,76,4); (615,77,9); (591,80,7); (968,82,7); (135,85,4); (712,86,3); (745,87,8); (232,90,3); (375,91,7); (595,93,6); (890,94,8); (586,96,9); (447,99,8);  
 Queue 10: (996,41,6); (466,44,3); (585,45,7); (869,48,7); (48,51,3); (685,51,7); (541,53,4); (829,54,8); (188,57,4); (887,57,6); (681,59,9); (431,61,7); (124,63,3); (921,63,8); (848,65,3); (774,66,5); (793,68,4); (141,70,5); (546,71,4); (437,73,7); (413,76,5); (198,78,7); (657,80,4); (41,82,4); (407,83,8); (930,85,6); (583,88,9); (73,91,7); (798,92,9); (573,95,3); (35,96,8); (60,98,5); (676,99,7);  
 Queue 11: (590,40,3); (405,43,3); (631,44,4); (964,45,4); (540,47,3); (454,49,4); (626,50,6); (34,52,7); (559,53,8); (364,56,7); (953,57,8); (855,59,8); (628,61,8); (796,63,4); (636,64,5); (891,65,5); (974,67,5); (528,69,5); (937,70,8); (677,74,7); (506,77,7); (801,79,9); (808,82,3); (543,83,3); (679,84,3); (424,85,4); (818,86,8); (734,89,7); (886,91,4); (799,92,6); (607,94,8); (393,96,9); (21,99,4); (458,100,7);  
 Queue 12: (130,42,1); (580,42,6); (991,44,3); (63,46,6); (911,48,6); (705,50,6); (345,52,7); (552,54,9); (103,57,3); (627,57,5); (341,58,9); (912,60,3); (449,61,7); (291,63,9); (276,65,9); (554,68,7); (310,70,7); (511,73,5); (794,75,5); (949,77,3); (832,78,8); (913,81,8); (174,84,5); (427,85,7); (682,88,3); (243,89,4); (574,90,7); (377,92,3); (598,93,7); (398,95,8); (795,96,4); (112,98,3); (82,99,8);

Queue 13: (207,42,1); (696,42,3); (635,43,3); (142,45,4); (613,46,7); (819,49,8); (810,51,8); (718,53,5); (85,56,5); (133,57,8); (351,58,5); (954,59,3); (761,60,3); (362,61,7); (915,62,9); (942,64,7); (202,67,9); (237,70,4); (556,71,4); (784,73,8); (976,76,7); (433,79,9); (500,82,6); (566,84,4); (469,85,6); (840,87,6); (771,89,8); (969,91,5); (604,93,9); (984,95,6); (238,97,7); (497,99,6);

Queue 14: (153,41,4); (758,43,6); (126,46,9); (951,49,7); (853,51,3); (465,52,8); (860,54,9); (399,57,6); (410,58,7); (494,60,6); (721,61,3); (457,62,7); (978,63,7); (1,66,6); (495,68,8); (371,70,3); (649,71,3); (30,73,7); (67,76,7); (925,78,4); (1000,79,3); (418,81,5); (876,82,4); (257,84,7); (370,86,9); (564,89,9); (980,91,9); (729,94,7); (360,96,6); (967,97,9); (624,100,6);

Queue 15: (664,41,5); (89,44,8); (268,47,9); (791,50,5); (162,52,7); (754,53,3); (59,55,5); (382,56,3); (214,57,8); (918,58,6); (531,60,9); (471,62,7); (129,64,7); (18,66,8); (916,68,7); (990,70,3); (206,72,4); (504,74,8); (551,77,3); (201,78,3); (489,79,8); (170,82,3); (71,83,7); (217,85,6); (901,86,4); (64,89,6); (736,90,5); (17,92,5); (768,93,6); (445,95,7); (693,96,5); (340,98,5); (852,99,3); (651,100,8);

Queue 16: (749,41,3); (488,43,6); (612,45,5); (688,47,7); (643,50,5); (896,51,5); (98,53,7); (894,55,5); (820,56,9); (530,58,5); (994,59,7); (510,61,6); (7,63,6); (547,64,4); (280,65,4); (706,66,9); (707,69,3); (419,70,4); (343,72,7); (308,75,6); (99,78,8); (160,80,8); (88,83,3); (297,84,9); (843,86,8); (885,89,5); (713,91,5); (684,92,9); (475,95,9); (328,97,6); (272,99,9);

Queue 17: (316,40,2); (216,43,9); (756,46,5); (84,49,8); (491,51,6); (934,52,5); (609,54,7); (535,56,7); (983,57,8); (248,60,8); (738,61,4); (542,62,6); (154,64,6); (767,65,6); (12,68,6); (928,69,6); (936,71,6); (802,74,3); (905,75,5); (120,78,4); (356,79,6); (451,81,7); (409,83,8); (263,86,5); (907,87,4); (247,89,9); (899,91,4); (11,93,8); (483,95,4); (116,96,4); (889,96,3); (988,97,9); (683,100,6);

Queue 18: (224,41,2); (240,43,5); (348,45,3); (244,46,7); (459,49,5); (816,50,9); (215,53,7); (70,56,9); (695,57,5); (703,58,8); (850,60,6); (108,62,8); (948,63,8); (179,66,5); (22,68,4); (301,69,7); (361,71,9); (525,75,3); (441,76,5); (258,78,4); (831,79,8); (562,82,8); (863,84,8); (65,88,6); (165,90,3); (751,90,3); (752,91,9); (222,94,5); (589,95,5); (426,96,5); (32,98,6); (868,99,3); (957,100,9);

Queue 19: (350,40,1); (740,42,5); (750,44,9); (284,48,7); (830,50,3); (558,51,3); (402,52,4); (269,53,4); (800,54,4); (287,56,4); (137,57,9); (39,59,4); (315,60,8); (747,61,7); (417,63,8); (386,65,7); (110,68,4); (313,69,5); (567,70,8); (587,74,8); (592,77,9); (168,80,3); (959,81,6); (461,83,4); (699,84,8); (474,87,8); (184,90,8); (381,92,9); (898,94,5); (140,96,3); (704,96,3); (938,97,8); (117,100,5);

Queue 20: (95,41,2); (242,43,3); (281,44,3); (480,45,6); (940,47,3); (477,49,6); (186,51,4); (213,52,4); (221,53,3); (846,53,4); (78,56,5); (58,57,9); (727,58,7); (690,60,6); (790,61,5); (37,63,6); (568,64,9); (970,66,3); (513,68,8); (637,70,7); (195,74,8); (132,77,6); (365,79,4); (353,80,8); (178,83,5); (728,84,3); (579,85,6); (149,88,3); (105,89,6); (826,90,8); (113,93,7); (929,94,9); (69,97,5); (599,98,5); (182,100,3);

.....

Time 150

Waiting clients:

Queue 1: (578,62,5); (190,64,5); (516,65,9); (786,68,8); (54,71,5); (44,73,9); (236,77,8); (856,79,6); (993,81,7); (460,84,7); (390,86,3); (481,87,5); (282,89,5); (875,90,5); (49,92,8); (400,94,3); (570,95,4); (219,96,9); (672,98,4); (51,100,5);

Queue 2: (169,62,1); (295,63,8); (225,65,6); (6,67,6); (414,69,3); (146,70,5); (38,72,6); (851,74,4); (131,76,9); (537,79,4); (722,80,3); (999,81,6); (654,83,8); (571,86,4); (220,88,8); (611,90,9); (158,93,5); (434,94,9); (463,96,9); (327,99,7);

Queue 3: (487,62,2); (569,63,6); (658,64,9); (189,68,3); (987,68,9); (92,72,3); (46,73,4); (23,75,4); (594,76,5); (446,78,3); (692,79,8); (203,82,8); (762,84,9); (425,88,3); (150,89,7); (171,91,5); (486,92,8); (813,94,8); (464,96,3); (329,97,4); (823,98,8);

Queue 4: (86,63,5); (349,64,5); (527,65,3); (346,66,7); (250,69,7); (164,71,8); (973,74,6); (326,77,5); (966,78,6); (87,81,6); (881,82,4); (548,84,3); (917,84,4); (597,86,3); (534,87,9); (642,90,7); (550,92,7); (519,94,9); (536,96,4); (950,97,9); (493,100,3);

Queue 5: (47,62,4); (963,63,6); (561,65,6); (318,67,6); (581,69,4); (660,70,4); (775,72,9); (246,76,4); (134,78,9); (241,81,4); (210,82,4); (507,83,7); (778,85,6); (499,88,4); (286,89,6); (317,91,7); (252,93,7); (183,95,4); (29,96,9); (359,98,7); (515,100,8);

Queue 6: (633,62,2); (766,63,3); (476,64,3); (670,64,5); (484,66,7); (290,69,3); (977,69,4); (333,71,3); (975,72,9); (325,76,6); (741,78,7); (267,81,9); (797,83,5); (363,85,4); (817,86,3); (538,88,4); (415,89,9); (908,91,7); (769,93,3); (828,94,9); (739,96,8); (397,99,8);

Queue 7: (539,62,1); (396,63,9); (733,65,7); (245,68,7); (196,70,9); (218,74,5); (13,76,3); (421,77,9); (66,80,3); (689,81,6); (342,83,6); (971,84,9); (847,88,7); (725,90,5); (909,91,8); (293,94,3); (283,95,3); (956,95,7); (442,97,5); (837,98,4); (265,100,6);

Queue 8: (662,62,8); (743,64,7); (52,67,7); (666,69,4); (708,70,3); (177,72,8); (659,75,3); (945,76,3); (159,78,5); (735,79,8); (330,82,4); (514,83,4); (845,84,4); (321,86,7); (8,89,3); (686,89,4); (992,90,3); (782,91,4); (783,92,8); (285,95,5); (307,96,4); (72,97,4); (544,98,5); (93,100,9);

Queue 9: (882,62,3); (824,63,8); (781,65,5); (518,67,7); (77,70,9); (264,73,6); (43,76,4); (615,77,9); (591,80,7); (968,82,7); (135,85,4); (712,86,3); (745,87,8); (232,90,3); (375,91,7); (595,93,6); (890,94,8); (586,96,9); (447,99,8);

Queue 10: (124,63,3); (921,63,8); (848,65,3); (774,66,5); (793,68,4); (141,70,5); (546,71,4); (437,73,7); (413,76,5); (198,78,7); (657,80,4); (41,82,4); (407,83,8); (930,85,6); (583,88,9); (73,91,7); (798,92,9); (573,95,3); (35,96,8); (60,98,5); (676,99,7);

Queue 11: (628,61,2); (796,63,4); (636,64,5); (891,65,5); (974,67,5); (528,69,5); (937,70,8); (677,74,7); (506,77,7); (801,79,9); (808,82,3); (543,83,3); (679,84,3); (424,85,4); (818,86,8); (734,89,7); (886,91,4); (799,92,6); (607,94,8); (393,96,9); (21,99,4); (458,100,7);

Queue 12: (291,63,9); (276,65,9); (554,68,7); (310,70,7); (511,73,5); (794,75,5); (949,77,3); (832,78,8); (913,81,8); (174,84,5); (427,85,7); (682,88,3); (243,89,4); (574,90,7); (377,92,3); (598,93,7); (398,95,8); (795,96,4); (112,98,3); (82,99,8);

Queue 13: (915,62,8); (942,64,7); (202,67,9); (237,70,4); (556,71,4); (784,73,8); (976,76,7); (433,79,9); (500,82,6); (566,84,4); (469,85,6); (840,87,6); (771,89,8); (969,91,5); (604,93,9); (984,95,6); (238,97,7); (497,99,6);

Queue 14: (457,62,4); (978,63,7); (1,66,6); (495,68,8); (371,70,3); (649,71,3); (30,73,7); (67,76,7); (925,78,4); (1000,79,3); (418,81,5); (876,82,4); (257,84,7); (370,86,9); (564,89,9); (980,91,9); (729,94,7); (360,96,6); (967,97,9); (624,100,6);

Queue 15: (471,62,4); (129,64,7); (18,66,8); (916,68,7); (990,70,3); (206,72,4); (504,74,8); (551,77,3); (201,78,3); (489,79,8); (170,82,3); (71,83,7); (217,85,6); (901,86,4); (64,89,6); (736,90,5); (17,92,5); (768,93,6); (445,95,7); (693,96,5); (340,98,5); (852,99,3); (651,100,8);

Queue 16: (7,63,5); (547,64,4); (280,65,4); (706,66,9); (707,69,3); (419,70,4); (343,72,7); (308,75,6); (99,78,8); (160,80,8); (88,83,3); (297,84,9); (843,86,8); (885,89,5); (713,91,5); (684,92,9); (475,95,9); (328,97,6); (272,99,9);

Queue 17: (542,62,4); (154,64,6); (767,65,6); (12,68,6); (928,69,6); (936,71,6); (802,74,3); (905,75,5); (120,78,4); (356,79,6); (451,81,7); (409,83,8); (263,86,5); (907,87,4); (247,89,9); (899,91,4); (11,93,8); (483,95,4); (116,96,4); (889,96,3); (988,97,9); (683,100,6);

Queue 18: (108,62,3); (948,63,8); (179,66,5); (22,68,4); (301,69,7); (361,71,9); (525,75,3); (441,76,5); (258,78,4); (831,79,8); (562,82,8); (863,84,8); (65,88,6); (165,90,3); (751,90,3); (752,91,9); (222,94,5); (589,95,5); (426,96,5); (32,98,6); (868,99,3); (957,100,9);

Queue 19: (747,61,1); (417,63,8); (386,65,7); (110,68,4); (313,69,5); (567,70,8); (587,74,8); (592,77,9); (168,80,3); (959,81,6); (461,83,4); (699,84,8); (474,87,8); (184,90,8); (381,92,9); (898,94,5); (140,96,3); (704,96,3); (938,97,8); (117,100,5);

Queue 20: (37,63,5); (568,64,9); (970,66,3); (513,68,8); (637,70,7); (195,74,8); (132,77,6); (365,79,4); (353,80,8); (178,83,5); (728,84,3); (579,85,6); (149,88,3); (105,89,6); (826,90,8); (113,93,7); (929,94,9); (69,97,5); (599,98,5); (182,100,3);

.....

Time 199

Waiting clients:

Queue 1: (460,84,3); (390,86,3); (481,87,5); (282,89,5); (875,90,5); (49,92,8); (400,94,3); (570,95,4); (219,96,9); (672,98,4); (51,100,5);

Queue 2: (654,83,3); (571,86,4); (220,88,8); (611,90,9); (158,93,5); (434,94,9); (463,96,9); (327,99,7);

Queue 3: (762,84,7); (425,88,3); (150,89,7); (171,91,5); (486,92,8); (813,94,8); (464,96,3); (329,97,4); (823,98,8);

Queue 4: (917,84,3); (597,86,3); (534,87,9); (642,90,7); (550,92,7); (519,94,9); (536,96,4); (950,97,9); (493,100,3);

Queue 5: (507,83,1); (778,85,6); (499,88,4); (286,89,6); (317,91,7); (252,93,7); (183,95,4); (29,96,9); (359,98,7); (515,100,8);

Queue 6: (363,85,4); (817,86,3); (538,88,4); (415,89,9); (908,91,7); (769,93,3); (828,94,9); (739,96,8); (397,99,8);

Queue 7: (971,84,8); (847,88,7); (725,90,5); (909,91,8); (293,94,3); (283,95,3); (956,95,7); (442,97,5); (837,98,4); (265,100,6);

Queue 8: (845,84,2); (321,86,7); (8,89,3); (686,89,4); (992,90,3); (782,91,4); (783,92,8); (285,95,5); (307,96,4); (72,97,4); (544,98,5); (93,100,9);

Queue 9: (135,85,3); (712,86,3); (745,87,8); (232,90,3); (375,91,7); (595,93,6); (890,94,8); (586,96,9); (447,99,8);

Queue 10: (407,83,1); (930,85,6); (583,88,9); (73,91,7); (798,92,9); (573,95,3); (35,96,8); (60,98,5); (676,99,7);

Queue 11: (424,85,4); (818,86,8); (734,89,7); (886,91,4); (799,92,6); (607,94,8); (393,96,9); (21,99,4); (458,100,7);

Queue 12: (427,85,7); (682,88,3); (243,89,4); (574,90,7); (377,92,3); (598,93,7); (398,95,8); (795,96,4); (112,98,3); (82,99,8);

Queue 13: (469,85,6); (840,87,6); (771,89,8); (969,91,5); (604,93,9); (984,95,6); (238,97,7); (497,99,6);

Queue 14: (257,84,2); (370,86,9); (564,89,9); (980,91,9); (729,94,7); (360,96,6); (967,97,9); (624,100,6);

Queue 15: (217,85,5); (901,86,4); (64,89,6); (736,90,5); (17,92,5); (768,93,6); (445,95,7); (693,96,5); (340,98,5); (852,99,3); (651,100,8);

Queue 16: (297,84,4); (843,86,8); (885,89,5); (713,91,5); (684,92,9); (475,95,9); (328,97,6); (272,99,9);

Queue 17: (409,83,1); (263,86,5); (907,87,4); (247,89,9); (899,91,4); (11,93,8); (483,95,4); (116,96,4); (889,96,3); (988,97,9); (683,100,6);

Queue 18: (863,84,6); (65,88,6); (165,90,3); (751,90,3); (752,91,9); (222,94,5); (589,95,5); (426,96,5); (32,98,6); (868,99,3); (957,100,9);

Queue 19: (699,84,5); (474,87,8); (184,90,8); (381,92,9); (898,94,5); (140,96,3); (704,96,3); (938,97,8); (117,100,5);

Queue 20: (579,85,6); (149,88,3); (105,89,6); (826,90,8); (113,93,7); (929,94,9); (69,97,5); (599,98,5); (182,100,3);

Simulation finished

Average waiting time : 95.648

Average service time : 6.006

Peak Hour : 100

## 6. Concluzii

Prin implementarea acestei teme mi-am aprofundat cunostințele de programare în Java, cunostințele despre threaduri și ce implica concurența threadurilor pentru datele noastre, despre structuri care sunt sigure pentru threaduri. Mi-am aprofundat cunostințele despre cozi și despre cum lucrăm cu acestea în Java. De asemenea, am exersat și construirea unei interfețe care se schimbă în mod constant.

Ca și posibilități de dezvoltare ulterioară, se poate lucra la interfața, o realizare mai „user friendly”, cu imagini pentru cozi și clienți mult mai atractive. De asemenea, mesajele de eroare la introducerea datelor ar putea fi mult mai explicite. La nivel de proiectare se pot aduce îmbunătățiri, iar codul poate fi optimizat.

## 7. Bibliografie

- [1] Cursurile de tehnici de programare
- [2] Cursurile de POO
- [3] Wikipedia
- [4] <https://stackoverflow.com>
- [5] <https://www.geeksforgeeks.org/>