

**Fundamental Programming Techniques**

**Assignment 2- Documentation**  
**Queues Simulator**

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## **1. Assignment objective**

The objective of this assignment is to develop a Java application which simulates the real-life situation of the queues in a supermarket. The application should be able to simulate a set of queues and a set of clients that enter those queues, wait there, are served and then finally leave. The secondary objectives of this project are: understanding the requirements and how the application is supposed to work, designing the simulator, implementing the simulator (both the actual functionality and the graphical user interface). Each of these sub-objectives will be described in detail in the following paragraphs.

## **2. Problem analysis, modeling, scenarios, use cases**

The functional requirements for this assignment are the following:

- The users should be allowed to insert the input variables of the simulation (number of queues, number of clients, simulation time, minimum/maximum arrival time, minimum/maximum processing/service time).
- The users should be allowed to choose the desired strategy for the simulation from the 2 options available (shortest time and shortest queue).
- The simulator should display on the user interface the situation of the queues in real time, from start to finish of the simulation time.
- The application should write in a text file the log of events of the simulation.
- The application should compute the average waiting time, average service time and peak hour and display these values in the text file.
- The application should handle bad inputs from the user.
- The simulator should randomly generate the clients, who are defined by the tuple (ID, arrival time, processing time).

The non-functional requirements of this problem are:

- The application should be easy to use, with a friendly interface.
- Except for the UI classes, the rest of the classes should contain at most 300 lines.
- The methods must be at most 30 lines long.
- The application should use multithreading (one thread per queue).

### **Use cases:**

- Use Case:** simulate the queues behavior based on the user input

Primary Actor: user

### **Main Success Scenario:**

- The user inserts all the required information in the graphical user interface.
- The user clicks on the “SIMULATE” button.
- The simulation is displayed in another window for the duration of the simulation time.
- The log of events is displayed in the txt file.

### **Alternative Sequence 1: Missing fields**

- The user doesn't fill in all the text fields
- The user is warned about the mistake
- The process starts again

### Alternative Sequence 2: Incorrect strategy

- The user inserts an incorrect strategy
- The user is warned about the mistake
- The process starts again

### Alternative Sequence 3: Incorrect numbers

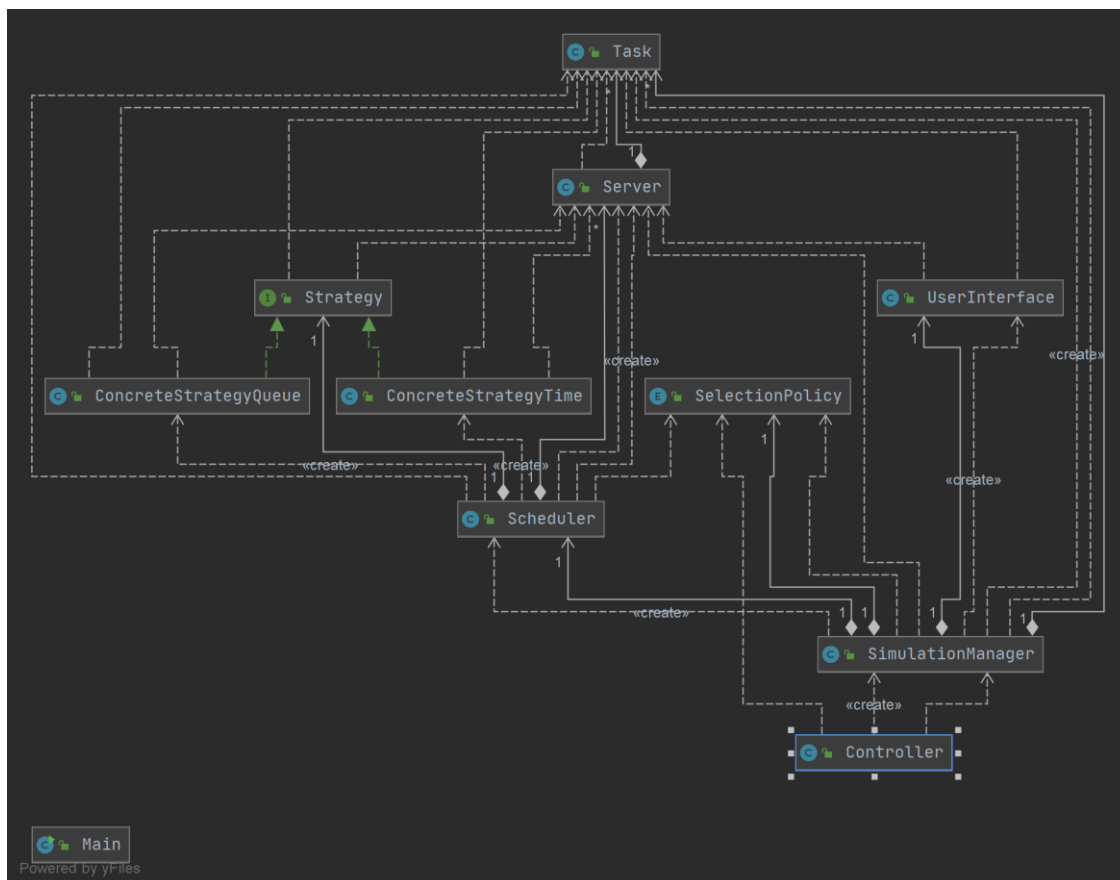
- The user inserts negative numbers or the minimum times are larger than the maximum times or the arrival/processing times are greater than the simulation time.
- The user is warned about the mistake.
- The process starts again.

## 3. Design (design decisions, UML diagrams, data structures, class design, interfaces, relationships, packages, algorithms, user interfaces)

My application has 8 classes (Task, Server, Simulation Manager, Scheduler, Concrete Strategy Time, Concrete Strategy Queue, Controller and User Interface), 1 interface (Strategy) and 1 enum (Selection Policy).

From the 8 classes, two of them are UI classes, one for each window of the user interface. The Controller is the one that handles the user inputs and the User Interface is responsible for displaying the simulation in real time.

The user interface is friendly and easy to use. There are informative labels for each text field and even labels which provide additional information such as what strategies are available. The scene for the simulation results is based on a grid pane which was a really good way of organizing things, but also on a scroll pane, because most of the time we will have too many clients or queues for the window to include all of them. I decided to represent clients as boxes labeled with client information because that way it is easier to observe them on screen.

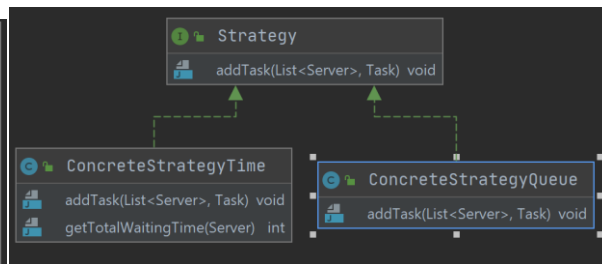


Task	
f ID	int
f arrivalTime	int
f processingTime	int
f waitingTime	int
m getArrivalTime()	int
m getProcessingTime()	int
m getID()	int
m getWaitingTime()	int
m setWaitingTime(int)	void
m setProcessingTime(int)	void
m compareTo(Task)	int

Server	
f tasks	BlockingQueue<Task>
f waitingPeriod	AtomicInteger
f stopThread	boolean
f currentTime	int
m getTasks()	BlockingQueue<Task>
m getWaitingPeriod()	AtomicInteger
m isStopThread()	boolean
m setStopThread(boolean)	void
m setCurrentTime(int)	void
m addTaskToQueue(Task)	void
m run()	void

SelectionPolicy	
SHORTEST_QUEUE	
SHORTEST_TIME	
m values()	SelectionPolicy[]
m valueOf(String)	SelectionPolicy

Scheduler	
f servers	List<Server>
f maxNrServers	int
f maxTasksPerServer	int
f strategy	Strategy
m getServers()	List<Server>
m changeStrategy(SelectionPolicy)	void
m dispatchTask(Task, SelectionPolicy)	void



SimulationManager	
f nrOfServers	int
f nrOfTasks	int
f simulationTime	int
f minArrivalTime	int
f maxArrivalTime	int
f minProcessingTime	int
f maxProcessingTime	int
f selectionPolicy	SelectionPolicy
f generatedTasks	List<Task>
f scheduler	Scheduler
f userInterface	UserInterface
f myWriter	FileWriter
f taskNumber	int
f averageServiceTime	double
f tasksInServersPerTime	int[]
m generateRandomTasks()	void
m setServersCurrentTime(int)	void
m getAverageServiceTime()	void
m getAverageWaitingTime()	double
m computeStatistic()	void
m writeWaitingTasks()	void
m terminateAllThreads()	void
m writeTime(int)	void
m writeQueues(int)	void
m run()	void

Controller	
f clients	int
f queues	int
f simulationT	int
f minArrivalT	int
f maxArrivalT	int
f minProcT	int
f maxProcT	int
f strategy	String
f titleLabel	Label
f clientsLabel	Label
f queuesLabel	Label
f simulationLabel	Label
f arrivalLabel	Label
f processingLabel	Label
f clientsTextField	TextField
f queuesTextField	TextField
f simulationTextField	TextField
f arrivalMinTextField	TextField
f arrivalMaxTextField	TextField
f processingMinTextField	TextField
f processingMaxTextField	TextField
f minLabel	Label
f maxLabel	Label
f simulateButton	Button
f errorLabel	Label
f emptyFieldsLabel	Label
f clearButton	Button
f strategyLabel	Label
f strategyTextField	TextField
f errorStrategyLabel	Label
f detailsLabel	Label
m clickClear(ActionEvent)	void
m clickSimulate(ActionEvent)	void

UserInterface	
f gridPane	GridPane
f time	Text
f maxNrTasks	int
f scrollPane	ScrollPane
m displayQueues(int)	void
m changeTime(String)	void
m styleText(Text, int)	void
m updateQ(List<Server>, int)	void
m updateListOfTasks(List<Task>, int, List<Server>, int)	void

Main	
m start(Stage)	void
m main(String[])	void

As data structures used, besides the primitives and the object types, I have used lists for storing tasks and servers. I have also used the Atomic Integer type, which is basically an int but guarantees thread safety, as it can only be modified by one thread at a time. I used also the Blocking Queue type, which is like a queue but is also more suitable for multi-threading, as it doesn't insert elements into it if it is full, until another thread takes elements from it and doesn't take elements from it if it's empty until another thread puts something in it.

#### **4. Implementation**

##### Task Class

This is the class for the client, having as fields the client ID, arrival time (the time at which the client finishes shopping and is ready to wait at a queue), the processing or service time (the time it takes for the client to be processed when it is at the head of the queue) and the waiting time (the difference between the moment at which the client begins to be processed and the arrival time). The only important method from this class is the overridden compareTo() method, used to sort the clients based on their arrival times.

##### Server Class

This is the class for the queue. As instance variables, each queue has a blocking queue of tasks and a waiting time (the number of clients in the queue). As part of the multithreading technique used for this project, each queue has its own thread, which is good for optimization purposes. Each thread takes care of its own queue and therefore they run simultaneously. In the constructor I set the maximum size of the queue to the total numbers of tasks. The method addTaskToQueue() simply puts a new task in the queue, and will later be used from another class. The most important method from this class is surely the overridden run() method for the threads. As long as the server thread is not stopped (we stop it using a control signal which becomes true only when the simulation time is over), the thread will sleep for 2 seconds, which corresponds to one simulation time unit (I put 2 seconds instead of 1 in order to really observe on the graphical interface the changes that are being made). Then, the thread will try to take the head of the queue to process it. If the queue is not empty, then the processing time of the current task will be decremented by one and only if that processing time reaches zero, the task is taken out from the queue and the waiting period of the queue is decremented. Also, we save the time at which the head of the queue starts being processed, so as to later compute the waiting time. So, this piece of code is executed by each server in the simulation concurrently, at each time unit.

##### Strategy Interface

This interface is defining a method which decides in which queue to place a task, and it will have two implementations based on the 2 policies available.

##### Selection Policy Enum

So, the two aforementioned strategies are SHORTEST\_TIME and SHORTEST\_QUEUE. The shortest queue strategy adds a task to the shortest queue, while the shortest time adds a task to the queue with the shortest total processing time.

##### ConcreteStrategyQueue Class

This class implements the addTask() method from the Strategy Interface, finding the shortest queue based on the waiting time and adding the task to it.

##### ConcreteStrategyTime Class

This class implements the addTask() method from the Strategy Interface, finding the queue with the shortest total processing time and adding the task to it.

##### Scheduler Class

This is the class responsible for distributing the tasks in the corresponding queues. As instance variables, we have the list of servers, the number of servers and the maximum number of tasks per server. In the constructor, we create the Server objects and start the corresponding threads for them. The method changeStrategy() is used to create a Strategy object based on the chosen policy. The dispatchTask() method, adds the task to the chosen queue, being the method from the chosen subclass.

### Simulation Manager Class

This class is the main class of the application, along with the Server Class. This class also has a corresponding thread, which basically adds elements to the queues, while the rest of the threads take out elements from the queues. A part of the instance variables are all the parameters introduced by the user in the graphical user interface. Here I have defined the generateRandomTasks() method, which generated N random tasks, defined by the ID, arrival time and processing time. The last 2 values are generated randomly from the interval introduced by the user. After that, the tasks are introduced in a list, which is then sorted in ascending order of the arrival times. In the run() method we have a while loop, so the main thread will run as long as the current time is smaller than the simulation time. The first thing I do is set the current times of the servers to the current time from the simulation manager because I use that time in the server class to remember the start of the processing for each task. Then I write the current time in the txt file. Then I iterate through all the generated tasks and add to the queues those who have the arrival time equal to the current time. After that, I write in the text file the situation in each server and also the list of waiting clients. I increment the current time and put this thread on sleep also for 2 seconds. When the current time is equal to the simulation time minus one, all threads are terminated and the statistics are computed and written into the txt file (peak hour, average waiting time and average service time).

The graphical user interface consists of 2 windows: the one where the user inserts the inputs and the one where the simulation is displayed.

### Controller Class

This interface has 9 text fields for the user to insert information in. There are text fields for: number of queues, number of clients, simulation time, min/max arrival time, min/max processing time and strategy. There is a Clear Button, which the user can use to clear out all the text fields. There is also the simulation method that will start the simulation, but only after all text fields are not empty and the information is valid. If at least one text field is empty, the user will get a warning. The same thing happens if the inserted numbers are negative or the minimum values are greater than the maximum values.

### User Interface Class

This is the graphical interface that displays the actual simulation. I have used a scroll pane and a grid pane for this scene. The method from this class are called at different moments in the run method from the Simulation Manager class. One of them displays the time, one displays the name of the queues (ex: Q0, Q1, Q2, etc), one of them updates the contents of the queues and the last one updates the tasks from the waiting list. The approach I have chosen for this is: I display each client from the queue/waiting list in a cell from the grid pane. At each step I override the cell with the current situation of the queue, meaning that I remove the node and then write it again. For these changes I have used the Platform.runLater() method, which runs the specified Runnable on the JavaFX Application Thread. This is because only the JavaFX thread can modify the graphical user interface.

## **5. Conclusions**

In conclusion, I definitely think that I have learned a lot of things from this assignment. It was for sure challenging in the beginning because I have never made an application which relies so heavily on threads. I had to really understand how they work in order to make the simulation work. But now I can see why they are useful. As for further developments, I think I could make an interface that resembles more the real-life situation from a supermarket, to make it look nicer and fun.

## **6. Results**

Here I will include the log of events from the first 2 simulations mentioned in the Assignment2 pdf. I have included the logs for both strategies. For the 3<sup>rd</sup> simulation, I have uploaded the logs on Git because of the size.

They are named: "log\_1000clients\_shortest\_queue.txt" and "log\_1000clients\_shortest\_time.txt".

- N=4,Q=2,Sim=60,[2,30],[2,4], SHORTEST\_QUEUE  
Log of events  
Time 0  
Q0:closed  
Q1:closed

Waiting tasks: (2, 6, 4),(1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 1  
Q0:closed  
Q1:closed  
Waiting tasks: (2, 6, 4),(1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 2  
Q0:closed  
Q1:closed  
Waiting tasks: (2, 6, 4),(1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 3  
Q0:closed  
Q1:closed  
Waiting tasks: (2, 6, 4),(1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 4  
Q0:closed  
Q1:closed  
Waiting tasks: (2, 6, 4),(1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 5  
Q0:closed  
Q1:closed  
Waiting tasks: (2, 6, 4),(1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 6  
Q0:(2,6,4),  
Q1:closed  
Waiting tasks: (1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 7  
Q0:(2,6,3),  
Q1:closed  
Waiting tasks: (1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 8  
Q0:(2,6,2),  
Q1:closed  
Waiting tasks: (1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 9  
Q0:(2,6,1),  
Q1:closed  
Waiting tasks: (1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 10  
Q0:closed  
Q1:closed  
Waiting tasks: (1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 11  
Q0:closed  
Q1:closed  
Waiting tasks: (1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 12  
Q0:closed  
Q1:closed  
Waiting tasks: (1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 13  
Q0:closed  
Q1:closed  
Waiting tasks: (1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 14  
Q0:closed  
Q1:closed  
Waiting tasks: (1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 15  
Q0:closed  
Q1:closed

Waiting tasks: (1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 16  
Q0:closed  
Q1:closed  
Waiting tasks: (1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 17  
Q0:closed  
Q1:closed  
Waiting tasks: (1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 18  
Q0:closed  
Q1:closed  
Waiting tasks: (1, 19, 4),(4, 28, 3),(3, 30, 2)  
Time 19  
Q0:(1,19,4),  
Q1:closed  
Waiting tasks: (4, 28, 3),(3, 30, 2)  
Time 20  
Q0:(1,19,3),  
Q1:closed  
Waiting tasks: (4, 28, 3),(3, 30, 2)  
Time 21  
Q0:(1,19,2),  
Q1:closed  
Waiting tasks: (4, 28, 3),(3, 30, 2)  
Time 22  
Q0:(1,19,1),  
Q1:closed  
Waiting tasks: (4, 28, 3),(3, 30, 2)  
Time 23  
Q0:closed  
Q1:closed  
Waiting tasks: (4, 28, 3),(3, 30, 2)  
Time 24  
Q0:closed  
Q1:closed  
Waiting tasks: (4, 28, 3),(3, 30, 2)  
Time 25  
Q0:closed  
Q1:closed  
Waiting tasks: (4, 28, 3),(3, 30, 2)  
Time 26  
Q0:closed  
Q1:closed  
Waiting tasks: (4, 28, 3),(3, 30, 2)  
Time 27  
Q0:closed  
Q1:closed  
Waiting tasks: (4, 28, 3),(3, 30, 2)  
Time 28  
Q0:(4,28,3),  
Q1:closed  
Waiting tasks: (3, 30, 2)  
Time 29  
Q0:(4,28,2),  
Q1:closed  
Waiting tasks: (3, 30, 2)  
Time 30  
Q0:(4,28,1),  
Q1:(3,30,2),



Waiting tasks:  
Time 31  
Q0:closed  
Q1:(3,30,1),  
Waiting tasks:  
Time 32  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 33  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 34  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 35  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 36  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 37  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 38  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 39  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 40  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 41  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 42  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 43  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 44  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 45  
Q0:closed  
Q1:closed

Waiting tasks:  
Time 46  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 47  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 48  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 49  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 50  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 51  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 52  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 53  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 54  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 55  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 56  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 57  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 58  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 59  
Q0:closed  
Q1:closed  
Waiting tasks:  
Average service time: 3.25  
Peak hour(s): 30,  
Average waiting time: 0.0

---

• N=4,Q=2,Sim=60,[2,30],[2,4], SHORTEST\_TIME

Log of events

Time 0

Q0:closed

Q1:closed

Waiting tasks: (2, 2, 2),(1, 4, 2),(4, 5, 4),(3, 12, 2)

Time 1

Q0:closed

Q1:closed

Waiting tasks: (2, 2, 2),(1, 4, 2),(4, 5, 4),(3, 12, 2)

Time 2

Q0:(2,2,2),

Q1:closed

Waiting tasks: (1, 4, 2),(4, 5, 4),(3, 12, 2)

Time 3

Q0:(2,2,1),

Q1:closed

Waiting tasks: (1, 4, 2),(4, 5, 4),(3, 12, 2)

Time 4

Q0:(1,4,2),

Q1:closed

Waiting tasks: (4, 5, 4),(3, 12, 2)

Time 5

Q0:(1,4,1),

Q1:(4,5,4),

Waiting tasks: (3, 12, 2)

Time 6

Q0:closed

Q1:(4,5,3),

Waiting tasks: (3, 12, 2)

Time 7

Q0:closed

Q1:(4,5,2),

Waiting tasks: (3, 12, 2)

Time 8

Q0:closed

Q1:(4,5,1),

Waiting tasks: (3, 12, 2)

Time 9

Q0:closed

Q1:closed

Waiting tasks: (3, 12, 2)

Time 10

Q0:closed

Q1:closed

Waiting tasks: (3, 12, 2)

Time 11

Q0:closed

Q1:closed

Waiting tasks: (3, 12, 2)

Time 12

Q0:(3,12,2),

Q1:closed

Waiting tasks:

Time 13

Q0:(3,12,1),

Q1:closed

Waiting tasks:

Time 14

Q0:closed

Q1:closed  
Waiting tasks:  
Time 15  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 16  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 17  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 18  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 19  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 20  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 21  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 22  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 23  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 24  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 25  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 26  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 27  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 28  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 29  
Q0:closed

Q1:closed  
Waiting tasks:  
Time 30  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 31  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 32  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 33  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 34  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 35  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 36  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 37  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 38  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 39  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 40  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 41  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 42  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 43  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 44  
Q0:closed

Q1:closed  
Waiting tasks:  
Time 45  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 46  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 47  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 48  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 49  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 50  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 51  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 52  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 53  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 54  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 55  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 56  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 57  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 58  
Q0:closed  
Q1:closed  
Waiting tasks:  
Time 59  
Q0:closed

Q1:closed  
Waiting tasks:  
Average service time: 2.5  
Peak hour(s): 5,  
Average waiting time: 0.0

---

• N=50, Q=5, Sim=60, [2,40], [1,7], SHORTEST\_QUEUE

Log of events

Time 0

Q0:closed

Q1:closed

Q2:closed

Q3:closed

Q4:closed

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

Time 1

Q0:closed

Q1:closed

Q2:closed

Q3:closed

Q4:closed

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

Time 2

Q0:(3,2,5),

Q1:(17,2,7),

Q2:closed

Q3:closed

Q4:closed

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

Time 3

Q0:(3,2,4),

Q1:(17,2,6),

Q2:(11,3,5),

Q3:(12,3,3),

Q4:closed

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

Time 4

Q0:(3,2,3),

Q1:(17,2,5),

Q2:(11,3,4),

Q3:(12,3,2),

Q4:(18,4,7),

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

Time 5

Q0:(3,2,2),

Q1:(17,2,4),

Q2:(11,3,3),

Q3:(12,3,1),

Q4:(18,4,6),

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

Time 6

Q0:(3,2,1), (27,6,5),

Q1:(17,2,3),

Q2:(11,3,2),

Q3:(7,6,3),

Q4:(18,4,5),

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

Time 7

Q0:(27,6,5), (9,7,1),

Q1:(17,2,2), (28,7,2),

Q2:(11,3,1), (34,7,6),

Q3:(7,6,2),

Q4:(18,4,4),

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

Time 8

Q0:(27,6,4), (9,7,1),

Q1:(17,2,1), (28,7,2),

Q2:(34,7,6), (48,8,3),

Q3:(7,6,1),

Q4:(18,4,3),

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

Time 9

Q0:(27,6,3), (9,7,1),

Q1:(28,7,2), (26,9,2),

Q2:(34,7,5), (48,8,3),

Q3:(23,9,3), (35,9,4),

Q4:(18,4,2),

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



Time 10

Q0:(27,6,2), (9,7,1), (4,10,3),

Q1:(28,7,1), (26,9,2), (37,10,5),

Q2:(34,7,4), (48,8,3),

Q3:(23,9,2), (35,9,4),

Q4:(18,4,1), (1,10,7),

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

Time 11

Q0:(27,6,1), (9,7,1), (4,10,3),

Q1:(26,9,2), (37,10,5),

Q2:(34,7,3), (48,8,3),

Q3:(23,9,1), (35,9,4),

Q4:(1,10,7),

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

Time 12

Q0:(9,7,1), (4,10,3),

Q1:(26,9,1), (37,10,5),

Q2:(34,7,2), (48,8,3),

Q3:(35,9,4), (36,12,7),

Q4:(1,10,6), (50,12,6),

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

Time 13

Q0:(4,10,3), (8,13,5),

Q1:(37,10,5),

Q2:(34,7,1), (48,8,3),

Q3:(35,9,3), (36,12,7),

Q4:(1,10,5), (50,12,6),

Waiting tasks: (31, 14, 3),(2, 15, 5),(32, 15, 1),(16, 16, 5),(30, 17, 2),(13, 18, 1),(43, 18, 5),(29, 19, 2),(49, 20, 6),(10, 21, 5),(47, 23, 1),(25, 27, 4),(6, 28, 7),(19, 28, 4),(45, 28, 1),(44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 14

Q0:(4,10,2), (8,13,5),

Q1:(37,10,4), (31,14,3),

Q2:(48,8,3),

Q3:(35,9,2), (36,12,7),

Q4:(1,10,4), (50,12,6),

Waiting tasks: (2, 15, 5),(32, 15, 1),(16, 16, 5),(30, 17, 2),(13, 18, 1),(43, 18, 5),(29, 19, 2),(49, 20, 6),(10, 21, 5),(47, 23, 1),(25, 27, 4),(6, 28, 7),(19, 28, 4),(45, 28, 1),(44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 15

Q0:(4,10,1), (8,13,5), (32,15,1),

Q1:(37,10,3), (31,14,3),

Q2:(48,8,2), (2,15,5),

Q3:(35,9,1), (36,12,7),

Q4:(1,10,3), (50,12,6),

Waiting tasks: (16, 16, 5),(30, 17, 2),(13, 18, 1),(43, 18, 5),(29, 19, 2),(49, 20, 6),(10, 21, 5),(47, 23, 1),(25, 27, 4),(6, 28, 7),(19, 28, 4),(45, 28, 1),(44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 16

Q0:(8,13,5), (32,15,1),

Q1:(37,10,2), (31,14,3),

Q2:(48,8,1), (2,15,5),

Q3:(36,12,7), (16,16,5),

Q4:(1,10,2), (50,12,6),

Waiting tasks: (30, 17, 2),(13, 18, 1),(43, 18, 5),(29, 19, 2),(49, 20, 6),(10, 21, 5),(47, 23, 1),(25, 27, 4),(6, 28, 7),(19, 28, 4),(45, 28, 1),(44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 17

Q0:(8,13,4), (32,15,1),

Q1:(37,10,1), (31,14,3),

Q2:(2,15,5), (30,17,2),

Q3:(36,12,6), (16,16,5),

Q4:(1,10,1), (50,12,6),

Waiting tasks: (13, 18, 1),(43, 18, 5),(29, 19, 2),(49, 20, 6),(10, 21, 5),(47, 23, 1),(25, 27, 4),(6, 28, 7),(19, 28, 4),(45, 28, 1),(44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 18

Q0:(8,13,3), (32,15,1),

Q1:(31,14,3), (13,18,1),

Q2:(2,15,4), (30,17,2),

Q3:(36,12,5), (16,16,5),

Q4:(50,12,6), (43,18,5),

Waiting tasks: (29, 19, 2),(49, 20, 6),(10, 21, 5),(47, 23, 1),(25, 27, 4),(6, 28, 7),(19, 28, 4),(45, 28, 1),(44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 19

Q0:(8,13,2), (32,15,1), (29,19,2),

Q1:(31,14,2), (13,18,1),

Q2:(2,15,3), (30,17,2),

Q3:(36,12,4), (16,16,5),

Q4:(50,12,5), (43,18,5),

Waiting tasks: (49, 20, 6),(10, 21, 5),(47, 23, 1),(25, 27, 4),(6, 28, 7),(19, 28, 4),(45, 28, 1),(44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 20

Q0:(8,13,1), (32,15,1), (29,19,2),

Q1:(31,14,1), (13,18,1), (49,20,6),

Q2:(2,15,2), (30,17,2),

Q3:(36,12,3), (16,16,5),

Q4:(50,12,4), (43,18,5),

Waiting tasks: (10, 21, 5),(47, 23, 1),(25, 27, 4),(6, 28, 7),(19, 28, 4),(45, 28, 1),(44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 21

Q0:(32,15,1), (29,19,2), (10,21,5),

Q1:(13,18,1), (49,20,6),

Q2:(2,15,1), (30,17,2),

Q3:(36,12,2), (16,16,5),

Q4:(50,12,3), (43,18,5),

Waiting tasks: (47, 23, 1),(25, 27, 4),(6, 28, 7),(19, 28, 4),(45, 28, 1),(44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 22

Q0:(29,19,2), (10,21,5),

Q1:(49,20,6),

Q2:(30,17,2),

Q3:(36,12,1), (16,16,5),

Q4:(50,12,2), (43,18,5),

Waiting tasks: (47, 23, 1),(25, 27, 4),(6, 28, 7),(19, 28, 4),(45, 28, 1),(44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 23

Q0:(29,19,1), (10,21,5),

Q1:(49,20,5), (47,23,1),

Q2:(30,17,1),

Q3:(16,16,5),

Q4:(50,12,1), (43,18,5),

Waiting tasks: (25, 27, 4),(6, 28, 7),(19, 28, 4),(45, 28, 1),(44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 24

Q0:(10,21,5),

Q1:(49,20,4), (47,23,1),

Q2:closed

Q3:(16,16,4),

Q4:(43,18,5),

Waiting tasks: (25, 27, 4),(6, 28, 7),(19, 28, 4),(45, 28, 1),(44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 25

Q0:(10,21,4),

Q1:(49,20,3), (47,23,1),

Q2:closed

Q3:(16,16,3),

Q4:(43,18,4),

Waiting tasks: (25, 27, 4),(6, 28, 7),(19, 28, 4),(45, 28, 1),(44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 26

Q0:(10,21,3),

Q1:(49,20,2), (47,23,1),

Q2:closed

Q3:(16,16,2),

Q4:(43,18,3),

Waiting tasks: (25, 27, 4),(6, 28, 7),(19, 28, 4),(45, 28, 1),(44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 27

Q0:(10,21,2),

Q1:(49,20,1), (47,23,1),

Q2:(25,27,4),

Q3:(16,16,1),

Q4:(43,18,2),

Waiting tasks: (6, 28, 7),(19, 28, 4),(45, 28, 1),(44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 28

Q0:(10,21,1), (19,28,4),

Q1:(47,23,1), (45,28,1),

Q2:(25,27,3),

Q3:(6,28,7),

Q4:(43,18,1),

Waiting tasks: (44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)

Time 29

Q0:(19,28,4),

Q1:(45,28,1),

Q2:(25,27,2),

Q3:(6,28,6),  
 Q4:closed  
 Waiting tasks: (44, 30, 5),(5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)  
 Time 30  
 Q0:(19,28,3),  
 Q1:(44,30,5),  
 Q2:(25,27,1),  
 Q3:(6,28,5),  
 Q4:closed  
 Waiting tasks: (5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)  
 Time 31  
 Q0:(19,28,2),  
 Q1:(44,30,4),  
 Q2:closed  
 Q3:(6,28,4),  
 Q4:closed  
 Waiting tasks: (5, 32, 4),(42, 32, 2),(46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)  
 Time 32  
 Q0:(19,28,1),  
 Q1:(44,30,3),  
 Q2:(5,32,4),  
 Q3:(6,28,3),  
 Q4:(42,32,2),  
 Waiting tasks: (46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)  
 Time 33  
 Q0:closed  
 Q1:(44,30,2),  
 Q2:(5,32,3),  
 Q3:(6,28,2),  
 Q4:(42,32,1),  
 Waiting tasks: (46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)  
 Time 34  
 Q0:closed  
 Q1:(44,30,1),  
 Q2:(5,32,2),  
 Q3:(6,28,1),  
 Q4:closed  
 Waiting tasks: (46, 35, 2),(24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)  
 Time 35  
 Q0:(46,35,2),  
 Q1:closed  
 Q2:(5,32,1),  
 Q3:closed  
 Q4:closed  
 Waiting tasks: (24, 36, 1),(33, 36, 4),(39, 36, 4),(20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)  
 Time 36  
 Q0:(46,35,1),  
 Q1:(24,36,1),  
 Q2:(33,36,4),  
 Q3:(39,36,4),  
 Q4:closed  
 Waiting tasks: (20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)  
 Time 37

Q0:closed  
 Q1:closed  
 Q2:(33,36,3),  
 Q3:(39,36,3),  
 Q4:closed  
 Waiting tasks: (20, 38, 5),(38, 38, 5),(40, 38, 5),(14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)  
 Time 38  
 Q0:(20,38,5),  
 Q1:(38,38,5),  
 Q2:(33,36,2),  
 Q3:(39,36,2),  
 Q4:(40,38,5),  
 Waiting tasks: (14, 39, 4),(22, 39, 3),(41, 39, 4),(15, 40, 3),(21, 40, 5)  
 Time 39  
 Q0:(20,38,4), (14,39,4),  
 Q1:(38,38,4), (22,39,3),  
 Q2:(33,36,1), (41,39,4),  
 Q3:(39,36,1),  
 Q4:(40,38,4),  
 Waiting tasks: (15, 40, 3),(21, 40, 5)  
 Time 40  
 Q0:(20,38,3), (14,39,4),  
 Q1:(38,38,3), (22,39,3),  
 Q2:(41,39,4), (21,40,5),  
 Q3:(15,40,3),  
 Q4:(40,38,3),  
 Waiting tasks:  
 Time 41  
 Q0:(20,38,2), (14,39,4),  
 Q1:(38,38,2), (22,39,3),  
 Q2:(41,39,3), (21,40,5),  
 Q3:(15,40,2),  
 Q4:(40,38,2),  
 Waiting tasks:  
 Time 42  
 Q0:(20,38,1), (14,39,4),  
 Q1:(38,38,1), (22,39,3),  
 Q2:(41,39,2), (21,40,5),  
 Q3:(15,40,1),  
 Q4:(40,38,1),  
 Waiting tasks:  
 Time 43  
 Q0:(14,39,4),  
 Q1:(22,39,3),  
 Q2:(41,39,1), (21,40,5),  
 Q3:closed  
 Q4:closed  
 Waiting tasks:  
 Time 44  
 Q0:(14,39,3),  
 Q1:(22,39,2),  
 Q2:(21,40,5),  
 Q3:closed  
 Q4:closed  
 Waiting tasks:  
 Time 45  
 Q0:(14,39,2),  
 Q1:(22,39,1),  
 Q2:(21,40,4),  
 Q3:closed

Q4:closed  
Waiting tasks:  
Time 46  
Q0:(14,39,1),  
Q1:closed  
Q2:(21,40,3),  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 47  
Q0:closed  
Q1:closed  
Q2:(21,40,2),  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 48  
Q0:closed  
Q1:closed  
Q2:(21,40,1),  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 49  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 50  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 51  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 52  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 53  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 54  
Q0:closed

Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:

Time 55

Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed

Waiting tasks:

Time 56

Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed

Waiting tasks:

Time 57

Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed

Waiting tasks:

Time 58

Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed

Waiting tasks:

Time 59

Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed

Waiting tasks:

Average service time: 3.94

Peak hour(s): 10, 20,

Average waiting time: 2.02

---

• N=50, Q=5, Sim=60, [2,40], [1,7], SHORTEST\_TIME

Log of events

Time 0

Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed

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

Time 1

Q0:closed  
Q1:closed

Q2:closed

Q3:closed

Q4:closed

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

Time 2

Q0:closed

Q1:closed

Q2:closed

Q3:closed

Q4:closed

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

Time 3

Q0:(10,3,3),

Q1:(37,3,6),

Q2:closed

Q3:closed

Q4:closed

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

Time 4

Q0:(10,3,2),

Q1:(37,3,5),

Q2:(36,4,6),

Q3:(42,4,2),

Q4:closed

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

Time 5

Q0:(10,3,1), (49,5,2),

Q1:(37,3,4),

Q2:(36,4,5),

Q3:(42,4,1),

Q4:(17,5,7),

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

Time 6

Q0:(49,5,2),

Q1:(37,3,3),

Q2:(36,4,4),



Q3:closed

Q4:(17,5,6),

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

Time 7

Q0:(49,5,1),

Q1:(37,3,2),

Q2:(36,4,3),

Q3:(2,7,4),

Q4:(17,5,5),

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

Time 8

Q0:(7,8,6),

Q1:(37,3,1),

Q2:(36,4,2),

Q3:(2,7,3),

Q4:(17,5,4),

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

Time 9

Q0:(7,8,5),

Q1:(4,9,1), (13,9,1),

Q2:(36,4,1),

Q3:(2,7,2),

Q4:(17,5,3),

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

Time 10

Q0:(7,8,4),

Q1:(13,9,1),

Q2:(45,10,1),

Q3:(2,7,1),

Q4:(17,5,2),

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

Time 11

Q0:(7,8,3),

Q1:(15,11,1),

Q2:(16,11,7),

Q3:(30,11,5),

Q4:(17,5,1),

Waiting tasks: (12, 12, 5),(26, 12, 4),(33, 12, 3),(19, 13, 3),(44, 13, 4),(41, 14, 3),(47, 16, 1),(18, 17, 1),(20, 17, 6),(28, 17, 7),(43, 17, 5),(50, 20, 7),(6, 21, 7),(25, 21, 2),(29, 21, 1),(27, 22, 4),(21, 23, 6),(24, 24, 3),(39, 24, 4),(40, 25, 5),(14, 26, 5),(3, 27, 2),(8, 27, 6),(9, 27, 7),(23, 27, 5),(38, 28, 2),(1,

30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)

Time 12

Q0:(7,8,2), (33,12,3),

Q1:(12,12,5),

Q2:(16,11,6),

Q3:(30,11,4),

Q4:(26,12,4),

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

Time 13

Q0:(7,8,1), (33,12,3),

Q1:(12,12,4),

Q2:(16,11,5),

Q3:(30,11,3), (19,13,3),

Q4:(26,12,3), (44,13,4),

Waiting tasks: (41, 14, 3),(47, 16, 1),(18, 17, 1),(20, 17, 6),(28, 17, 7),(43, 17, 5),(50, 20, 7),(6, 21, 7),(25, 21, 2),(29, 21, 1),(27, 22, 4),(21, 23, 6),(24, 24, 3),(39, 24, 4),(40, 25, 5),(14, 26, 5),(3, 27, 2),(8, 27, 6),(9, 27, 7),(23, 27, 5),(38, 28, 2),(1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)

Time 14

Q0:(33,12,3), (41,14,3),

Q1:(12,12,3),

Q2:(16,11,4),

Q3:(30,11,2), (19,13,3),

Q4:(26,12,2), (44,13,4),

Waiting tasks: (47, 16, 1),(18, 17, 1),(20, 17, 6),(28, 17, 7),(43, 17, 5),(50, 20, 7),(6, 21, 7),(25, 21, 2),(29, 21, 1),(27, 22, 4),(21, 23, 6),(24, 24, 3),(39, 24, 4),(40, 25, 5),(14, 26, 5),(3, 27, 2),(8, 27, 6),(9, 27, 7),(23, 27, 5),(38, 28, 2),(1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)

Time 15

Q0:(33,12,2), (41,14,3),

Q1:(12,12,2),

Q2:(16,11,3),

Q3:(30,11,1), (19,13,3),

Q4:(26,12,1), (44,13,4),

Waiting tasks: (47, 16, 1),(18, 17, 1),(20, 17, 6),(28, 17, 7),(43, 17, 5),(50, 20, 7),(6, 21, 7),(25, 21, 2),(29, 21, 1),(27, 22, 4),(21, 23, 6),(24, 24, 3),(39, 24, 4),(40, 25, 5),(14, 26, 5),(3, 27, 2),(8, 27, 6),(9, 27, 7),(23, 27, 5),(38, 28, 2),(1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)

Time 16

Q0:(33,12,1), (41,14,3),

Q1:(12,12,1), (47,16,1),

Q2:(16,11,2),

Q3:(19,13,3),

Q4:(44,13,4),

Waiting tasks: (18, 17, 1),(20, 17, 6),(28, 17, 7),(43, 17, 5),(50, 20, 7),(6, 21, 7),(25, 21, 2),(29, 21, 1),(27, 22, 4),(21, 23, 6),(24, 24, 3),(39, 24, 4),(40, 25, 5),(14, 26, 5),(3, 27, 2),(8, 27, 6),(9, 27, 7),(23, 27, 5),(38, 28, 2),(1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)

Time 17

Q0:(41,14,3),

Q1:(47,16,1), (18,17,1), (28,17,7),

Q2:(16,11,1), (20,17,6),

Q3:(19,13,2), (43,17,5),

Q4:(44,13,3),

Waiting tasks: (50, 20, 7),(6, 21, 7),(25, 21, 2),(29, 21, 1),(27, 22, 4),(21, 23, 6),(24, 24, 3),(39, 24, 4),(40, 25, 5),(14, 26, 5),(3, 27, 2),(8, 27, 6),(9, 27, 7),(23, 27, 5),(38, 28, 2),(1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)

Time 18

Q0:(41,14,2),

Q1:(18,17,1), (28,17,7),

Q2:(20,17,6),

Q3:(19,13,1), (43,17,5),

Q4:(44,13,2),

Waiting tasks: (50, 20, 7),(6, 21, 7),(25, 21, 2),(29, 21, 1),(27, 22, 4),(21, 23, 6),(24, 24, 3),(39, 24, 4),(40, 25, 5),(14, 26, 5),(3, 27, 2),(8, 27, 6),(9, 27, 7),(23, 27, 5),(38, 28, 2),(1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)

Time 19

Q0:(41,14,1),

Q1:(28,17,7),

Q2:(20,17,5),

Q3:(43,17,5),

Q4:(44,13,1),

Waiting tasks: (50, 20, 7),(6, 21, 7),(25, 21, 2),(29, 21, 1),(27, 22, 4),(21, 23, 6),(24, 24, 3),(39, 24, 4),(40, 25, 5),(14, 26, 5),(3, 27, 2),(8, 27, 6),(9, 27, 7),(23, 27, 5),(38, 28, 2),(1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)

Time 20

Q0:(50,20,7),

Q1:(28,17,6),

Q2:(20,17,4),

Q3:(43,17,4),

Q4:closed

Waiting tasks: (6, 21, 7),(25, 21, 2),(29, 21, 1),(27, 22, 4),(21, 23, 6),(24, 24, 3),(39, 24, 4),(40, 25, 5),(14, 26, 5),(3, 27, 2),(8, 27, 6),(9, 27, 7),(23, 27, 5),(38, 28, 2),(1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)

Time 21

Q0:(50,20,6),

Q1:(28,17,5),

Q2:(20,17,3), (25,21,2),

Q3:(43,17,3), (29,21,1),

Q4:(6,21,7),

Waiting tasks: (27, 22, 4),(21, 23, 6),(24, 24, 3),(39, 24, 4),(40, 25, 5),(14, 26, 5),(3, 27, 2),(8, 27, 6),(9, 27, 7),(23, 27, 5),(38, 28, 2),(1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)

Time 22

Q0:(50,20,5),

Q1:(28,17,4),

Q2:(20,17,2), (25,21,2),

Q3:(43,17,2), (29,21,1), (27,22,4),

Q4:(6,21,6),

Waiting tasks: (21, 23, 6),(24, 24, 3),(39, 24, 4),(40, 25, 5),(14, 26, 5),(3, 27, 2),(8, 27, 6),(9, 27, 7),(23, 27, 5),(38, 28, 2),(1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)

Time 23

Q0:(50,20,4),

Q1:(28,17,3), (21,23,6),

Q2:(20,17,1), (25,21,2),

Q3:(43,17,1), (29,21,1), (27,22,4),

Q4:(6,21,5),

Waiting tasks: (24, 24, 3),(39, 24, 4),(40, 25, 5),(14, 26, 5),(3, 27, 2),(8, 27, 6),(9, 27, 7),(23, 27, 5),(38, 28, 2),(1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)

Time 24

Q0:(50,20,3), (39,24,4),

Q1:(28,17,2), (21,23,6),

Q2:(25,21,2), (24,24,3),  
 Q3:(29,21,1), (27,22,4),  
 Q4:(6,21,4),  
 Waiting tasks: (40, 25, 5),(14, 26, 5),(3, 27, 2),(8, 27, 6),(9, 27, 7),(23, 27, 5),(38, 28, 2),(1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)  
 Time 25  
 Q0:(50,20,2), (39,24,4),  
 Q1:(28,17,1), (21,23,6),  
 Q2:(25,21,1), (24,24,3),  
 Q3:(27,22,4),  
 Q4:(6,21,3), (40,25,5),  
 Waiting tasks: (14, 26, 5),(3, 27, 2),(8, 27, 6),(9, 27, 7),(23, 27, 5),(38, 28, 2),(1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)  
 Time 26  
 Q0:(50,20,1), (39,24,4),  
 Q1:(21,23,6),  
 Q2:(24,24,3), (14,26,5),  
 Q3:(27,22,3),  
 Q4:(6,21,2), (40,25,5),  
 Waiting tasks: (3, 27, 2),(8, 27, 6),(9, 27, 7),(23, 27, 5),(38, 28, 2),(1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)  
 Time 27  
 Q0:(39,24,4), (8,27,6),  
 Q1:(21,23,5), (23,27,5),  
 Q2:(24,24,2), (14,26,5),  
 Q3:(27,22,2), (3,27,2), (9,27,7),  
 Q4:(6,21,1), (40,25,5),  
 Waiting tasks: (38, 28, 2),(1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)  
 Time 28  
 Q0:(39,24,3), (8,27,6),  
 Q1:(21,23,4), (23,27,5),  
 Q2:(24,24,1), (14,26,5),  
 Q3:(27,22,1), (3,27,2), (9,27,7),  
 Q4:(40,25,5), (38,28,2),  
 Waiting tasks: (1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)  
 Time 29  
 Q0:(39,24,2), (8,27,6),  
 Q1:(21,23,3), (23,27,5),  
 Q2:(14,26,5),  
 Q3:(3,27,2), (9,27,7),  
 Q4:(40,25,4), (38,28,2),  
 Waiting tasks: (1, 30, 3),(31, 30, 5),(34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)  
 Time 30  
 Q0:(39,24,1), (8,27,6),  
 Q1:(21,23,2), (23,27,5),  
 Q2:(14,26,4), (1,30,3),  
 Q3:(3,27,1), (9,27,7),  
 Q4:(40,25,3), (38,28,2), (31,30,5),  
 Waiting tasks: (34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)  
 Time 31  
 Q0:(8,27,6),  
 Q1:(21,23,1), (23,27,5),  
 Q2:(14,26,3), (1,30,3),  
 Q3:(9,27,7),  
 Q4:(40,25,2), (38,28,2), (31,30,5),  
 Waiting tasks: (34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)  
 Time 32

Q0:(8,27,5),  
 Q1:(23,27,5),  
 Q2:(14,26,2), (1,30,3),  
 Q3:(9,27,6),  
 Q4:(40,25,1), (38,28,2), (31,30,5),  
 Waiting tasks: (34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)  
 Time 33  
 Q0:(8,27,4),  
 Q1:(23,27,4),  
 Q2:(14,26,1), (1,30,3),  
 Q3:(9,27,5),  
 Q4:(38,28,2), (31,30,5),  
 Waiting tasks: (34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)  
 Time 34  
 Q0:(8,27,3),  
 Q1:(23,27,3),  
 Q2:(1,30,3),  
 Q3:(9,27,4),  
 Q4:(38,28,1), (31,30,5),  
 Waiting tasks: (34, 35, 7),(46, 35, 4),(48, 35, 1),(5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)  
 Time 35  
 Q0:(8,27,2), (34,35,7),  
 Q1:(23,27,2), (46,35,4),  
 Q2:(1,30,2), (48,35,1),  
 Q3:(9,27,3),  
 Q4:(31,30,5),  
 Waiting tasks: (5, 36, 2),(11, 36, 4),(22, 36, 1),(35, 37, 2),(32, 39, 5)  
 Time 36  
 Q0:(8,27,1), (34,35,7),  
 Q1:(23,27,1), (46,35,4),  
 Q2:(1,30,1), (48,35,1), (5,36,2), (22,36,1),  
 Q3:(9,27,2), (11,36,4),  
 Q4:(31,30,4),  
 Waiting tasks: (35, 37, 2),(32, 39, 5)  
 Time 37  
 Q0:(34,35,7),  
 Q1:(46,35,4),  
 Q2:(48,35,1), (5,36,2), (22,36,1),  
 Q3:(9,27,1), (11,36,4),  
 Q4:(31,30,3), (35,37,2),  
 Waiting tasks: (32, 39, 5)  
 Time 38  
 Q0:(34,35,6),  
 Q1:(46,35,3),  
 Q2:(5,36,2), (22,36,1),  
 Q3:(11,36,4),  
 Q4:(31,30,2), (35,37,2),  
 Waiting tasks: (32, 39, 5)  
 Time 39  
 Q0:(34,35,5),  
 Q1:(46,35,2), (32,39,5),  
 Q2:(5,36,1), (22,36,1),  
 Q3:(11,36,3),  
 Q4:(31,30,1), (35,37,2),  
 Waiting tasks:  
 Time 40  
 Q0:(34,35,4),  
 Q1:(46,35,1), (32,39,5),  
 Q2:(22,36,1),  
 Q3:(11,36,2),

Q4:(35,37,2),  
Waiting tasks:  
Time 41  
Q0:(34,35,3),  
Q1:(32,39,5),  
Q2:closed  
Q3:(11,36,1),  
Q4:(35,37,1),  
Waiting tasks:  
Time 42  
Q0:(34,35,2),  
Q1:(32,39,4),  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 43  
Q0:(34,35,1),  
Q1:(32,39,3),  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 44  
Q0:closed  
Q1:(32,39,2),  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 45  
Q0:closed  
Q1:(32,39,1),  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 46  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 47  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 48  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 49  
Q0:closed

Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 50  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 51  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 52  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 53  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 54  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 55  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 56  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed  
Waiting tasks:  
Time 57  
Q0:closed  
Q1:closed  
Q2:closed  
Q3:closed  
Q4:closed

Waiting tasks:

Time 58

Q0:closed

Q1:closed

Q2:closed

Q3:closed

Q4:closed

Waiting tasks:

Time 59

Q0:closed

Q1:closed

Q2:closed

Q3:closed

Q4:closed

Waiting tasks:

Average service time: 3.88

Peak hour(s): 27, 28, 30, 36,

Average waiting time: 1.82

---

## **7. Bibliography**

ASSIGNMENT\_2\_SUPPORT\_PRESENTATION\_v1.pptx