SE4420 Modeling and Simulation in Acquisition Homework 1 Winter 2026

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Question #1

(1 point) The length of a queue during a 30 minute period is 3 for the first 5 minutes, 4 for the next 10 minutes, 2 for the next 6 minutes, and 3 for the last 9 minutes. What is the average queue length during this time?

Answer #1

$\bar{L} = \frac{1}{T} \sum_{i=1}^{n} L_i t_i$

$\bar{L} = ((3 * 5) + (4 * 10) + (2 * 6) + (3 * 9))/30$

$\bar{L} = (15 + 40 + 12 + 27)/30$

$\bar{L} = 94/30 = 3.133$ people

Question #2

(4 points) Compute this problem manually without the aid of a simulation tool. A Navy helicopter mechanic starts his shift and services incoming helicopters at the following interarrival times in hours:

[0, 1.4, 2.1, 1.9, 0.2, 1.5]

Thus the first pilot arrives at the very beginning of his shift. The respective helicopter service times in hours are:

[2.2, 1.2, .3, 2.8, .2, 1.8]

Calculate the minimum and maximum queue length for this period, the total queue time (total time spent in queue for all pilots), the average waiting time in queue, the total idle time for the mechanic, and the resource utilization for the mechanic. Show all your work.

Answer #2

Pilot	Interarrival	Service Times (Hr)	Arrival Clock Time	Time Service Start	Time Service End	Pilot Wait Time	Mechanic Idle Time	Queue Start	Queue End
1	0.0	2.2	0.0	0.0	2.2	0.0	0.0	1	1
2	1.4	1.2	1.4	2.2	3.4	0.8	0.0	0	0
3	2.1	0.3	3.5	3.5	3.8	0.0	0.1	0	0
4	1.9	2.8	5.4	5.4	8.2	0.0	1.6	0	2
5	0.2	0.2	5.6	8.2	8.4	2.6	0.0	2	1
6	1.5	1.8	7.1	8.4	10.2	1.3	0.0	0	0

Minimum Queue Length: 0

Maximum Queue Length: 2

Total Queue Time: 4.7

Average Waiting Time in queue (Queue Only): 0.783

Total Idle Time for Mechanic: 1.7

Resouce Utilization for the Mechanic: 83.33%

In [2]:

```
data = {
    "Pilot": [1, 2, 3, 4, 5, 6],
    "Interarrival": [0.0, 1.4, 2.1, 1.9, 0.2, 1.5],
    "Service Times (Hr)": [2.2, 1.2, 0.3, 2.8, 0.2, 1.8],
    "Arrival Clock Time": [0.0, 1.4, 3.5, 5.4, 5.6, 7.1],
    "Time Service Start": [0.0, 2.2, 3.5, 5.4, 8.2, 8.4],
    "Time Service End": [2.2, 3.4, 3.8, 8.2, 8.4, 10.2],
    "Pilot Wait Time": [0.0, 0.8, 0.0, 0.0, 2.6, 1.3],
    "Mechanic Idle Time": [0.0, 0.0, 0.1, 1.6, 0.0, 0.0],
    "Queue Start": [1, 0, 0, 0, 2, 0],
    "Queue End": [1, 0, 0, 2, 1, 0]
}
minQueueLength = min(data["Queue Start"])
maxQueueLength = max(data["Queue Start"])
queueOnlyTime = sum(data["Pilot Wait Time"])
averageWaitingTimeQueue = queueOnlyTime / len(data["Pilot"])
totalIdleTime = sum(data["Mechanic Idle Time"])
mechanicUtilization = sum(data["Service Times (Hr)"])/max(data["Time Service End"])
print(f"Minimum Queue Length: {minQueueLength}")
print(f"Maximum Queue Length: {maxQueueLength}")
print(f"Total Queue Time: {queueOnlyTime:.1f}")
print(f"Average Waiting Time in queue {averageWaitingTimeQueue:.3f}")
print(f"Total Idle Time for Mechanic: {totalIdleTime:.1f}")
print(f"Resouce Utilization for the Mechanic: {mechanicUtilization:.2%}")
```

```
Minimum Queue Length: 0
Maximum Queue Length: 2
Total Queue Time: 4.7
Average Waiting Time in queue 0.783
Total Idle Time for Mechanic: 1.7
Resouce Utilization for the Mechanic: 83.33%
```

Question #3

(5 points) Below is another depiction of the class example for the Navy cargo ship maintenance facility scenario. This is for the single facility configuration and all time units are in days.

1) What is the average waiting time for the ships that need service?

2) Calculate the 20-day resource utilization of the single facility using fractional days. The facility is open and staffed 24 hours each day available for service.

Ship	Interarrival Time	Service Time	Arrival Time	Service Start	Service End
1	0.0	2.5	0.0	0.0	2.5
2	1.0		1.0		
3	1.0	2.0	2.0	2.5	4.5

Ship	Interarrival Time	Service Time	Arrival Time	Service Start	Service End
4	1.0		3.0		
5	1.0	3.0	4.0	4.5	7.5
6	1.0	1.5	5.0	7.5	9.0
7	1.0		6.0		
8	1.0	2.0	7.0	9.0	11.0
9	1.0	1.0	8.0	11.0	12.0
10	1.0		9.0		
11	1.0		10.0		
12	1.0		11.0		
13	1.0	2.0	12.0	12.0	14.0
14	1.0		13.0		
15	1.0		14.0		
16	1.0	0.5	15.0	15.0	15.5
17	1.0		16.0		
18	1.0	1.5	17.0	17.0	18.5
19	1.0	3.0	18.0	18.5	21.5
20	1.0		19.0		

Answer 3

Average waiting time for ships needing service: 0.9 days

In [3]:

```
data = {
    "Ship": list(range(1, 21)),
    "Interarrival Time": [
        0, 1, 1, 1, 1, 1, 1, 1, 1, 1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1
    ],
    "Service Time": [
        2.5, None, 2, None, 3, 1.5, None, 2, 1, None,
        None, None, 2, None, None, 0.5, None, 1.5, 3, None
    ],
    "Arrival Time": [
        0, 1, 2, 3, 4, 5, 6, 7, 8, 9,
        10, 11, 12, 13, 14, 15, 16, 17, 18, 19
    ],
    "Service Start": [
        0, None, 2.5, None, 4.5, 7.5, None, 9, 11, None,
        None, None, 12, None, None, 15, None, 17, 18.5, None
    ],
    "Service End": [
        2.5, None, 4.5, None, 7.5, 9, None, 11, 12, None,
        None, None, 14, None, None, 15.5, None, 18.5, 21.5, None
    ]
}

wait_time_table = []

for i in range(len(data["Ship"])):
    service_start = data["Service Start"][i]
    arrival_time = data["Arrival Time"][i]
```

```
    service_end = data["Service End"][i]

    if service_start is not None:
        wait_time = service_start - arrival_time
        if service_end > 20:
          facility_time=20-service_start
        else:
          facility_time=service_end-service_start

        wait_time_table.append({
            "Ship": data["Ship"][i],
            "Arrival Time": arrival_time,
            "Service Start": service_start,
            "Wait Time": wait_time,
            "Facility Use": facility_time
        })

wait_time_table

averageWaitingTime = sum([item["Wait Time"] for item in wait_time_table]) / len(wait_time_
utilization = sum([item["Facility Use"] for item in wait_time_table]) / 20
print(f"Average Waiting Time: {averageWaitingTime:.1f} days")
print(f"Utilization {utilization:.2%}")
```

```
Average Waiting Time: 0.9 days
Utilization 87.50%
```

Question #4

(1 point) In Problem 3, how might the resource utilization change for the first facility when a second facility is added? In this case ships will be serviced by the second facility when the first is busy. Assume the same inputs for ship arrivals and service durations.

A. it will be the same

B. it will increase

C. it will decrease

D. it cannot be determined

Answer 4

C.) It will decrease