**PRACTICE QUESTIONS – WEEK 12**

In the dataset “Queue”, you are given the data of the first three days of the week for a Bank of America outlet based in Downtown Atlanta. All times are in minutes. Wherever necessary round the answers to 2 decimal points unless otherwise mentioned.

1. The arrival rate per hour on Monday is 125.71 customers/hour calculated as – numbers of customers arrived divided by the total number of hours they arrived in (880/7 = 125.71). On the basis of the above, calculate the arrival rate (in hours) on Tuesday and Wednesday.

Note: Consider total working hours on Tuesday and Wednesday as 8 hours and 7 hours respectively. **(1 point)**

**Answer:**

**Arrival rate on Tuesday = 90 customers/hour**

**Arrival rate on Wednesday = 145.71 customers/hour**

1. What is the utilization rate on Monday, Tuesday and Wednesday If the service rate on Monday is 127.05 customer/hour, Tuesday is 110.84 customers/hour and on Wednesday is 208.78 customers/hour **(3 points)**

**utilization Monday = 0.99, utilization Tuesday = 0.81, utilization Wednesday = 0.70**

1. Calculate the average number of customers in the queue and in the system for all the 3 days. Use the service and arrival rates calculated above. **(1.5 points)**

**Answer:**

**The average number of customers in the system on Monday is 94.11**

**The average number of customers in the system on Tuesday is 4.32**

**The average number of customers in the system on Wednesday is 2.31**

**The average number of customers in the queue on Monday is 93.13**

**The average number of customers in the queue on Tuesday is 3.51**

**The average number of customers in the queue on Wednesday is 1.61**

1. Calculate the average time spent by a customer in the queue and in the system (in hours). Use the service and arrival rates calculated above. **(1.5 points)**

**Answer:**

**The average time a customer spends in the system on Monday is 0.75**

**The average time a customer spends in the system on Tuesday is 0.05**

**The average time a customer spends in the system on Wednesday is 0.02**

**The average time a customer spends in the queue on Monday is 0.74**

**The average time a customer spends in the queue on Tuesday is 0.04**

**The average time a customer spends in the queue on Wednesday is 0.01**

1. What is the probability of having 100 customers in the system on Monday?

Round the answer to 4 decimal places. **(1 point)**

**Answer:**

**Probability of having 100 customers in the system on Monday 0.0037**

1. Now we will use the “queuing” package in R to verify our above calculations for Monday.  
   Use the below code:   
     
   #Inputs to our MM1 model

i\_mm1 <- NewInput.MM1(lambda= 125.7, mu= 127.05, n=100)

## Build the model

o\_mm1 <- QueueingModel(i\_mm1)

Report(o\_mm1)

1. You are the general manager of the bank, based on the calculations above, what changes would you recommend? **(1 point)**
2. Increase number of servers on Wednesday
3. Increase number of servers on Tuesday
4. Increase number of servers on Monday

**Answer: The wait times and queues on Monday are much higher compared to the other days and the bank should increase the number of servers on Monday.**

**Rubric for grading:**

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| Question 1 | **1 point** (0.5 points each for calculating arrival rates on Tuesday and Wednesday correctly) |
| Question 2 | **3 points** (0.5 points each for service rate and utilization on the 3 days) |
| Question 3 | **1.5 points** (0.5 points each for calculating the values for all 3 days) |
| Question 4 | **1.5 points** (0.5 points each for calculating the values for all 3 days) |
| Question 5 | **1 point** |
| Question 6 | **No points** |
| Question 7 | **1 point** |