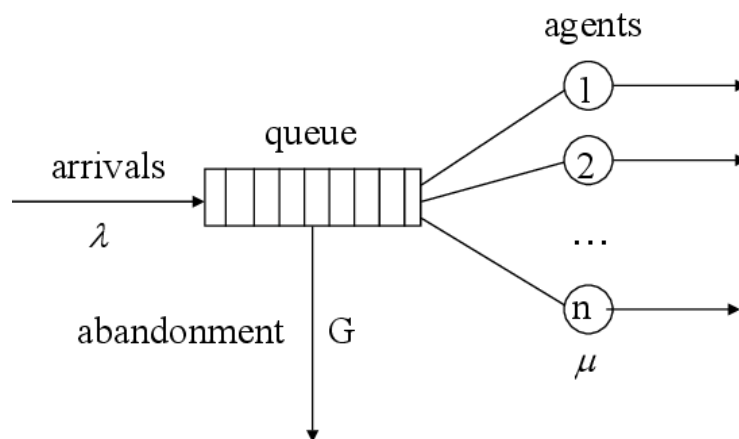


BM17BAM – Assignment 1

Part 1: Restaurant Analytics – Simulation (7 Points)

As consultants for a global fine-dining restaurant chain, you are tasked with analyzing customer reneging behavior, i.e., when customers abandon the queue and decide not to dine at the restaurant. Understanding and mitigating queue abandonment is crucial for enhancing customer satisfaction and improving restaurant performance.



Your first task is to simulate the restaurant's queue system under different abandonment scenarios to understand how customer abandonment impacts queue dynamics and waiting times. Consider that the restaurant has a single queue following the M/M/1 characteristics, where on average 30 customers arrive per hour and service rate is 20 customers/hour. Please follow the instructions below:

- **Use the Provided Code:** Start with the provided M/M/1 queue simulation code from Lecture 3.
- **Modify for Abandonment:** Adjust the code to incorporate customer abandonment for each scenario.
- **Data Collection:** For each scenario, record:
 - Total number of customers served.
 - Total number of customers who abandoned the queue.
 - Average waiting time for customers who were served.
 - Average time before abandonment for customers who left.

1. Simulate Three Different Abandonment Scenarios

a. Random Abandonment Rate (1.5 points)

- **Description:** Customers abandon the queue randomly based on a statistical distribution of your choice with a specific mean.
- **Task:** Choose an appropriate statistical distribution to model random abandonment. Implement this in your simulation.

b. Abandonment Depends on Queue Length at Arrival (1.5 points)

- **Description:** The probability of a customer abandoning the queue increases with the length of the queue upon their arrival.
- **Task:** Develop a model where the abandonment rate is a function of the queue length at the time of the customer's arrival. Incorporate this into your simulation.

c. Abandonment Depends on Waiting Time (1.5 points)

- **Description:** Customers decide to leave the queue if their waiting time exceeds a certain threshold, which may depend on the initial queue length.
- **Task:** Implement abandonment behavior based on the customer's waiting time. Define the threshold and adjust your simulation accordingly.

2. Discussion and Visualization (2.5 points)

- **Visualizations:**
 - Create graphs or charts illustrating queue length over time, waiting times, and abandonment instances for each scenario.
- **Discussion:**
 - Analyze how abandonment affects queue dynamics and customer waiting times.
 - Provide insights and recommendations for the restaurant management to reduce customer abandonment.

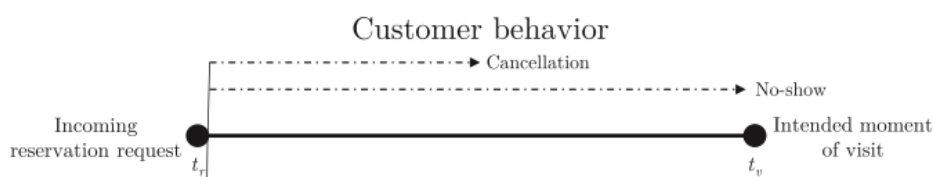
Part 2: Restaurant Analytics – Data from the Field (8 Points)

Collecting data on queue behavior can be challenging due to selection bias, as it often excludes individuals who have left the queue or changed their mind about joining it. As a result, field observational data tends to be somewhat inconsistent or complex. In your situation, the restaurant management has supplied a dataset that includes the following entries:

- **Customer ID:** Unique alphanumeric identifier assigned to each customer.
- **Type of Transaction:** Describes the nature of the arrival, e.g., "Walkin." (DROP)
- **Number of Visits:** Represents the total number of visits made by the customer to date.
- **Group Size:** Indicates the number of individuals in the customer's party.
- **Status:** Outcome or status of the visit, such as "No Show", "User Cancelled", "Seated".
- **Arrival Time:** Time at which the customer initially arrived.
- **Arrival Date:** Date of the customer's arrival.
- **Status Time:** Time when the customer's status (e.g., "No Show") was recorded.
- **Status Date:** Date when the customer's status was recorded.
- **Position in Queue:** The customer's position in the queue upon arrival.

Do note that field data has errors, for example, the *Status Time* column may have updated incorrectly. If the customer informs that they want to leave the queue by cancelling, the status time should reflect when they canceled, but the update for some cancelations is at 11:59.

The *No Show* status is someone that arrives at the queue and leaves without informing (e.g., You might see no-shows that appear days later). Please see the figure below that summarizes the customer behavior on reservation.



Develop a method to estimate the actual wait time each customer experiences, considering the limitations of the data (e.g., unknown actual leave times for those who renege). Use this estimated wait time to analyze how it relates to renegeing behavior.

Tasks

1. Data Preparation (1.5 Points)

- **Clean the Dataset:** Address any errors and inconsistencies in the data.
- **Deal with Missing Data:** Estimate missing or incorrect entries where feasible, such as *Status Time* and *Status Date* for customers who have incomplete information.

2. Wait Time Estimation (2.5 Points)

- **Propose a Model:** Develop a method to estimate the wait time for each customer upon arrival, considering whether they were served or abandoned the queue.

3. Analysis (4 Points)

- **Relationship Examination:** Analyze how the estimated wait times relate to the likelihood of a customer reneging.
- **Modeling:** Use appropriate statistical or machine learning techniques (e.g., logistic regression, Tree-Based) to model this relationship.

Deliverables

- **Methodology:** Provide a detailed explanation of your methodology and assumptions made during the estimation and analysis.
- **Visualizations:** Include visualizations such as scatter plots, histograms to illustrate your findings.
- **Reflection:** Reflect on how wait times influence reneging behavior based on your analysis.
- **Discussion:** Discuss the implications of your findings for managing reneging behavior in the restaurant context.
- **Code:** Submit Python or R code implementing your estimation and analysis in the appendix.

Report Submission: Ensure that your report includes all analyses, findings, and explanations. Please provide your code in the appendix. Follow a scientific format for citations, bibliography, and overall structure.

File Formats: Submit your report with the code in appendix as pdf on Canvas by Tuesday 19th 23:59. (Cover page must have Student Names, IDs, and Group Number)

You are encouraged—but not limited—to review the following research papers to support and motivate your discussion:

- Roy, D., Spiliotopoulou, E., & de Vries, J. (2022). Restaurant analytics: Emerging practice and research opportunities. *Production and Operations Management*, 31(10), 3687-3709.
- Ülkü, S., Hydock, C., & Cui, S. (2020). Making the wait worthwhile: Experiments on the effect of queueing on consumption. *Management Science*, 66(3), 1149–1171.
- De Vries, J., Roy, D., & De Koster, R. (2018). Worth the wait? How restaurant waiting time influences customer behavior and revenue. *Journal of Operations Management*, 63, 59–78. <http://linkinghub.elsevier.com/retrieve/pii/S0272696318300214>

While these are a good starting point, feel free to explore and reference additional papers, as finding other relevant sources is highly encouraged.