Modelling and Simulation for Bank Queue System

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- Part 1: Problem formulation and Objectives: -

The Problem:

A bank has one drive-in teller (who can serve customers without leaving their cars). The drive-in teller has a room (i.e., a queue) for one additional customer to wait. Customers arriving when the drive-in teller queue is full will park their cars and go inside the bank to transact business. Inside the bank, the waiting area is sufficient to accommodate all customers, and there is one teller who is as efficient as the drive-in teller in terms of serving the customers.

Reformulation of The Problem:

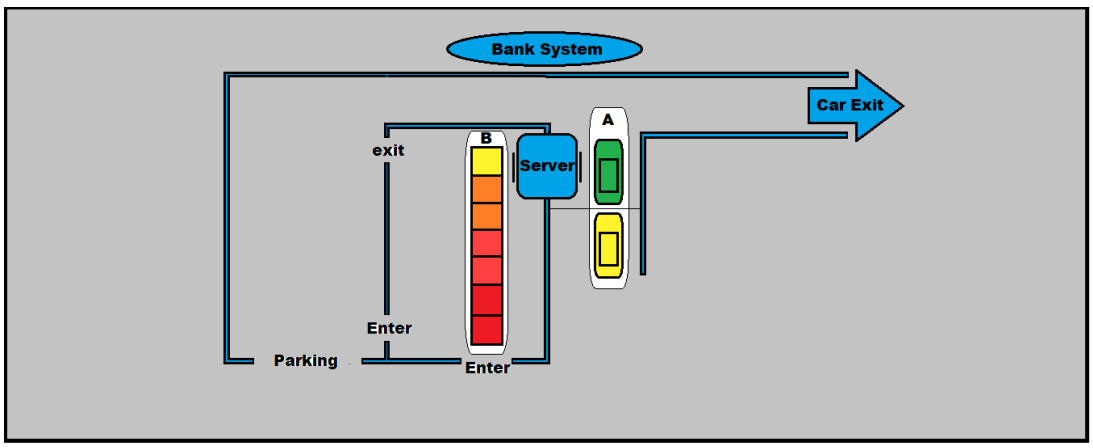
To reformulate bank problem, I will be dividing bank system into two main parts:

Queue **(A):**

The bank has one Server (S1) who could serve customers without leaving their cars, so we have first queue (A). Queue (A) has length = 2, which mean the queue (A) accommodate just two cars.

Queue **(B):**

The Server (S2) serve customers inside the bank if the Queue (A) is full, then the next customer will be serving inside bank.



Objectives: -

The objective of simulate multi-queue-system is to make bank works more efficiently, also helping customer without more waiting, and simulate to reach optimal maximum length of these two queues.

Bank system considered as discrete because the state variables change instantaneously at separated points in time, so the given in bank problem is Time between Arrivals & Service Time, So I'm going to simulate according to this value and their probability.

Time between Arrivals (Minutes)	Probability	Service Time (Minutes)	Probability
0	0.09	1	0.20
1	0.17	2	0.40
2	0.27	3	0.28
3	0.20	4	0.12
4	0.15		
5	0.12		

The plan to simulate multi-queue-bank: -

From lecture (2): steps

(Problem formulation, setting objective, Model conceptualization, Data collection, Model translation, Verified, Validated, Experimental design, Production runs and analysis, More runs, Documentation and reporting).

1) Analyze and Understand the problem.

2) Calculate the cumulative probability for **Time Between Arrivals** and make Range to get a random value.

3) Calculate the cumulative probability for **Service Time** and make the range to get a random value.

4) Design model that aid to experimentation to **estimate** time.(wait ,service ,idle ,length). In table below.

5) Build a program that generate the random values of (Time between arrivals and Service Time) for each customer and calculate other time attributes. Attributes in table below.

6) Design the length of the simulation runs, trials, and the number of replications to be made of each run.

7) Analysis result of program and write conclusion.

Part 2: System components & Calendar: -

System Components: -

System	Entities	Attributes	Activitie	Events	State Variables
Bank	Drive in Queue	-Inter Arrival -Arrivals -Service Time -Service Start -Service End -Waiting -Spend in Sys	Get Service	Arrivals; Wait; Departure;	If Drive in full which is =2, then next customer goes inside bank.
Bank	Inside bank Queue	-Inter Arrival -Arrivals -Service Time -Service Start -Service End -Waiting -Spend in Sys	Get Service	Arrivals; Checking; Wait; Departure;	Goes inside

System Analysis & Calendar Table: -

Time between Arrivals:

Time between Arrivals	Probability	Cumulative probability	Random digit
0	0.09	0.09	01-9
1	0.17	0.26	10-26
2	0.27	0.53	27-53
3	0.20	0.73	54-73
4	0.15	0.88	74-88
5	0.12	1	89-1

Service Time:

Service Time	Probability	Cumulative probability	Random digit
1	0.20	0.20	0-20
2	0.40	0.60	21-60
3	0.28	0.88	61-88
4	0.12	1	89-100

Create Simulation Table:

Customer number	Inter arrival	arrival	Services time	Queue type	Service start	Waiting	Service End	Time spend in system	Idle
1	-	0	1	Drive in	0	0	1	1	
2	3	3	1	Drive in	3	0	4	1	
3	3	6	2	Drive in	6	0	8	2	
4	2	8	3	Drive in	8	0	11	3	
5	1	9	1	Drive in	11	2	12	3	
6	0	9	2	Inside	9	0	11	2	
7	1	10	2	Inside	11	1	12	3	
8	3	13	3	Drive in	13	0	16	3	
9	3	16	2	Drive in	16	0	18	2	
10	3	19	2	Drive in	19	0	21	2	

Part 3: Experimental design parameters: -

The output of translated program is: -

the average of service time in Queue (A).
average of service time in Queue(B).
average of waiting time in Queue(A).
average of waiting time in Queue (B).
the maximum length in Queue (B).
the probability of waiting in Queue(B).
the time of server being idle in Queue (A).
the time of server being idle in Queue (B).
the summation of minutes server being idle in Queue (A). the summation of minutes server being idle in Queue (B).

Number of runs =10;
Number of customers=100;

so, to meet optimal result of these averages by taking average of averages of each run.

Note: prat 4 tables below for more explanation.

Part 4: Result Analysis: -

- The average service time of 10 runs in **Drive In** Queue = sum of Averages / number of runs.
- The average service time of 10 runs in **Inside Bank** Queue = sum of Averages / number of runs.
- The average waiting time of 10 runs in **Drive In** Queue = sum of Averages / number of runs.
- The average waiting time of 10 runs in **Inside Bank** in Queue = sum of Averages / number of runs.

Service Time & Waiting Time Analysis: -

Run	Customer Numbers	Drive In		Inside Bank		
		Average Service Time	Average waiting time	Average Service Time	Average waiting time	Probability of waiting
1	100	2.3953	0.9883	2.500	0.2857	0.0714
2	100	2.3118	0.7956	2.285	0.2857	0.1428
3	100	2.3820	0.8089	2.454	0.8181	0.2727
4	100	2.1888	0.6777	2.000	0.6	0.3
5	100	2.4505	0.8901	2.222	0.0	0.0
6	100	2.4318	0.9090	2.250	1.0	0.3
7	100	2.2349	0.7191	2.727	1.1818	0.3636
8	100	2.2359	0.6741	2.0	0.7272	0.3636
9	100	2.2747	0.8681	3.111	0.7777	0.2222
10	100	2.2921	0.6067	2.0	0.6363	0.3636

Idle time Analysis: -

Run	Drive in idle time	Total Idle (Min)	Inside bank idle time	Total Idle (Min)
1	26	41 min	8	194 min
2	29	57 min	8	154 min
3	20	43 min	7	162 min
4	41	72 min	4	162 min
5	32	61 min	6	203 min
6	29	50 min	5	176 min
7	32	58 min	8	170 min
8	33	59 min	7	192 min
9	27	44 min	13	167 min
10	37	73 min	3	105 min

Conclusion: -

The average service time of 10 runs in Drive In Queue =	**2.316**
The average service time of 10 runs in Inside Bank Queue =	**2.353**
The average waiting time of 10 runs in Drive In Queue =	**0.787**
The average waiting time of 10 runs in Inside Bank in Queue =	**0.627**
The probability that a customer wait in the inside-bank queue =	**0.239**
Maximum length inside bank queue	**2.533**