Simulation Examples

Ex

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Simulation steps using Simulation Table

1. Determine the characteristics of each of the inputs to the simulation. Quite often, these may be modeled as probability distributions, either continuous or discrete.
2. Construct a simulation table. Each simulation table is different, for each is developed for the problem at hand. Example: there are p inputs, x_{ij}; $j = 1, 2, \ldots, p$ and one response, y_i , for each of repetitions $i = 1, 2, \ldots, n$. Initialize the table by filling in the data for repetition 1.
3. For each repetition i, generate a value for each of the p inputs, and evaluate the function, calculating a value of the response y_i . The input values may be computed by sampling values from the distributions determined in step 1. A response typically depends on the inputs and one or more previous responses. Determine the characteristics of each of the inputs to the simulation (probability distributions).

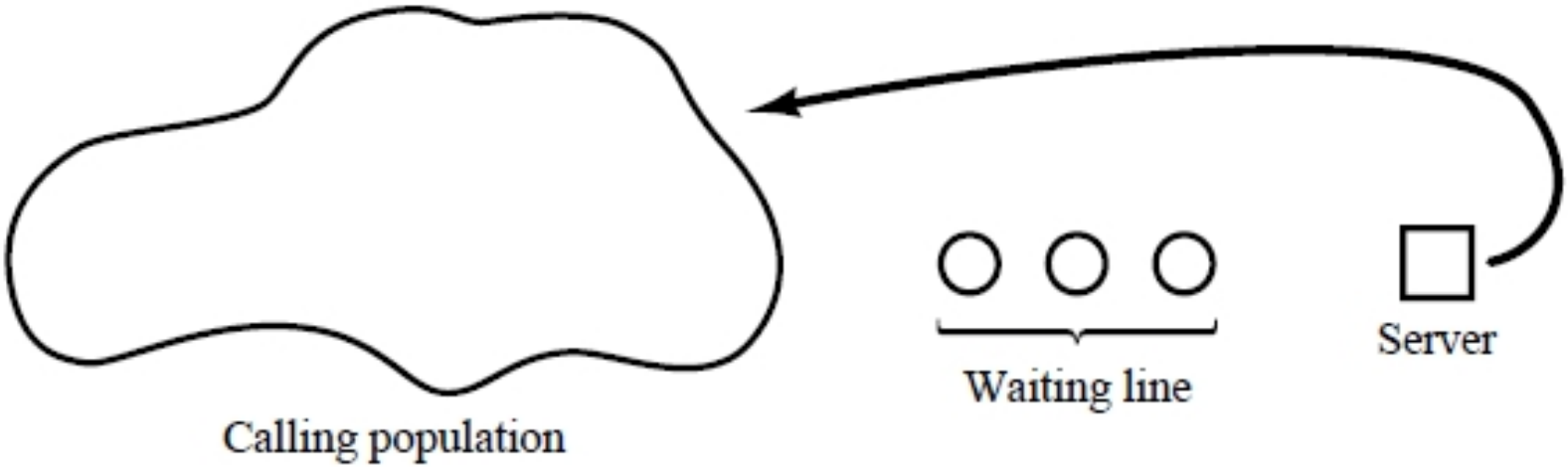
Simulation Table

	Inputs					Response
Repetitions	x_{i1}	x_{i2}	$\ldots$	x_{ij}	$\ldots$	y_i
1						
2						
$\vdots$						
n						

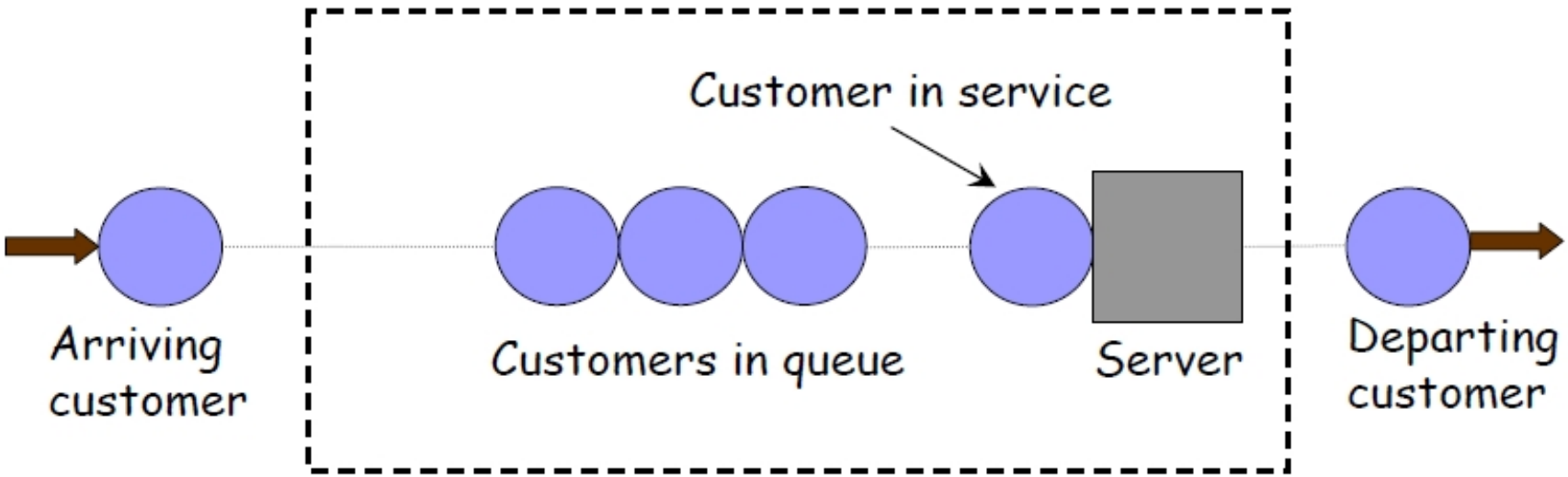
Simulation of Queueing Systems

- A queueing system is described by
  - Calling population
  - Arrival rate
  - Service mechanism
  - System capacity
  - Queueing discipline

Simulation of Queueing Systems

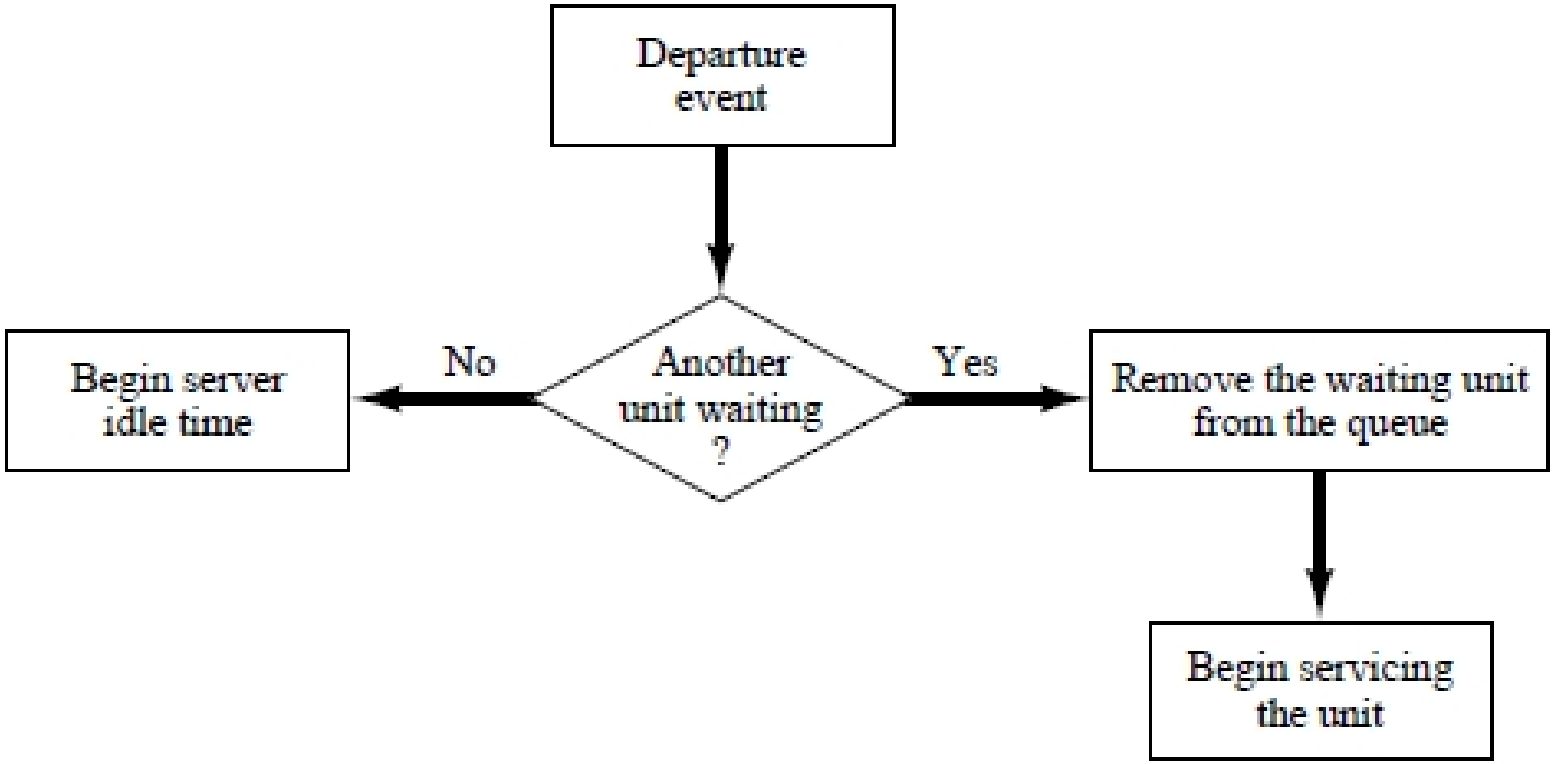


Single-Server Simulation

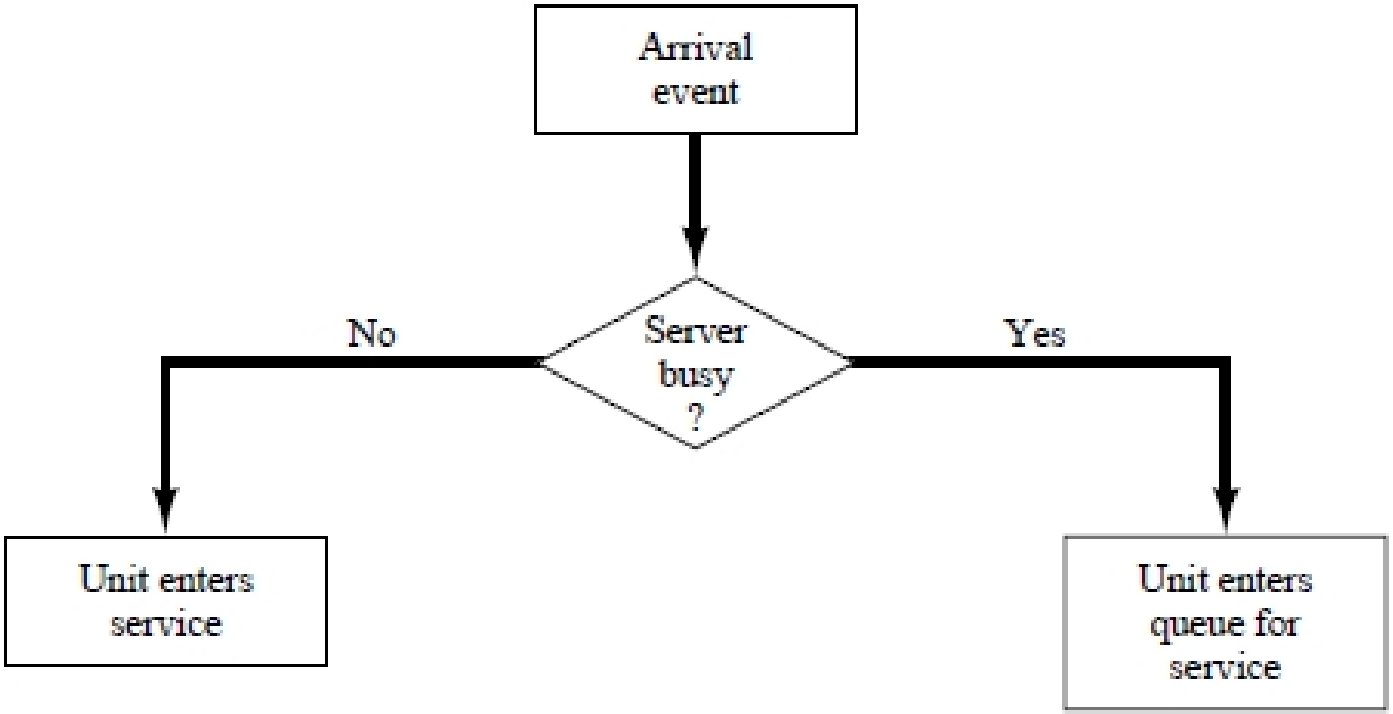


What are the events?

Departure Event



Arrival Event



		Queue status	
		Not Empty	Empty
Server status	Busy	Enter Queue	Enter Queue
	Idle	Impossible	Enter service

Simulation of Queueing Systems

The interarrival and service times are taken from distributions!

Customer	Interarrival Time	Arrival Time on Clock	Service Time
1	-	0	2
2	2	2	1
3	4	6	3
4	1	7	2
5	2	9	1
6	6	15	4

The simulation run is build by meshing clock, arrival and service times!

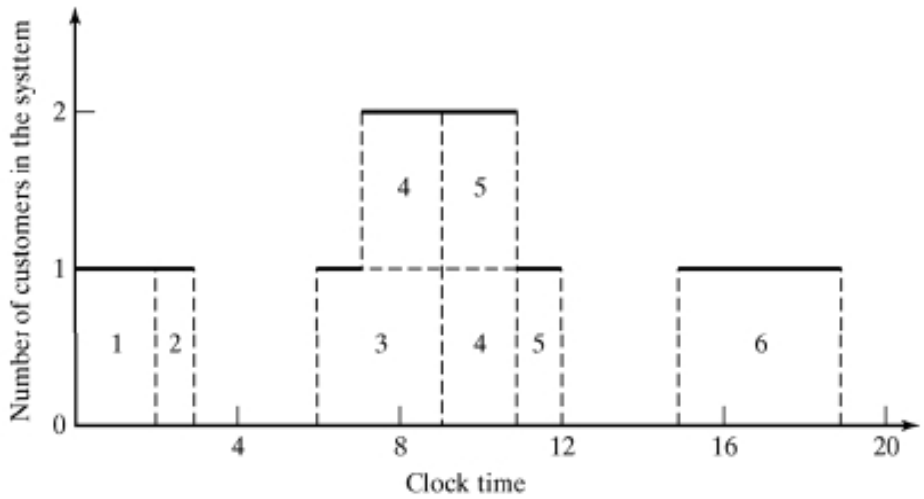
Customer Number	Arrival Time [Clock]	Time Service Begins [Clock]	Service Time [Duration]	Time Service Ends [Clock]
1	0	0	2	2
2	2	2	1	3
3	6	6	3	9
4	7	9	2	11
5	9	11	1	12
6	15	15	4	19

Simulation of Queueing Systems II

Chronological ordering of events

Clock Time	Customer Number	Event Type	Number of customers
0	1	Arrival	1
2	1	Departure	0
2	2	Arrival	1
3	2	Departure	0
6	3	Arrival	1
7	4	Arrival	2
9	3	Departure	1
9	5	Arrival	2
11	4	Departure	1
12	5	Departure	0
15	6	Arrival	1
19	6	Departure	0

Number of customers in the system



Example: Grocery Center

- One checkout counter
- Arrival time between customers are 1 to 8 minutes (equal probability)
- Service time vary from 1 to 6 (service time table)

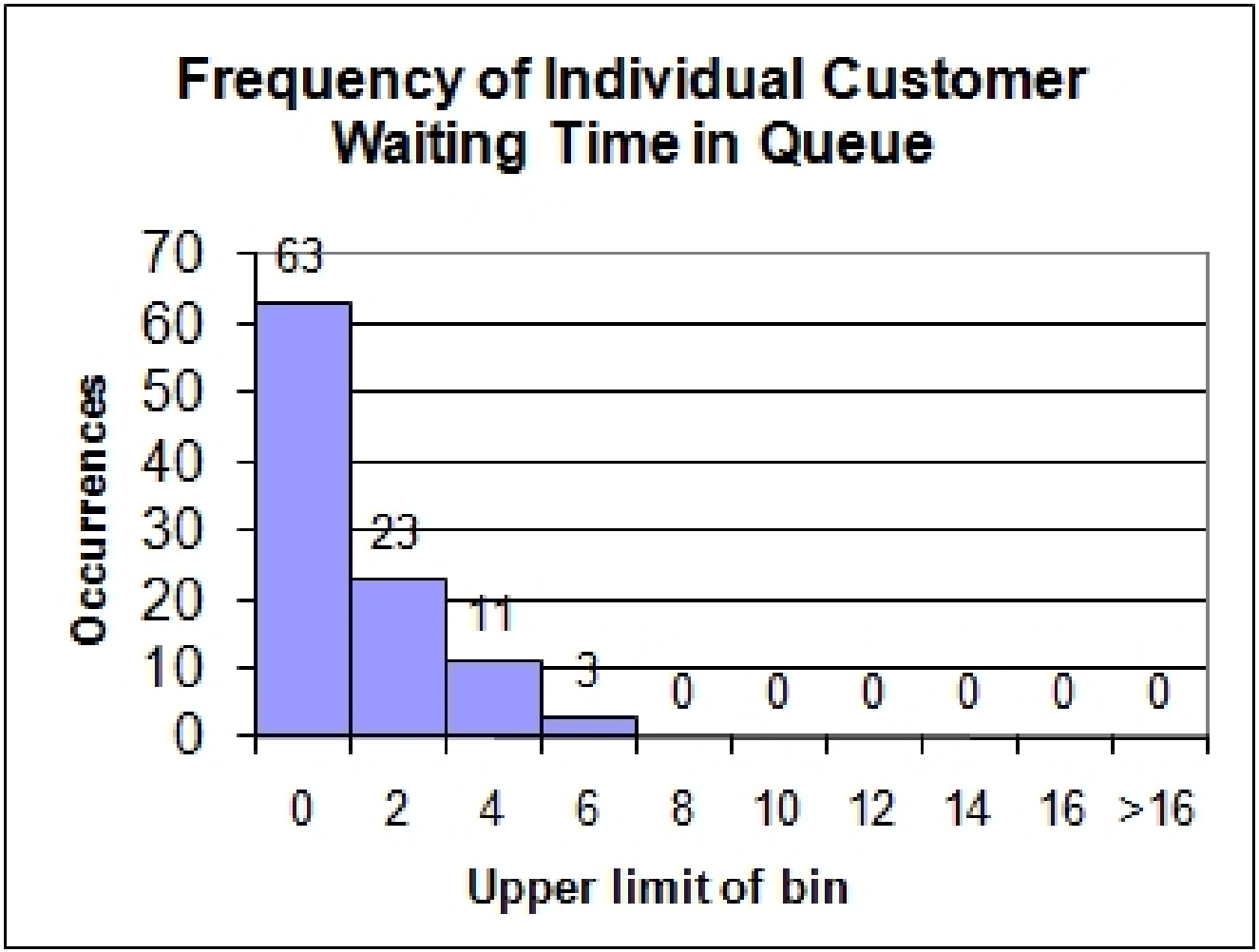
$$\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 0.10 & 0.20 & 0.30 & 0.25 & 0.10 & 0.05 \end{pmatrix}$$

- We are going to analysis for 100 customers.

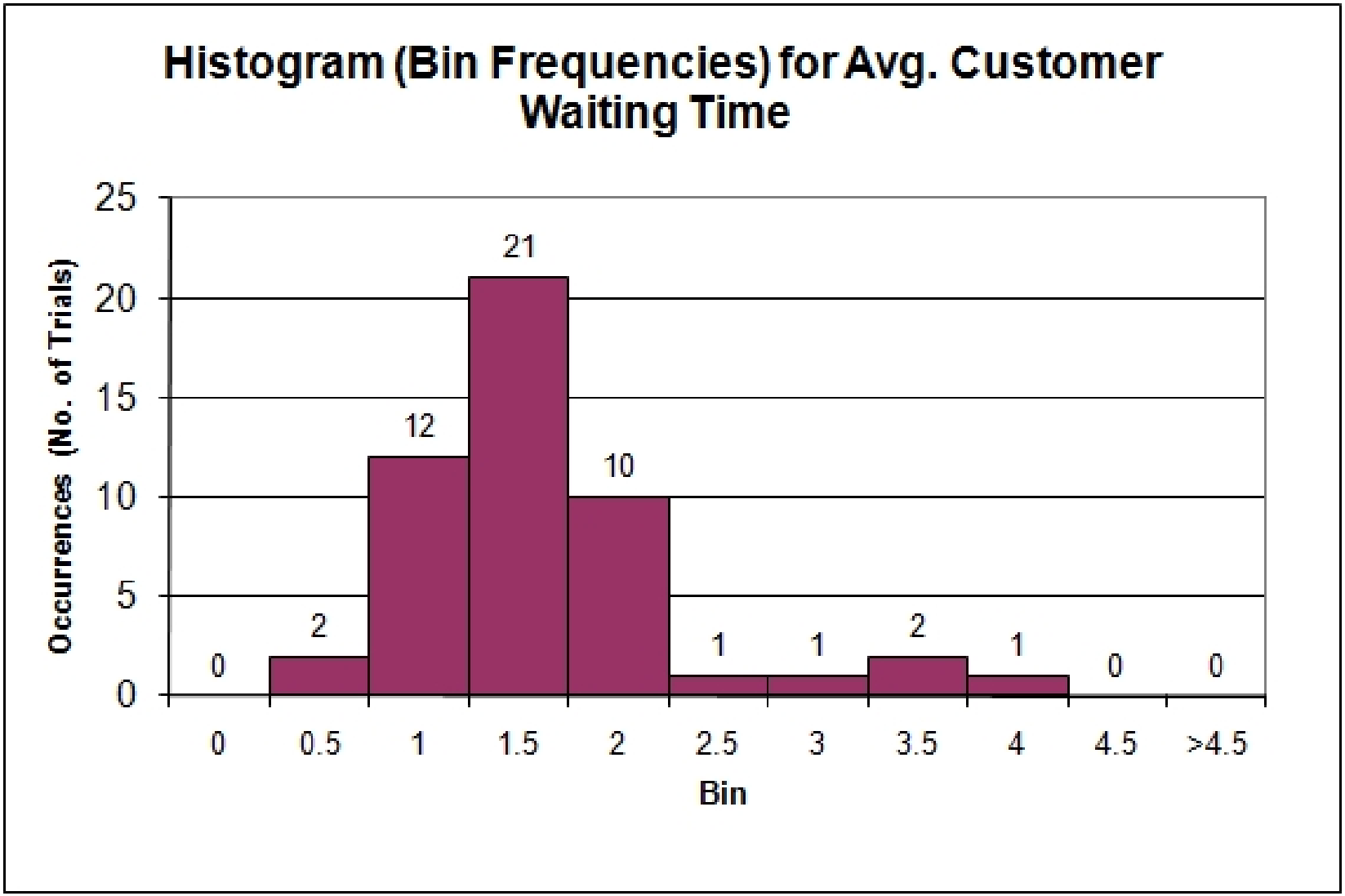
Outputs

- Average waiting time=174/100=1.74 minutes
- The probability that a customer has to wait=0.46
- The proportion of idle time of the server=101/418=0.24
- Average service time=317/100=3.17

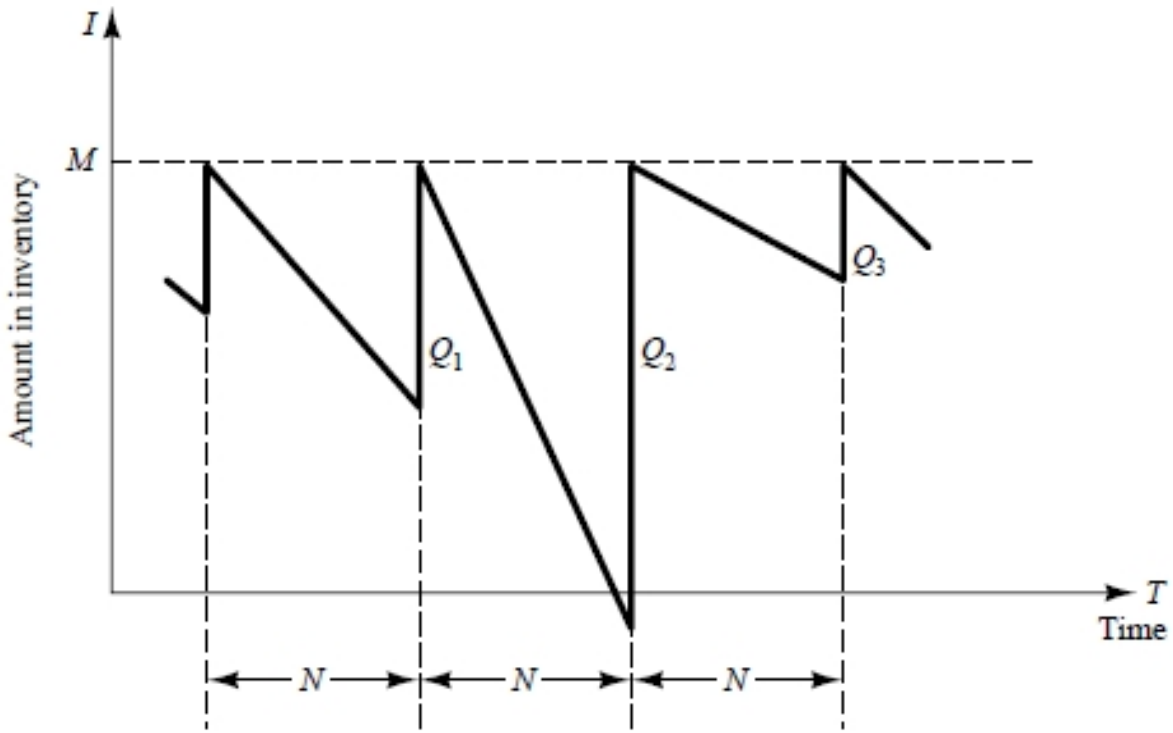
Frequency of waiting time in queue



Frequency distribution of avg. waiting time

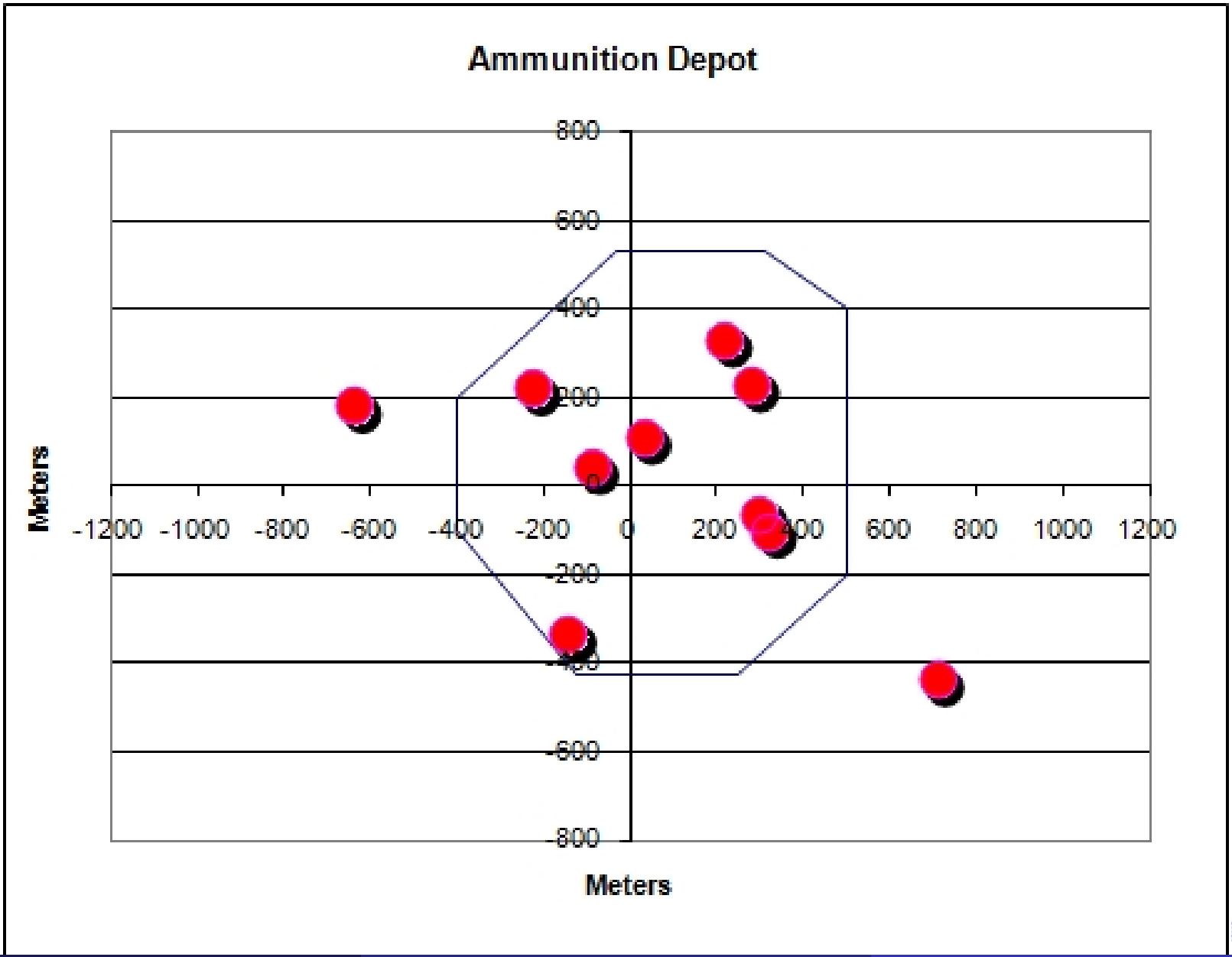


Simulation of Inventory Systems



- N: Length of periodic review that inventory level is checked — An order is made to bring the inventory to the level M
- Lead Time: the length of time between the placement and receipt of an order (here is zero)
- Q: order quantity

Random normal numbers



Results of 400 Trials