

SIMULATION

1. A company manufactures around 200 mopeds. Depending upon the availability of raw materials and other conditions, the daily production has been varying from 196 mopeds to 204 mopeds, whose probability distribution is as given below :

Production/day :	196	197	198	199	200	201	202	203	204
Probability :	0.05	0.09	0.12	0.14	0.20	0.15	0.11	0.08	0.06

The finished mopeds are transported in a specially designed three storied lorry that can accommodate only 200 mopeds.

Using the following 15 random numbers 82, 89, 78, 24, 53, 61, 18, 45, 04, 23, 50, 74, 27, 54, 10 Simulate the process to find out :

- (i) What will be the average number of mopeds waiting in the factory ?
- (ii) What will be the average number of empty space on the lorry.

2. A trader deals in a perishable commodity, the daily demand and supply of which are random variables. Records of the past 500 trading days show the following :

Supply		Demand	
Tons available	Number of days	Tons demanded	Number of days
10	40	10	50
20	50	20	110
30	190	30	200
40	150	40	100
50	70	50	40

The trader buys the commodity at ` 2,000 per ton and sells at ` 3,000 per ton. If any of the commodity remains at the end of the day it has re-saleable value of ` 800 ton. The loss through unsatisfied demand is ` 1,000 per ton.

From this random numbers, simulate six day trading : 31, 18, 63, 84, 15, 79, 07, 32, 43, 75, 81, 27.

Use the random numbers alternatively, i.e., first pair (31) to simulate supply, second pair (18) to simulate demand. Compute the profit for next 6 days.

3. Dr. STRONG is a dentist who schedules all her patients for 30 minutes appointments. Some of the patients take more or less than 30 minutes depending on the type of dental work to be done. The following summary shows the various categories of work, their probabilities and the time actually to complete the work :

Category	Time required (minutes)	Probability of category
Filling	45	0.40
Crown	60	0.15
Cleaning	15	0.15
Extraction	45	0.10
Checkup	15	0.20

Simulate the dentist's clinic for four hours and determine the average waiting time for the patients as well as the idleness of the doctor. Assume that all the patients show up at the clinic at exactly their scheduled arrival time starting at 8.00 A.M. Use the following random numbers handling the above problem :

40 82 11 34 25 66 17 79

4. A book store wishes to carry 'Ramayana' in stock. Demand is probabilistic and replenishment of stock takes 2 days (i.e. if an order is placed on March 1, it will be delivered at the end of the day on March 3). The probabilities of demand are given below :

Demand (daily)	0	1	2	3	4
Probability	0.05	0.10	0.30	0.45	0.10

Each time an order is placed, the store incurs an ordering cost of ` 10 per order. The store also incurs a carrying cost of ` 0.50 per book per day. The stock out cost is ` 18 per unit. The inventory carrying cost is calculated on the basis of stock at the end of each day.

The manager of the book store wishes to compare two options for his inventory decision.

- A. Order 5 books when the inventory at the beginning of the day plus orders outstanding is less than 8 books.
- B. Order 14 books when the inventory at the beginning of the day plus orders outstanding is less than 8.

Currently (beginning of 1st day) the store has a stock of 8 books plus 6 books ordered two days ago and expected to arrive next day. Using Monte Carlo Simulation for 10 cycles, recommend which options the manager should choose.

The two digit random nos. are :89,34,78,63,61,81,39,16,13,73

5. The occurrence of rain in a city on a day is dependent upon whether or not it rained on the previous day. If it rained on the previous day, the rain distribution is given by :

Event	Probability
No rain	0.50
1 cm. Rain	0.25
2 cm. Rain	0.15
3 cm. Rain	0.05
4 cm. Rain	0.03
5 cm. Rain	0.02

If it did not rain the previous day, the rain distribution is given by :

Event	Probability
No rain	0.75
1 cm. Rain	0.15
2 cm. Rain	0.06
3 cm. Rain	0.04

Simulate the city's weather for 10 days and determine by simulation the total days without rain as well as the total rainfall during the period. Use the following random numbers for simulation. Assume that for the first day of the simulation it had not rained the day before.

67 92 39 55 98 78 70 06 78 76

6. At a small store of readymade garments, there is one clerk at the counter who is to check bills, receive payments and place the packed garments into fancy bags. The arrival of customer at the store is random and service time varies from one minute to six minutes, the frequency distribution for which is given below:

Time between arrivals (minutes)	Frequency	Service Time (in minutes)	Frequency
1	5	1	1
2	20	2	2
3	35	3	4
4	25	4	2
5	10	5	1
6	5	6	0

The store starts work at 11 a.m. and closes at 12 noon for lunch and the customers are served on the "first come first served basis".

Using Monte Carlo simulation technique, find average length of waiting line, average waiting time, average service time and total time spent by a customer in system.

You are given the following set of random numbers, first twenty for arrivals and last twenty for service:
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64	04	02	70	03	60	16	18	36	38
07	08	59	53	01	62	36	27	97	86
30	75	38	24	57	09	12	18	65	25
11	79	61	77	10	16	55	52	59	63

Answer: Average queue length = 1.3
 Average waiting time per customer = 2.8 minutes
 Average service time = 2.7 minutes
 Time a customer spends in system = 2.8 + 2.7 = 5.5 minutes.