Simulation and Modelling

NATIONAL UNIVERSITY
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CS4056

Muhammad Shahid Ashraf

Notes

Questions

Consider the following continuously operating job shop. Interarrival times of jobs are distributed as follows:

Time Between Arrivals (hours)	Probability
0	0.23
1	0.37
2	0.28
3	0.12

Processing times for jobs are normally distributed, with mean 50 minutes, and standard deviation 8 minutes. Construct a simulation table and perform a simulation for 10 new customers. Assume that, when the simulation starts, there is one job being processed (scheduled to be completed in 25 minutes) and there is one job with a 50-minute processing time in the queue.

Notes

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Consider the following continuously operating job shop. Interarrival times of jobs are distributed as follows:

Time Between Arrivals (hours)	0	1	2	3
Probability	0.23	0.37	0.28	0.12

Processing times for jobs are normally distributed, with mean 50 minutes, and standard deviation 8 minutes.

customer	iaHrs	iaMins	arrivalMins	svcTimeMins	timeSvcBegin	queueWaitMins	timeSvcEnd	timeInSystem
-2	0	0	0	25.00000	0.0000	0.0000	25.0000	25.00000
-1	0	0	0	50.00000	25.0000	25.0000	75.0000	75.00000
1	0	0	0	44.77022	75.0000	75.0000	119.7702	119.77022
2	3	180	180	51.34450	180.0000	0.0000	231.3445	51.34450
3	0	0	180	56.01599	231.3445	51.3445	287.3605	107.36049
4	2	120	300	76.54174	300.0000	0.0000	376.5417	76.54174
5	3	180	480	53.34800	480.0000	0.0000	533.3480	53.34800
6	2	120	600	61.63021	600.0000	0.0000	661.6302	61.63021
7	2	120	720	46.44826	720.0000	0.0000	766.4483	46.44826
8	2	120	840	49.49184	840.0000	0.0000	889.4918	49.49184
9	2	120	960	45.26930	960.0000	0.0000	1005.2693	45.26930
10	2	120	1080	36.87723	1080.0000	0.0000	1116.8772	36.87723

Notes

Questions

2. A baker is trying to figure out how many dozens of bagels to bake each day. The probability distribution of the number of bagel customers is as follows:

Number of Customers/Day	8	10	12	14
Probability	0.35	0.30	0.25	0.10

Customers order 1, 2, 3, or 4 dozen bagels according to the following probability distribution.

Number of Dozen Ordered/Customer	1	2	3	4
Probability	0.4	0.3	0.2	0.1

Bagels sell for $8.40 per dozen. They cost $5.80 per dozen to make. All bagels not sold at the end of the day are sold at half-price to a local grocery store. Based on 5 days of simulation, how many dozen (to the nearest 5 dozen) bagels should be baked each day?

Notes

Table with cakes =21

day	customers	dozenOrdered	revenue	lostProfit	salvage	dailyCost	dailyProfit
1	12	29	176.4	20.8	0.0	121.8	54.6
2	8	15	126.0	0.0	25.2	121.8	29.4
3	10	21	176.4	0.0	0.0	121.8	54.6
4	12	33	176.4	31.2	0.0	121.8	54.6
5	12	33	176.4	31.2	0.0	121.8	54.6
6	14	30	176.4	23.4	0.0	121.8	54.6
7	10	19	159.6	0.0	8.4	121.8	46.2
8	12	23	176.4	5.2	0.0	121.8	54.6
9	10	16	134.4	0.0	21.0	121.8	33.6
10	12	24	176.4	7.8	0.0	121.8	54.6
11	8	17	142.8	0.0	16.8	121.8	37.8
12	8	15	126.0	0.0	25.2	121.8	29.4
13	8	16	134.4	0.0	21.0	121.8	33.6
14	8	13	109.2	0.0	33.6	121.8	21.0
15	14	37	176.4	41.6	0.0	121.8	54.6

Notes

Table with cakes = maxProfit

day	customers	dozenOrdered	revenue	lostProfit	salvage	dailyCost	dailyProfit
1	12	27	168.0	18.2	0.0	116	52.0
2	12	21	168.0	2.6	0.0	116	52.0
3	10	21	168.0	2.6	0.0	116	52.0
4	12	27	168.0	18.2	0.0	116	52.0
5	10	18	151.2	0.0	8.4	116	43.6
6	14	28	168.0	20.8	0.0	116	52.0
7	8	18	151.2	0.0	8.4	116	43.6
8	10	23	168.0	7.8	0.0	116	52.0
9	10	18	151.2	0.0	8.4	116	43.6
10	8	15	126.0	0.0	21.0	116	31.0
11	10	22	168.0	5.2	0.0	116	52.0
12	14	30	168.0	26.0	0.0	116	52.0
13	10	17	142.8	0.0	12.6	116	39.4
14	8	20	168.0	0.0	0.0	116	52.0
15	14	28	168.0	20.8	0.0	116	52.0

Notes

Questions

dozPerDay	fiveDayProfit
0	0.0
5	195.0
10	390.0
15	580.8
20	641.4
25	773.4
30	615.6

dozPerDay	fiveDayProfit
0	0.0
5	195.0
10	390.0
15	568.2
20	670.8
25	605.4
30	502.2
35	273.0
40	300.0
45	129.6
50	194.4
55	-76.8
60	-180.0

Notes

Questions

The random variables X, Y, and Z are distributed as follows:

$$X \sim N(\mu = 100, \sigma^2 = 100)$$
$$Y \sim N(\mu = 300, \sigma^2 = 225)$$
$$Z \sim N(\mu = 40, \sigma^2 = 64)$$

Simulate 50 values of the random variable

$$W = \frac{X + Y}{Z}$$

Prepare a histogram of the resulting values, using class intervals of width equal to 3.

Notes

X	Y	Z	W
111.45702	288.3623	50.45701	7.923959
103.75655	316.3378	47.84899	8.779585
106.16933	312.2355	47.42582	8.822299
80.01467	300.8194	42.12282	9.041038
97.04698	264.7004	30.82301	11.736277
107.68640	307.2664	48.32868	8.586056
82.48616	300.0555	29.63558	12.908189
84.51611	306.4951	38.26131	10.219492
117.54004	291.5027	28.03801	14.588866
94.86519	291.5616	49.36427	7.828066
103.53755	281.2953	37.48716	10.265725
98.23719	288.5267	51.33691	7.533836
106.13298	277.5952	34.45530	11.136986
103.21006	309.0004	29.65680	13.899355
121.31378	301.0081	37.58870	11.235342
90.53218	278.7096	39.57997	9.329007
88.68662	302.7349	29.74888	13.157522
94.41480	311.6319	39.31072	10.329159
109.22515	305.3534	39.16444	10.585588

Notes

Questions

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6. Given A, B, and C, which are uncorrelated random variables. Variable A is normally distributed with $\mu = 100$ and $\sigma^2 = 400$. Variable B is discrete uniformly distributed with a probability distribution given by $p(b) = 1/5$ with $b = 0, 1, 2, 3$ and 4. Variable C is distributed in accordance with the following table:

Value of C	*Probability*
10	.10
20	.25
30	.50
40	.15

Use simulation to estimate the mean of a new variable D, that is defined as

$$D = (A - 25B)/(2C)$$

Use a sample of size 100.

Notes

Questions

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Value of B	Probability	Cumulative Probability
0	0.2	0.2
1	0.2	0.4
2	0.2	0.6
3	0.2	0.8
4	0.2	1

Value of C	Probability	Cumulative Probability
10	0.1	0.1
20	0.25	0.35
30	0.5	0.85
40	0.15	1

Notes

Questions

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Customer	A	B	C	D
1	79.23	2	30	2
2	113.04	3	30	32
3	58.53	0	20	1.46
4	99.68	0	20	2.49
5	87.15	0	10	4.36
6	91.05	1	40	0.83
7	66.97	1	30	0.7
8	104.88	3	30	0.5
9	61.6	1	30	0.61
10	98.92	3	30	0.4
Average	86.1	1.4	27	4.53

Notes