بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Lecture: 04

Queuing System

Problem: A banking queuing system in a cash counter have several data is given below:

Customer	1	2	3	4	5	6
Inter arrival time	-	2	4	1	2	6
Service Time	2	1	3	2	1	4

Calculate the Average waiting time, Utilization and Service time of this system. Also calculate the chronological ordering of events with graph.

Solution:

| Customer	Inter arrival time	Arrival Time	Service Time	Time Service Begin	Waiting Time	Time Service End	Idle Time
1	-	0	2	0	0	2	0
2	2	2	1	2	0	3	0
3	4	6	3	6	0	9	3
4	1	7	2	9	2	11	0
5	2	9	1	11	2	12	0
6	6	15	4	15	0	19	3
Total			**15**		**4**	**19**	**6**

Average Waiting Time: 4/6= 0.67

Utilization: $\frac{end\ time - idle\ time}{end\ time} \times 100 = \frac{19-6}{19} * 100 =$ **68.42.%**

Total Service Time: 15

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Chronological Ordering of events:

Event type	Customer Number	Event Clock
Arrival	1	0
Departure	1	2
Arrival	2	2
Departure	2	3
Arrival	3	6
Arrival	4	7
Departure	3	9
Arrival	5	9
Departure	4	11
Departure	5	12
Arrival	6	15
Departure	6	19

Chronological Event Chart

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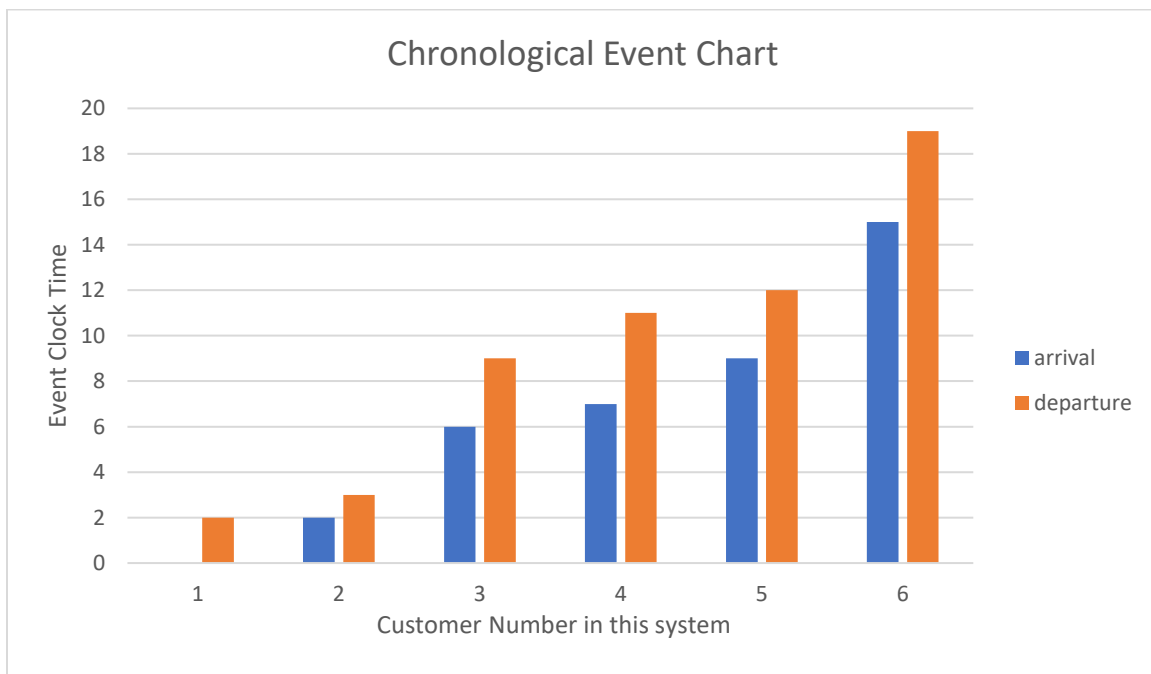
Random Number Generator

LCM (Linear Congruential Method)

$X_{i+1} = (a \cdot X_i + C) \bmod m$

$R_i = \dfrac{Xi}{m}$

X_0 = Seed element

a= multiplier

C= increment

m= Module

if C=0 => multiplicative LCM

C ≠ 0 => mixed LCM

Problem 1: Using LCM generate a sequence of random number with X_0 = 3, a= 5 C=1 and m= 8

Solution:

$X_0 = 3$; $R_0 = \dfrac{3}{8} = \mathbf{0.37}$

$X_{0+1} = (5 * 3+1) \bmod 8 = 0$; $R_1 = \dfrac{0}{8} = \mathbf{0}$

$X_2 = (5*0+1) \bmod 8= 1$; $R_2 = \dfrac{1}{8} = \mathbf{0.125}$

$X_3 = (5*1+1) \bmod 8 =6$; $R_3 = \dfrac{6}{8} = \mathbf{0.75}$

$X_4 = (5*6+1) \bmod 8 =7$; $R_4 = \dfrac{7}{8} = \mathbf{0.875}$

$X_5 = (5*7 +1) \bmod 8= 4$; $R_5 = \dfrac{4}{8} = \mathbf{0.5}$

$X_6 = (5*4+1) \bmod 8= 5$; $R_6 = \dfrac{5}{8} = \mathbf{0.625}$

$X_7 = (5*5+1) \bmod 8= 2$; $R_7 = \dfrac{2}{8} = \mathbf{0.25}$

$X_8 = (5*2+ 1) \bmod 8 = \mathbf{3}$; $R_8 = \dfrac{3}{8} = \mathbf{0.37}$

Sequence: 3, 0,1,6,7,4,5, 2,3

Random Number: 0.37, 0, 0.125, 0.75, 0.875, 0.5, 0.625, 0.25

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Problem 2 (try yourself): Using LCM generate a sequence of random number with $X_0 = 27$, a= 17, C=43 and m= 100

Solution:

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