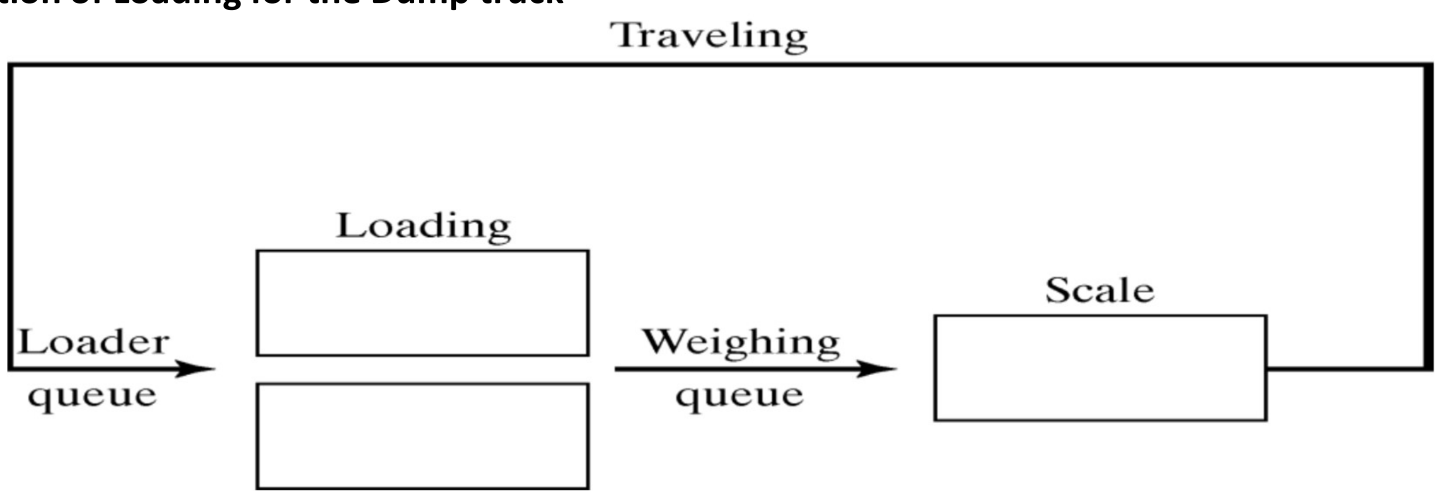
Fair Use Notice

Problems

The Dump truck problem

- Six dump trucks are used to haul coal from the entrance of a small mine to the railroad. Each truck is loaded by one of two loaders. After loading, a truck immediately moves to scale, to be weighted as soon as possible. Both the loaders and the scale have a first come, first serve waiting line(or queue) for trucks. The time taken to travel from loader to scale is considered negligible. After being weighted, a truck begins a travel time and then afterward returns to the loader queue.
- **Distribution of Loading for the Dump truck**



The Dump truck problem

Loading time	Probability	Cumulative probability	Random-Digit Assignment
5	0.30	0.30	1-3
10	0.50	0.80	4-8
15	0.20	1.00	9-0

Distribution of Weighing Time for the Dump Truck

Weighing time	Probability	Cumulative probability	Random-Digit Assignment
12	0.70	0.70	1-7
16	0.30	1.00	8-0

Distribution of Travel Time for the Dump Truck

Travel time	Probability	Cumulative probability	Random-Digit Assignment
40	0.40	0.40	1-4
60	0.30	0.70	5-7
80	0.20	0.90	8-9
100	0.10	1.00	0

The Dump truck problem

- A company uses 6 trucks to haul manganese ore from kolar to industry. There are two loaders, to load each truck. After loading a truck moves to the weighing scale to be weighted. The queue discipline is FIFO. When it is weighed, a truck travel to industry and returns to the loader queue. The distribution of loading time, weighing time and travel time are as follows:

Loading time	10	5	5	10	15	10	10
Weighing time	12	12	12	16	12	16	
Travel time	60	100	40	40	80		

- **Calculate total busy time of both loaders, the scale, average loader and scale utilization. Assume 5 trucks are at the loader and one is at the scale, at time “0”.**

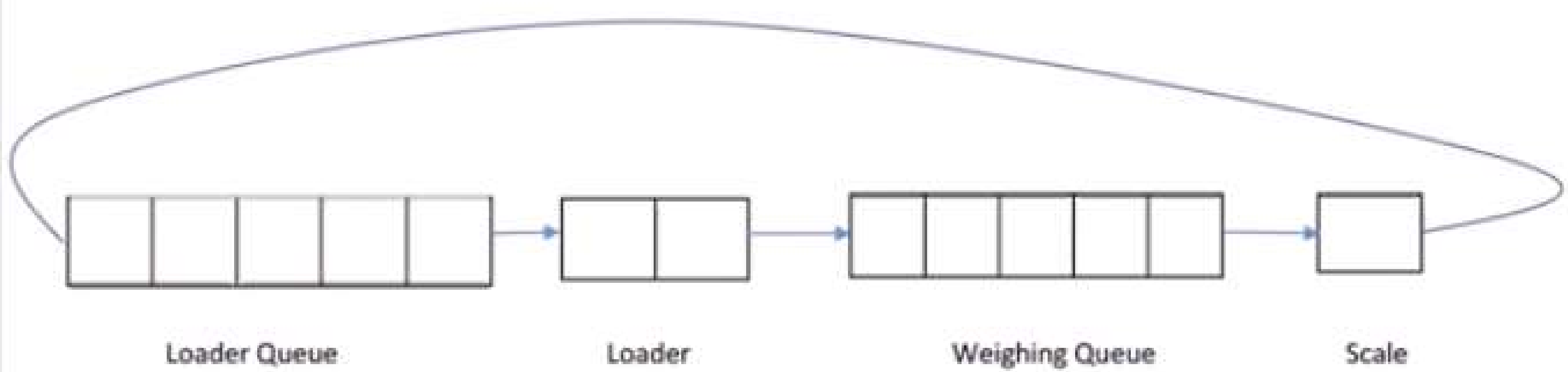
The Dump truck problem

- The model has the following components:
- **System state**
- [LQ(t), L(t),WQ(t), W(t)], where
- LQ(t) = number of trucks in loader queue
- L(t) = number of trucks (0,1, or 2)being Loaded
- WQ(t*)*= number of trucks in weigh queue
- W(t) = number of trucks (0 or 1) being weighed, all at simulation time *t*
- **Event notices**
- *(ALQ, t, DTi),* dump truck arrives at loader queue (ALQ) at time t
- (EL, t, *DTi),* dump truck i ends loading *(EL)* at time t
- (EW, t, *DTi),* dump truck i ends weighing *(EW)* at time t

The Dump truck problem

- **Entities** The six dump trucks *(DTI,..., DT6)*
- **Lists**
- Loader queue, all trucks waiting to begin loading, ordered on a first-come,
- first-served basis
- Weigh queue, all trucks waiting to be weighed, ordered on a first-come,
- first-serve basis.
- **Activities** Loading time, weighing time, and travel time.
- **Delays** Delay at loader queue, and delay at scale.

The Dump truck problem



Clock t	LQ(t)	L(t)	WQ(t)	W(t)	Loader queue	Weigh queue	FEL	B_L	B_S

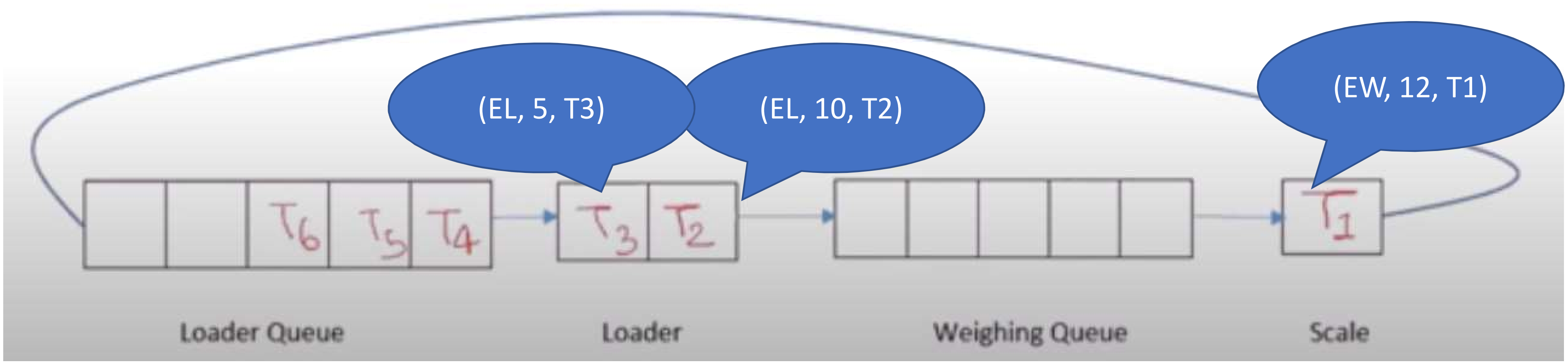
The Dump truck problem

Assume 5 trucks are at the loader and one is at the scale, at time "0".

Clock(t)	LQ(t)	L(t)	WQ(t)	W(t)	BL	BS
0	3	2	0	1	0	0

BL= how much time the loaders are occupied

BS= How much time the scale is busy



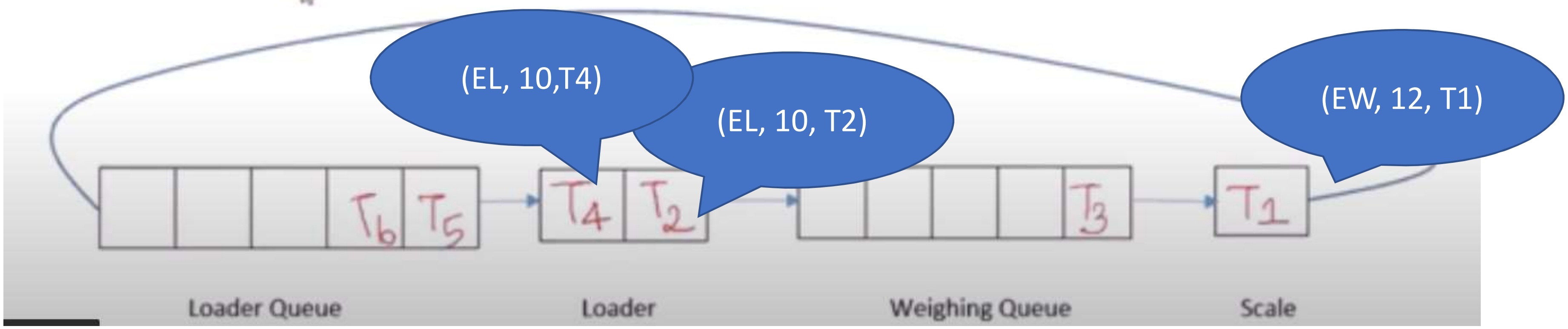
The Dump truck problem

Clock(t)	LQ(t)	L(t)	WQ(t)	W(t)	BL	BS
5	2	2	1	1	10	5

Loading time	10	5	5	10	15	10	10
Weigh time	12	12	12	16	12	16	
Travel time	60	100	40	40	80		

BL= 5-0=5
BL= 5+5=10

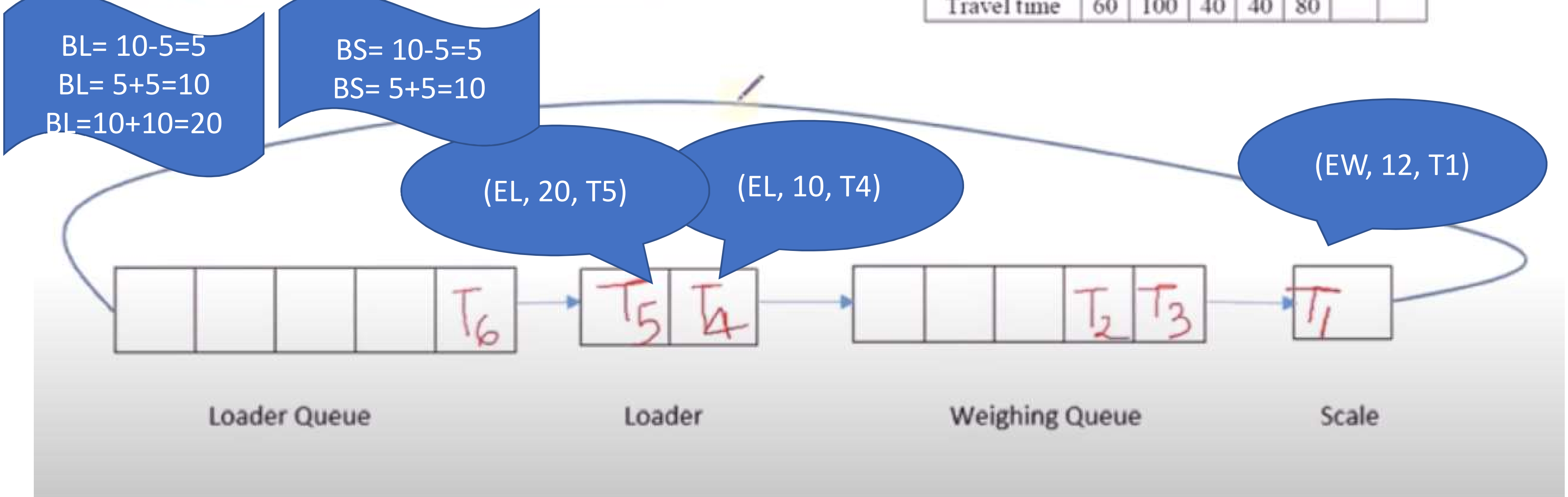
Eman
(EL, 5, T3)



The Dump truck problem

Clock(t)	BL	BS
10	20	10

Loading time	10	5	5	10	15	10	10
Weigh time	12	12	12	16	12	16	
Travel time	60	100	40	40	80		

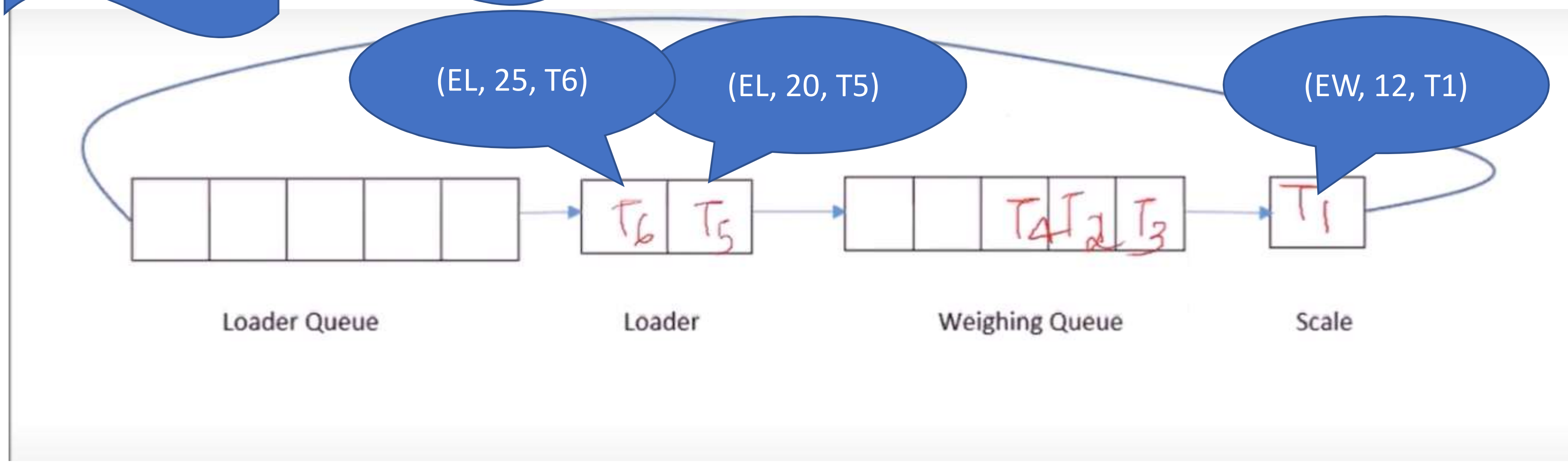


The Dump truck problem

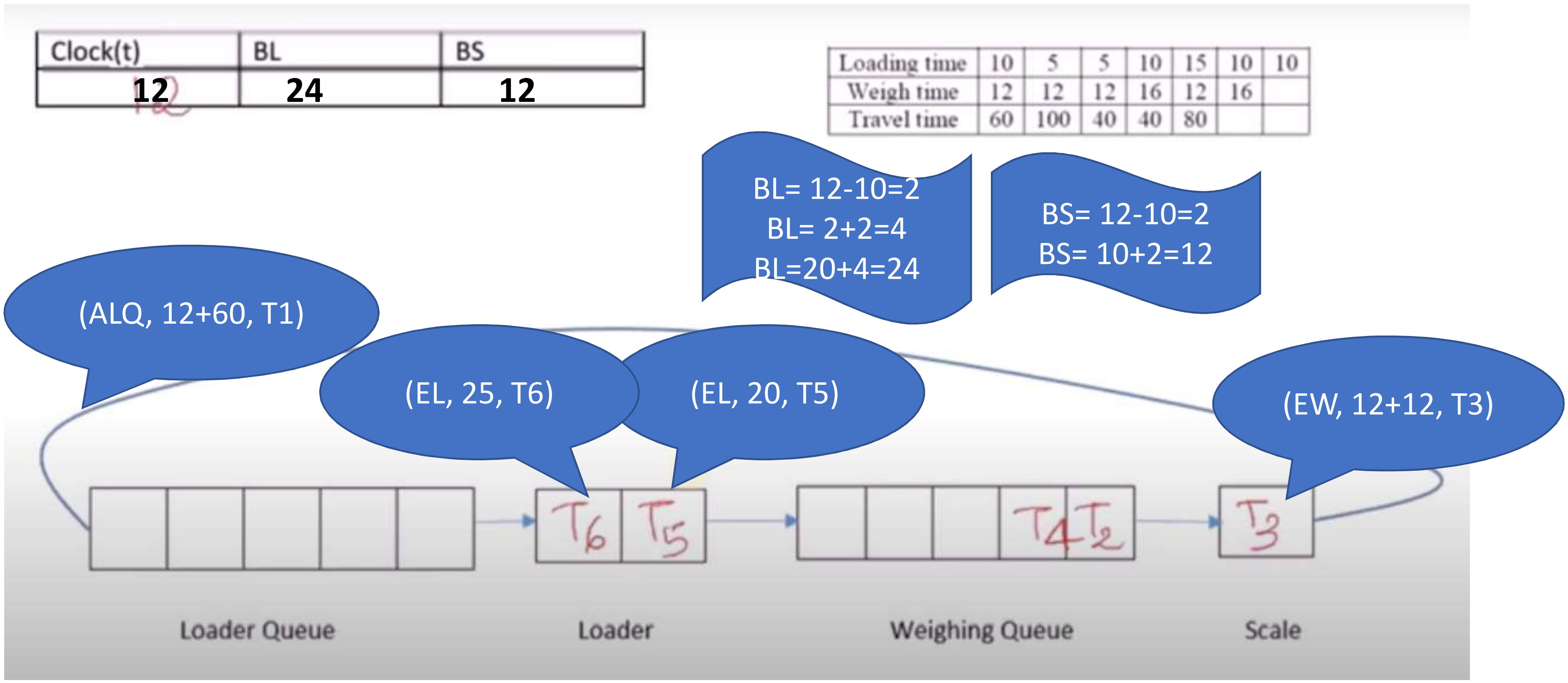
Clock(t)	LQ(t)	L(t)	WQ(t)	W(t)	BL	BS
10	0	2	3	1	24	12

BL= 10-5=5
BL= 5+5=10
BL=10+10=20

BS= 5-0=5
BS= 5+5=10



The Dump truck problem



The Dump truck problem

Clock t	LQ(t)	L(t)	WQ(t)	W(t)	Loader queue	Weigh queue	FEL	B_L	B_S
0	3	2	0	1	DT4 DT5 DT6		(EL,5,DT3) (EL,10,DT2) (EL,12,DT1)	0	0
5	2	2	1	1	DT5 DT6	DT3	(EL,10,DT2) (EL,5 + 5 ,DT4) (EW,12,DT1)	10	5
10	1	2	2	1	DT6	DT3 DT2	(EL,10,DT4) (EW,12,DT1) (EL,10+10,DT5)	20	10
10	0	2	3	1		DT3 DT2 DT4	(EW,12,DT1) (EL,20,DT5) (EL,10+15,DT6)	20	10
12	0	2	2	1		DT2 DT4	(EL,20,DT5) (EW,12+12,DT3) (EL,25,DT6) (ALQ,12+60,DT1)	24	12
20	0	1	3	1		DT2 DT4 DT5	(EW,24,DT3) (EL,25,DT6) (ALQ,72,DT1)	40	20
24	0	1	2	1		DT4 DT5	(EL,25,DT6) (EW,24+12,DT2) (ALQ,72,DT1) (ALQ,24+100,DT3)	44	24

The Dump truck problem

- **Average Loader Utilization = BL/ total number of loaders/total time**
- **44 / 2 /24= 0.92**

- **Average Scale Utilization =BS/ Total time =24/24 = 1.00**

Home Assignment

- Use all the numbers given in the distribution of loading time, weighing time and travel time and then stop the simulation.
- **Calculate total busy time of both loaders, the scale, average loader and scale utilization.**

The Newspaper Seller‘s Problem

- A classical inventory problem concerns the purchase and sale of newspapers. The paper seller buys the papers for 33 cents each and sells them for 50 cents each. Newspapers not sold at the end of the day are sold as scrap for 5 cents each. Newspapers can be purchased in bundles of 10. Thus, the paper seller can buy 50, 60, and so on. The salvage value of scrap papers is 5 cents each.
- There are three types of Newsday‘s, good, fair, and poor, with probabilities of 0.35, 0.45, and 0.25, respectively. The distribution of papers demanded on each of these days is given in table 2.15. The problem is to determine the optimal number of papers the newspaper seller should purchase. This will be accomplished by simulating demands for 10 days and recording profits from sales each day. Find the optimal number of newspaper the newsstand should purchase.

The Newspaper Seller's Problem

- Distribution of newspapers demanded on each of these days is:

Demand	Good	Fair	Poor
40	0.03	0.10	0.44
50	0.05	0.18	0.22
60	0.15	0.40	0.16
70	0.20	0.20	0.12
80	0.35	0.08	0.06
90	0.15	0.04	0.00
100	0.07	0.00	0.00

- Random digits for types of news day
- 58, 17, 21, 45, 43, 36, 27, 73, 86, 19
- Random digits for demand
- 93, 63, 31, 19, 91, 75, 84, 37, 23, 02
- Assume the newsstand buy 70 newspapers each day.

The Newspaper Seller's Problem

Type for newsday	Probability	Cumulative Probability	Random digit assignment
Good	0.35	0.35	00-35
Fair	0.45	0.80	36-80
Poor	0.20	1.00	81-00

Random digit assignment for type of Newsday

Random digits for types of news day
58, 17, 21, 45, 43, 36, 27, 73, 86, 19

The Newspaper Seller's Problem

Random digit assignment for Newspaper demanded

Demand	Probability			Cumulative prob			RDA		
	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor
40	0.03	0.10	0.44	0.03	0.1	0.44	0-3	0-10	0-44
50	0.05	0.18	0.22	0.08	0.28	0.66	4-8	11-28	45-66
60	0.15	0.40	0.16	0.23	0.68	0.82	9-23	29-68	67-82
70	0.20	0.20	0.12	0.43	0.88	0.94	24-43	69-88	83-94
80	0.35	0.08	0.06	0.78	0.96	1	44-78	89-96	95-00
90	0.15	0.04	0.00	0.93	1	1	79-93	97-00	-
100	0.07	0.00	0.00	1	1	1	94-00	-	-

Random digits for demand
93, 63, 31, 19, 91, 75, 84, 37, 23, 02

The Newspaper Seller's Problem

Profit= (revenue from sales) –(cost of newspapers) – (Lost profit from excess demand) +(salvage from sale of scrap)

Day	Type of news day	Demand	Revenue from sales	Lost profit from excess demand	Salvage from sale of scrap	Daily profit
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

The Newspaper Seller‘s Problem

Profit= (revenue from sales) –(cost of newspapers) – (Lost profit from excess demand) +(salvage from sale of scrap)

Profit= 35 -(70x0.33)- 1.7 +0 = 10.20

Day	Type of news day	Demand	Revenue from sales	Lost profit from excess demand	Salvage from sale of scrap	Daily profit
1	Fair	80	70 x 0.5=35	10 x 0.17 =1.7	--------	10.20
2	Good	80				
3	Good	70				
4	Fair	50				
5	Fair	80				
6	Fair	70				
7	Good	90				
8	Fair	60				
9	Poor	40				
10	Good	40				

The Newspaper Seller's Problem

Profit= 35 -(70x0.33)-0 +0 = 11.9

Day	Type of news day	Demand	Revenue from sales	Lost profit from excess demand	Salvage from sale of scrap	Dai[illegible]ofit
1	Fair	80	70 x 0.5=35	10 x 0.17 =1.7	--------	10.20
2	Good	80	35	1.7	-----	10.20
3	Good	70	35	----	-------	11.9
4	Fair	50	25	-----	1.00	2.9
5	Fair	80	35	1.5	------	10.20
6	Fair	70	35	-----	-------	11.9
7	Good	90	35	3.4	------	8.5
8	Fair	60	30	-----	0.5	7.4
9	Poor	40	20	------	1.5	-1.6
10	Good	40	20	-------	1.5	-1.6
	Total		305	8.5	4.5	70

Pro= 25-(70x0.33)-0 +1 = 2.9

Pro= 35-(70x0.33)-3.4 +0 = 2.9

- Home Assignment

The Newspaper Seller‘s Problem

- A classical inventory problem concerns the purchase and sale of newspapers. The paper seller buys the papers for Rs. 20 each and sells them for Rs. 30 each. Newspapers not sold at the end of the day are sold as scrap for Rs. 5 each. Newspapers can be purchased in bundles of 10. Thus, the paper seller can buy 50, 60, and so on.
- There are three types of Newsday‘s, good, fair, and poor, with probabilities of 0.35, 0.45, and 0.25, respectively. The distribution of papers demanded on each of these days is given in table 2.15. The problem is to determine the optimal number of papers the newspaper seller should purchase. This will be accomplished by simulating demands for 15 days and recording profits from sales each day.

The Newspaper Seller‘s Problem

- Distribution of newspapers demanded on each of these days is:

Demand	Good	Fair	Poor
40	0.03	0.10	0.44
50	0.05	0.18	0.22
60	0.15	0.40	0.16
70	0.20	0.20	0.12
80	0.35	0.08	0.06
90	0.15	0.04	0.00
100	0.07	0.00	0.00

- Random digits for types of news day
- 36, 27, 73, 86, 19, 58, 17, 21, 45, 43, 23, 42, 39, 68, 77
- Random digits for demand
- 93, 63, 31, 19, 91, 75, 84, 37, 23, 02, 8, 23, 44, 72, 52
- Assume the newsstand buy 60 newspapers each day. Simulate the total profit for 15 days.

The reliability Problem

- A milling machine has three different bearings that fail in service. The distribution of the life of each bearing is identical, as shown in Table 2.22. When a bearing fails, the mill stops, a repairperson is called, and a new bearing is installed. The delay time of the repairperson's arriving at the milling machine is also a random variable having the distribution given in Table 2.23. Downtime for the mill is estimated at $10 per minute. The direct on-site cost of the repairperson is $30 per hour. It takes 20 minutes to change one bearing, 30 minutes to change two bearings, and 40 minutes to change three bearings. A proposal has been made to replace all three bearings whenever a bearing fails. Management needs an evaluation of the proposal. The total cost per 10,000 bearing-hours will be used as the measure of performance.

The reliability Problem

Distribution of bearing life

Bearing life	Probability
1000	0.10
1100	0.13
1200	0.25
1300	0.13
1400	0.09
1500	0.12
1600	0.02
1700	0.06
1800	0.05
1900	0.05

Delay Distribution table

Delay time	Probability
5	0.60
10	0.30
15	0.10

The reliability Problem

Bearing Life Time Random Digit

Bearing 1	Bearing 2	Bearing 3
67	70	76
8	43	65
49	86	61
84	93	96
44	81	65
30	44	56
10	19	11
63	51	86

The reliability Problem

Bearing Life Distribution

Bearing life	Probability	Cumulative Probability	RDA
1000	0.10	0.1	0-10
1100	0.13	0.23	11-23
1200	0.25	0.48	24-48
1300	0.13	0.61	49-61
1400	0.09	0.7	62-70
1500	0.12	0.82	71-82
1600	0.02	0.84	83-84
1700	0.06	0.9	85-90
1800	0.05	0.95	91-95
1900	0.05	1	96-00

Delay Time Distribution

Delay time	Probability	Cumulative Probability	RDA
5	0.60	0.6	1-6
10	0.30	0.9	7-9
15	0.10	1	-

The reliability Problem

Bearing Simulation

	Bearing 1		Bearing 2		Bearing 3		First Failure	Random Digit	Delay
	RD	Life(hrs)	RD	Life(hrs)	RD	Life(hrs)			
1	67	1400	70	1400	76	1500	1400	3	5
2	8	1000	43	1200	65	1400	1000	5	5
3	49	1300	86	1700	61	1300	1300	7	10
4	84	1600	93	1800	96	1900	1600	1	5
5	44	1200	81	1500	65	1400	1200	4	5
6	30	1200	44	1200	56	1300	1200	3	5
7	10	1100	19	1100	11	1100	1100	7	10
8	63	1400	51	1300	86	1700	1300	8	10
							10,100		55

Delay Random Digits : 3, 5, 7, 1, 4, 3, 7, 8

The reliability Problem

- **Data given in the problem**
- Cost of each bearing = $32
- Cost of delay time/ downtime = $10
- Cost of repair person = $ 30/hour
- It takes 20 minutes to change one bearing, 30 minutes to change two bearings and 40 minutes to change three bearings.
- It will be assumed in this example that the times are never exactly the same and thus no more than one bearing is changed at any breakdown.

The reliability Problem

- Cost of bearing = (8 * 3) * 32 = $768
- Cost of delay time = 3* 55 * 10 = $1650
- Cost of down time during repair= (8 * 3) * 20min/b * 10 = 4800
- Cost of mechanics= ((8 * 3) * 20min/b * 30)/60 = 240

- **Total cost = Cost of bearing + Cost of delay time + Cost of down time during repair + Cost of mechanics**
- **Total Cost = 768 + 1650 + 4800 + 240 = $6358**

The reliability Problem

- **Total life of the bearings = 10100 * 3 = 30300 / 10000 hours= 3.03**
- **Total cost 10,000 bearing hours = 6358 / 3.03 = $2098.35**

Home Assignment

- For the first set of bearings, the earliest failure is at 1 ,000 hours. All three bearings are replaced at that time, even though the remaining bearings had more life in them. The total cost per 10,000 bearing-hours will be used as the measure of performance.

	Bearing 1 Life (Hours)	Bearing 2 Life (Hours)	Bearing 3 Life (Hours)	First Failure (Hours)	Delay (Minutes)
1	1,700	1,100	1,000	1,000	10
2	1,000	1,800	1,200	1,000	5
3	1,500	1,700	1,300	1,300	5
4	1,300	1,100	1,800	1,100	5
5	1,200	1,100	1,300	1,100	5
6	1,000	1,200	1,200	1,000	10
7	1,500	1,700	1,200	1,200	5
8	1,300	1,700	1,000	1,000	10
9	1,800	1,200	1,100	1,100	15
10	1,300	1,300	1,100	1,100	5
11	1,400	1,300	1,900	1,300	10
12	1,500	1,300	1,400	1,300	5
13	1,500	1,800	1,200	1,200	10
14	1,000	1,900	1,400	1,000	5
15	1,300	1,700	1,700	1,300	5
Total					110