The Newspaper Seller's Problem

Problem formulation

- A classic example of a decision-making problem under uncertainty.
- The newspaper seller buys the newspapers for **33 cents**, and sells them for **50 cents**, with profits equal to **17 each**.
- At the end of the day the remaining newspapers are sold for **5 cents** each as scrap.
- The newspapers can be purchased as bundles, that is the seller can buy 10, 20, 30, etc. from these newspapers

Cont.

- The type of news is one important factor in this process
  - Good news means people are more interested in buying newspapers, and poor news means people are not interested much in reading the newspaper.
- if you know that the distribution of the news type is 0.35, 0.45, and 0.20 for good, fair, and poor news, respectively.
  - Find the best number of newspapers to buy to maximize the profits

Distributions

- The news type distribution

Type of Newsday	*Probability*	*Cumulative Probability*	*Random-Digit Assignment*
Good	0.35		
Fair	0.45		
Poor	0.20		

- The demand distribution for each news type

	Demand Probability Distribution		
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

Cumulative

Type of Newsday	*Probability*	*Cumulative Probability*	*Random-Digit Assignment*
Good	0.35	0.35	01–35
Fair	0.45	0.80	36–80
Poor	0.20	1.00	81–00

	Cumulative Distribution			*Random-Digit Assignment*		
Demand	*Good*	*Fair*	*Poor*	*Good*	*Fair*	*Poor*
40	0.03	0.10	0.44	01–03	01–10	01–44
50	0.08	0.28	0.66	04–08	11–28	45–66
60	0.23	0.68	0.82	09–23	29–68	67–82
70	0.43	0.88	0.94	24–43	69–88	83–94
80	0.78	0.96	1.00	44–78	89–96	95–00
90	0.93	1.00		79–93	97–00	
100	1.00			94–00		

Profits calculation

- The profits from selling newspapers can be expressed in the following equation

$$Profit = Revenue - Cost + Salvage - Lost\ Profit$$

1. $Revenue$: number of sold newspapers * sell price
2. $Cost$: number of purchased papers * cost of each paper
3. $Salvage$: number of scrap papers * price of scrap paper
4. $Lost\ Profits$: The number of over-demanded papers * profit from each paper

Simulation

- We will simulate the process for 20 days starting with 70 newspapers bought by the newspaper's man
  - Another run will be with 80 papers
  - Another with 100
  - Another with 20
  - Compare to see which number of newspapers should be bought to provide the highest profits
- Each simulation can be run (repeated several times, e.g.,10 times) and take the average profits for each number of bought papers

Simulation table

- We start by creating random numbers for the news type and demand

Day	Random Digits for Type of Newsday	Type of Newsday	Random Digits for Demand	Demand	Revenue from Sales	Lost Profit from Excess Demand	Salvage from Sale of Scrap	Daily Profit
1	94		80					
2	77		20					
3	49		15					
4	45		88					
5	43		98					

Simulation table

- Select the expected type of news from its distribution

Day	Random Digits for Type of Newsday	Type of Newsday	Random Digits for Demand
1	94		80
2	77		20
3	49		15
4	45		88
5	43		98

Type of Newsday	Probability	Cumulative Probability	Random-Digit Assignment
Good	0.35	0.35	01–35
Fair	0.45	0.80	36–80
Poor	0.20	1.00	81–00

Simulation table

- The demand amount depends upon its distribution, based on the news type

Day	Random Digits for Type of Newsday	Type of Newsday	Random Digits for Demand	Demand
1	94	Poor	80	
2	77	Fair	20	
3	49	Fair	15	
4	45	Fair	88	
5	43	Fair	98	

	Cumulative Distribution			Random-Digit Assignment		
Demand	Good	Fair	Poor	Good	Fair	Poor
40	0.03	0.10	0.44	01–03	01–10	01–44
50	0.08	0.28	0.66	04–08	11–28	45–66
60	0.23	0.68	0.82	09–23	29–68	67–82
70	0.43	0.88	0.94	24–43	69–88	83–94
80	0.78	0.96	1.00	44–78	89–96	95–00
90	0.93	1.00	1.00	79–93	97–00	
100	1.00	1.00	1.00	94–00		

Simulation table

- it is the value that corresponds to the interval 46-82 of the poor column

Day	Random Digits for Type of Newsday	Type of Newsday	Random Digits for Demand	Demand
1	94	Poor	80	
2	77	Fair	20	
3	49	Fair	15	
4	45	Fair	88	
5	43	Fair	98	

	Cumulative Distribution			Random-Digit Assignment		
Demand	Good	Fair	Poor	Good	Fair	Poor
40	0.03	0.10	0.44	01–03	01–10	01–44
50	0.08	0.28	0.66	04–08	11–28	45–66
60	0.23	0.68	0.82	09–23	29–68	67–82
70	0.43	0.88	0.94	24–43	69–88	83–94
80	0.78	0.96	1.00	44–78	89–96	95–00
90	0.93	1.00	1.00	79–93	97–00	
100	1.00	1.00	1.00	94–00		

Simulation table

70 bought – 60 sold = 10 remaining (scrap)
10 * 0.05 = 0.5$

This comes from the equation earlier
60 * 50 = 300 = 30$

Day	Random Digits for Type of Newsday	Type of Newsday	Random Digits for Demand	Demand	Revenue from Sales	Lost Profit from Excess Demand	Salvage from Sale of Scrap	Daily Profit
1	94	Poor	80	60	$30.00	–	$0.50	$7.40
2	77	Fair	20	50				
3	49	Fair	15	50				
4	45	Fair	88	70				
5	43	Fair	98	90				

daily profits = 30$ – (70 * 33)$ + 0.5$
=30$ – 23.1$ + 0.5$ = 7.4$

Simulation table

- We complete the same. Note the difference between day 4 and day 5 => same revenue from sales. However, cause at day 5 we missed some profits, this caused the daily profit to decrease

Day	Random Digits for Type of Newsday	Type of Newsday	Random Digits for Demand	Demand	Revenue from Sales	Lost Profit from Excess Demand	Salvage from Sale of Scrap	Daily Profit
1	94	Poor	80	60	$30.00	–	$0.50	$7.40
2	77	Fair	20	50	25.00	–	1.00	2.90
3	49	Fair	15	50	25.00	–	1.00	2.90
4	45	Fair	88	70	35.00	–	–	11.90
5	43	Fair	98	90	35.00	$3.40	–	8.50

Demand greater than supply

Simulation table

- This process continues till the end of the simulation, then we calculate the total profits

$$TotalProfit = Total\ Revenue - TotalCost + TotalSalvage - TotalLost\ Profit$$

Day	Random Digits for Type of Newsday	Type of Newsday	Random Digits for Demand	Demand	Revenue from Sales	Lost Profit from Excess Demand	Salvage from Sale of Scrap	Daily Profit
20	78	Fair	96	80	35.00	1.70	–	10.20
					$645.00	$13.60	$5.50	$174.90

$$Total\ profits = 645\$ - (70 * 0.33 * 20)\$ + 5.5\$ - 13.6\$$$
$$= 645\$ - 462\$ + 5.5\$ - 13.6\$$$
$$= 174.9\$$$

More ideas

- We can plot the daily profits to see the whole performance
  - This plot for another run for the simulation, using the same parameters