Sunday Newspaper Decision - Prof. Richard B. Goldstein

Sunday papers cost the retailer $1.00 each and sell for $2.00. The unsold newspapers have a salvage value of $0.40 and unmet demand has a hidden cost of $0.20 per customer. The retailer can stock 100, 125, or 150 Sunday papers and the demand can be 100, 125, or 150.

Decision Table:

Supply = Demand or (S=D) Profit = (2 – 1)*D = D

Supply > Demand Profit = (2 – 1)*D + (0.40 – 1)*(S – D) = 1.6*D - 0.6*S

Demand > Supply Profit = (2 – 1)*S - 0.2*(D – S) = 1.2*S – 0.2*D

		DEMAND		
SUPPLY		100	125	150
	100	100	95	90
	125	85	125	120
	150	70	110	150
	Prob.	0.2	0.3	0.5

STRATEGIES

Optimist Supply Value (uses maximax strategy)
100 100
125 125
150 150 ← Optimist's Choice

Pessimist Supply Value (uses maximin strategy)
100 90 ← Pessimist's Choice
125 85
150 70

Hurwicz Let α = level of optimism from 0 to 1
Value = Pessimist Value + (Optimist Value – Pessimist Value)*α

Example α = 0.3

α = 0.3 Supply Value
100 90 + (100 - 90)*0.3 = 93
125 85 + (125 – 85)*0.3 = 97 ← Best Choice
150 70 + (150 – 70)*0.3 = 94

Equally Likely

Equally Likely	Supply	Value	
	100	95	
	125	110	← Tied Choice
	150	110	← Tied Choice

Regret Table Regret = Best Value in Column – Current Entry

		DEMAND				
		100	125	150	row max	
SUPPLY	100	0	30	60	60	
	125	15	0	30	30	← Tied Choice
	150	30	15	0	30	← Tied Choice
	Prob.	0.2	0.3	0.5		

Expected Value

EV_{100} = 100*0.2 + 95*0.3 + 90*0.5 = 93.5
EV_{125} = 85*0.2 + 125*0.3 + 120*0.5 = 114.5
EV_{150} = 70*0.2 + 110*0.3 + 150*0.5 = 122.0 ← Best Choice

Expected Value with Perfect Information (EVwPI)

EVwPI = 100*0.2 + 125*0.3 + 150*0.5 = 132.5

Expected Value of Perfect Information (EVoPI or EVPI)

EVPI = 132.5 – 122.0 = 10.5

Expected Regrets / Opportunity Losses

EOL_{100} = 0*0.2 + 30*0.3 + 60*0.5 = 39.0
EOL_{125} = 15*0.2 + 0*0.3 + 30*0.5 = 18.0
EOL_{150} = 30*0.2 + 15*0.3 + 0*0.5 = 10.5 ← Best Choice

Note: 93.5 + 39.0 = 132.5
114.5 + 18.0 = 132.5 ← All add to the EVwPI
122.0 + 10.5 = 132.5

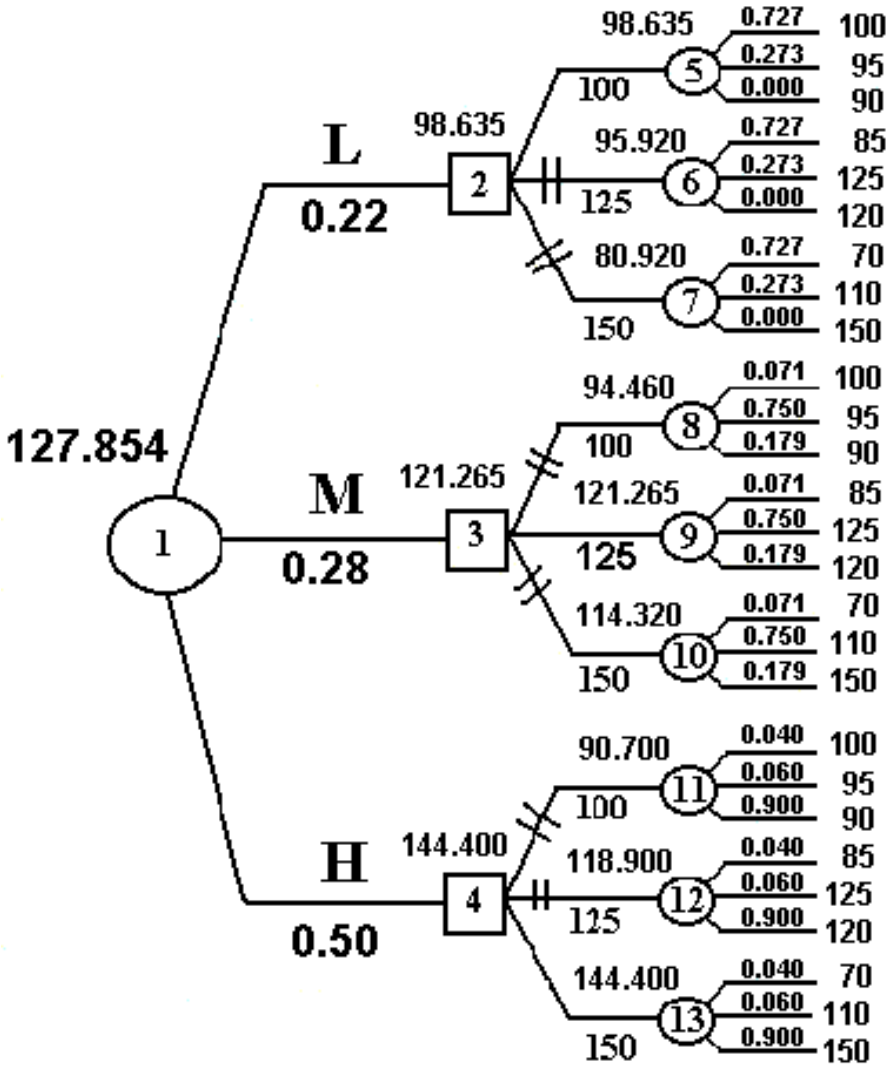
Conditional Probabilities:

A survey taken earlier in the week can result in the predicted demand of low (**L**), medium (**M**), or high (**H**). Based upon the experience of the past several weeks,

P(L | 100) = 0.8	**P(L | 125) = 0.2**	**P(L | 150) = 0.0**
P(M | 100) = 0.1	**P(M | 125) = 0.7**	**P(M | 150) = 0.1**
P(H | 100) = 0.1	**P(H | 125) = 0.1**	**P(H | 150) = 0.9**
1.0	**1.0**	**1.0**

Bayes' Probability Calculations:

Prior Probability	Conditional Probability	Joint Probability	Revised Probability
P(100) = 0.2	P(L | 100) = 0.8	P(L ∩ 100) = 0.16	P(100 | L) = 0.16/0.22 = 0.727
P(125) = 0.3	P(L | 125) = 0.2	P(L ∩ 125) = 0.06	P(125 | L) = 0.06/0.22 = 0.273
P(150) = 0.5	P(L | 150) = 0	P(L ∩ 150) = 0.00	P(150 | L) = 0.00/0.22 = 0.000
1.0		P(L) = 0.22	1.000
P(100) = 0.2	P(M | 100) = 0.1	P(M ∩ 100) = 0.02	P(100 | M) = 0.02/0.28 = 0.071
P(125) = 0.3	P(M | 125) = 0.7	P(M ∩ 125) = 0.21	P(125 | M) = 0.21/0.28 = 0.750
P(150) = 0.5	P(M | 150) = 0.1	P(M ∩ 150) = 0.05	P(150 | M) = 0.05/0.28 = 0.179
1.0		P(M) = 0.28	1.000
P(100) = 0.2	P(H | 100) = 0.1	P(H ∩ 100) = 0.02	P(100 | H) = 0.02/0.50 = 0.040
P(125) = 0.3	P(H | 125) = 0.1	P(H ∩ 125) = 0.03	P(125 | H) = 0.03/0.50 = 0.060
P(150) = 0.5	P(H | 150) = 0.9	P(H ∩ 150) = 0.45	P(150 | H) = 0.45/0.50 = 0.900
1.0		P(H) = 0.50	1.000



EV_{100} = 100*0.2 + 95*0.3 + 90*0.5 = 93.5
EV_{125} = 85*0.2 + 125*0.3 + 120*0.5 = 114.5
EV_{150} = 70*0.2 + 110*0.3 + 150*0.5 = 122.0 ← Best Choice

EV with uncertainty = 122.0
EVwPI = 100(0.2) + 125(0.3) + 150(0.5) = 132.5
EVPI = 132.5 – 122.0 = 10.5

Efficiency of Survey = $\frac{127.854 - 122}{132.5 - 122} = \frac{5.854}{10.5} = 0.557 = 55.7\%$