

## Supplement 1

### Operational Decision-Making Tools: Decision Analysis

S1-1. a. *Minimin*:

South Korea 15.2  
China 17.6  
Taiwan 14.9  
Poland 13.8  
Mexico 12.5 ← minimum  
**Select Mexico**

b. *Minimax*:

South Korea 21.7  
China 19.0 ← minimum  
Taiwan 19.2  
Poland 22.5  
Mexico 25.0  
**Select China**

c. *Hurwicz* ( $\alpha = 0.40$ ):

South Korea:  $15.2(0.40) + 21.7(0.60) = 19.10$   
China:  $17.6(0.40) + 19.0(0.60) = 18.44$   
Taiwan:  $14.9(0.40) + 19.2(0.60) = 17.48$  ← minimum  
Poland:  $13.8(0.40) + 22.5(0.60) = 19.02$   
Mexico:  $12.5(0.40) + 25.0(0.60) = 20.0$   
**Select Taiwan**

d. *Equal likelihood*:

South Korea:  
 $21.7(0.33) + 19.1(0.33) + 15.2(0.33) = 18.48$   
China:  $19.0(0.33) + 18.5(0.33) + 17.6(0.33) = 18.18$   
Taiwan:  $19.2(0.33) + 17.1(0.33) + 14.9(0.33) = 16.90$  ← minimum  
Poland:  $22.5(0.33) + 16.8(0.33) + 13.8(0.33) = 17.52$   
Mexico:  $25.0(0.33) + 21.2(0.33) + 12.5(0.33) = 19.37$   
**Select Taiwan**

S1-2.  $EV(\text{South Korea}) = 21.7(.30) + 19.1(.40) + 15.2(.30) = 18.71$

$EV(\text{China}) = 19.0(.30) + 18.5(.40) + 17.6(.30) = 18.38$

$EV(\text{Taiwan}) = 19.2(.30) + 17.1(.40) + 14.9(.30) = 17.07$  ← minimum

$EV(\text{Poland}) = 22.5(.30) + 16.8(.40) + 13.8(.30) = 17.61$

$EV(\text{Mexico}) = 25.0(.30) + 21.2(.40) + 12.5(.30) = 19.73$

**Select Taiwan**

# Full file at <https://FratStock.eu>

Expected value of perfect information =  $19(.30) + 16.8(.40) + 12.5(.30) = 16.17$

EVPI =  $16.17 - 17.07 = \$-0.9$  million

The EVPI is the maximum amount the *cost* of the facility could be reduced (.9 million) if perfect information can be obtained.

S1-3. a. *Maximax criteria:*

Office building 4.5 ← maximum

Parking lot 2.4

Warehouse 1.7

Shopping mall 3.6

Condominiums 3.2

**Select office building**

b. *Maximin criteria:*

Office building 0.5

Parking lot 1.5 ← maximum

Warehouse 1.0

Shopping mall 0.7

Condominiums 0.6

**Select parking lot**

c. *Equal likelihood:*

Office building:  $0.5(0.33) + 1.7(0.33) + 4.5(0.33) = 2.21$  ← maximum

Parking lot:  $1.5(0.33) + 1.9(0.33) + 2.4(0.33) = 1.91$

Warehouse:  $1.7(0.33) + 1.4(0.33) + 1.0(0.33) = 1.35$

Shopping mall:  $0.7(0.33) + 2.4(0.33) + 3.6(0.33) = 2.21$  ← maximum

Condominiums:  $3.2(0.33) + 1.5(0.33) + 0.6(0.33) = 1.75$

**Select office building or shopping mall**

d. *Hurwicz criteria ( $\alpha = 0.3$ ):*

Office building:  $4.5(0.3) + 0.5(0.7) = 1.70$

Parking lot:  $2.4(0.3) + 1.5(0.7) = 1.77$  ← maximum

Warehouse:  $1.7(0.3) + 1.0(0.7) = 1.21$

Shopping mall:  $3.6(0.3) + 0.7(0.7) = 1.57$

Condominiums:  $3.2(0.3) + 0.6(0.7) = 1.38$

**Select parking lot**

S1-4. a) EV (Office building) =  $.5(.50) + 1.7(.40) + 4.5(.10) = 1.38$

EV (Parking lot) =  $1.5(.50) + 1.9(.40) + 2.4(.10) = 1.75$

EV (Warehouse) =  $1.7(.50) + 1.4(.40) + 1.0(.10) = 1.51$

EV (Shopping mall) =  $0.7(.50) + 2.4(.40) + 3.6(.10) = 1.67$

EV (Condominiums) =  $3.2(.50) + 1.5(.40) + .06(.10) = 2.26$  ← maximum

**Select Condominium project**

b) EVPI = Expected value of perfect information – expected value without perfect information

=  $3.01 - 2.26 = \$0.75$  million

- S1-5. a. Maximax: Risk fund, maximax payoff = \$167,000  
 b. Maximin: Savings bond maximin payoff = \$30,000  
 c. Equal likelihood: Bond fund, maximum payoff = \$35,000
- S1-6. a. Best decision, given probabilities: Bond fund, maximum payoff = \$35,000  
 b. Expected value *given* perfect information  
 $= (5 \cdot 0.1) + (4 \cdot 0.2) + (4.2 \cdot 0.4) + (9.3 \cdot 0.2) + (16.7 \cdot 0.1) = \$6.51$   
 EVPI = \$6.51 - \$3.50 = \$3.01 or \$30,100
- S1-7. Since the payoff table includes “costs,” the decision criteria must be reversed.  
 a. Minimin: Philippines, minimum cost = \$170,000  
 b. Minimax: Brazil, minimum cost = \$570,000  
 c. Equal likelihood: Philippines, minimum cost = \$399,000  
 d. Minimax regret: Philippines, minimum regret = \$70,000
- S1-8 a. EV (China) = 5.328  
 EV (India) = 5.375  
 EV (Philippines) = 5.218  
 EV (Brazil) = 5.178 *Select*  
 EV (Mexico) = 5.202  
 b. EV *given* perfect information =  $=(1.7)(0.09) + (3.8)(0.27) + (5.4)(0.64) = \$4.635$   
 EVPI = \$5.178 - 4.365 = \$0.813 or \$813,000
- S1-9. Since this payoff table includes “losses,” the decision criteria must be reversed.  
 a. Minimin: Thailand, minimum loss = \$3 million  
 b. Minimax: India, minimum loss = \$14 million  
 c. Equal likelihood: India, minimum loss = \$8.91 million  
 d. Minimax regret: Philippines, minimum regret = \$2 million
- S1-10. EV (China) = \$10.91  
 EV (India) = 7.21 *Select*  
 EV (Thailand) = 9.77  
 EV (Philippines) = 7.54
- S1-11. a.

Product	Expected Value
Widget	$160,000(0.2) + 90,000(0.5) - 50,000(0.3) = \$62,000$
Hummer	$70,000(0.2) + 40,000(0.5) + 20,000(0.3) = \$40,000$
Nimnot	$45,000(0.2) + 35,000(0.5) + 30,000(0.3) = \$35,500$

The best option is to introduce the widget.

- b. EV given perfect information:  
 $160,000(0.2) + 90,000(0.5) + 30,000(0.3) = \$86,000.$

EV without perfect information: Widget at \$62,000.  
 Value of perfect information:  $\$86,000 - \$62,000 = \$24,000$

The company would consider this a maximum; since perfect information is rare, it would probably pay

# Full file at <https://FratStock.eu>

less than \$24,000.

- c. Maximax: Introduce widget, maximax payoff = \$160,000  
 Maximin: Introduce nimnot, maximin payoff = \$30,000.  
 Minimax regret: Introduce widget, Minimax regret = \$80,000  
 Equal likelihood: Introduce widget, maximum payoff = \$66,000

- S1-12. a. Maximax: Major physical revision, maximum payoff = \$972,000  
 b. Maximin: Paperback, maximum payoff = \$68,000  
 c. Equal likelihood: Major content revision, maximum payoff = \$419,430  
 d. Hurwicz: Major content revision, maximum payoff = \$273,900

S1-13.

Publication Decision	Expected Value
Paperback	\$216,290
Similar revision	386,340
Major content revision	468,780
Major physical revision	405,970

Best decision = major content revision

Overall “best” decision appears to be a “major content revision”

$$\begin{aligned} \text{EVPI} &= (.23)(68,000) + (.46)(515,000) + (.31)(972,000) - 468,780 \\ &= \$85,080 \end{aligned}$$

This is the maximum amount Wiley would pay an “expert” for additional information about the future competitive market.

- S1-14. a. Maximax: Singapore, maximum payoff = \$71 million  
 b. Maximin: Kaohsiung, maximum payoff = -\$15 million  
 c. Equal likelihood: Kaohsiung, maximum payoff = \$28.05 million  
 d. Hurwicz: Singapore, maximum payoff = \$37.8 million  
 e. Minimax regret: Singapore, minimum regret = \$9 million

S1-15. Expected value

Port	Expected Value
Hong Kong	\$22.99
Singapore	34.52
Shanghai	24.54
Busan	28.30
Kaohsiung	33.66

- a. Best decision = Singapore
- b. Singapore appears to be the best “overall” decision.

S1-16. Expected value

Lease Decision	Expected Value
1 – year	\$65,980
2 – year	103,010
3 – year	133,810

# Full file at <https://FratStock.eu>

4 – year	154,300
5 – year	114,210

$$S1-17. \text{EVPI} = (.17)(1,228,000) + (.34)(516,000) + (.49)(-551,000) - 154,300 \\ = \$237,740$$

This is the maximum amount the restaurant owner would pay an energy “expert” for additional information about future energy prices.

- S1-18. a. Maximax: Food court, maximum payoff = \$87,000  
 b. Maximin: Child care center, maximum payoff = \$17,000  
 c. Hurwicz: Lockers and showers, maximum payoff = \$32,250  
 d. Equal likelihood: Lockers and showers, maximum payoff = \$34,980

S1-19.

Service Facility	Expected Value
Child care center	\$30,560
Swimming pool	7,610
Lockers and showers	44,150
Food court	15,440
Spa	20,580

Best decision = Lockers and showers

S1-16. a. Payoff table:

	Demand				
	20 0.10	21 0.20	22 0.30	23 0.30	24 0.10
Stock (lb)					
20	20.00	20.00	20.00	20.00	20.00
21	18.50	21.00	21.00	21.00	21.00
22	17.00	19.50	22.00	22.00	22.00
23	15.50	18.00	20.50	23.00	23.00
24	14.00	16.50	19.00	21.50	24.00

$$\text{EV}(20) = \$20$$

$$\text{EV}(21) = 18.50(0.1) + 21(0.2) + 21(0.3) + 21(0.3) + 21(0.1) = \$20.75$$

$$\text{EV}(22) = 17(0.1) + 19.50(0.2) + 22(0.3) + 22(0.3) + 22(0.1) = \$21.00$$

$$\text{EV}(23) = 15.50(0.1) + 18(0.2) + 20.50(0.3) + 23(0.3) + 23(0.1) \\ = \$20.50$$

$$\text{EV}(24) = 14(0.1) + 16.50(0.2) + 19(0.3) + 21.50(0.3) + 24(0.1) \\ = \$19.25$$

Order 22 lb of apples for a profit of \$21.00.

- b. Maximax: Stock 24 lb for a maximax profit of \$24.00.  
 Maximin: Stock 20 lb for a maximin profit of \$20.00.

S1-21. a. Payoff table:

Stock (lb) (boxes)	Demand					
	25 0.10	26 0.15	27 0.30	28 0.20	29 0.15	30 0.10
25	50	50	50	50	50	50
26	49	52	52	52	52	52
27	48	51	54	54	54	54
28	47	50	53	56	56	56
29	46	49	52	55	58	58
30	45	48	51	54	57	60

$$EV(25) = 50(0.1) + 50(0.15) + 50(0.3) + 50(0.2) + 50(0.15) + 50(0.1) = \$50.00$$

$$EV(26) = 49(0.1) + 52(0.15) + 52(0.3) + 52(0.2) + 52(0.15) + 52(0.1) = \$51.70$$

$$EV(27) = 48(0.1) + 51(0.15) + 54(0.3) + 54(0.2) + 54(0.15) + 54(0.1) = \$52.95$$

$$EV(28) = 47(0.1) + 50(0.15) + 53(0.3) + 56(0.2) + 56(0.15) + 56(0.1) = \$53.30$$

$$EV(29) = 46(0.1) + 49(0.15) + 52(0.3) + 55(0.2) + 58(0.15) + 58(0.1) = \$53.05$$

$$EV(30) = 45(0.1) + 48(0.15) + 51(0.3) + 54(0.2) + 57(0.15) + 60(0.1) = \$52.35$$

Best decision: Stock 28 boxes, for a profit of \$53.30.

b. Expected value under uncertainty:

$$EV = 50(0.10) + 52(0.15) + 54(0.30) + 56(0.20) + 58(0.15) + 60(0.10) = \$54.90$$

$$EVPI = \$54.90 - \$53.30 = \$1.60$$

S1-22. a) Stock 25, maximum of minimum payoffs = \$50

b) Stock 30, maximum of maximum payoffs = \$60

c) 25:  $50(.4) + 50(.6) = 50$ ;      26:  $52(.4) + 49(.6) = 50.2$ ;      27:  $54(.4) + 48(.6) = 50.4$ ;  
 28:  $56(.4) + 47(.6) = 50.6$ ;    29:  $58(.4) + 46(.6) = 50.8$ ;    30:  $60(.4) + 45(.6) = 51$ ; stock 30 boxes.

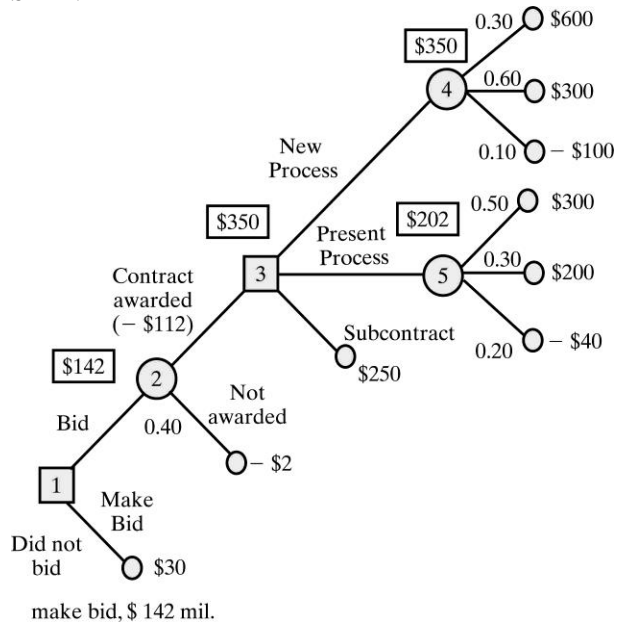
d) Stock 28 or 29 boxes; minimum regret = \$4.

S1-23.  $EV(\text{press}) = 40,000(.4) - 8,000(.6) = \$11,200$ ;

$EV(\text{lathe}) = 20,000(.4) + 4,000(.6) = \$10,400$ ;

$EV(\text{grinder}) = 12,000(.4) + 10,000(.6) = \$10,800$ ; Purchase press.

S1-24.



- S1-25. a. Maximax = Gordon  
b. Maximin = Jackson  
c. Hurwicz ( $\alpha = 0.25$ )

$$\text{Morris} = 4.4(0.25) + (-3.2)(0.75) = -\$1.3\text{M}$$

$$\text{O'Neil} = 6.3(0.25) + (-5.1)(0.75) = -\$2.3\text{M}$$

$$\text{Jackson} = 5.8(0.25) + (-2.7)(0.75) = -\$0.58\text{M}$$

$$\text{Gordon} = 9.6(0.25) + (-6.3)(0.75) = -\$2.33\text{M}$$

**Select Jackson**

- d. Equal likelihood

$$\text{Morris} = 4.4(0.33) + (1.3)(0.33) + (-3.2)(0.33) = \$.83\text{M}$$

$$\text{O'Neil} = 6.3(0.33) + (1.8)(0.33) + (-5.1)(0.33) = +\$0.99\text{M}$$

$$\text{Jackson} = 5.8(0.33) + (0.7)(0.33) + (-2.7)(0.33) = +\$1.254\text{M}$$

$$\text{Gordon} = 9.6(0.33) + (-1.6)(0.33) + (-6.3)(0.33) = \$.561\text{M}$$

**Select Jackson**

- e.  $\text{EV}(\text{Morris}) = (-3.2)(0.15) + (1.3)(0.55) + (4.4)(0.30) = \$1.56\text{M}$   
 $\text{EV}(\text{O'Neil}) = (-5.1)(0.18) + (1.8)(0.26) + (6.3)(0.56) = \$3.08\text{M}$   
 $\text{EV}(\text{Jackson}) = (-2.7)(0.21) + (0.7)(0.32) + (5.8)(0.47) = \$2.38\text{M}$   
 $\text{EV}(\text{Gordon}) = (-6.3)(0.30) + (-1.6)(0.25) + (9.6)(0.45) = \$2.03\text{M}$

**Select O'Neil.**

- S1-26. a. Maximax = Real Estate  
b. Maximin = Nursing

- c. Equal Likelihood: **select Real Estate**

$$\text{Graphic design} = \$170,000$$

$$\text{Nursing} = \$187,500$$

$$\text{Real Estate} = \mathbf{\$202,500}$$

$$\text{Medical Technology} = \$195,000$$

$$\text{Culinary technology} = \$170,000$$

$$\text{Computer information technology} = \$186,250$$

- d. Hurwicz ( $\alpha = 0.25$ ): **select Nursing**

$$\text{Graphic design} = \$141,250$$

$$\text{Nursing} = \mathbf{\$161,250}$$

$$\text{Real Estate} = \$158,750$$

$$\text{Medical Technology} = \$157,500$$

$$\text{Culinary technology} = \$136,250$$

$$\text{Computer information technology} = \$158,750$$

- S1-27.  $\text{EV}(\text{Graphic design}) = \$164,250$   
 $\text{EV}(\text{Nursing}) = \$183,500$   
 $\text{EV}(\text{Real Estate}) = \$174,400$   
 $\text{EV}(\text{Medical Technology}) = \mathbf{\$187,500}$   
 $\text{EV}(\text{Culinary technology}) = \$149,250$   
 $\text{EV}(\text{Computer information technology}) = \$174,750$

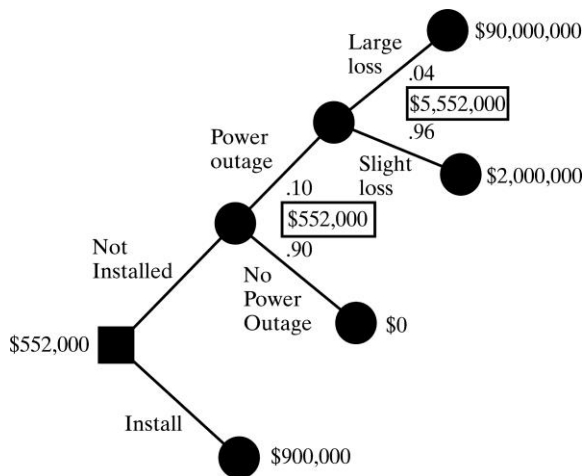


- S1-28. a. Maximax = Juan Ramon  
b. Maximin = Alan Rodriguez  
c. Equal likelihood:  
Garcia = 106.92  
**Ramon = 119.46**            **SELECT**  
Terry = 103.29  
Rodriguez = 96.03  
Washburn = 92.73  
d. Hurwicz:  
Garcia = 91.95  
**Ramon = 95.10**            **SELECT**  
Terry = 94.55  
Rodriguez = 95.75  
Washburn = 84.35
- S1-29. a. EV(Garcia) = 100.3  
**EV(Ramon) = 112.4**   **SELECT**  
EV(Terry) = 98.2  
EV(Rodriguez) = 91.6  
EV(Washburn) = 85.2  
b. Probably Terry; he seems to have the best tradeoff between low cost and wins. However, this is an objective opinion depending on the degree of risk the decision maker is willing to take on.  
c. EV(Garcia) = 109.71  
**EV(Ramon) = 109.74**            **SELECT**  
EV(Terry) = 106.81  
EV(Rodriguez) = 100.00  
EV(Washburn) = 93.48
- S1-30. a. Maximax = Hong Kong  
b. Maximin = Pusan  
c. Equal likelihood:  
Shanghai = \$0.44 billion  
Singapore = \$0.37 billion  
Pusan = \$0.43 billion  
Kaoshiung = \$0.41 billion  
**Hong Kong = \$0.47 billion**  
d. Hurwicz (alpha = .55):  
Shanghai = \$0.47 billion  
Singapore = \$0.41 billion  
Pusan = \$0.46 billion  
Kaoshiung = \$0.54 billion  
**Hong Kong = \$0.77 billion**
- S1-31. EV(Shanghai) = \$0.608 billion  
EV(Singapore) = \$0.606 billion  
EV(Pusan) = \$0.502 billion  
EV(Kaoshiung) = \$0.487 billion  
**EV(Hong Kong) = \$0.724 billion**

S1-32.  $EV(\text{snow shoveler}) = \$30(.12) + 60(.19) + 90(.24) + 120(.22) + 150(.13) + 180(.08) + 210(.02) = \$101.10$

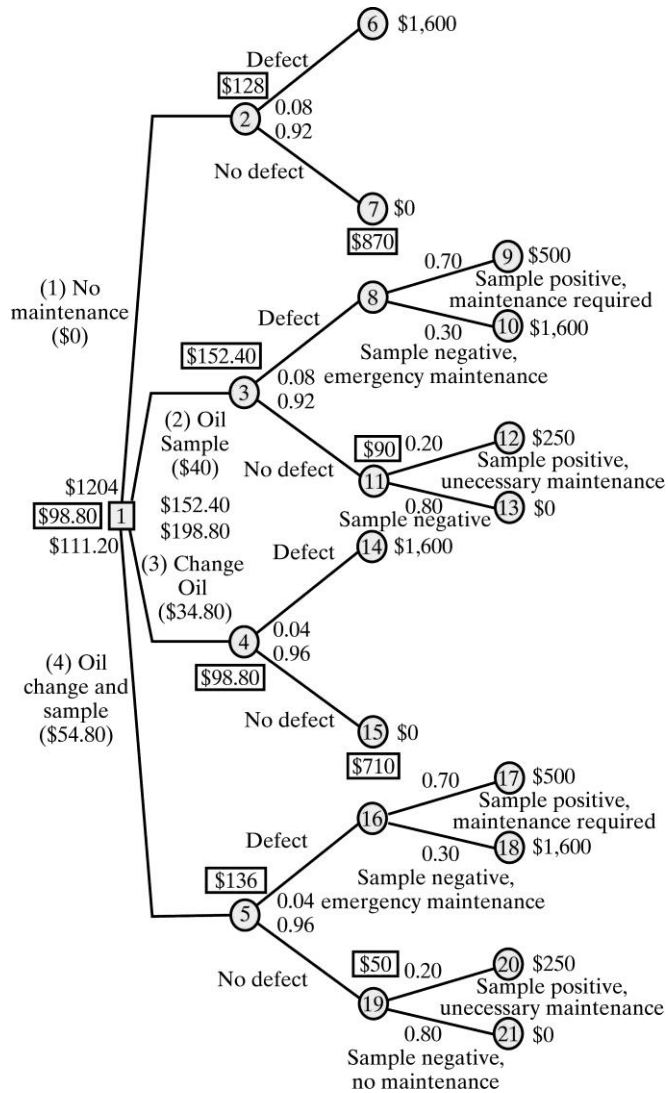
The cost of the snow blower (\$575) is much more than the annual cost of the snow shoveler, thus on the basis of one year the snow shoveler should not be purchased. However, the snow blower could be used for an extended period of time such that after approximately 6 years the cost of the snow blower would be recouped. Thus, the decision hinges on whether or not the decision maker thinks 6 years is too long to wait to recoup the cost of the snow blower.

S1-33.



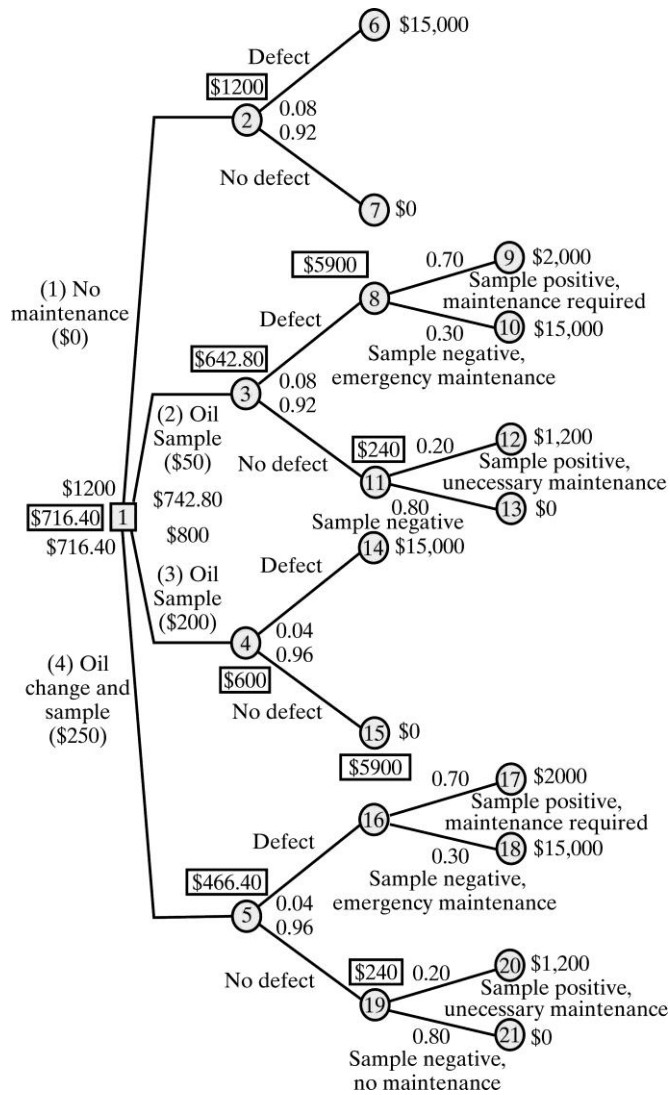
Since cost of installation (\$900,000) is greater than expected value of not installing (\$552,000), do not install an emergency power generator

S1-34.



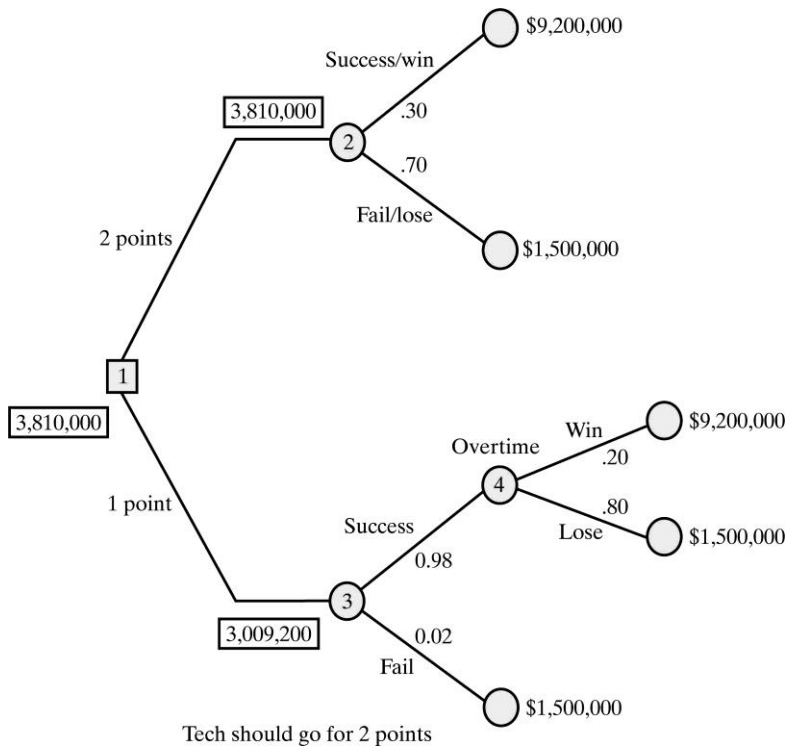
Select strategy 3; Change oil regularly; EV = \$98.80

S1-35.



Select Strategy 4; Change oil and sample; EV = \$716.40

S1-36. a.



b.  $.98[9.2x + 1.5(1-x)] + (.02)(1.5) = 3.810$

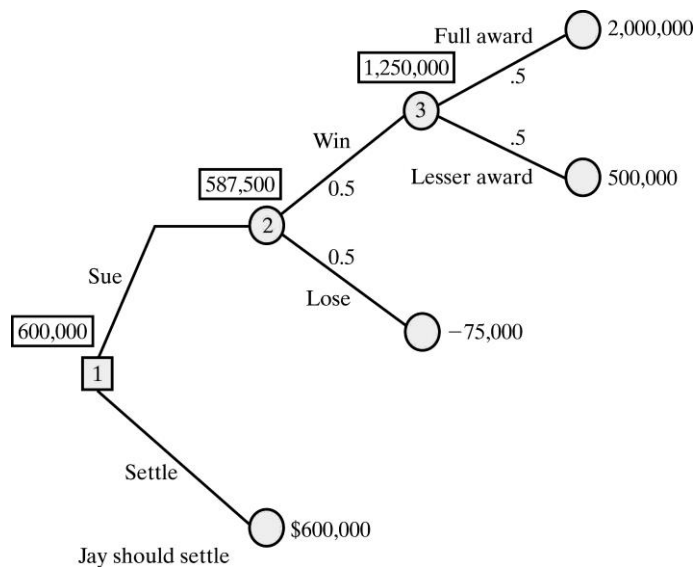
$$.98[7.7x + 1.5] + .030 = 3.810$$

$$7.546x + 1.47 + .030 = 3.810$$

$$7.546x = 2.31$$

$x = .306$  probability of winning in overtime

S1-37.



S1-38. The following table includes the medical costs for all the final nodes in the decision tree.

Expense	Plan 1	Plan 2	Plan 3
100	481	160	318
500	884	560	438
1,500	984	1,290	738
3,000	1,134	1,440	1,188
5,000	1,334	1,640	1,788
10,000	1,834	2,140	3,288

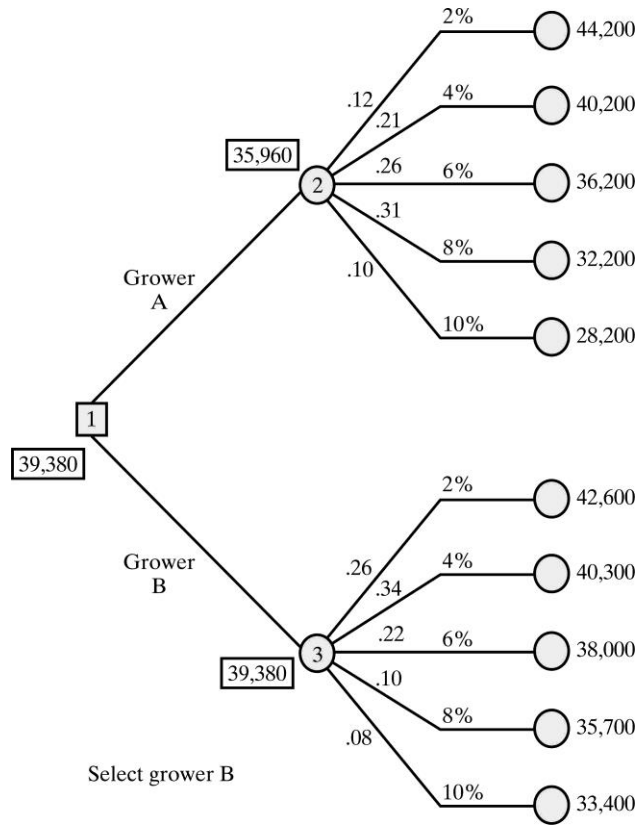
$E(1) = 954$

$E(2) = 976.5$

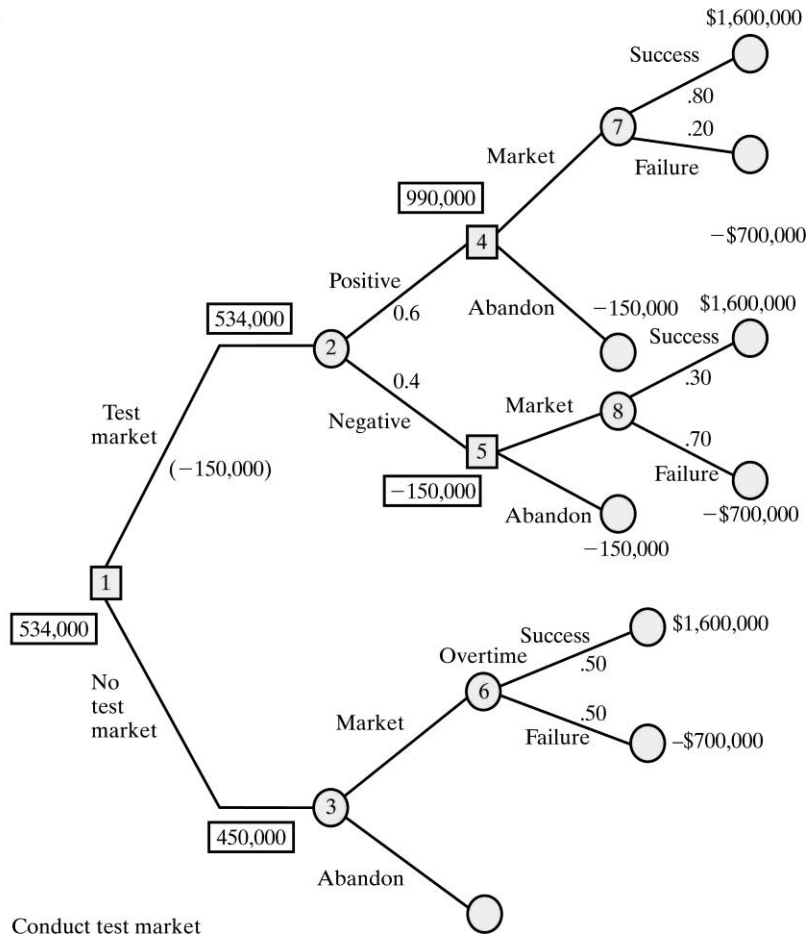
$E(3) = 810$

Select plan 3

S1-39.



S1-40.





## CASE S1.1: *Whither an MBA at Strutledge? -Continued*

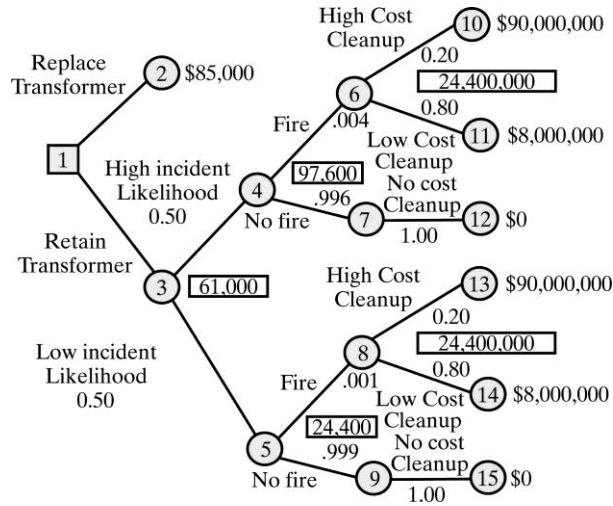
- a. Maximax: IT, maximum payoff = \$517,000
- b. Maximin: Health Administration, maximum payoff = -\$75,000
- c. Equal likelihood: Nursing, maximum payoff = \$114,500
- d. Hurwicz: Nursing, maximum payoff = \$86,000
- e. They do not have sufficient insight into the probability of the future success of the programs to indicate either optimism or pessimism; or for “political” reasons they feel it is imprudent to express a “preference.”
- f. Best decision = Nursing

Graduate Program	Expected Value
MBA	-27,470
Computer Science	-45,000
Information Technology	10,790
Nursing	<b>126,760</b>
Health Administration	124,250

- g. Nursing appears to be the best overall decision.
- h. Depends on student answer.

**CASE S1.2 : Transformer Replacement at Mountain State Electric Service**

The decision tree solution for this problem is shown below. The decision should be to retain the existing transformer; the cost of replacement (\$85,000) is greater than the cost of retention (\$61,000).



**CASE S1.3: Evaluating Projects at Nexcom Systems**

Project	EV
1	404,368
2	434,976
<b>3</b>	<b>442,891</b>
4	344,490
5	262,252

