Chapter Twelve: Decision Analysis

**PROBLEM SUMMARY**

1. Decision-making criteria without probabilities
2. Decision-making criteria without probabilities
3. Decision-making criteria without probabilities
4. Decision-making criteria without probabilities
5. Decision-making criteria without probabilities
6. Decision-making criteria without probabilities
7. Decision-making criteria without probabilities
8. Decision-making criteria without probabilities
9. Decision-making criteria without probabilities
10. Decision-making criteria without probabilities
11. Decision-making criteria without probabilities
12. Decision-making criteria without probabilities
13. Decision-making criteria without probabilities
14. Decision-making criteria without probabilities
15. Expected value
16. Expected value and opportunity loss
17. Expected value
18. Expected value and opportunity loss, EVPI
19. Expected value
20. Indifferent probability
21. Expected value (12–10)
22. Expected value (12–11)
23. Expected value, EVPI (12–12)
24. Expected value, EVPI (12–13)
25. Expected value (12–10)
26. Payoff table, expected value
27. Payoff table, expected value
28. Payoff table, expected value
29. Payoff table, expected value
30. Payoff table, decision making without probabilities
31. Expected value (12–14)
32. Decision tree (12–25)
33. Sequential decision tree
34. Sequential decision tree
35. Sequential decision tree
36. Bayesian analysis, EVSI (12–13)
37. Bayesian analysis, EVSI (12–18)
38. Bayesian analysis, EVSI (12–25)
39. Bayesian analysis
40. Sequential decision tree
41. Sequential decision tree
42. Sequential decision tree
43. Sequential decision tree
44. Sequential decision tree
45. EVSI, EVPI (12–44)
46. Sequential decision tree
47. Sequential decision tree
48. Sequential decision tree (12–40)
49. Sequential decision tree (12–14)
50. Bayesian analysis, EVSI
51. Utility
52. Expected value, utility

**PROBLEM SOLUTIONS**

1. a) Lease land; maximum payoff = $90,000
   b) Savings certificate; maximum of minimum payoffs = $10,000

2. a) Drive-in window; maximum payoff = $20,000
   b) Breakfast; maximum of minimum payoffs = $4,000

3. a)

<table>
<thead>
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<tbody>
<tr>
<td>Bellhop</td>
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<tr>
<td>Management</td>
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</table>

Choose bellhop job.

b) Bellhop: 120,000(.4) + 60,000(.6) = $84,000; management: 85,000(.4) + 85,000(.6) = $85,000; select management job.

c) Bellhop: 120,000(.5) + 60,000(.5) = $90,000; management: 85,000(.5) + 85,000(.5) = 85,000; select bellhop job.

4. a) Course III, maximax payoff = A
   b) Course I, maximin payoff = D
5. a) Plant corn; maximax payoff = $35,000
   b) Plant soybeans; maximin payoff = $20,000
   c) Plant corn; minimum regret = $12,000

d) Corn: $35,000(.3) + 8,000(.7) = $16,100;
   peanuts: 18,000(.3) + 12,000(.7) = $13,800;
   soybeans: 22,000(.3) + 20,000(.7) = $20,600;
   plant soybeans.

e) Corn: 35,000(.5) + 8,000(.5) = $21,500;
   peanuts: 18,000(.5) + 12,000(.5) = $15,000;
   soybeans: 22,000(.5) + 20,000(.5) = $21,000;
   plant corn.

6. Note that this payoff table is for costs.
   a) Product 3, minimin payoff = $3.00
   b) Product 3, minimax payoff = $6.50

7. a) Build shopping center; maximax payoff = $105,000
    b) Lease equipment; maximin payoff = $40,000
    c) Stable Increase

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<thead>
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<tr>
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<td>20,000</td>
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<tr>
<td>Lease</td>
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<td>0</td>
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</table>

Build shopping center.

d) Houses: $70,000(.2) + 30,000(.8) = $38,000;
   shopping center: $105,000(.2) + 20,000(.8) = $37,000;
   lease: $40,000(.2) + 40,000(.8) = $40,000; lease equipment.

e) Houses: 70,000(.5) + 30,000(.5) = $50,000;
   shopping center: 105,000(.5) + 20,000(.5) = $62,500;
   lease: 40,000(.5) + 40,000(.5) = $40,000; build shopping center.

8. a) Purchase motel; maximax payoff = $20,000
    b) Purchase theater; maximin payoff = $5,000
    c) Shortage Stable Surplus

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<tr>
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<tr>
<td>Restaurant</td>
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<tr>
<td>Theater</td>
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<td>9,000</td>
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</table>

Select either motel or restaurant (both have minimum regret values of $14,000).

d) Motel: 20,000(.4)—8,000(.6) = $3,200; restaurant:
   8,000(.4) + 2,000(.6) = $4,400; theater:
   6,000(.4) + 5,000(.6) = $5,400; select theater.

e) Motel: −8,000(.3) + 15,000(.3) + 20,000(.3) = $9,000;
   restaurant: 2,000(.3) + 8,000(.3) + 6,000(.3) = $5,333;
   theater:
   6,000(.3) + 6,000(.3) + 5,000(.3) = $5,666; select motel.

9. a) LaPlace criterion:
   EV(A|A) = 10.2(.33) + 7.3(.33) + 5.4(.33) = 7.6
   EV(G|GT) = 9.6(.33) + 8.1(.33) + 4.8(.33) = 7.4
   EV(A|N) = 12.5(.33) + 6.5(.33) + 3.2(.33) = 7.3
   Select Alabama vs. Auburn.

b) Select Alabama vs. Auburn; maximin payoff = 5.4

c) Select Army vs. Navy; maximax payoff = 12.5

10. a) Risk fund, maximax payoff = $147,000
    b) Savings bonds maximin payoff = $30,000
    c) Money market: 2(.2) + 3(1.20) + 4(2) + 4.3(.2) + 5(.2) = 36,000; stock growth: −3(.2) − 2(.2) + 2.5(.2) + 4(2) + 6(.2) = 15,000; bond:
   6(.2) + 5(.2) + 3(.2) + 2(.2) = 38,000; government:
   4(.2) + 3.6(.2) + 3.2(.2) + 3(.2) + 2.8(.2) = 33,200; risk:
   −9(.2) −4.5(.2) + 1.2(.2) + 8.3(.2) + 14.7(.2) = 21,400; savings bonds:
   3(2) + 3(.2) + 3.2(.2) + 3(.2) + 3.5(.2) = 32,200; select bond fund.

11. a) Pass, maximax payoff = 20 yd
    b) Either off tackle or option, maximin payoff = −2 yd
    c) Off tackle: 3(.2) −2(.2) + 9(.2) + 7(.2) −1(.2) = 3.2; option: −1(.2) + 8(.2) −2(.2) + 9(.2) + 12(.2) = 5.2; toss sweep: 6(.2) + 16(.2) −5(.2) + 3(.2) + 14(.2) = 6.8; draw:
   −2(.2) + 4(.2) + 3(.2) + 10(.2) −3(.2) = 2.4; pass: 8(.2) + 20(.2) + 12(.2) −7(.2) −8(.2) = 5.0; screen: −5(.2) −2(.2) + 8(.2) + 3(.2) + 16(.2) = 4.0;
   use toss sweep.

12. a) Minimin:
   South Korea 15.2
   China 17.6
   Taiwan 14.9
Philippines 13.8  
Mexico 12.5 ← minimum  
Select Mexico  

b) Minimax:  
South Korea 21.7  
China 19.0 ← minimum  
Taiwan 19.2  
Philippines 22.5  
Mexico 25.0  
Select China  

c) Hurwicz (α = .40):  
South Korea: 15.2(.40) + 21.7(.60) = 19.10  
China: 17.6(.40) + 19.0(.60) = 18.44  
Taiwan: 19.2(.40) + 17.1(.33) + 14.9(.33) = 16.90 ← minimum  
Philippines: 13.8(.40) + 22.5(.60) = 19.00  
Mexico: 12.5(.40) + 25.0(.60) = 20.0  
Select Taiwan  

d) Equal likelihood:  
South Korea: 21.7(.33) + 19.1(.33) + 15.2(.33) = 18.48  
China: 19.0(.33) + 18.5(.33) + 17.6(.33) = 18.18  
Taiwan: 19.2(.33) + 17.1(.33) + 14.9(.33) = 16.90 ← minimum  
Philippines: 22.5(.33) + 16.8(.33) + 13.8(.33) = 17.52  
Mexico: 25.0(.33) + 21.2(.33) + 12.5(.33) = 19.37  
Select Taiwan  

13. a) Maximax criteria:  
Office park 4.5 ← maximum  
Office building 2.4  
Warehouse 1.7  
Shopping center 3.6  
Condominiums 3.2  
Select office park  

b) Maximin criteria:  
Office park 0.5 ← maximum  
Office building 1.5 ← maximum  
Warehouse 1.0  
Shopping center 0.7  
Condominiums 0.6  
Select office building  

c) Equal likelihood  
Office park: 0.5(.33) + 1.7(.33) + 4.5(.33) = 2.21 ← maximum  
Office building: 1.5(.33) + 1.9(.33) + 2.4(.33) = 1.91  
Warehouse: 1.7(.33) + 1.4(.33) + 1.0(.33) = 1.35  
Shopping center: 0.7(.33) + 2.4(.33) + 3.6(.33) = 2.21 ← maximum  
Condominiums: 3.2(.33) + 1.5(.33) + 0.6(.33) = 1.75  

14. a) Maximax = Gordan  
b) Maximin = Johnson  
c) Hurwicz (α = .60)  
Byrd = 4.4(.6) + (–3.2)(.4) = $1.36M  
O’Neil = 6.3(.6) + (–5.1)(.4) = $1.74M  
Johnson = 5.8(.6) + (–2.7)(.4) = $2.40M  
Gordan = 9.6(.6) + (–6.3)(.4) = $3.24M  
Select Gordan  

d) Equal likelihood  
Byrd = 4.4(.33) + (1.3)(.33) + (–3.2)(.33) = +$0.83M  
O’Neil = 6.3(.33) + (1.8)(.33) + (–5.1)(.33) = +$0.99M  
Johnson = 5.8(.33) + (0.7)(.33) + (–2.7)(.33) = +$1.25M  
Gordan = 9.6(.33) + (–1.6)(.33) + (–6.3)(.33) = +$0.86M  
Select Johnson  

15. EV(office park) = 40,000(.4) – 8,000(.6) = $11,200;  
EV(lathe) = 20,000(.4) + 4,000(.6) = $10,400;  
EV(grinder) = 12,000(.4) + 10,000(.6) = $10,800; purchase press.  

16. a) EV(sunvisors) = –500(.3) –200(.15) + 1500(.55) = $645; EV(umbrellas) = 2,000(.3) + 0(.15) – 900(.55) = $105; carry sunvisors.  

b) Opportunity loss table:  

<table>
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<tr>
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<th>Rain</th>
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<th>Sunshine</th>
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<tr>
<td>Sunvisors</td>
<td>2,500</td>
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<td>0</td>
</tr>
<tr>
<td>Umbrellas</td>
<td>0</td>
<td>0</td>
<td>2,400</td>
</tr>
</tbody>
</table>

EOL(sunvisors) = 2,500(.3) + 200(.15) + 0 = $780; EOL(umbrellas) = 0 + 0 + 2,400(.55) = $1,320; select sunvisors since it has the minimum expected regret.  

17. EV (snow shoveler) = $30(.13) + 60(.18) + 90(.26) + 120(.23) + 150(.10) + 180(.07) + 210(.03) = $99.60  
The cost of the snow blower ($625) is much more than the annual cost of the snow shoveler, thus on the basis of one year the snow shoveler should be used. However, the snow blower could be used for an extended period of time such that after approximately six years the cost of the snow blower would be recouped. Thus, the decision hinges on weather or not the
decision maker thinks 6 years is too long to wait to recoup the cost of the snow blower.

18. a) EV(widget) = 120,000(.2) + 70,000(.7) - 30,000(.1) = $70,000; EV(hummer) = 60,000(.2) + 40,000(.7) + 20,000(.1) = $42,000; EV(nimnot) = 35,000(.2) + 30,000(.7) + 30,000(.1) = $31,000; introduce widget.

b) EOL(A) = 0 + 0 + 60,000(.1) = $6,000; EOL(B) = 60,000(.2) + 30,000(.7) + 10,000(.1) = $34,000; EOL(C) = 85,000(.2) + 40,000(.7) + 0 = $45,000; select A (widget).

c) Expected value given perfect information = 120,000(.2) + 70,000(.7) + 30,000(.1) = $76,000; EVPI = 76,000 - 70,000 = $6,000; the company would consider this a maximum, and since perfect information is rare, it would pay less than $6,000 probably.

19. EV(operate) = 120,000(.4) + 40,000(.2) + (-40,000)(.4) = $40,000; leasing = $40,000; if conservative, the firm should lease. Although the expected value for operating is the same as leasing, the lease agreement is not subject to uncertainty and thus does not contain the potential $40,000 loss. However, the risk taker might attempt the $120,000 gain.

20. To be indifferent, the expected value for the investments would equal each other: EV(stocks) = EV(bonds). Next, let the probability of good economic conditions equal p and the probability of bad conditions equal 1 - p:

\[
\begin{align*}
\text{EV(stocks)} &= 10,000(p) + 4,000(1-p) \\
\text{EV(bonds)} &= 7,000(p) + 2,000(1-p) \\
\text{EV(stocks)} &= \text{EV(bonds)} \\
10,000(p) + (-4,000) &+ 7,000(p) + 2,000(1-p) \\
10,000p - 4,000 + 4,000p &= 7,000p + 2,000 \\
9,000p &= 6,000 \\
p &= .667
\end{align*}
\]

Therefore, probability of good conditions = \( p = .667 \), probability of bad conditions = \( 1 - p = .333 \).

21. EV(money market) = 2(.2) + 3.1(.3) + 4(.3) + 4.3(.1) + 5(.1) = 34,600; EV(stock growth) = -3(.2) - 2(.3) + 2.5(.3) + 4(.1) + 6(.1) = 5,500; EV(bond) = 6(.2) + 5(.3) + 3(.3) + 3(.1) + 2(.1) = 41,000; EV(government) = 4(.2) + 3(.3) + 3(.3) + 3(.1) + 2.8(.1) = 34,200; EV(risk) = -9(.2) - 4(.3) + 1.2(.3) + 8.3(.1) + 14.7(.1) = -49,000; EV(savings bonds) = 3(.2) + 3(.3) + 3(.4) + 3.5(.1) + 31,500; purchase bond fund.

22. a) EV(off tackle) = 3(.4) - 2(.10) + 9(.20) + 7(.20) - 1(.10) = 4.10; EV(option) = -1(.4) + 8(.10) - 2(.20) + 9(.2) + 12(.10) = 3; EV(toss sweep) = 6(.4) + 16(.10) - 5(.20) + 3(.20) + 14(.10) = 5.0; EV(draw) = -2(.4) + 4(.10) + 3(.20) + 10(.20) - 3(.10) = 1.9; EV(pass) = 8(.4) + 20(.10) + 12(.20) - 7(.20) - 8(.10) = 5.4; EV(screen) = -5(.4) - 2(.10) + 8(.20) + 3(.20) + 16(.10) = 1.6; PASS is best, followed by toss sweep, off tackle, option, draw, and screen.

b) EV(off tackle) = 3(.10) - 2(.10) + 9(.10) + 7(.10) - 1(.60) = 1.1; EV(option) = -1(.10) + 8(.10) - 2(.10) + 9(.10) + 12(.60) = 8.6; EV(toss sweep) = 6(.10) + 16(.10) - 5(.10) + 3(.10) + 14(.60) = 10.4; EV(draw) = -2(.10) + 4(.10) + 3(.10) + 10(.10) - 3(.60) = -3; EV(pass) = 8(.10) + 20(.10) + 12(.10) - 7(.10) - 8(.60) = -1.5; EV(screen) = -5(.10) - 2(.10) + 8(.10) + 3(.10) + 16(.60) = 10.0; select toss sweep. Yes, it is likely Tech will make the first down.

23. EV (South Korea) = 21.7(.40) + 19.1(.5) + 15.2(.10) = 19.75
EV (China) = 19.0(.40) + 18.5(.50) + 17.6(.10) = 18.61
EV (Taiwan) = 19.2(.40) + 17.1(.50) + 14.9(.10) = 17.72
EV (Philippines) = 22.5(.40) + 16.8(.50) + 13.8(.10) = 18.78
EV (Mexico) = 25.0(.40) + 21.2(.50) + 12.5(.10) = 21.85
Select Taiwan

Expected value of perfect information = 19(.40) + 16.8(.50) + 12.5(.10) = 17.25
EVPI = 17.25 - 17.72 = $-0.47 million

The EVPI is the maximum amount the cost of the facility could be reduced ($0.47 million) if perfect information can be obtained.

24. a) EV (Office park) = .5(.50) + 1.7(.40) + 4.5(.10) = 1.38
EV (Office building) = 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 center) = 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
EVPI = $0.75 million

25. Using expected value; EV(compacts) = 300,000(0.6) + 150,000(0.4) = $240,000; EV(full-sized) = -100,000(0.6) + 600,000(0.4) = $180,000; EV(trucks) = 120,000(0.6) + 170,000(0.4) = $140,000; select the compact car dealership.

26. Payoff matrix:

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<tr>
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EV(20) = $20.00; EV(21) = 18.50(0.1) + 21.00(0.2) + 21.00(0.3) + 21.00(0.1) = $20.75; EV(22) = 17.00(0.1) + 19.50(0.2) + 22.00(0.3) + 22.00(0.1) = $21.00; EV(23) = 15.50(0.1) + 18.00(0.2) + 20.50(0.3) + 23.00(0.0) + 23.00(0.1) = $20.50; EV(24) = 14.00(0.1) + 16.50(0.2) + 19.00(0.3) + 21.50(0.3) + 24.00(0.1) = $19.25; stock 22 lb.

27. Revenue and cost data: sales revenue = $12.00/case; cost = $10/case; salvage for unsold cases = $2/case; shortage cost = $4/case

a) Payoff matrix:

<table>
<thead>
<tr>
<th>Demand</th>
<th>.10</th>
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b) EV(15) = 30(.2) + 26(.25) + 22(.4) + 18(.15) = $24.00; EV(16) = 22(.2) + 32(.25) + 28(.4) + 24(.15) = $27.20; EV(17) = 14(.2) + 24(.25) + 34(.4) + 30(.15) = $26.90; EV(18) = 6(.2) + 16(.25) + 26(.4) + 36(.15) = $21.00; stock 16 cases.

c) Opportunity loss table:

<table>
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<tr>
<th></th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
</tr>
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</table>
| EOL(15) = 0(.2) + 6(.25) + 12(.4) + 18(.15) = $9.00; EOL(16) = 8(.2) + 0(.25) + 6(.4) + 12(.15) = $5.80; EOL(17) = 16(.2) + 8(.25) + 0(.4) + 6(.15) = $6.10; EOL(18) = 24(.2) + 16(.25) + 8(.4) + 0(.15) = $12.00; stock 16 cases.

d) Expected value with perfect information = $30(.2) + 32(.25) + 34(.4) + 36(.15) = $33; EVPI = 33 – EV(16) = 33 – 27.20 = $5.80

28. a) Payoff matrix:

<table>
<thead>
<tr>
<th>Demand</th>
<th>.10</th>
<th>.15</th>
<th>.20</th>
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</tr>
<tr>
<td>27</td>
<td>48</td>
<td>51</td>
<td>54</td>
<td>54</td>
<td>54</td>
<td>54</td>
<td></td>
<td></td>
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<tr>
<td>28</td>
<td>47</td>
<td>50</td>
<td>53</td>
<td>56</td>
<td>56</td>
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<td></td>
</tr>
<tr>
<td>29</td>
<td>46</td>
<td>49</td>
<td>52</td>
<td>55</td>
<td>58</td>
<td>58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>45</td>
<td>48</td>
<td>51</td>
<td>54</td>
<td>57</td>
<td>60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b) EV(25) = 50(.10) + 50(.15) + 50(.30) + 50(.20) + 50(.15) + 50(.10) = 50.0; EV(26) = 49(.10) + 52(.15) + 52(.30) + 52(.20) + 52(.15) + 52(.10) = 51.7; EV(27) = 48(.10) + 51(.15) + 54(.30) + 54(.20) + 54(.15) + 54(.10) = 52.95; EV(28) = 47(.10) + 50(.15) + 53(.30) + 56(.20) + 56(.15) + 56(.10) = 53.30; EV(29) = 46(.10) + 49(.15) + 52(.30) + 55(.20) + 58(.15) + 58(.10) = 53.05; EV(30) = 45(.10) + 48(.15) + 51(.30) + 54(.20) + 57(.15) + 60(.10) = 52.35; since EV(28) = 53.30 is the maximum, 28 boxes of Christmas cards should be stocked.

c) Compute expected value under certainty: EV = 50(.10) + 52(.15) + 54(.30) + 56(.20) + 58(.15) + 60(.10) = $54.90; EVPI = 54.90 – 53.30 = $1.60

29. a) Payoff matrix:

<table>
<thead>
<tr>
<th>Demand</th>
<th>.05</th>
<th>.10</th>
<th>.15</th>
<th>.20</th>
<th>.25</th>
<th>.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock (dozens)</td>
<td>20</td>
<td>22</td>
<td>24</td>
<td>26</td>
<td>28</td>
<td>30</td>
</tr>
<tr>
<td>20</td>
<td>20.00</td>
<td>18.00</td>
<td>16.00</td>
<td>14.00</td>
<td>12.00</td>
<td>10.00</td>
</tr>
<tr>
<td>22</td>
<td>17.50</td>
<td>22.00</td>
<td>20.00</td>
<td>18.00</td>
<td>16.00</td>
<td>14.00</td>
</tr>
<tr>
<td>24</td>
<td>15.00</td>
<td>19.50</td>
<td>24.00</td>
<td>22.00</td>
<td>20.00</td>
<td>18.00</td>
</tr>
<tr>
<td>26</td>
<td>12.50</td>
<td>17.00</td>
<td>21.50</td>
<td>26.00</td>
<td>24.00</td>
<td>22.00</td>
</tr>
<tr>
<td>28</td>
<td>10.00</td>
<td>14.50</td>
<td>19.00</td>
<td>23.50</td>
<td>28.00</td>
<td>26.00</td>
</tr>
<tr>
<td>30</td>
<td>7.50</td>
<td>12.00</td>
<td>16.50</td>
<td>21.00</td>
<td>25.50</td>
<td>30.00</td>
</tr>
</tbody>
</table>
b) \[ EV(20) = 20.00(.05) + 18.00(.10) + 16.00(.25) + 14.00(.30) + 12.00(.20) + 10.00(.10) = \$14.40; \]
\[ EV(22) = 17.50(.05) + 22.00(.10) + 19.50(.10) + 24.00(.25) + 22.00(.30) + 20.00(.20) + 18.00(.10) = \$18.08; \]
\[ EV(24) = 15.00(.05) + 19.50(.10) + 24.00(.25) + 22.00(.30) + 20.00(.20) + 18.00(.10) = \$21.10; \]
\[ EV(26) = 12.50(.05) + 17.00(.10) + 21.50(.25) + 26.00(.30) + 24.00(.20) + 22.00(.10) = \$22.50; \]
\[ EV(28) = 10.00(.05) + 14.50(.10) + 19.00(.25) + 23.50(.30) + 28.00(.20) + 26.00(.10) = \$21.95; \]
\[ EV(30) = 7.50(.05) + 12.00(.10) + 16.50(.25) + 21.00(.30) + 25.50(.20) + 30.00(.10) = \$20.10; \]
since \( EV(26) = \$22.50 \) is the maximum, the green house owner should grow 26 dozen carnations.

c) Opportunity cost table:

<table>
<thead>
<tr>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>.05</td>
</tr>
<tr>
<td>.10</td>
</tr>
<tr>
<td>.25</td>
</tr>
<tr>
<td>.30</td>
</tr>
<tr>
<td>.20</td>
</tr>
<tr>
<td>.10</td>
</tr>
<tr>
<td>Stock (dozens)</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>22</td>
</tr>
<tr>
<td>24</td>
</tr>
<tr>
<td>26</td>
</tr>
<tr>
<td>28</td>
</tr>
<tr>
<td>30</td>
</tr>
</tbody>
</table>

\[ EOL(20) = 0(.05) + 4.00(.10) + 8.00(.25) + 12.00(.30) + 16.00(.20) + 20.00(.10) = \$11.20; \]
\[ EOL(22) = 2.50(.05) + 0(.10) + 4.00(.25) + 8.00(.30) + 12.00(.20) + 16.00(.10) = \$7.53; \]
\[ EOL(24) = 5.00(.05) + 2.50(.10) + 0(.25) + 4.00(.30) + 8.00(.20) + 12.00(.10) = \$4.50; \]
\[ EOL(26) = 7.50(.05) + 5.00(.10) + 2.50(.25) + 0(.30) + 4.00(.20) + 8.00(.10) = \$3.10; \]
\[ EOL(28) = 10.00(.05) + 7.50(.10) + 5.00(.25) + 2.50(.30) + 0(.20) + 4.00(.10) = \$3.65; \]
\[ EOL(30) = 12.50(.05) + 10.00(.10) + 7.50(.25) + 5.00(.30) + 2.50(.20) + 0(.10) = \$5.50; \]
since \( EOL(26) = \$3.10 \) is the minimum, 26 dozen carnations should be grown.

d) The expected value under certainty: \( EV = 20.00(.05) + 22.00(.10) + 24.00(.25) + 26.00(.30) + 28.00(.20) + 30.00(.10) = \$25.60; \)
\( EVPI = \$25.60 – 22.50 = \$3.10 \)

30. 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.
32. Select compact car.

33. Since cost of installation ($800,000) is greater than expected value of not installing ($495,000), do not install an emergency power generator.

34. Since cost of installation ($800,000) is greater than expected value of not installing ($495,000), do not install an emergency power generator.
35.

36. \( P(c) = \) probability of contract = .40; \( P(n) = \) probability of no contract = .60; \( P(f|c) = .70; P(u|c) = .30; \\
\( P(u|n) = .80; P(f|n) = .20 \)

\[
P(c|f) = \frac{P(f|c)P(c)}{P(f|c)P(c) + P(f|n)P(n)} \\
= \frac{(.70)(.40)}{(.70)(.40) + (.20)(.60)} = .70 \\
P(f) = P(f|c)P(c) + P(f|n)P(n) = (.70)(.40) + (.20)(.60) = .40 \\
P(n|f) = \frac{P(f|n)P(n)}{P(f|n)P(n) + P(f|c)P(c)} \\
= \frac{(.20)(.60)}{(.20)(.60) + (.70)(.40)} = .30 \\
P(n|u) = \frac{P(u|n)P(n)}{P(u|n)P(n) + P(u|c)P(c)} \\
= \frac{(.80)(.60)}{(.80)(.60) + (.30)(.40)} = .80 \\
P(u) = P(u|n)P(n) + P(u|c)P(c) = (.80)(.60) + (.30)(.40) = .60 \\
P(clu) = \frac{P(u|c)P(c)}{P(u|c)P(c) + P(u|n)P(n)} \\
= \frac{(.30)(.40)}{(.30)(.40) + (.80)(.60)} = .20
Decision strategy: If report is favorable, purchase a lathe. If report is unfavorable, purchase a grinder. EV (strategy) = $16,480; EVSI = EV with information − EV without information = $16,480 − 11,200 = $5,280

37. \( P(f) = \) favorable market conditions = .2; \( P(s) = \) stable market conditions = .7; \( P(u) = \) unfavorable market conditions = .1; \( P(\text{plf}) = .60; P(\text{nlf}) = .40; P(\text{pis}) = .30; P(\text{nus}) = .70; P(\text{plu}) = .10; P(\text{nlu}) = .90

<table>
<thead>
<tr>
<th>States of Nature</th>
<th>Prior Probabilities</th>
<th>Conditional Probabilities</th>
<th>( (2) \times (3) )</th>
<th>Posterior Probabilities</th>
<th>( (4) ÷ Σ(4) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Favorable</td>
<td>( P(f) = .2 )</td>
<td>( P(\text{plf}) = .60 )</td>
<td>.12</td>
<td>( P(\text{fp}) = .12/.34 = .353 )</td>
<td></td>
</tr>
<tr>
<td>Stable</td>
<td>( P(s) = .7 )</td>
<td>( P(\text{pis}) = .30 )</td>
<td>.21</td>
<td>( P(\text{sp}) = .21/.34 = .618 )</td>
<td></td>
</tr>
<tr>
<td>Unfavorable</td>
<td>( P(u) = .1 )</td>
<td>( P(\text{nus}) = .70 )</td>
<td>.01</td>
<td>( P(\text{pu}) = .01/.34 = .029 )</td>
<td></td>
</tr>
</tbody>
</table>

\( P(p) = .34 \)

Posterior probability table for a negative report:

<table>
<thead>
<tr>
<th>States of Nature</th>
<th>Prior Probabilities</th>
<th>Conditional Probabilities</th>
<th>( (2) \times (3) )</th>
<th>Posterior Probabilities</th>
<th>( (4) ÷ Σ(4) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Favorable</td>
<td>( P(f) = .2 )</td>
<td>( P(\text{nul}) = .40 )</td>
<td>.08</td>
<td>( P(\text{fn}) = .08/.66 = .121 )</td>
<td></td>
</tr>
<tr>
<td>Stable</td>
<td>( P(s) = .7 )</td>
<td>( P(\text{nus}) = .70 )</td>
<td>.49</td>
<td>( P(\text{sn}) = .49/.66 = .742 )</td>
<td></td>
</tr>
<tr>
<td>Unfavorable</td>
<td>( P(u) = .1 )</td>
<td>( P(\text{nus}) = .90 )</td>
<td>.09</td>
<td>( P(\text{nu}) = .09/.66 = .137 )</td>
<td></td>
</tr>
</tbody>
</table>

\( P(n) = .66 \)

\[ \$84,750 \]

\[ \$46,480 \]

\[ \$31,765 \]

\[ \$62,350 \]

\[ \$39,680 \]

\[ \$30,605 \]

\[ \$70,000 \]

\[ \$60,000 \]

\[ \$60,000 \]

\[ \$70,000 \]

\[ \$40,000 \]

\[ \$40,000 \]

\[ \$40,000 \]

\[ \$3,000 \]

\[ \$60,000 \]

\[ \$3,000 \]

\[ \$3,000 \]

\[ \$3,000 \]

\[ \$3,000 \]

\[ \$3,000 \]

\[ \$3,000 \]

\[ \$3,000 \]

\[ \$3,000 \]

Decision strategy: Produce the widget regardless of the report. EV(strategy) = $69,966; EVSI = EV with information − EV without information = $69,966 − $70,000 = 0. Additional information has no value, since the owner will produce the widget in either case.

38. Let \( s^- = \) shortage; \( s^+ = \) surplus; \( P(s^-) = .6; P(s^+) = .4. \) Let \( S^- = \) report of shortage; \( S^+ = \) report of surplus; \( P(S^-|s^-) = .90; P(S^+|s^-) = .10; P(S^+|s^+) = .70; P(S^-|s^+) = .30. \)
b. Expected value given perfect information = 
300,000(.6) + 600,000(4) = $420,000; EVPI = 
$420,000 - 240,000 = $180,000; EVSI = 
$102,094; efficiency = EVSI/EVPI = 
$102,094/$180,000 = .51 or 51%
39. \[ P(s) = .10 \]
\[ P(f) = .90 \]
\[ G = \text{good review} \]
\[ B = \text{bad review} \]
\[ P(\text{G|s}) = .70 \]
\[ P(\text{B|s}) = .30 \]
\[ P(\text{G|f}) = .20 \]
\[ P(\text{B|f}) = .80 \]

\[ P(s|G) = \frac{P(\text{G|s}) P(s)}{P(\text{G|s}) P(s) + P(\text{G|f}) P(f)} \]
\[ = \frac{(.70)(.10)}{(.70)(.10) + (.20)(.90)} = .28 \]

\[ P(f|G) = .72 \]
\[ P(s|B) = .04 \quad P(G) = .25 \]
\[ P(f|B) = .96 \quad P(B) = .75 \]

\[ EVSI = EV_{\text{with information}} - EV_{\text{w/o information}} \]
\[ = $0.31M - (-4.7M) \]
\[ = $5.01M \]

Hire Sickel; if good review produce, if bad review don’t produce
40.
(a) $\text{Tech should go for 2 points}$

(b) \[
\begin{align*}
0.98[7.0x + 1.7 (1-x)] + (0.2)(1.7) &= 3.449 \\
0.98[5.3x + 1.7] + 0.034 &= 3.449 \\
5.194x + 1.666 + 0.034 &= 3.449 \\
5.194x &= 1.749 \\
x &= 0.3367 \text{ probability of winning in overtime}
\end{align*}
\]
The following table includes the medical costs for all the final nodes in the decision tree.

<table>
<thead>
<tr>
<th>Expense</th>
<th>Plan 1</th>
<th>Plan 2</th>
<th>Plan 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>484</td>
<td>160</td>
<td>388</td>
</tr>
<tr>
<td>500</td>
<td>884</td>
<td>560</td>
<td>438</td>
</tr>
<tr>
<td>1,500</td>
<td>984</td>
<td>1,290</td>
<td>738</td>
</tr>
<tr>
<td>3,000</td>
<td>1,134</td>
<td>1,440</td>
<td>1,188</td>
</tr>
<tr>
<td>5,000</td>
<td>1,334</td>
<td>1,640</td>
<td>1,788</td>
</tr>
<tr>
<td>10,000</td>
<td>1,834</td>
<td>2,140</td>
<td>3,288</td>
</tr>
</tbody>
</table>

E(1) = 954
E(2) = 976.5
E(3) = 820.5

Select plan 3
Select grower B
The EV without the test market is $450,000, which is $84,000 less than the EV with the test market. Since the cost of the test market is $150,000,

\[
\text{EVSI} = 150,000 + 84,000 = 234,000
\]
\[
\text{EVPI} = 800,000 + 450,000 = 350,000
\]
Ellie should invest in the index fund with an expected return of $65,200.
Select strategy 3