

Year	Cost/Unit (\$)	Year	Cost/Unit (\$)
1	20.00	5	26.60
2	24.50	6	30.00
3	28.20	7	31.00
4	27.50	8	36.00

- Construct a time series plot. What type of pattern exists in the data?
- Use simple linear regression analysis to find the parameters for the line that minimizes MSE for this time series.
- What is the average cost increase that the firm has been realizing per year?
- Compute an estimate of the cost/unit for next year.



23. **Percentage of Adults Who Exercise Regularly.** The medical community unanimously agrees on the health benefits of regular exercise, but are adults listening? During each of the past 15 years, a polling organization has surveyed Americans about their exercise habits. In the most recent of these polls, slightly over half of all American adults reported that they exercise for 30 or more minutes at least three times per week. The following data show the percentages of adults who reported that they exercise for 30 or more minutes at least three times per week during each of the 15 years of this study. **LO 4, 5**

Year	Percentage of Adults Who Reported That They Exercise for 30 or More Minutes At Least Three Times per Week
1	41.0
2	44.9
3	47.1
4	45.7
5	46.6
6	44.5
7	47.6
8	49.8
9	48.1
10	48.9
11	49.9
12	52.1
13	50.6
14	54.6
15	52.4

- Construct a time series plot. Does a linear trend appear to be present?
  - Use simple linear regression to find the parameters for the line that minimizes MSE for this time series.
  - Use the trend equation from part (b) to forecast the percentage of adults next year (Year 16 of the study) who will report that they exercise for 30 or more minutes at least three times per week.
  - Would you feel comfortable using the trend equation from part (b) to forecast the percentage of adults three years from now (Year 18 of the study) who will report that they exercise for 30 or more minutes at least three times per week?
24. **Estimating Seasonal Effects for Keyboard Sales.** Wild Willie's Electronics Emporium is a consumer electronics retailer located in Cheyenne, Wyoming. The following time series provides the number of bluetooth keyboards Wild Willie's has sold in each quarter of the past four years. **LO 4, 5, 6**

Quarter	Year 1	Year 2	Year 3
1	71	68	62
2	49	41	51
3	58	60	53
4	78	81	72

- a. Construct a time series plot. What type of pattern exists in the data?
- b. Use a multiple linear regression model with dummy variables as follows to develop an equation to account for seasonal effects in the data.  $Qtr1 = 1$  if Quarter 1, 0 otherwise;  $Qtr2 = 1$  if Quarter 2, 0 otherwise;  $Qtr3 = 1$  if Quarter 3, 0 otherwise.
- c. Compute the quarterly forecasts for next year.
25. **Estimating Trend and Seasonal Effects in Shoplifting.** The following time series shows the number of shoplifters apprehended in Brannigan's Outdoor Outfitters during each quarter of the past three years. **LO 4, 5, 6**

Quarter	Year 1	Year 2	Year 3
1	4	6	7
2	2	3	6
3	3	5	6
4	5	7	8

- a. Construct a time series plot. What type of pattern exists in the data?
- b. Use a multiple regression model with dummy variables as follows to develop an equation to account for seasonal effects in the data.  $Qtr1 = 1$  if Quarter 1, 0 otherwise;  $Qtr2 = 1$  if Quarter 2, 0 otherwise;  $Qtr3 = 1$  if Quarter 3, 0 otherwise.
- c. Compute the quarterly forecasts for next year.
26. **Textbook Sales.** The quarterly sales data (number of copies sold) for a college textbook over the past three years follow. **LO 4, 5, 6**

Quarter	Year 1	Year 2	Year 3
1	1690	1800	1850
2	940	900	1100
3	2625	2900	2930
4	2500	2360	2615

- a. Construct a time series plot. What type of pattern exists in the data?
- b. Use a regression model with dummy variables as follows to develop an equation to account for seasonal effects in the data.  $Qtr1 = 1$  if Quarter 1, 0 otherwise;  $Qtr2 = 1$  if Quarter 2, 0 otherwise;  $Qtr3 = 1$  if Quarter 3, 0 otherwise.
- c. Compute the quarterly forecasts for next year.
- d. Let  $t = 1$  to refer to the observation in Quarter 1 of Year 1;  $t = 2$  to refer to the observation in Quarter 2 of Year 1;  $\dots$ ; and  $t = 12$  to refer to the observation in Quarter 4 of Year 3. Using the dummy variables defined in part (b) and also using  $t$ , develop an equation to account for seasonal effects and any linear trend in the time series. Based upon the seasonal effects in the data and linear trend, compute the quarterly forecasts for next year.
27. **Air Pollution.** Air pollution control specialists in southern California monitor the amount of ozone, carbon dioxide, and nitrogen dioxide in the air on an hourly basis. The hourly time series data exhibit seasonality, with the levels of pollutants showing patterns that vary over the hours in the day. On July 15, 16, and 17, the following



**Risk neutral** A decision maker who is neutral to risk. For this decision maker the decision alternative with the best expected value is identical to the alternative with the highest expected utility.

**Risk profile** The probability distribution of the possible payoffs associated with a decision alternative or decision strategy.

**Risk taker** A decision maker who would choose a lottery over a better guaranteed payoff.

**Sample information** New information obtained through research or experimentation that enables an updating or revision of the state-of-nature probabilities.

**Sensitivity analysis** The study of how changes in the probability assessments for the states of nature or changes in the payoffs affect the recommended decision alternative.

**States of nature** The possible outcomes for chance events that affect the payoff associated with a decision alternative.

**Utility** A measure of the total worth of a consequence reflecting a decision maker's attitude toward considerations such as profit, loss, and risk.

**Utility function for money** A curve that depicts the relationship between monetary value and utility.

### Problems

1. **Two Decision Alternatives and Three States of Nature.** The following payoff table shows profit for a decision analysis problem with two decision alternatives and three states of nature. **LO 1, 2**

Decision Alternative	State of Nature		
	$s_1$	$s_2$	$s_3$
$d_1$	250	100	25
$d_2$	100	100	75

- Construct a decision tree for this problem.
  - If the decision maker knows nothing about the probabilities of the three states of nature, what is the recommended decision using the optimistic, conservative, and minimax regret approaches?
2. **Four Decision Alternatives and Four States of Nature.** Suppose that a decision maker faced with four decision alternatives and four states of nature develops the following profit payoff table. **LO 1**

Decision Alternative	State of Nature			
	$s_1$	$s_2$	$s_3$	$s_4$
$d_1$	14	9	10	5
$d_2$	11	10	8	7
$d_3$	9	10	10	11
$d_4$	8	10	11	13

- If the decision maker knows nothing about the probabilities of the four states of nature, what is the recommended decision using the optimistic, conservative, and minimax regret approaches?
- Which approach do you prefer? Explain. Is establishing the most appropriate approach before analyzing the problem important for the decision maker? Explain.
- Assume that the payoff table provides cost rather than profit payoffs. What is the recommended decision using the optimistic, conservative, and minimax regret approaches?

5. **The Expected Value Approach to Optimal Decision Determination.** The following profit payoff table was presented in Problem 1. Suppose that the decision maker obtained the probability assessments  $P(s_1) = 0.65$ ,  $P(s_2) = 0.15$ , and  $P(s_3) = 0.20$ . Use the expected value approach to determine the optimal decision. **LO 1**

Decision Alternative	State of Nature		
	$s_1$	$s_2$	$s_3$
$d_1$	250	100	25
$d_2$	100	100	75

6. **Market Segment Investment.** Investment advisors estimated the stock market returns for four market segments: computers, financial, manufacturing, and pharmaceuticals. Annual return projections vary depending on whether the general economic conditions are improving, stable, or declining. The anticipated annual return percentages for each market segment under each economic condition are as follows. **LO 1, 4**

Market Segment	Economic Condition		
	Improving	Stable	Declining
Computers	10	2	-4
Financial	8	5	-3
Manufacturing	6	4	-2
Pharmaceuticals	6	5	-1

- a. Assume that an individual investor wants to select one market segment for a new investment. A forecast shows stable to declining economic conditions with the following probabilities: improving (0.2), stable (0.5), and declining (0.3). What is the preferred market segment for the investor, and what is the expected return percentage?
- b. At a later date, a revised forecast shows a potential for an improvement in economic conditions. New probabilities are as follows: improving (0.4), stable (0.4), and declining (0.2). What is the preferred market segment for the investor based on these new probabilities? What is the expected return percentage?
7. **Data Warehouse Operation.** Kang Corporation is considering three options for managing its data processing operation: continuing with its own staff, hiring an outside vendor to do the managing (referred to as *outsourcing*), or using a combination of its own staff and an outside vendor. The cost of the operation depends on future demand. The annual cost of each option (in thousands of dollars) depends on demand as follows. **LO 1, 3**

Staffing Options	Demand		
	High	Medium	Low
Own staff	650	650	600
Outside vendor	900	600	300
Combination	800	650	500

- a. If the demand probabilities are 0.2, 0.5, and 0.3, which decision alternative will minimize the expected cost of the data processing operation? What is the expected annual cost associated with that recommendation?
- b. Construct a risk profile for the optimal decision in part (a). What is the probability of the cost exceeding \$700,000?

8. **Two States of Nature and Two Decision Alternatives.** The following payoff table shows the profit for a decision problem with two states of nature and two decision alternatives. **LO 1, 4**

Decision Alternative	State of Nature	
	$s_1$	$s_2$
$d_1$	10	1
$d_2$	4	3

- Use graphical sensitivity analysis to determine the range of probabilities of state of nature  $s_1$  for which each of the decision alternatives has the largest expected value.
  - Suppose  $P(s_1) = 0.2$  and  $P(s_2) = 0.8$ . What is the best decision using the expected value approach?
  - Perform sensitivity analysis on the payoffs for decision alternative  $d_1$ . Assume the probabilities are as given in part (b), and find the range of payoffs under states of nature  $s_1$  and  $s_2$  that will keep the solution found in part (b) optimal. Is the solution more sensitive to the payoff under state of nature  $s_1$  or  $s_2$ ?
9. **Cleveland to Myrtle Beach Air Service.** Myrtle Air Express<sup>®</sup> decided to offer direct service from Cleveland to Myrtle Beach. Management must decide between a full-price service using the company's new fleet of jet aircraft and a discount service using smaller capacity commuter planes. It is clear that the best choice depends on the market reaction to the service Myrtle Air offers. Management developed estimates of the contribution to profit for each type of service based upon two possible levels of demand for service to Myrtle Beach: strong and weak. The following table shows the estimated quarterly profits (in thousands of dollars). **LO 1, 4**

Service	Demand for Service	
	Strong	Weak
Full price	\$960	-\$490
Discount	\$670	\$320

- What is the decision to be made, what is the chance event, and what is the consequence for this problem? How many decision alternatives are there? How many outcomes are there for the chance event?
  - If nothing is known about the probabilities of the chance outcomes, what is the recommended decision using the optimistic, conservative, and minimax regret approaches?
  - Suppose that management of Myrtle Air Express believes that the probability of strong demand is 0.7 and the probability of weak demand is 0.3. Use the expected value approach to determine an optimal decision.
  - Suppose that the probability of strong demand is 0.8 and the probability of weak demand is 0.2. What is the optimal decision using the expected value approach?
  - Use graphical sensitivity analysis to determine the range of demand probabilities for which each of the decision alternatives has the largest expected value.
10. **Video Game Profitability.** Video Tech is considering marketing one of two new video games for the coming holiday season: Battle Pacific or Space Pirates. Battle Pacific is a unique game and appears to have no competition. Estimated profits (in thousands of dollars) under high, medium, and low demand are as follows: