



4. When applying LP to diet problems, the objective function is usually designed to
 - a. maximize profits from blends of nutrients.
 - b. maximize ingredient blends.
 - c. minimize production losses.
 - d. maximize the number of products to be produced.
 - e. minimize the costs of nutrient blends.
5. The diet problem is
 - a. also called the feed mix problem in agriculture.
 - b. a special case of the ingredient mix problem.
 - c. a special case of the blending problem.
 - d. all of the above.
6. The selection of specific investments from among a wide variety of alternatives is the type of LP problem known as
 - a. the product mix problem.
 - b. the investment banker problem.
 - c. the portfolio selection problem.
 - d. the Wall Street problem.
 - e. none of the above.

Problems

 8-1 (**Production problem**) Winkler Furniture manufactures two different types of china cabinets: a French Provincial model and a Danish Modern model. Each cabinet produced must go through three departments: carpentry, painting, and finishing. The table on this page contains all relevant information concerning production times per cabinet produced and production capacities for each operation per day, along with net revenue per unit produced. The firm has a contract with an Indiana distributor to produce a minimum of 300 of each cabinet per week (or 60 cabinets per day). Owner Bob Winkler would like to determine a product mix to maximize his daily revenue.

- (a) Formulate as an LP problem.
- (b) Solve using an LP software program or spreadsheet.

 8-2 (**Investment decision problem**) The Heinlein and Krampf Brokerage firm has just been instructed by one of its clients to invest \$250,000 of her money obtained recently through the sale of land holdings in Ohio. The client has a good deal of trust in the investment house, but she also has her own ideas about the distribution of the funds being invested. In particular, she requests that the firm select whatever stocks and bonds they believe are well rated but within the following guidelines:

- Municipal bonds should constitute at least 20% of the investment.
- At least 40% of the funds should be placed in a combination of electronic firms, aerospace firms, and drug manufacturers.
- No more than 50% of the amount invested in municipal bonds should be placed in a high-risk, high-yield nursing home stock.




Subject to these restraints, the client's goal is to maximize projected return on investments. The analysts at Heinlein and Krampf, aware of these guidelines, prepare a list of high-quality stocks and bonds and their corresponding rates of return:

INVESTMENT	PROJECTED RATE OF RETURN (%)
Los Angeles municipal bonds	5.3
Thompson Electronics, Inc.	6.8
United Aerospace Corp.	4.9
Palmer Drugs	8.4
Happy Days Nursing Homes	11.8

- (a) Formulate this portfolio selection problem using LP.
- (b) Solve this problem.

Data for Problem 8.1

CABINET STYLE	CARPENTRY (HOURS/ CABINET)	PAINTING (HOURS/ CABINET)	FINISHING (HOURS/ CABINET)	NET REVENUE/ CABINET (\$)
French Provincial	3	1.5	0.75	28
Danish Modern	<u>2</u>	<u>1</u>	<u>0.75</u>	25
Department capacity (hours)	360	200	125	

Note:  means the problem may be solved with QM for Windows;  means the problem may be solved with Excel; and  means the problem may be solved with QM for Windows and/or Excel.

In addition, the stable owner is aware that an overfed horse is a sluggish worker. Consequently, he determines that a total of 6 pounds of feed per day is the most that any horse needs to function properly. Formulate this problem and solve for the optimal daily mix of the three feeds.

- 8-5 The Kleenglass Corporation makes a dishwasher that has excellent cleaning power. This dishwasher uses less water than most competitors, and it is extremely quiet. Orders have been received from several retail stores for delivery at the end of each of the next 3 months, as shown below:

MONTH	NUMBER OF UNITS
June	195
July	215
August	205

Due to limited capacity, only 200 of these dishwashers can be made each month on regular time, and the cost is \$300 each. However, an extra 15 units per month can be produced if overtime is used, but the cost goes up to \$325 each. Also, if there are any dishwashers produced in a month that are not sold in that month, there is a \$20 cost to carry this item to the next month. Use linear programming to determine how many units to produce in each month on regular time and on overtime to minimize the total cost while meeting the demand.

- 8-6 Eddie Kelly is running for reelection as mayor of a small town in Alabama. Jessica Martinez, Kelly's campaign manager during this election, is planning the marketing campaign, and there is some stiff competition. Martinez has selected four ways to advertise: television ads, radio ads, billboards, and newspaper ads. The costs of these, the audience reached by each type of ad, and the maximum number available are shown in the following table:

TYPE OF AD	COST PER AD	AUDIENCE REACHED/AD	MAXIMUM NUMBER
TV	\$800	30,000	10
Social media	\$400	22,000	10
Billboards	\$500	24,000	10
Newspapers	\$100	8,000	10

In addition, Martinez has decided that there should be at least six ads on TV or social media or some combination of those two. The amount spent on billboards and newspapers together must not exceed the amount spent on TV ads. While fundraising is still continuing, the monthly budget for advertising has been set at \$15,000. How many ads of each type should be placed to maximize the total number of people reached?

- 8-7 (*Media selection problem*) The advertising director for Diversey Paint and Supply, a chain of four retail stores on Chicago's North Side, is considering two media possibilities. One plan is for a series of half-page ads in the Sunday *Chicago Tribune* newspaper, and the other is for advertising time on Chicago TV. The stores are expanding their lines of do-it-yourself tools, and the advertising director is interested in an exposure level of at least 40% within the city's neighborhoods and 60% in northwest suburban areas.

The TV viewing time under consideration has an exposure rating per spot of 5% in city homes and 3% in the northwest suburbs. The Sunday newspaper has corresponding exposure rates of 4% and 3% per ad. The cost of a half-page *Tribune* advertisement is \$925; a television spot costs \$2,000.

Diversey Paint would like to select the least costly advertising strategy that would meet desired exposure levels.

- Formulate using LP.
- Solve the problem.

- 8-8 (*Automobile leasing problem*) Sundown Rent-a-Car, a large automobile rental agency operating in the Midwest, is preparing a leasing strategy for the next six months. Sundown leases cars from an automobile manufacturer and then rents them to the public on a daily basis. A forecast of the demand for Sundown's cars in the next six months follows:

MONTH	MARCH	APRIL	MAY	JUNE	JULY	AUGUST
Demand	420	400	430	460	470	440

Cars may be leased from the manufacturer for either three, four, or five months. These are leased on the first day of the month and are returned on the last day of the month. Every six months the automobile

MINERAL PRODUCT (UNITS/LB)	MINIMUM DAILY REQUIREMENT (UNITS)
1	6
0.5	2
6	9
2	8
1.5	5
\$0.17	

SECTOR	S
A	
B	
C	
D	
E	

A company is considering opening one new production facility, and three locations are being considered. For this facility location problem, how many transportation models must be developed and solved?

- a. 1
- b. 2
- c. 3
- d. 4

Four cranes are being assigned to five construction jobs. One of the jobs will be delayed until one of the cranes becomes available after finishing the first job. An assignment model will be used. To allow specialized software to find a solution to this problem,

- a. nothing special must be done to this problem.
- b. one dummy crane must be used in the model.
- c. one dummy job must be used in the model.
- d. both a dummy job and a dummy crane must be used in the model.

Which network model is used to determine how to connect all points of a network together while minimizing the total distance between them?

- a. the assignment model
- b. the maximal-flow model
- c. the shortest-route model
- d. the minimal-spanning tree model

6. In a typical shortest-route model, the objective is to
 - a. minimize the number of nodes in the route.
 - b. minimize the time or distance to get from one point to another.
 - c. minimize the number of arcs in the route.
 - d. travel through all nodes in the best way possible.
7. A large city is planning for the Olympic Games, which will be coming in a few years. The transportation system is being evaluated to determine what expansion is needed to handle the large number of visitors to the games. Which of the following models would most likely help the city planners determine the capacity of the current system?
 - a. the transportation model
 - b. the maximal-flow model
 - c. the shortest-route model
 - d. the minimal-spanning tree model
8. The computing center of a large university is installing fiber-optic cables to link fifteen buildings on campus. Which of the following models could be used to determine the least amount of cable required to connect all the buildings?
 - a. the transportation model
 - b. the maximal-flow model
 - c. the shortest-route model
 - d. the minimal-spanning tree model

Discussion Questions and Problems

Discussion Questions

- 9-1 Is the transportation model an example of decision making under certainty or decision making under uncertainty? Why?
- 9-2 Explain how to determine the number of variables and constraints in a transportation problem when only the number of sources and the number of destinations are known.
- 9-3 Explain what it means for an assignment model to be balanced.
- 9-4 Explain the purpose of the transshipment constraints in the linear program for a transshipment model.
- 9-5 Describe a problem that can be solved by using the shortest-route model.
- 9-6 Explain how the maximal-flow model might be viewed as a transshipment model.

Problems*

Q: 9-7

The management of the Executive Furniture Corporation decided to expand the production capacity at its Des Moines factory and to cut back the production capacities at its other two factories. It also recognizes a shifting market for its desks and revises the requirements at its three warehouses.

The table on this page provides the requirement at each of the warehouses, the capacity at each of the factories, and the shipping cost per unit to ship from each factory to each warehouse. Find the least-cost way to meet the requirements given the capacity at each factory.

Q: 9-8

The Hardrock Concrete Company has plants in three locations and is currently working on three major construction projects, each located at a different site. The shipping cost per truckload of concrete, daily

FROM \ TO	ALBUQUERQUE	BOSTON	CLEVELAND	CAPACITY
DES MOINES	\$5	\$4	\$3	300
EVANSVILLE	\$8	\$4	\$3	150
FORT LAUDERDALE	\$9	\$7	\$5	250
REQUIREMENTS	200	200	300	

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