

Transportation Models

BUS 735: Business Decision Making and Research

Thursday, December 2, 2010

Learning Objective	Active Learning Activity
Learn what transportation models are.	Lecture / Discussion
Learn how to formulate transportation problems.	Worksheet problem.
Build our expertise and experience with transportation models	Quiz
Learn how transportation models can be useful for problems not really involving transporting things.	
Learn what assignment models are.	Lecture / Discussion
Learn how handle assignments with a transportation model.	Worksheet problem.

Goals of this class meeting

- Specific Goals:
 - Learn how to formulate models involving transporting goods from suppliers to destinations.
 - Learn how to use the transportation model framework for finding optimal assignments.
 - Continue to perfect our linear programming / Excel skills!
- Learning Objectives:
 - Be able to construct and solve linear programming models to answer business optimization problems.
 - Be able to use standard computer packages such as SPSS and Excel to conduct the quantitative analyses described in the learning objectives above.

1 Transportation Models

Transportation Models

- **Transportation Models:** class of problems involving transporting goods from suppliers to destinations, usually at minimum cost.
- Assumptions:
 - Each source has a fixed supply (not essential).
 - Each destination has a fixed demand (not essential).
- The cost of transporting goods differs between points.
- Meeting demand at each location typically requires supply from multiple sources.

Example: Getting grain to mills

- We have three different grain elevators scattered around the Great Plains that can supply grain:
 1. Kansas City supplies 150 tons of grain.
 2. Omaha supplies 175 tons of grain.
 3. Des Moines supplies 275 tons of grain.
- We have three different grain mills that need grain:
 1. Chicago needs 200 tons of grain.
 2. St. Louis needs 100 tons of grain.
 3. Cincinnati needs 300 tons of grain.

Quiz!

A large manufacturing company is downsizing amid tough economic times and seemingly permanent changes in the profitability of the manufacturing sector in the United States. The company is closing three plants: Pittsburgh, PA; Gary, IN; and Detroit, MI. There are some highly skilled employees working at these plants they would like to keep and send to their overseas plants in Bangladesh, Thailand, and India.

The number of skilled employees who have agreed to transfer overseas at each plant are as follows:

Closing Plant	Transferable Employees
Pittsburgh, PA	60
Gary, IN	105
Detroit, MI	70

The number of employees that can be accommodated at each of the overseas plants are as follows:

Oversees Plant	Employees Demanded
Bangladesh	45
Thailand	90
India	35

Due to differences in the type of manufactured goods produced at each plant and the differences in the manufacturing processes, not all transferable employees will be equally productive at the various overseas operations. The increase in profitability per year at the overseas plants that results from transferring a highly trained American employee depends on what plant she/he is coming from and what plant she/he is going to. The following table shows how much annual profit will increase by for each employee depending on their experience and their new assignment:

Employee's Original Plant	Oversees Plant Assignment		
	Bangladesh	Thailand	India
Pittsburgh, PA	\$50K	\$80K	\$60K
Gary, IN	\$100K	\$90K	\$120K
Detroit, MI	\$70K	\$60K	\$80K

The company wants to transfer the employees so as to maximize profits.

Quiz!

1. What are your decision variables? How many do you have? Carefully define the notation you decide to use.
2. What is your objective function?
3. There are two sources for constraints. Describe them. Do you have a balanced or an unbalanced model?

4. Write down all of your constraints.

5. Solve the problem in Excel. Print out the results. Point out how many employees are transferred between plants, and what the maximum profit is for the manufacturing company.

2 Assignment Models

Assignment Models

- **Assignment models** are like transportation models, except you decide whether or to assign a source to a destination (or employee to a task).
- Decision variables are **binary**.
- Suppose you have 3 employees and 3 tasks. How many different possible assignments are there?
- Constraints:
 - Each assignment must get at most 1 assignee.
 - Each assignee must get at most 1 assignment.
 - Non-negativity constraints.
 - Integer constraints (use Integer Programming).

Worksheet questions

Fancy Pants Department Store has four salespeople with a great deal of experience throughout the store, and is ready to give three promotions to department supervisor. The three departments that need supervisors are Women's clothing, Men's Clothing, and Jewelry. Each employee has worked previously in all these departments, and the store keeps data on sales for each employee for each department. The employees' average monthly sales numbers are,

Salesperson	Department		
	Men	Women	Jewelry
Abby	\$340	\$160	\$610
Beth	\$560	\$370	\$520
Carla	\$270	\$540	\$350
Deborah	\$360	\$220	\$630

The store manager thinks it is reasonable to promote the employees to supervise departments in such a way that maximizes the expected sales of the department. What assignments should be made to achieve the managers objective? Does everyone get promoted? What are the total expected sales for the supervisors?

Homework

- Linear programming / Sensitivity analysis: Page 103, problems 40, 41.
- Transportation models: Pages 251-252, problems 15, 16, and 17.