

## 3 Transportation Model and its Variants

1. MG Auto has three plants in Los Angeles, Detroit, and New Orleans and two major distribution centers in Denver and Miami. The quarterly capacities of the three plants are 1000, 1500, and 1200 cars, and the demands at the two distribution centers for the same period are 2300 and 1400 cars. The mileage chart between the plants and the distribution centers is given in the table below.

Plants	Distribution Centers		Capacity
	Denver	Miami	
Los Angeles	1027	2342	1000
Detroit	1158	1086	1500
New Orleans	1303	661	1200
Demand	2300	1400	3700

The trucking company in charge of transporting the cars charges 8 cents per mile per car. Find the transportation plan that minimizes the total cost.

2. Three refineries (R1, R2 and R3) with a daily production capacity of 25'000, 15'000 and 5'000 ton. of gas, respectively, supply three large distribution centers (D1, D2 and D3) which needs are respectively 15'000, 10'000 and 20'000 ton. The supply is done throughout a pipeline network in a price of 200 m.u. per ton, per km. Distances between refineries and distribution centers (in km) are given in the table:

	D1	D2	D3
R1	5	70	320
R2	75	15	220
R3	300	200	2

Determine the assignment that provides the best service quality.

- Formulate the problem as a linear programming problem.
  - Find the optimal solution.
  - Solve the problem assuming that refinery R2 stopped the production of gas.
  - Solve the problem considering that needs in distribution center D3 are now 10'000 ton.
  - Solve the problem considering that the production in refinery R1 is equal to 20'000 ton.
3. A company produces a product in two factories (F1 and F2) and has three selling points (S1, S2 and S3). The maximum production for the next period is 400 tons and 800 tons in factories F1 and F2, respectively. The potential sales in the three selling points are 400 tons, 500 tons and 300 tons, respectively. The transportation cost, in hundreds of monetary units (m.u.) per ton transported, between each factory and each selling point are in the following table:

	S1	S2	S3
F1	10	20	25
F2	25	15	20

The product is sold by 15,000 m.u., 18,000 m.u. and 20,000 m.u. per ton in selling points S1, S2 and S3 respectively and the management of the company wants to maximize the total profit (revenue - cost). Determine the optimal solution.

4. The METRO WATER DISTRICT is an agency that administers water distribution in a large geographic region. The main customers are four cities (Berdo: C1; Los Devils: C2; Sam Go: C3 and Hollyglass: C4) and the water supply is from three rivers (Colombo: R1; Sacron: R2 and Calorie: R3). It is possible to supply any of the cities with water from any of the rivers, except C4, that cannot be supplied by R3.

The costs (in m.u.) of sending one million Kl of water from river Ri to city Cj, are in the table below, as well as the availabilities and needs.

	C1	C2	C3	C4	Availabilities (millions of Kl)
R1	16	13	22	17	50
R2	14	13	19	15	60
R3	19	20	23	×	50
Minimum needed (millions of Kl)	30	70	0	10	
Requested (millions of Kl)	50	70	30	∞	

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5. The company BETTER PRODUCTS has decided to initiate the production of four new products (P1, P2, P3 and P4), using three plants (F1, F2 and F3) that currently have excess production capacity. The products require a comparable production effort per unit, so available production capacity of plants is measured by the number of units of any product that can be produced per day, as given in the table below. The bottom row gives the required production rate per day to meet projected sales. Each plant can produce any of these products, except that plant F2 cannot produce product P3. However, the variable costs per unit of each product differ from plant to plant, as shown in the main body of the table:

Product unit cost (m.u.)	P1	P2	P3	P4	Daily capacity available (units)
F1	41	27	28	24	75
F2	40	20	×	23	75
F3	37	30	27	21	45
Production rate per day (units)	20	50	30	50	

Management now needs to make a decision on how to split up the production of the products among plants. Two kinds of options are available.

- (a) Permit product splitting, where the same product is produced in more than one plant;
- (b) Prohibit product splitting and each plant can only produce one product.

Write a report to help in this decision.

6. A department has opened three vacancies for translators:

Vacancy 1: Portuguese/French;

Vacancy 2: Portuguese/German;

Vacancy 3: Portuguese/Greek.

Four candidates applied and in the selection tests they achieved the following grades (in scale from a minimum of zero to a maximum of ten):

Candidate	Portuguese/French	Portuguese/German	Portuguese/Greek
A	8.5	7.0	6.0
B	7.5	8.0	6.5
C	6.0	7.5	8.5
D	7.0	6.5	8.0

Determine the assignment that provides the best service quality.

## Some solutions

**3.1**  $x^* = (1000, 0, 1300, 200, 0, 1200)$ ,  $z^* = 313200$ .

**3.3**  $x^* = (400, 0, 0, 0, 500, 300)$ ,  $z^* = 3500$ .

**3.4**  $x^* = (0, 50, 0, 0, 30, 20, 0, 10, 20, 0, 30, 0)$ ,  $z^* = 2550$ .

**3.5(a)**  $x^* = (0, 0, 30, 0, 0, 50, 0, 25, 20, 0, 0, 25)$ ,  $z^* = 3680$ .

**3.5(b)** F1 produces P3, F2 produces P1 & P2, F3 produces P4,  $x^* = (0, 0, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1)$ ,  $z^* = 3690$ .

**3.6** V1 for C3, V2 for C2, V3 for C4,  $x^* = (0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1)$ ,  $z^* = 22$ .