Optimization Techniques And Applications

Transportation and Purchasing Problem

Bachelor of Technology in
Computer Science And Engineering

Submitted by
Group 17

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CERTIFICATE

This is to certify that this project submitted by Group-17 of A2 batch, in requirement of Optimization Techniques And Applications course of Computer Science Engineering, is a bonafide record of work carried out by them at the Department of Computer Science Engineering, The LNM Institute of Information Technology, Jaipur, (Rajasthan) India, during the 3rd semester under my supervision and guidance and the same has not been submitted elsewhere.

Dated: ___________________ Signature: ___________________

Dr. Jayprakash Kar

Acknowledgments

“The pleasure that follows successful completion of a project remains incomplete without a word of gratitude for the people without whose cooperation this achievement would remain a distant dream. It is not a mere formality to place a record of the tireless efforts, ceaseless cooperation, constant guidance and encouragement of all the people associated with it. Rather, it is a distinct necessity for the authenticity and readability of the project.”

First and foremost, we would like to express our gratitude towards our mentor and distinguished faculty Dr.Jayaprakash Kar who provided us with an opportunity to work on this project and learn more about optimisation, which is a basic necessity in our daily lives.
Thank You, Sir for being a continuous support since the inception of this project.

Also, we would like to thank our friends and batchmates who participated enthusiastically in the discussions and always helped us whenever we faced any problem.

Thank You.

Abstract

In this fast paced, ever changing world, a simple chain of supply and demand has proven to be a constant. In the economic theory, the law of supply and demand is one of the fundamental principles that govern an economy. It is described as the state where, as the supply increases, the prices tend to drop, while as the demand increases, the prices tend to rise.

An important factor affecting this cycle is that of **transportation** of everything from raw materials to final product. Optimisation of the cost/price involved in the transportation sector, is thus an important aspect for smooth functioning of the economy.

This project thus aims to do the same with the use of MATLAB, as prescribed by our instructor and mentor, Dr. Jayaprakash Kar.

Problem Definition

The FORCE automobile company assembles automobiles in three plants situated in three different cities -- Mumbai, Delhi and Bengaluru. They ship automobile parts from three different companies namely Nissan, Audi and Skoda. The engines are shipped to the plants in railroad cars, each of which is capable of holding one engine. Each engine manufacturing company is able to supply the following number of engines on a monthly basis:

S.No.	Company	Supply
1.	Nissan	150
2.	Audi	175
3.	Skoda	275
	Total	600 Engines

The FORCE automobile company's plants demands the following number of engines per month:

S.No.	Plant	Demand
A.	Mumbai	200
B.	Delhi	100
C.	Bengaluru	300
	Total	600 Engines

The cost of transporting and purchasing one engine from each source company to each plant (destination) differs according to the distance and rail system. These costs are shown in the following table. For example, the cost of shipping one engine from the Audi company to the plant in Mumbai is $7.

S.No.		A. Mumbai ($)	B. Delhi ($)	C. Bengaluru ($)
1	**Nissan**	6	8	10
2.	**Audi**	7	11	11
3.	**Skoda**	4	5	12

The problem is to determine how many engines to purchase and transport from each manufacturing company to each assembly plant on a monthly basis in order to minimize the total cost of purchasing and transportation.

Framework/Model

The framework on which the problem statement is based on is **Transportation and Purchase Model.**

Formulation:

The linear programming model for this problem is formulated in the equations that follow:

Minimize: $Z = \$(6x_{1A} + 8x_{1B} + 10x_{1C} + 7x_{2A} + 11x_{2B} + 11x_{2C} + 4x_{3A} + 5x_{3B} + 12x_{3C})$

Subject to $x_{ij} >= 0$
where $i = 1,2,3$
and $j = A,B,C$

x_{ij} = number of engines to be brought from company i to plant j

Constraints for **demand** of each plant:
$x_{1C} + x_{2C} + x_{3C} = 300$
$x_{1B} + x_{2B} + x_{3B} = 100$
$x_{1A} + x_{2A} + x_{3A} = 200$

Constraints for **supply** by each company:
$x_{3A} + x_{3B} + x_{3C} = 275$
$x_{2A} + x_{2B} + x_{2C} = 175$
$x_{1A} + x_{1B} + x_{1C} = 150$

In this model the decision variables, x_{ij}, represent the number of engines transported from each company, i (where i = 1, 2, 3), to each plant, j (where j = 1, 2, 3).
The objective function represents the total transportation cost for each route.
Each term in the objective function reflects the cost of the engines transported for one route.
For example, if 20 engines are transported from company 1 to plant A, the cost of $6 is multiplied by x_{1A}(=20), which equals $120.

The first three constraints in the linear programming model represent the fulfilment of demand at each plant; the last three constraints represent the fulfilment of supply at each manufacturing company.
As an example, consider the last supply constraint: $x_{1A} + x_{1B} + x_{1C} = 150$. This constraint represents the engines transported from Nissan company to all three plants: Mumbai(x_{1A}), Delhi(x_{1B}) and Bengaluru(x_{1C}). The amount transported from Nissan company is limited to the 150 engines available.

Note that this constraint (as well as all others) is an equation rather than an inequality, because all the engines available will be needed to meet the total demand of 600 engines. In other words, the three plants demand a total of 600 engines, which is the exact amount that can be supplied by the three manufacturing companies. Thus, all that can be supplied will be, in order to meet demand. This type of model, in which supply exactly equals demand, is referred to as a ***balanced transportation model.***

Algorithm Used

The Algorithm being used is **Dual Simplex Method.**

Code

```
lb=zeros(9,1);
ub=Inf(9,1);
A=zeros(6,9);
b=zeros(6,1);
Aeq=zeros(6,9);
beq=zeros(6,1);

Aeq(1,[3,6,9])=[1,1,1];
Aeq(2,[2,5,8])=[1,1,1];
Aeq(3,[1,4,7])=[1,1,1];
Aeq(4,[7,8,9])=[1,1,1];
Aeq(5,[4,5,6])=[1,1,1];
Aeq(6,[1,2,3])=[1,1,1];

beq(1)=300;
beq(2)=100;
beq(3)=200;
beq(4)=275;
beq(5)=175;
beq(6)=150;

f=zeros(9,1);

f(1)=6;
f(2)=8;
f(3)=10;
f(4)=7;
f(5)=11;
f(6)=11;
f(7)=4;
f(8)=5;
f(9)=12;
```

Editor - /Users/anushka/Desktop/OTA.m

OTA2.m | OTA.m

```
lb=zeros(9,1);
ub=Inf(9,1);
A=zeros(6,9);
b=zeros(6,1);
Aeq=zeros(6,9);
beq=zeros(6,1);
Aeq(1,[3,6,9])=[1,1,1];
Aeq(2,[2,5,8])=[1,1,1];
Aeq(3,[1,4,7])=[1,1,1];
Aeq(4,[7,8,9])=[1,1,1];
Aeq(5,[4,5,6])=[1,1,1];
Aeq(6,[1,2,3])=[1,1,1];
beq(1)=300;
beq(2)=100;
beq(3)=200;
beq(4)=275;
beq(5)=175;
beq(6)=150;
f=zeros(9,1);
f(1)=6;
f(2)=8;
f(3)=10;
f(4)=7;
f(5)=11;
f(6)=11;
f(7)=4;
f(8)=5;
f(9)=12;
```

Command Used:

```
>> [x,fval]=linprog(f,[],[],Aeq,beq,lb)
```

Output on the console:

```
x =
   25
    0
  125
    0
    0
  175
  175
  100
    0

fval =
     4525
```

```
Command Window
New to MATLAB? See resources for Getting Started.
>> OTA
>> [x,fval]=linprog(f,[],[],Aeq,beq,lb)

Optimal solution found.


x =

    25
     0
   125
     0
     0
   175
   175
   100
     0


fval =

        4525

>>
>>
```

Result

The optimized value of the objective function(f) turns out to be 4525. This means that the minimum cost for purchase and transportation in the fulfilment of the given supply and demand of the companies and plants respectively is $4525.

This is achieved when the following number of engines are transported from each manufacturing company to each plant:

	A. Mumbai	**B. Delhi**	**C. Bengaluru**	**Supply**
Nissan	25	0	125	150
Audi	0	0	175	175
Skoda	175	100	0	275
Demand	200	100	300	**600**