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THE ROLE OF UNBALANCED ASSIGNMENT PROBLEM ON ELECTRICITY GENERATION

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ABSTRACT

E*lectricity generation plays a vital role in the economical condition of India. Electricity is mainly generated from four power plants to all the five regions of India. The aim of this paper is to find the best assignment of power plants to all the five regions and to find the best optimal solution, so that the electricity generation to all five regions can be maximized. This is done successfully by a different unbalanced assignment problem.*

Keywords: *Electricity generation, unbalanced assignment problem and maximization.*

2000 Mathematical Subject Classification: *90C70, 90C26.*

1. INTRODUCTION

Mathematics is the study of topics such as quantity, structure, space, and change. It plays an important role in forming the basis of all other sciences which deal with the material substance of space and time. Precise calculations are made while planning for the development of new townships, buildings, bridges, etc [8].

Operations Research or operational research is a discipline that deals with the application of advanced analytical methods in making better decisions [9].

In our daily life we make decisions even without noticing them. The decisions are taken simply by common sense, judgment and expertise without using any mathematical or any other model in simple situations. But the decisions we are concerned here are complex and heavily responsible [11].

Assignment problem is an important concept in the field of optimization techniques. We obtain solutions to various everyday problems using this technique. Different methods of solving assignment problems were studied by Kuhn H. W [1], Pandian P. and Nagarajan G. [2], Shweta Singh *et al*. [3], Srinivasan N and Iraninan D. [4], Sudhakar V. J. *et al*. [5], Thirupathi A and Iraninan D [6].

Electricity generation is the process of generating electric power from sources of primary energy. The environmental impact of electricity generation is significant because modern society uses large amounts of electrical power [7]. This power is normally generated at power plants that convert some other kind of energy into electrical power.

In this paper, data has been collected about various powerplants in India through which electricity is generated and the installed capacity of each power plants in regions such as North, South, East, West and Other regions such as North eastern and islands. A method of assignment problem is used to find out which powerplant can be assigned to each of the region, so that the electricity generation is sufficient to satisfy their power requirements.

2. METHOD OF THE PROBLEM

The method of the assignment problem is as follows: We consider power plants and regions as rows and columns respectively.

Step-1: If the problem is of maximization type then convert it into minimization problem by finding the smallest value of each row. Subtract this smallest number from every number in that row.

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Step-2: Now add 1 to all element and we get at least one ones in each row. Then we will have assignment in terms of ones, if there are some rows and columns without assignment, as we cannot get the optimum solution. Then we go to the next step.

Step-3: In case if the problem is unbalanced we make it balanced by adding a dummy row or dummy column with '1' as entries.

Step-4: Find the maximum element Mi for each i^{th} row of the matrix. Divide this value by corresponding entries of the ith row. In this manner, we now get atleast one value as 1 in each row.

Step-5: Now, the unique position of the matrix corresponding to the $(i, j)^{th}$ position of '1' is discussed. Assignment is given for that unique position. Delete the columns and rows correspondingly. The above said procedure is continued to see the assignment in the same fashion and is taken further for discussion.

Step-6: In cases where more than one row contain the constituents of same column, the difference between the two consecutive maximums of unit costs are taken for rows having same column values. Assignment is given to that column which has maximum difference. The corresponding rows and columns are deleted for which the rows have been assigned.

Step-7: Repeat from steps 4 and 6 till all Power plants are assigned uniquely to the corresponding Regions.

Step-8: Find the total cost by using the expression

$$\sum_{i=1}^{n}\sum_{j=1}^{n} Cij\ Xij$$

2.1 Assignment of powerplants to five regions of India

In this section, based on the data on the installed capacity of powerplants in different regions of India, a method of assignment problem is used to find out which powerplant can be increased in it's installed capacity in each of the region, so as to maximize the electricity generation all over India.

The data has been collected from 'Government Of India Ministry of Power Central Electricity Authority Jan-2017' [4] which gives details about the of electricity generated to each part of India through various power plants.

The following table gives a detailed account of the amount of electricity generated from four power plants to all the five regions of India. The four types of power plants are Thermal, Nuclear, Hydro and Renewable Energy Source(RES). Electricity is generated from these powerplants to all parts of India. It is aimed to find out, which power plant can be increased in its installed capacity in each region so that the electricity generation is maximized all over India.

Table-1: All India installed capacity

Region / Power Plant	North	South	East	West	Northeast
Thermal	523.06	462.28	301.68	837.96	21.17
Nuclear	16.20	23.20	0.00	18.40	0.00
Hydro	183.83	117.39	53.78	74.48	12.42
RES	102.47	217.21	8.97	168.61	2.80

Since the problem is on maximization, we convert it into minimization by subtracting the minimum element of each row from each element in that row.

Table-2

Region / Power Plant	North	South	East	West	Northeast
Thermal	501.89	441.11	280.51	816.79	0.00
Nuclear	16.20	23.20	0.00	18.40	0.00
Hydro	171.41	104.97	41.36	62.06	0.00
RES	99.67	214.41	6.17	165.81	0.00

Adding 1 to all entries in Table 2, we get,

Table-3

Region / Power Plant	North	South	East	West	Northeast
Thermal	502.89	442.11	281.51	817.79	1
Nuclear	17.20	24.20	1	19.40	1
Hydro	172.41	105.97	42.36	63.06	1
RES	100.67	215.41	7.17	166.81	1

As, the problem is unbalanced, we make it a balanced one by adding a dummy row with one as its entries. The resulting table is:

Table-4

Region / Power Plant	North	South	East	West	Northeast
Thermal	502.89	442.11	281.51	817.79	1
Nuclear	17.20	24.20	1	19.40	1
Hydro	172.41	105.97	42.36	63.06	1
RES	100.67	215.41	7.17	166.81	1
DR	1	1	1	1	1

Where DR means Dummy Row.

Find the maximum element for each row of the matrix. Divide this value by corresponding entries of the each row. In this manner, we now get atleast one value as 1 in each row.

Table-5

Region / Power Plant	North	South	East	West	Northeast
Thermal	1.63	1.85	2.91	1	817.79
Nuclear	1.41	1	24.20	1.25	24.20
Hydro	1	1.63	4.07	2.73	172.41
RES	2.41	1	30.04	1.29	215.41
DR	1	1	1	1	1

Identifying the position of 1's we have,

Power plants	Regions	Difference
Thermal	West	
Nuclear	South	4.8
Hydro	North	
RES	South	48.6
DR	North, South, East, West, Northeast	0

Assign the power plant RES → South for generating electricity and delete corresponding row and column.

Now the remaining entries are tabulated as follows:

Table-6

Region / Power Plant	North	East	West	Northeast
Thermal	502.89	281.51	817.79	1
Nuclear	17.20	1	19.40	1
Hydro	172.41	42.36	63.06	1
DR	1	1	1	1

Find the maximum element for each row of the matrix. Divide this value by corresponding entries of the each row. In this manner, we now get atleast one value as 1 in each row.

Table-7

Region / Power Plant	North	East	West	Northeast
Thermal	1.63	2.91	1	817.79
Nuclear	1.13	19.40	1	19.40
Hydro	1	4.07	2.73	172.41
DR	1	1	1	1

Again identifying the position of 1's. we have,

Power plants	Regions	Difference
Thermal	West	314.9*
Nuclear	West	2.2
Hydro	North	
DR	North, East, West, Northeast	0

Assign the power plant Thermal → West for generating electricity and delete the corresponding row and column.

The resulting entries are tabulated as follows:

Table-8

Region / Power Plant	North	East	Northeast
Nuclear	17.20	1	1
Hydro	172.41	42.36	1
DR	1	1	1

Find the maximum element for each row of the matrix. Divide this value by corresponding entries of the each row. In this manner, we now get atleast one value as 1 in each row.

Table-9

Region / Power Plant	North	East	Northeast
Nuclear	1	17.20	17.20
Hydro	1	4.07	172.42
DR	1	1	1

Identifying the position of 1's

Power plants	Regions	Difference
Nuclear	North	16.20
Hydro	North	130.05
DR	North, East, Northeast	0

Assign the power plants Hydro → North for generating electricity and delete corresponding row and column.

The resulting entries are as follows:

Table-10

Region / Power Plant	East	Northeast
Nuclear	1	1
DR	1	1

Locating the position of 1's, we get,

Power plants	Regions	Difference
Nuclear	East	0
DR	East, Northeast	0

Assign Nuclear → East and the Northeastern region is marked for Dummy entry.

Thus, the final assignment is as follows:

RES → South
Thermal → West
Hydro → North
Nuclear → East

and the total installed capacity is 1239 MU. Although all the power plants generates electricity to all the regions of India, based on the above assignment if the installed capacity of power plant is increased in that particular region, then the electricity generation all over India will be maximized.

3. CONCLUSION

Electricity generation has always been an economical sector of India. In this paper based on the installed capacity of power plant generators all over India, results have obtained as to which generator is highly profitable in each region. if the capacity of respective generators in their respective regions increased then this will still bloom to be a highly profitable sector.

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