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Solving Interval Linear Assignment Problem Using Best Assignment Method

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Abstract: In this paper, we discussed about best solution for the assignment problem using best job method. In this contribution they converted this crisp assignment problem as an interval assignment problem and using best assignment method. We conclude that minimal computation time, less complexity and same optimal solution.
Keywords: Best job method, Hungarian method, Interval linear assignment, Best assignment method.
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I. INTRODUCTION

An assignment plan is optimal if it minimizes the total cost (or) maximizes the profit. This type of linear assignment problem can be solved by very well-known Hungarian method [5] in this contex. Ahmad, H.A. [1] introduced the best candidates' method, Dr. A. Rameshkumar, S. Deepa [3] has introduced solving assignment problems using Best Job Method. Sarangam Majumdar [4] introduced an interval linear assignment problem, Ramesh, G and Ganesan, K [5] extended assignment problem with generalized interval arithmetic, S. Deepa and Dr. A. Ramesh Kumar [6] developed some different interval works an new interval linear assignment problems. Amutha, S, Lakshmi. S, Narmatha. S [7] studied the method of solving extension of interval in Assignment problem. In this paper a general interval linear assignment problem is taken into consideration with basis assumption that one person can perform one job at a time. Here the new method (i.e.,) best assignment method has been proposed to handle such type of problems. We solved balanced and unbalanced problems using this best assignment method. Corresponding results are compared and has been reported.

II. DEFINITION

2.1. Interval Arithmetic

The interval form of the parameters may be written as

$$\left[\underline{X}, \overline{X}\right] = \left\{x : x \in IR/\underline{x} \le x \le \overline{x}\right\}$$

where $\underline{x}$ is the left value and $\overline{x}$ is the right value of the interval respectively.

We define m = $\dfrac{\underline{x}+\overline{x}}{2}$ is the centre and w = $\underline{x}$ - $\overline{x}$ is the width of the interval $\left[\underline{x}, \overline{x}\right]$.

Let $\left[\underline{x}, \overline{x}\right]$ and $\left[\underline{y}, \overline{y}\right]$ be two elements then the following arithmetic are well known [8].

(i) $\left[\underline{x}, \overline{x}\right]+\left[\underline{y}, \overline{y}\right]=\left[\underline{x}+\underline{y}, \overline{x}+\overline{y}\right]$

(ii) $\left[\underline{x}, \overline{x}\right]-\left[\underline{y}, \overline{y}\right]=\left[\underline{x}-\overline{y}, \overline{x}-\underline{y}\right]$

III. BEST ASSIGNMENT METHOD

Step 1: Find out the smallest value of each column in the cost matrix.

Step 2: Find the minimum value in first row. Suppose that the minimum value in first column with first row next. Checks the element already select the minimum value of first column. If No then continue the next row. If, Yes then select the next minimum element of its first row. Continue this process. In such way that the minimum element of each row is not selected that minimum element of corresponding column.

Step 3: Draw lines through appropriate rows and columns with contain zero of the cost matrix are covered and the minimum number of lines is used.

Step 4: Test for optimality

i) If the minimum number of covering lines is equal to the order of the cost matrix then optimality is reached.
ii) If the minimum number of covering line is less than the order of matrix then go to step 5.

Step 5: Determine the smallest value of the cost matrix which are not covered by any lines. Subtract this entry from all uncrossed elements and add it to the crossing having element contain zero. Then go to step 3.

IV. BEST INTERVAL ASSIGNMENT METHOD

Algorithm:

Step 1: Find out the mid values of each interval in the cost matrix. Next the smallest interval of each column in the cost matrix.

Step 2: Find the interval of minimum value in first row. Suppose that the interval of minimum value in first column with first row next check the interval already select the minimum value of the first column. If no continue the next row, if yes, then select the next minimum interval of its first row. Continue this process. In such way that the minimum interval of each row is not selected that minimum interval of corresponding column.

Step 3: Crossing of zeros by drawing minimum number of lines to cross all zeros. Then select the smallest interval of uncrossed elements and subtract it from every other uncrossed. Uncrossed interval element and add it to every element at the intersection of two lines.

Step 4: Make job allocation to machine.

V. NUMERICAL EXAMPLES

Example 5.1.

Let us consider a best assignment problem discussed by S. Deepa ad Dr. A. Ramesh Kumar (3). The assignment cost of assigning any job to any one machine is given in the following table.

Table 1: Cost matrix with crisp entries

	M_1	M_2	M_3	M_4
J_1	10	30	25	15
J_2	30	15	20	10
J_3	10	30	20	40
J_4	50	40	35	45

By applying Hungarian Method and Best Job Method got an optimal assignment as J_1, J_2, J_3, J_4 jobs are assign to M_1, M_2, M_3, M_4 machines respectively and minimum assignment cost is 75. The converted this crisp assignment problem as an interval assignment problem as given below.

Table 2: Cost matrix with interval entries

[9, 11]	[29, 31]	[24, 26]	[14, 16]
[29, 31]	[14, 16]	[19, 21]	[9, 11]
[9, 11]	[29, 31]	[19, 21]	[39, 41]
[49, 51]	[39, 41]	[34, 36]	[44, 46]

Applying their best interval assignment method.

Table 3: Best Interval Assignment

	[9, 11]	[14, 16]	[19, 21]	[9, 11]
[14, 16]	[9, 11]	[29, 31]	[24, 26]	[-2, 2]
[29, 31]	[-2, 2]	[-2, 2]	[19, 21]	[-2, 2]
[29, 31]	[-2, 2]	[-2, 2]	[-2, 2]	[39, 41]
[34, 36]	[49, 51]	[39, 41]	[-2, 2]	[44, 46]

The optimal assignment schedule is given by

$J_1 \rightarrow M_4$ $J_2 \rightarrow M_2$ $J_3 \rightarrow M_1$ $J_4 \rightarrow M_3$

The optimal assignment cost

= [14, 16] + [14 + 16] + [9, 11] + [34, 36]

= [71, 79]

Example (Unbalanced) 5.2:

Let us consider the second problem of best job method with rows representing 4 Jobs J_1, J_2, J_3, J_4 and columns representing the machine M_1, M_2, M_3, M_4. The problem is to find the optimal assignment so that the total cost of assignment becomes minimum.

Table 1: Cost matrix with crisp entries

	M_1	M_2	M_3
J_1	6	14	20
J_2	14	11	16
J_3	12	16	28
J_4	16	10	7

First, the assignment problem is unbalanced. We convert the balanced with cost entries zero. Next, converted the crisp assignment problem as an interval assignment problem as given below.

Table 2: Cost matrix with interval entries

[5, 7]	[13, 15]	[19, 21]	[0, 0]
[13, 15]	[10, 12]	[15, 17]	[0, 0]
[11, 13]	[15, 17]	[27, 29]	[0, 0]
[15, 17]	[9, 11]	[6, 8]	[0, 0]

by using Best Interval Assignment Method.

Table 3: Best Interval Assignment

	[5, 7]	[9, 11]	[6, 8]	[0, 0]
[13, 15]	[-2, 2]	[-2, 2]	[19, 21]	[0, 0]
[10, 12]	[13, 15]	[-2, 2]	[15, 17]	[0, 0]
[11, 13]	[-2, 2]	[15, 17]	[27, 29]	[0, 0]]
[15, 17]	[-2, 2]	[-2, 2]	[-2, 2]	[0, 0]

By applying Hungarian Method and Best Job Method got an assignment as J_1, J_2, J_3, J_4 jobs are assigned to M_1, M_2, M_3, M_4 machines respectively and minimum assignment cost is 24.

Now we shall solve the same assignment problem given in Table (1) by applying the Best Interval Assignment Method got an optimal assignment.

The optimal assignment schedule is given by

$J_1 \rightarrow M_1$ $J_2 \rightarrow M_2$ $J_3 \rightarrow M_4$ $J_4 \rightarrow M_3$

The optimal minimum cost

= [5, 7] + [10 + 12] + [0, 0] + [6, 8]

= [21, 27]

Example (Maximized Problem) 5.3:

Let us consider the example problem three of best job method with rows as jobs and column as machines. To find the optimal assignment, So that the total cost of assignment becomes maximum.

Table 1: Cost matrix with crisp entries

	M_1	M_2	M_3	M_4
J_1	33	21	35	23
J_2	29	23	37	31
J_3	31	31	33	29
J_4	27	25	35	37

Applying Hungarian Method and Best Job Method got an assignment as J_1, J_2, J_3, J_4 jobs are assigned to M_1, M_2, M_3, M_4 machines respectively and maximum assignment cost is 138.

Next, first the entries of crisp assignment problem convert to interval assignment problem and applying their Best Interval Assignment got as same optimal assignment.

$J_1 \rightarrow M_1$ $J_2 \rightarrow M_3$ $J_3 \rightarrow M_2$ $J_4 \rightarrow M_4$

The optimal maximum cost

= [32, 34] + [36, 38] + [30, 32] + [36, 38]

= [134, 142]

VI. CONCLUSION

The proposed method uses a new linear space solution to solve balanced and unbalanced assignment problems .Based on an experiment our proposed method provides same optimal cost than of the Hungarian method. It has been found that although the resultant obtained via this method is same but the numbers of possibilities have been reduced which consecutively saves time and easier to perform.

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