RESEARCH PAPER

A Novel AI-Based Approach for Finding Optimal Solutions to Assignment Problems

Nazreen Banu M [1*], Rajeswari E [2*], Rajeshwaran N [3*], Jebaraj J [4*], Gayathri M [5*]

[1*] Professor, Department of Mathematics, V.S.B. College of Engineering Technical campus, Coimbatore 642 09, Tamilnadu, India.
Email: nazreenmathematics@gmail.com

[2*] Assistant Professor, Department of Mathematics, V.S.B. College of Engineering Technical campus, Coimbatore 642 109, Tamilnadu, India.
Email: rajeswarivsbmaths@gmail.com

[3*] Assistant Professor, Department of Mathematics, V.S.B. College of Engineering Technical campus, Coimbatore 642 109, Tamilnadu, India.
Email: rajesjw851@gmail.com

[4*] Assistant Professor, Department of Mathematics, V.S.B. College of Engineering Technical campus, Coimbatore 642 109, Tamilnadu, India.
Email: doctorjebaraj@gmail.com

[5*] Assistant Professor, Department of Mathematics, V.S.B. College of Engineering Technical campus, Coimbatore 642 109, Tamilnadu, India.
Email: gayathrirasu55@gmail.com

ABSTRACT

This study proposes a novel **Artificial Intelligence (AI)-assisted Mean Assignment Method (MAM)** for obtaining optimal solutions to assignment problems. The proposed method is based on the statistical concepts of **mean ($\bar{x}$)** and **mean deviation ($x-\bar{x}$)** and consists of three computational steps. The mean ($\bar{x}$) is used to determine the midpoint of each row, while the deviation of individual costs (cij) from the corresponding mean is utilized to identify the most suitable assignments. To enhance the decision-making process, an **AI-based optimization framework** is incorporated to evaluate assignment alternatives and efficiently identify promising solutions. The performance of the proposed AI-assisted MAM is compared with the classical **Hungarian Method** in terms of optimality, computational efficiency, and execution time. The experimental results demonstrate that both methods obtain optimal solutions; however, the proposed MAM achieves the optimal solution with significantly fewer computational steps and reduced computation time. The integration of AI further enhances the method's capability to efficiently evaluate and select suitable assignments. Thus, the proposed **AI-assisted Mean Assignment Method** provides a simple, efficient, and computationally attractive alternative to conventional approaches for solving assignment problems.

Keywords: Assignment, Hungarian method, Mean Assignment method, Mean Deviation, Optimizing.

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INTRODUCTION

Effective time management and organizational planning play an important role in improving productivity, operational efficiency, and overall quality of life (Jackson & Valerie, 2009). In modern organizations, the efficient allocation of available resources, personnel, and tasks is essential for achieving optimal performance while minimizing computational effort and decision-making time. Assignment problems provide a mathematical framework for allocating individuals to jobs, workers to machines, or resources to tasks in an optimal manner.

The classical **Hungarian Method** is one of the most widely used techniques for obtaining optimal solutions to assignment problems. It is based on the principle of matrix reduction, in which appropriate values are subtracted from and added to the cost matrix to transform the original problem into an equivalent opportunity-cost matrix. Although the Hungarian Method provides an effective procedure for solving minimization assignment problems, it generally requires several computational steps. Moreover, maximization assignment problems must first be transformed into minimization problems before applying the Hungarian algorithm, which may increase computational complexity and processing time.

With the rapid development of **Artificial Intelligence (AI)**, intelligent computational techniques are increasingly being incorporated into optimization and decision-making problems. AI-based approaches can assist in identifying promising assignment alternatives, reducing unnecessary computations, and improving the efficiency of optimization procedures. The integration of AI with mathematical optimization can therefore provide a more intelligent and efficient framework for solving complex assignment problems.

In this study, a novel **AI-assisted Mean Assignment Method (MAM)** is proposed for obtaining optimal solutions to assignment problems. The proposed method utilizes the concepts of the **mean** ($\bar{x}$)and **mean deviation** ($x - \bar{x}$) to identify suitable assignments through a simplified three-step procedure. An AI-assisted decision-making mechanism is incorporated to evaluate assignment alternatives and support the selection of optimal or near-optimal assignments efficiently. The performance of the proposed method is compared with the classical Hungarian Method based on **optimality, computational steps, and computation time**. The primary objective is to develop a simple and efficient approach that can reduce computational effort while maintaining the optimal solution of assignment problems.

2. LITERATURE REVIEW

The assignment problem is actually a special case of transportation problem in which the workers represent the destination and the jobs represent the sources. The supply and demand at each sources and destination respectively exactly equals 1. The cost of transporting worker i to job j is c_{ij}. In effect, the assignment model can be solved directly as a regular transportation model (Taha, 2007). The objective of the assignment model is to determine the minimum-cost assignment of workers to jobs. Dubey, Shrivastava, and Singh (2012) introduced a new approach to solving assignment problem namely: matrix ones assignment method. They further carried out a comparative analysis of Hungarian method and matrix ones assignment method (MOA). An example using matrix ones assignment methods and the existing Hungarian method was solved and compared graphically. Also some of the variations and some special cases in assignment problem and its applications were discussed. They discovered that both methods are equally efficient in solving minimization case of assignment problems. Ghadle and Muley (2013) carried out a study on revised ones assignment method for solving assignment problem. Their algorithm is very similar to the matrix ones assignment method by Dubey et al. (2012). The new method is based on creating ones in the assignment matrix and to complete exact assignment to their ones. The algorithm can be utilized for all types of assignment problems with maximization or minimization.

3. METHODOLOGY

This study presents an **AI-assisted algorithmic approach** for solving assignment problems and compares its performance with the classical Hungarian Method. The proposed approach integrates the **Mean Assignment Method (MAM)** with an Artificial Intelligence (AI)-based decision-making mechanism to improve assignment selection and computational efficiency. The methodology is designed to solve both maximization and minimization assignment problems while reducing the number of computational iterations required to obtain an optimal solution.

Step 1: Determine the mean for each row

Step 2: Determine the mean deviations for each row;

Each row must have number of positive values $\geq \frac{\text{number of rows}}{2}$. Approximate to whole number.

Each column must have number of negative values $\geq \frac{\text{number of columns}}{3}$. Approximate to whole number.

Assign if these conditions are met. If not, go to step 3.

Step 3: Create more positive values by adding the most positive value throughout the matrix. Assign if the conditions in step 2 above are now met. If not, repeat step 3.

To assign, calculate for the column totals of the optimal matrix, consider the column with the highest positive total (most-positive) and assign the highest positive value in this column. Then move to the column with the next highest positive total and assign the highest positive value in the column. Continue until all the assignment has been made. If a highest positive value appear twice or more in a column, check these values row-wise and assign the one that appear once on a row.

The mean ($\bar{x}$) gives the mid-point for each row. The farther the costs (c_{ij}'s) are from the mean, the higher their suitability for assignment. For minimization problems, the left side of the number line is considered and the most negative values are the most suitable for assignment. This will ultimately result to the minimum total cost. However, for maximization problems, the right side of the number line is considered and the most positive values are the most suitable for assignment. This will ultimately result to the maximum profit. For a minimization problem, an iteration is optimal and ready for assignment if the number of negative values in each row is $\geq \frac{\text{number of rows}}{2}$ and the number of negative values in each column is $\geq \frac{numberofcolumns}{3}$. This is to allow for sufficient negative values for easy assignment. For a maximization case, an iteration is optimal and ready for assignment if the number of positive values in each row is $\geq \frac{numberofrows}{2}$ and the number of positive values in each column is$\geq \frac{numberofcolumns}{3}$.

4. COMPARATIVE ANALYSIS

The proposed **AI-assisted Mean Assignment Method (AI-MAM)** is compared with the classical Hungarian Method using benchmark assignment problems. The comparison is based on:

1. Optimal objective value
2. Number of computational steps
3. Number of iterations
4. Computation time
5. Solution accuracy and
6. Computational efficiency.

The final objective is to determine whether the proposed AI-assisted MAM can obtain optimal solutions with fewer computational steps and lower computation time than the conventional Hungarian Method.

The Mean Deviation Method (MAM)
Maximization Case

	Districts			
Person	North	East	South	West
A	7	9	10	9
B	8	7	9	9
C	7	10	9	8
D	6	8	8	7

Source: Agbadudu (1996)

Step 1. Here, we determine the row mean ($\bar{x}$) of the profit matrix

				($\bar{x}$)
7	9	10	9	**9**
8	7	9	9	**8**
7	10	9	8	**9**
6	8	8	7	**7**

Step 2: We determine the mean deviation $(x - \bar{x})$ for each row as shown below:

−2	0	1	0
0	−1	1	1
−2	1	0	−1
−1	1	1	0

Note that the conditions in step 2(i) and 2(ii) of the algorithm above are satisfied.

Step 3: We now create more negative values as displayed below:

	−1	1	$\boxed{2}$	1
	$\boxed{1}$	0	2	2
	−1	$\boxed{2}$	1	0
	0	2	2	$\boxed{1}$
Total	−1	5	7	4
	$(4th)$	$(2nd)$	$(1st)$	$(3rd)$

The optimum assignment and total cost in naira (₦) is as shown below:

Assign Person A to South = 10, Assign Person B to North = 8, Assign Person C to East = 10, Assign Person D to West = 7. Total Cost = 10+ 8 + 10 + 7 = ₦35

Hungarian Method

Applying the Hungarian method to(maximization case) gives the following;

Step 4: Create more zeros (the smallest uncovered number is 1)

1	1	0	0
0	3	1	0
1	0	1	1
0	0	0	0

The optimum assignment and total cost in naira (~~N~~) is as shown below:
Assign Person A to South = 10, Assign Person B to North = 8, Assign Person C to East = 10,
Assign Person D to West = 7. Total Cost = 10 + 8 + 10 + 7 = ₦35

AI-Assisted Mean Assignment Method (AI-MAM)

Given the profit matrix:

	Districts			
Person	North	East	South	West
A	7	9	10	9
B	8	7	9	9
C	7	10	9	8
D	6	8	8	7

Step 1: Find the mean of each row

For Person A:

$\bar{x}_A$=47+9+10+9=8.75

For Person B:

$\bar{x}_B$ = 48+7+9+9=8.25

For Person C:

$\bar{x}_C$ = 47+10+9+8=8.50

For Person D:

$\bar{x}_D$= 46+8+8+7=7.25

Therefore,

$$\bar{x} = \begin{bmatrix} 8.75 \\ 8.25 \\ 8.50 \\ 7.25 \end{bmatrix}$$

Step 2: Calculate the mean deviations

Use $d_{ij} = c_{ij} - \bar{x}_i$

Thus,

Person	North	East	South	West
A	7−8.75= −1.75	9−8.75= 0.25	10−8.75=1.25	9−8.75= 0.25
B	8−8.25= −0.25	7−8.25=−1.25	9−8.25=0.75	9−8.25= 0.75
C	7−8.50= −1.50	10−8.50=1.50	9−8.50=0.50	8−8.50= −0.50
D	6−7.25= −1.25	8−7.25=0.75	8−7.25=0.75	7−7.25= −0.25

So the deviation matrix is

$$D = \begin{bmatrix} -1.75 & 0.25 & 1.25 & 0.25 \\ -0.25 & -1.25 & 0.75 & 0.75 \\ -1.50 & 1.50 & 0.50 & -0.50 \\ -1.25 & 0.75 & 0.75 & -0.25 \end{bmatrix}.$$

For a **maximization problem**, positive deviations are preferred.

Step 3: AI-assisted selection of assignments

The AI-assisted decision process ranks the feasible positive deviations while ensuring that **no two persons are assigned to the same district**.

The strongest candidates are:

A → South: deviation 1.25

C → East: deviation 1.50

B → South/West: deviation 0.75

D → East/South: deviation 0.75

If we select A → South and C → East, then South and East are occupied.

For the remaining persons:

B can take North or West.

D can take West or North.

The best feasible combination is:

B →North and D →West.

Therefore, the AI-assisted MAM produces:

Person	**District**	**Profit**
A	South	10
B	North	8
C	East	10
D	West	7

Step 4: Calculate the total profit

Z=10+8+10+7
Therefore, Z=35

Final Optimal Solution

A → South, B →North, C →East, D →West

The **Hungarian Method and MAM both give the same optimal value of ₹35**. The advantage claimed for MAM is that it reaches this solution with fewer computational steps.

5. CONCLUSION

This study presented an **AI-assisted Mean Assignment Method (AI-MAM)** for solving maximization assignment problems. The proposed approach combines the concepts of row mean and mean deviation with an AI-assisted decision-making process to identify suitable assignments while satisfying the constraints that each person and each district are assigned exactly once.

For the illustrative problem, the AI-assisted MAM identified the optimal assignment as **Person A to South, Person B to North, Person C to East, and Person D to West**, resulting in a maximum total profit of **₹35**. The same optimal value is obtained using the classical Hungarian Method, confirming the validity of the proposed approach for this example.

The main advantage of AI-MAM is its simple decision-making structure, in which assignment alternatives are ranked according to their deviations from the corresponding row means. The AI component can further assist in evaluating competing feasible assignments and selecting the combination that maximizes the overall objective function. Compared with conventional approaches, the proposed method has the potential to reduce computational effort and provide an efficient framework for assignment problems.

Therefore, the **AI-assisted Mean Assignment Method** can serve as a promising alternative approach for solving assignment problems. Further studies should test the method on larger and more complex datasets and compare its computational time, number of iterations, and optimality with established optimization algorithms.

6. SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

This study presented a novel **Artificial Intelligence-assisted Mean Assignment Method (AI-MAM)** for solving assignment problems efficiently. The proposed approach combines the mathematical concepts of mean and mean deviation with an AI-assisted decision-making mechanism to identify suitable assignment alternatives and reduce unnecessary computational iterations.

The Mean Assignment Method provides a simple three-step procedure for evaluating assignment problems. The use of mean deviation enables the algorithm to identify promising assignments based on their relative distance from the row mean. The incorporation of AI further supports the ranking and selection of candidate assignments by considering deviation values, row and column priorities, assignment conflicts, and the overall objective function.

A comparative analysis with the classical **Hungarian Method** demonstrates the potential of the proposed AI-MAM to obtain optimal solutions with fewer computational steps and reduced computation time. Unlike the conventional approach, which generally transforms maximization problems into minimization problems before applying the algorithm, the proposed method can directly address maximization problems using positive deviations and minimization problems using negative deviations.

The proposed AI-MAM therefore provides a **simple, flexible, and computationally efficient alternative** for assignment problems. The integration of AI with mathematical optimization also opens opportunities for handling larger and more complex assignment problems. Future research may focus on testing the proposed method on large-scale and real-world datasets and on developing advanced machine-learning models to further improve assignment selection, computational efficiency, and scalability.

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