International Journal of Advance Research in Science and Engineering
Volume No. 11, Issue No. 05, May 2022
www.ijarse.com
IJARSE
ISSN 2319 - 8354

A Computational Study on Assignment Problem with Ramanujan Primes: Case (III)

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Abstract

The goal of this research is to look at a specific instance of the Assignment Problem. It is produced by treating Ramanujan Primes as cost assignments. Some cases have been thoroughly examined. Few new discoveries have been made. This study discovered the generalised optimal assignments in different cases. The tables with detailed computational values for various scenarios are given.

1.INTRODUCTION:

One of the well-known methods for obtaining extremely good assignments for the given assignment problem is the Hungarian method.

Phase (i): The first and most important priority is to determine whether the given assignment problem is balanced. If the problem is not a balanced assignment problem, it should be converted by inserting dummy rows or columns with zero cost values.

Phase (ii): In this phase, find the minimum element in the first row and subtract it from the remaining elements in the first row. The procedure is repeated for the remaining rows. Similarly, find the smallest element in the first column and subtract it only from the first column's remaining elements. It is also extended to the remaining columns.

Phase (iii): Examine the rows sequentially to find the one zero in each row and assign it to the single zero by encircling it.The remaining zeroes in its column are crossed out. Repeat the process until all of the zeroes in the rows and columns are either encircled or crossed out.

Phase(iv): The optimum condition is defined as the number of assigned zeroes being equal to the number of rows/columns. If the current phase meets the optimality condition, the positions of assigned zeroes will provide the optimal assignment, and the sum of the cost values of the respective positions will provide the optimal solution (i.e. Total minimum cost of the assignment problem).

Phase(v):Consider the concept of drawing the fewest number of lines covering all zeroes, including assigned zeroes and crossed out zeroes, at the stage of not satisfying optimality condition at any cycle. It is always preferable to take the smallest number of lines that is less than or equal to the number of rows/columns.

Phase(vi):Consider the minimum element from the uncovered elements that will be subtracted from all of the uncovered elements in phase (vi). This minimum element will be added at the point where horizontal and vertical lines intersect. The remaining elements that are crossed by a single line are left alone. Repeat the process from phase (iv) until we find the best solution.

3. BASIC ASSIGNMENT MODEL:

3.1 Case(A) :

The mathematical model of assignment problem in case (i) is defined as

$$Min / Max\ Z = \sum_{i=1}^{4}\sum_{j=1}^{4} c_{ij}x_{ij}$$

Subject to the constraints:

$$\sum_{i=1}^{5} x_{ij} = 1 \text{ for j=1,2,3 and 4}$$

$$\sum_{j=1}^{5} x_{ij} = 1 \text{ for i=1,2,3 and 4}$$

x_{ij} = either 0 or 1 for all i,j

Here x_{ij} denotes the assignment of i^{th} resource to j^{th} activity with the successive numbers of Ramanujan primes column wise.

Table-1: Tabular Form of 4x4 Assignment Problem with Ramanujan primes

4x4	I	II	III	IV
A	2	41	71	127
B	11	47	97	149
C	17	59	101	151
D	29	67	107	167

Table-2: Hungarian Method With 4x4 Assignment Problems in Minimization Casewith cycle-1

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Minimization (4X4)	**C1**	**(A,III), (B,II), (C,I).**	**P_{32},P_{33},P_{34}, P_{42},P_{43},P_{44}**	**3**	**(A,III), (B,II), (C,IV), (D,I).**	**298**

Table-3: Hungarian Method With 4x4 Assignment Problems in Minimization Casewith cycle-2

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Minimization (4X4)	**C2**	**(A,III), (B,II), (C,I)**	**P_{23},P_{24},P_{33}, P_{34},P_{43},P_{44}**	**3**	**(A,III), (B,II), (C,IV), (D,I).**	**298**

Table-4: Hungarian Method With 4x4 Assignment Problems in Minimization Casewith cycle-3

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Minimization (4X4)	**C3**	**(A,III), (B,II), (C,I)**	**P_{23},P_{24},P_{33}, P_{34},P_{43},P_{44}**	**3**	**(A,III), (B,II), (C,IV), (D,I).**	**298**

Table-5: Hungarian Method With 4x4 Assignment Problems in Minimization Casewith cycle-4

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Minimization (4X4)	C4	(A,III), (B,II), (C,IV), (D,I)	*	*	(A,III), (B,II), (C,IV), (D,I).	298

Table-6: Hungarian Method With 4x4 Assignment Problems inMaximization Case with cycle-1

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Maximization Type (*5x5*)	C1	(A,I), (B,IV), (C,III)	P_{21},P_{22},P_{23}, P_{41},P_{42},P_{43}	3	(A,I), (B,III), (C,II), (D,IV)	325

Table-7: Hungarian Method With 4x4 Assignment Problems inMaximization Case with cycle-2

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Maximization Type (*5x5*)	C2	(A,I), (B,III), (D,IV)	P_{21},P_{22},P_{31},P_{32}	4	(A,I), (B,III), (C,II), (D,IV)	325

Table-8: Hungarian Method With 4x4 Assignment Problems inMaximization Case with cycle-3

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Maximization Type (5x5)	C3	(A,I), (B,III), (C,II)	P_{41},P_{42},P_{43},P_{44}	3	(A,I), (B,III), (C,II), (D,IV)	325

Table-9: Hungarian Method With 4x4 Assignment Problems inMaximization Case with cycle-4

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Maximization Type (5x5)	C4	(A,I), (B,III), (C,II), (D,IV)	*	*	(A,I), (B,III), (C,II), (D,IV)	325

Table-10: Bottle Neck Method With 4x4 Assignment Problem in Minimization Case with cycle-1

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Minimization (4X4)	C1	(A,III), (B,II), (C,I).	P_{32},P_{33},P_{34}, P_{42},P_{43},P_{44}	3	(A,IV), (B,III), (C,II), (D,I)	312

Table-11: Bottle Neck Method With 4x4 Assignment Problem in Minimization Case with cycle-2

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Minimization (4X4)	C2	(A,III), (B,II), (C,I)	P_{32},P_{33},P_{34}, P_{42},P_{43},P_{44}	3	(A,IV), (B,III), (C,II), (D,I)	312

Table-12: Bottle Neck Method With 4x4 Assignment Problem in Minimization Case with cycle-3

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Minimization (4X4)	C3	(A,III), (B,II), (C,I)	P_{33},P_{34},P_{43},P_{44}	4	(A,IV), (B,III), (C,II), (D,I)	312

Table-13: Bottle Neck Method With 4x4 Assignment Problem in Minimization Case with cycle-4

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Minimization (4X4)	C4	(A,III), (C,II), (D,I)	P_{21},P_{22},P_{23},P_{24}	3	(A,IV), (B,III), (C,II), (D,I)	312

Table-14: Bottle Neck Method With 4x4 Assignment Problem in Minimization Case with cycle-5

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Minimization (4X4)	**C5**	**(A,IV),(B,III), (C,II),(D,I)**	*	*	**(A,IV), (B,III), (C,II), (D,I)**	**312**

Table-15: Bottle Neck Method With 4x4 Assignment Problem inMaximization Case with cycle-1

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Maximisation (4X4)	**C1**	**(A,IV), (D,I)**	**P_{11},P_{12},P_{13}, P_{21},P_{22},P_{23}**	**3**	**(A,IV), (B,III), (C,II), (D,I)**	**312**

Table-16: Bottle Neck Method With 4x4 Assignment Problem inMaximization Case with cycle-2

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Maximisation (4X4)	**C2**	**(A,IV),(D,I)**	**P_{11},P_{12},P_{13}, P_{21},P_{22},P_{23}**	**3**	**(A,IV), (B,III), (C,II), (D,I)**	**312**

International Journal of Advance Research in Science and Engineering
Volume No. 11, Issue No. 05, May 2022
www.ijarse.com
IJARSE
ISSN 2319 - 8354

Table-17: Bottle Neck Method With 4x4 Assignment Problem inMaximization Case with cycle-3

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Maximisation (4X4)	C3	(A,IV), (B,II), (D,I)	P_{21},P_{22},P_{31},P_{32}	4	(A,IV), (B,III), (C,II), (D,I)	312

Table-18: Bottle Neck Method With 4x4 Assignment Problem inMaximization Case with cycle-4

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Maximisation (4X4)	C4	(B,III), (C,II), (D,I)	P_{11},P_{12},P_{13},P_{14}	3	(A,IV), (B,III), (C,II), (D,I)	312

Table-19: Bottle Neck Method With 4x4 Assignment Problem inMaximization Case with cycle-5

Objective Function Type	Cycle	Assigned Zero Positions	Positions Of Uncovered Elements	Minimum No. Of Lines In Cycle Wise	Optimal Assignment	Total Assignment Cost
Maximisation (4X4)	C5	(A,IV), (B,III), (C,II), (D,I)	*	*	(A,IV), (B,III), (C,II), (D,I)	312

4. CONCLUSIONS:

In this specific case study on the assignment problem with RamanujanPrimes,
The following observations are made:

(i).The movement of uncovered elements varies on a regular basis, cycle after cycle and size after size.

(ii).As we approach the ideal situation, all assigned zeros must be covered by a minimum number of lines, and any extra zeros play an important role in many cycles.

(iii).In this model's Minimization and Maximization scenarios, the Hungarian approach and Bottleneck method successfully extract potential Optimum Assignments and Total cost values.

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