



## Solving a travelling salesman problem with heuristic model approach and comparing with AMPL solution

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### Article information

#### Article history:

Received November 22, 2019

Accepted March 7, 2020

Available online December 1, 2020

#### Keywords:

Programming,  
Optimization,  
AMPL Programming,  
constraints

### Abstract

The paper will focus on the two strategies to take care of the TSP issue of a book shop. The TSP issue arrangement finds the ideal course which advances the course and cost. The paper shows the examination aftereffect of Hungarian strategy hand approach and AMPL program. The client characterized work is associated with AMPL to take care of a progressively muddled issue. This shows the better outcome between the both. The motivation behind the paper is to discover the figuring by AMPL programming and approach for ideal course. The AMPL writing computer programs is utilized for the arrangement of Linear and Non direct conditions. Right now we are examining the issue of book retailer who needs to visit the five urban areas to satisfy the interest.

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DOI: [10.33899/IQJOSS.2020.182153](https://doi.org/10.33899/IQJOSS.2020.182153), ©Authors, 2020, College of Computer Science and Mathematics, University of Mosul.

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## 1- Introduction

The TSP issue manages the briefest visit in n-urban areas, where every city is visited precisely once before coming back to the beginning stage. The related TSP model is characterized by two bits of information. The quantities of urban communities are 'n'. The separations  $d_{ij}$  between urban communities  $i$  and  $j$  ( $d_{ij} = \infty$  if urban areas  $i$  and  $j$  are not connected). The greatest number of visits in a n-city circumstances is  $!(n-1)$  (Jain and Bhanat, 2012) [5] Introduced task based whole number straight definition. This finished up the task modular that can prompt infeasible arrangement. Infeasibility can be expelled by presenting extra limitations. [5] learned about a sales rep of five urban communities which is consider assigned visit of  $i^{th}$  to  $j^{th}$  city by choice factor  $X_{ij}$ , where  $i, j = 1, 2, 3, 4, 5$ . To illuminate the ILPP, programming LINGO rendition 11 was utilized. Topsy-turvy Traveling sales rep issue is contemplated with TIME WINDOW (ATSP-TW) by (Fischetti and Grosschal, 2001) [2]. The genuine word application focus on is the control of a stacker crane in a warehouse. TSP is the streamlining issue yet with expanding the quantity of urban areas it is changed over in the mind boggling voyaging issue. (Gupta and Panwar, 2013) [3]. (Nilofar and Rizwanullah, 2017) [7] upgrade conveying of bundles at twelve arbitrarily picked pizza focuses in the city of Jaipur. This issue is otherwise called the Traveling Salesman Problem. The Traveling sales rep issue includes a sales rep who must make a voyage through various urban communities utilizing the most brief way. Right now least cost voyage through scarcely any pizza focuses is required, which are associated [7] close Traveling Salesman Problem can figured out by utilizing Two optimality and Branch and Bound technique, Branch and Bound strategy is better as it readies the framework in various advances. At each progression the cost network is determined. This strategy is anything but difficult to apply and can be used for the

Traveling Salesman Problem. (Yakovela and Fleyn, Working Paper arrangement 20) [12] Presented a mapping of chicken stockpile chains and investigates information sources and yields of the frameworks which have significant ramifications for the maintainability. This paper aims to build up linkages among development and supportability of the nourishment framework. hereditary calculation, insect settlement streamlining and counterfeit neural system which has various methodologies and various parameters for taking care of the voyaging sales rep issue. (Chaudhary, Jain, and Pal, 2016) [1] Portrayed Genetic calculations (GA) are essentially founded on natural selection chromosome among the species which are created by arbitrary changes in their quality structure in the developmental science. (Htun, 2018) [4] Explored on different calculations like Ant Colony Optimization Algorithms (ACO), Particle Swarm Optimization (PSO) and Genetic Algorithms (GA) accessible with particular ascribes to discover the closest ideal answer for the voyaging sales rep issue. It additionally relates the voyaging sales rep issue with the accessible calculations and gives the preferences in giving an answer for TSP. The plan of TSP depict by the (Matai, Singh, and Mittal) [6]. As indicated by [6] the TSP is the most ideal approach to visiting all urban areas by sales rep and coming back to the beginning stage with ideal expense. (Sharma and Shrimali, 2017) [9] Studied to discover the job of Operations Research systems for made an occupation task model which help to enhance the work profitability and cost minimize regarding time. (Sharma and Sharimali, 2017) [8] Studied the job of Operations Research strategies for structuring a Material Handling model which will assist with enhancing the profitability and lessen cost. (Waight and Chang, 2001) [11] Presented encounters with blended number straight programming based present moment hydro planning. The point by point MILP definition of the STHS issue is depicted and a productive arrangement strategy with the utilization of a propelled displaying/streamlining bundle is proposed. (Schouwenaars, Moor, and Feron, 2001) [10] Conclude direction arranging of different vehicles that legitimately fuses crash shirking as blended number/straight limitations. A scientific programming Formulation has been proposed including paired imperatives for stationary and moving impediment evasion and multi-vehicle way arranging.

## 2- Preliminary

Advancement assumes a significant job in taking care of different designing issues which are Non-deterministic in nature. The objective of the improvement procedure is to decide either a greatest or a base estimation of the issue being settled, for the most part known as the goal work. These issues incorporate, yet not constrained to, frameworks structure, power arrange activity, power age, remote correspondences directing and minimization of vitality misfortunes during power transmission. Appropriate proportions of effectiveness of streamlining calculations require appraisal of computational time and combination rate notwithstanding the precision to decide the base or most extreme qualities. Cuckoo Search Optimization (CSO) is one such meta-heuristic calculation which imitates brood parasitism discovered cuckoo's. The eggs of the fledgling speak to the potential arrangements. Step by step, the calculation replaces the poor arrangements with new and better arrangements. The CSO has a few applications in different fields, for example, neural systems, work planning, and so forth. One such issue which can be explained with Cuckoo Search Optimization is Traveling Salesman Problem. TSP model is defined by the number of cities  $n$  and distance matrix  $\|d_{ij}\|$ , the definition of a tour disallows linking a city to itself by assigning a very high penalty to the diagonal elements of the distance matrix. A TSP is symmetric if  $d_{ij} = d_{ji}, \forall i, j$  otherwise the TSP is asymmetric.

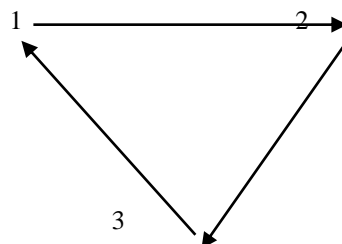
We define  $x_{ij} = \begin{cases} 1, & i = j \\ 0, & i \neq j \end{cases}$

That is if city 'j' is reached from city 'i', then value assign 1 and otherwise 0.

The TSP model is given as

$$\text{Min. } Z = \sum_{i=1}^n d_{ij} \sum_{j=1}^n x_{ij} \text{ and } d_{ij} = \infty, \forall i = j$$

If we discuss the 5- cities problem then there will be some sub tour. So eliminate the sub tours by mathematical condition. In TSP problem prefer the Hamiltonian route which connects with all the nodes. Each Full tour associates with the sub tours. As per the five cities problem of TSP there can be consider the sub tours



These types of sub tours have to be eliminated by the constraint. So, there introduce the constraint.

### 3- Methodology

The maximum numbers of tours in an  $n$  city problem is  $!(n-1)$ . Assignment Model is also the type of TSP problem. Where we can find the optimized path of salesman with the assigning the path. The Hungarian method here we apply to solve the problem of a book salesman. Here we approach to solve the problem as a sales man who lives in Basin must visit the four cities. Once a month he has to tour among four cities Wald, Bon, Mena and Kiln. The distances from Basin to Wald 120 Milles, Basin to Wald 220 Miles, Basin to Mena 150 Miles and Basin to Kiln 210 Miles. There we have the data of distances between cities in table

	Delhi	Ghaziabad	Meerut	Noida	Ludhiana
Delhi	0	120	220	150	120
Ghaziabad	120	0	80	110	130
Meerut	220	80	0	160	185
Noida	150	110	160	0	190
Ludhiana	210	130	185	190	0

In this touring problem our purpose is to minimize the cost and touring distance respectively. In Hungarian approach first we change the all diagonal zero's to dashes or infinity symbols. Now The Distance matrix can be written as

	Delhi	Ghaziabad	Meerut	Noida	Ludhiana
Delhi	$\infty$	120	220	150	120
Ghaziabad	120	$\infty$	80	110	130
Meerut	220	80	$\infty$	160	185
Noida	150	110	160	$\infty$	190
Ludhiana	210	130	185	190	$\infty$

Now this distance matrix is converted to the assignment problem matrix. Now we can apply the Row reduction, in this the row minimum number subtracted by the others number of row, So we get the resultant matrix

	Delhi	Ghaziabad	Meerut	Noida	Ludhiana
Delhi	$\infty$	0	100	30	90
Ghaziabad	40	$\infty$	0	30	50
Meerut	140	0	$\infty$	180	105
Noida	40	0	50	$\infty$	80
Ludhiana	80	0	55	60	$\infty$

Now we can apply the column reduction and get the resultant matrix

	Delhi	Ghaziabad	Meerut	Noida	Ludhiana
Delhi	$\infty$	0	50	0	40
Ghaziabad	0	$\infty$	0	0	0
Meerut	100	0	$\infty$	50	55
Noida	0	0	0	$\infty$	30
Ludhiana	40	0	5	30	$\infty$

Now by the assigning process, allot the Zero from row one and cross the entire zero in that row and column. And find the resultant matrix

	Delhi	Ghaziabad	Meerut	Noida	Ludhiana
Delhi	$\infty$	30	100	0	50
Ghaziabad	0	$\infty$	0	0	0
Meerut	100	0	$\infty$	20	25
Noida	0	0	20	$\infty$	0

Ludhiana	40	0	25	0	$\infty$
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The resultant matrix is showing the assigned path to the salesman for optimize the tour path. Here by Hungarian heuristic approach provide the path for this problem. In this problem, there are two paths we find 1-4-1 and 1-4-5. The path 1-4-1 cannot be considered because it will be a sub tour. So we consider the path for salesman is 1-4-5-2-3 -1. N Here the distance find 1-4 = 150, 4-5 = 190, 5-2 = 130, 2-3 = 80, 3-1 = 220. The total distance cover by the salesman is 770 miles. Presently we ascertain the way of this issue with AMPL programming. What's more, contrast the arrangement and the hand approach ideal arrangement by Hungarian technique. What's more, contrast the arrangement and the hand approach ideal arrangement by Hungarian technique. AMPL is a demonstrating programming approach for increasingly complex scientific issues. It is a decisive and basic programming style. AMPL is well-known configuration portrayal of complex scientific issues. Complex scientific detailing issue streamlining models characterize through revelatory language components, for example, scalar, sets, multidimensional parameters and choice factors, imperatives and destinations, which permit giving the improvised arrangement of complex numerical issues in the area of scientific enhancement.

#### AMPL PROGRAMMING:-

FILE NAME:- tsp.mod

```

minimize z:
    sum{i in city, j in city} DIST[i,j]*x[i,j];

subject to
    # exactly one outgoing
    c1{k in city}: sum{i in city} x[i,k] = 1;

    # exactly one incoming
    c2{k in city}: sum{j in city} x[k,j] = 1;

    # no subtours
    c3{k in city, j in city: j > 1 and k > 1}:
        U[j] - U[k] + N*x[j,k] <= N-1;

data;
param: city: names :=
    1 "DELHI"
    2 "GAJIYABAD"
    3 "MEERUT"
    4 "NOIDA"
    5 "LUDHIYANA"
;

param DIST: 1 2 3 4 5 :=
    1 50000 120 220 150 210
    2 120 50000 80 110 130
    3 220 80 50000 160 185
    4 150 110 160 50000 190
    5 210 130 185 190 50000
;

Result:-
ampl: include welcome.run
CPLEX 12.6.3.0: optimal integer solution; objective 725
24 MIP simplex iterations
0 branch-and-bound nodes
z = 725

x [*,*]
: 1 2 3 4 5 :=

```

```

1  0  0  0  1  0
2  1  0  0  0  0
3  0  1  0  0  0
4  0  0  0  0  1
5  0  0  1  0  0
;

U [*] :=
1  0
2  4
3  2
4  0
5  1
;

1 (DELHI) -> 4 (NOIDA) [1.00]
2 (GAJIYABAD) -> 1 (DELHI) [1.00]
3 (MEERUT) -> 2 (GAJIYABAD) [1.00]
4 (NOIDA) -> 5 (LUDHIYANA) [1.00]
5 (LUDHIYANA) -> 3 (MEERUT) [1.00]
CPLEX 12.6.3.0: optimal integer solution; objective 725
22 MIP simplex iterations
0 branch-and-bound nodes
z = 725

x [*,*]
:   1   2   3   4   5   :=
1  0   0   0   1   0
2  1   0   0   0   0
3  0   1   0   0   0
4  0   0   0   0   1
5  0   0   1   0   0
;

U [*] :=
1  0
2  4
3  2
4  0
5  1
;

```

#### **4- Result & Conclusion**

Voyaging Salesmen issue is the predominant idea of concern for the Operations research. Here in the validity of TSP with the customary strategy and AMPL programming is duly examined. After the proper exam the results of the both methods, it can be concluded that the TSP with AMPL is better way of solving. With both the way and we discover the consequence of TSP and analyze the outcome which is increasingly idealistic. The complete separation spread by the sales rep is 770 miles with the Hungarian heuristic methodology. What's more, to take care of the issue with the AMPL programming we found the separation spread by sales reps 725 miles. The AMPL programming give the base separation spread by sales reps which is 45 miles lower than the outcome by heuristic methodology. AMPL programming is the better tool to avoid the mistake during calculate the optimum path. The result shows that AMPL composing PC programs is likewise the methodology for settle the TSP model. With the AMPL PC programming the mistake can be take out which might be happen with conventional estimation technique.

## 5- Reference

1. Chaudhary, D. D, Jain, R., and Pal, A, (2016), "Review Paper on Solving the Travelling Salesman Problem Using Genetic Algorithm, Ant Colony Optimization, Artificial Neural Network", International Journal of Advanced Research in Computer and Communication Engineering , issue 6.
2. Fischetti, M., and Grosschal, M. (2001),"Researchgate. Article in mathematical programming".
3. Gupta, S., and Panwar, P., ( 2013),"Solving Travelling salesman problem using Genetic Algorithm", International journal of advanced research in computer science and software engineering , Vol.3.
4. Htun, T. T., (2018), "A Survey Review on Solving Algorithms for Travelling Salesman Problem (TSP)", International journal of scienetific and research publication , Volume 8.
5. Jain, L., and Bhanat, A. (2012), "Traveling salesman problem: A case study", International journal of computers & Technology , Vol.3,No.1.
6. Matai, R., Singh, S. P., and Mittal, M. L. (2010)," Travelling Sales problem: An overview of Applications, formulation, and solution approach".
7. Nilofar, and Rizwanullah, M. (2017)," The new approach to travelling sales man problem using branch and bound methos with case study of Dommino's Pizza. Advance in fuzzy Mathematics" , Volume-12.
8. Sharma, G. S., and Shrimali, S. (2017). "Operations research Mode for Enhancing Productivity of Material Handling", International Journal of Current Advanced Research , volume 6.
9. Sharma, G. S., and Shrimali, S.(2017), "Operations Research Model for Mnpower productivity Enhancement in industries, International Journal of Current Advanced Research , volume 6.
10. Schouwenaar, Tom., and Moor, ( 2001), "MIXED INTEGER PROGRAMMING FOR MULTI-VEHICLE PATH PLANNING", ECC2001 conference.
11. Waight, J. G., and Chang, G. W. (2001),"ExperiencesWith Mixed Integer Linear Programming Based Approaches on Short-Term Hydro Scheduling", IEEE , vol.16.
12. Yakovela, N., and Fleyn, A. (Working Paper series 20), "Innovation and the Food Supply Chain: a Case Study of Chicken", The Centre For Business Relationships .

## حل مشكلة بائع متجول باستخدام نهج النموذج الإرشادي والمقارنة مع حل AMPL

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قسم الرياضيات ، كلية بورنيما للهندسة ، جايبور

**الخلاصة:** ستركز الورقة على الاستراتيجيتين للعناية بمسألة TSP لمتجر الكتب. يجد ترتيب مشكلة برنامج TSP الدورة التدريبية المثالية التي تقدم الدورة التدريبية والتكلفة. تُظهر الورقة أثر فحص النهج اليدوي الإستراتيجي الهنغاري وبرنامج AMPL. يرتبط العمل المميز للعميل بـ AMPL لمعالجة مشكلة مشوشة بشكل تدريجي. هذا يدل على نتيجة أفضل بين الاثنين. الدافع وراء هذه الورقة هو اكتشاف طريقة برمجة AMPL ومنهج الدورة التدريبية المثالية. يتم استخدام برامج الكمبيوتر المكتوبة AMPL لترتيب الشروط الخطية وغير المباشرة. في الوقت الحالي ، ندرس قضية بائع الكتب بالتجزئة الذي يحتاج إلى زيارة المناطق الحضرية الخمس لإرضاء الاهتمام.

**الكلمات المفتاحية:** برمجة؛ تحسين؛ برمجة AMPL ؛ قيود