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Optimal travel route for different destinations in Kathmandu valley using travelling salesman problem using excel spreadsheet

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Abstract
This report deals with the shortest distance problem for the tourist to visit different places within Kathmandu valley exactly once and finally return to the starting place. The places can be chosen by the tourist himself/herself. This problem is based on the Travelling Sales-man Problem. This report gives a solution to find an optimum route for tourist using Evolu-tionary Algorithms (EA) technique to reduce the localization of the solution thereby giving more accurate result than the nonlinear approach. For the project, 49 different places were selected and by using the user defined function in google script, the distance among they were calculated. The problem was solved in excel spreadsheet and solver was used to find the optimum result i.e. shortest possible for the tourist out of (n-1)! Ways between n num-bers of places. This project help to save the time and money of the tourist by selecting the optimum route. This will certainly flourish the optimization technique in the field of the tourism industry.

Keywords: Optimization, Evolutionary Algorithm, Excel Spreadsheet, Solver

1. Introduction
1.1 Background
Kathmandu is a major tourist destination, and one of the major factors responsible for its popularity is the large number of Hindu temples and Buddhist monasteries. The options you have for some street shopping fun in Kathmandu are Thamel, Asan and Indra Chowk where you can buy good quality clothes. And, if you are into nature and wildlife, Shivapuri National Park and Godawari Botanical Garden, housing a wide variety of flora and fauna, will please your senses.
It will be of great ease to every visitor if they can plan their route with the aim of shortening their travel distance and spend more of the time visiting the places of their interest. Given a set of destination and distance between every pair of cities, the problem is to find the shortest possible route that visits every destination exactly once and returns to the starting point.
Travelling Salesman Problem method addresses the fore mentioned problem. Several approaches are available to formulate the algorithm for TSP namely, naive solution, dynamic programming, approximate minimum spanning tree and more.

1.2 Literature review
The travel itinerary for an executive of a non-profit organization was computed using Con-corde’s TSP solver. The trip involved a chartered aircraft to visit cities in the 48 continental states plus Washington, D.C. (Commercial flights were used to visit Alaska and Hawaii.) It would have been nice if the problem was the same as that solved in 1954 by Dantzig, Fulkerson, and Johnson, but different cities were involved in this application (and some-what different travel costs, since flight distances do not agree with driving distances), (USA Trip, 2005) [4].
The order picking problem associated with material handling in warehouse (Ratliff & Rosenthal, 1983). An order arrives for a certain subset of the items stored in the ware-house. Some vehicle has to collect all items of this order to ship them to the customer. The relation to the TSP is immediately seen. The storage locations of the items correspond to the nodes of the graph. The distance between two nodes is given by the time needed to move the vehicle from one location to the other.

The problem of finding a shortest route for the vehicle with minimum pickup time can now be solved as a TSP (Matai, Singh, & Mittal, 2010) [1].

In May 2004, the traveling salesman problem of visiting all 24,978 cities in Sweden was solved: a tour of length 855,597 TSPLIB units (approximately 72,500 kilometers) was found and it was proven that no shorter tour exists. At the time of the computation, this was the largest solved TSP instance, surpassing the previous record of 15,112 cities through Germany set in April 2001. The current record an 85,900-city tour that arose in a chip-design application. (Optimal 85,900-City Tour, 2008) [2].

1.3 Objectives

1.3.1 Main objective

To formulate a model for the application of Travelling Salesman Problem (TSP) method to calculate shortest path.

1.3.2 Specific objective

To analyze the several constraints that can bring changes in optimal solution to analyze and select the best suitable method for formulating the algorithm to compute feasibility of the model.

1.3.3 Limitations

The accuracy of the data depends on the accuracy of the Google maps.

Only the distance between the nodes were considered neglecting the traffic effect/route ratings.

Not more than 5 destination places have been considered in the array matrix sheet

2. Methodology

2.2.1 Data collection

The primary data for the project is the distance between different tourist area. The script editor in the Google sheet was used to make a user defined function GOOGLEMAPS () using Google maps object. The function was used to calculate the distance among 49 tourist site. The selected tourist sites are:

1. Kathmandu Durbar Square, Kathamndu 44600
2. Patan Durbar Square, Patan 44700
3. Bhaktapur Durbar square, Durbar square, Bhaktapur 44800
4. Nagarkot, Nepal
5. Chandragiri, Nepal
6. Swayambhunath Stupa, Kathmandu 44600
7. Narayanhiti Palace Museum North Gate Rd, Kathmandu 44600
8. Boudhha, Kathmandu 44600
9. Shivapuri Nagarjun National Park Hiking Trail, Budhanilkantha
10. Shree Pashupatinath Temple - Gwola Mahadyo, Pashupati Nath Road 44621, Kathmandu 44600
11. Godawari Botanical Garden, Godawari 44709
12. Thamel, Kathmandu 44600
13. White Monastery, Nagarjun 44600
14. Phulchowki, Ryale 45200
15. Casino Royale, Lal Durbar Marg, Katmandu 44600
16. Taudaha, Kirtipur 44600
17. Dhulikhel, Nepal
18. Chisapani Taal, Haibung
19. Namo Buddha, Kathmandu 45200
20. Kakani, 44900
21. Chitlang, Nepal
22. Lankuri Bhanjyang, 44709
23. Garden of Dreams, Tridevi Sadak, Kathmandu 44600
24. Chabahil, Ring Road, Kathmandu 44600
25. Pimbahal Pokhari Krishna Temple, Pimbahal Marg Pimbahal, Patan 44600
26. Sundarijal, Nepal
27. Nag Daha, Patan 44700
28. Dakshinkali, Nepal
29. Bungamati, Nepal
30. Chobhar, Kirtipur 44600
31. Kirtipur, 44600
32. Tribhuvan University, TU Rd, Kirtipur 44618
33. AIRPORT HOTEL, Aakarshan International Pvt. Ltd., Aakarshan Bhawan, Sambhu Marga, Kathmandu 44600
34. Guhyeshwori Temple, Kathmandu 44621
35. Jhor Mahankal, 44100
36. Kalanki, Kathmandu
37. Gongabu Bus Park, Kathmandu 44600
38. Institute Of Medicine, TRIBHUVAN UNIVERSITY, Kathmandu 44600
39. Bir Hospital, Kanti Path, Kathmandu 44600
40. Nepal Mediciti Hospital, Nakhkhu Ukalo Road, Nakhkhu Patan, Karyabinayak 44600
41. Grande International Hospital, Tokha Rd, Kathmandu 44600
42. Pulchowk Campus, IOE Pulchwok Cricket Ground, Patan 44600
43. Royal Nepal Golf Club, Kathmandu 44600
44. New Baneshwor, Kathmandu 44600
45. Maitighar, Kathmandu 44600
46. Bhadrakali Marg, Kathmandu 44600
47. Changunarayan Temple, Changunarayan 44600
48. Pilot Baba Ashram, Ghyampe Danda Sadak, Anantalingeshwar

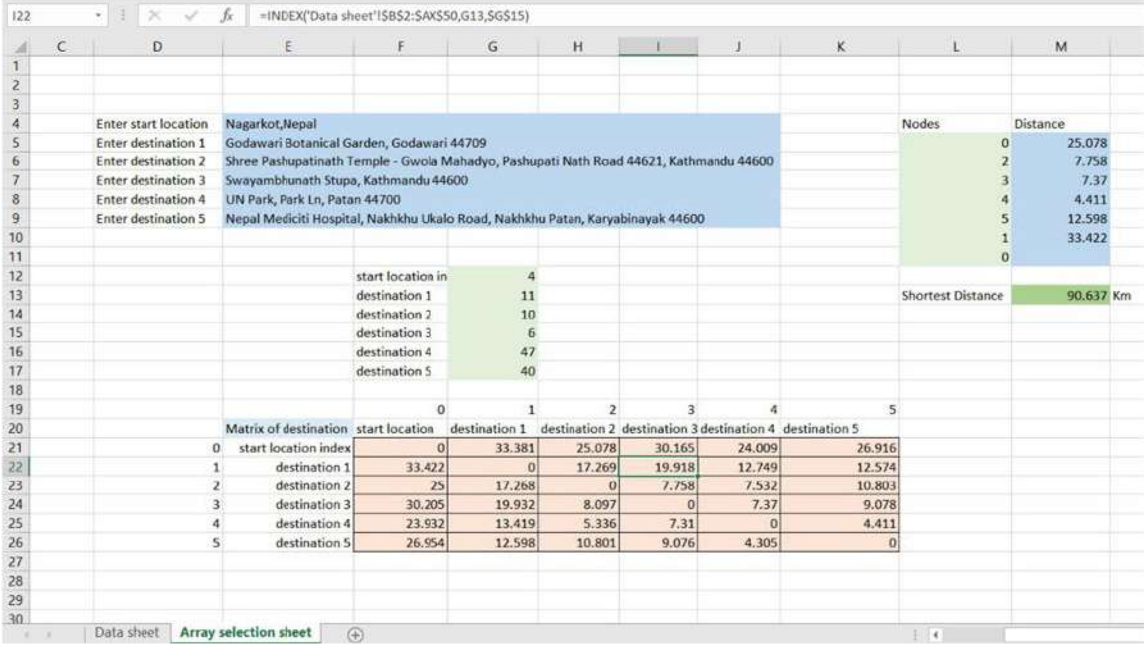
2.2 Modelling of the problem

For n-1 number of places to visit by a tourist, he can take (n-1)! of paths to travel. Not all the paths are optimal for the tourist to travel. Starting at any above locations, a tourist will have approximately 1:241391559 10^{61} paths to visit all the tourist areas. This type of problem commonly called TSP is solved using Evolutionary Algorithms (EA). A start set representing possible solution called chromosomes is given at beginning. Here the path. Each chromosomes has individual value called genes. The genes here can be compared with the node or places to visit. New chromosomes (path) are created by crossover and mutation. Crossover is the probabilistic exchange of values (nodes) between solution vectors. Mutation is the random replacement of values (nodes) in a solution vector. Chromosomes (paths) are then evaluated according to the objective function with the fittest surviving into the next generation. (Ragsdale, 2008). The result is a gene (node) pool that evolves over time to produce better and better solutions to a problem. This model of EA can be used in spreadsheet to obtain more and more better path for the problem. The better path here means the shortest path.

2.3 Spreadsheet modelling of the problem

An excel sheet that uses drop down button to select the start location out of 49 places and enter the maximum of any 5 destination was made. The user's choice was matched from the data sheet and its index returned in array selection sheet.

The matrix of destination was created using INDEX function to take the value of distance among the user selected location from the data sheet. The array selection sheet is shown as below:



I22 =INDEX('Data sheet'!$B$2:$AX$50,G13,$G$15)

Enter start location	Nagarkot,Nepal
Enter destination 1	Godawari Botanical Garden, Godawari 44709
Enter destination 2	Shree Pashupatinath Temple - Gwola Mahadyo, Pashupati Nath Road 44621, Kathmandu 44600
Enter destination 3	Swayambhunath Stupa, Kathmandu 44600
Enter destination 4	UN Park, Park Ln, Patan 44700
Enter destination 5	Nepal Mediciti Hospital, Nakhkhu Ukalo Road, Nakhkhu Patan, Karyabinayak 44600

Nodes	Distance
0	25.078
2	7.758
3	7.37
4	4.411
5	12.598
1	33.422
0	
Shortest Distance	90.637 Km

start location in	4
destination 1	11
destination 2	10
destination 3	6
destination 4	47
destination 5	40

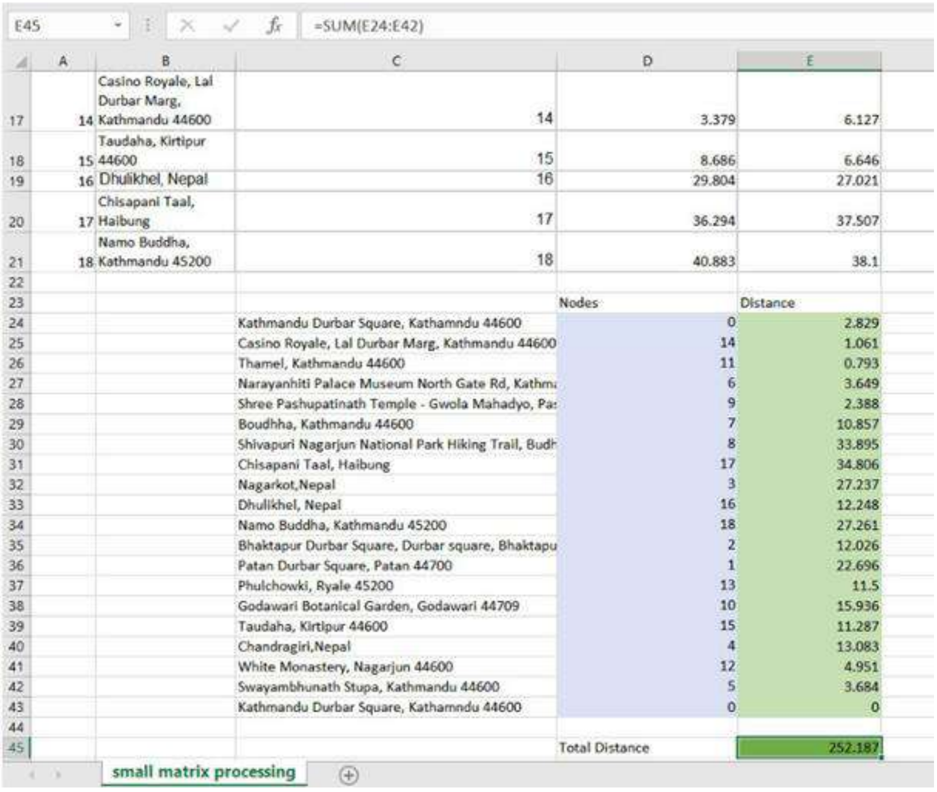
		0	1	2	3	4	5
	Matrix of destination	start location	destination 1	destination 2	destination 3	destination 4	destination 5
0	start location index	0	33.381	25.078	30.165	24.009	26.916
1	destination 1	33.422	0	17.269	19.918	12.749	12.574
2	destination 2	25	17.268	0	7.758	7.532	10.803
3	destination 3	30.205	19.932	8.097	0	7.37	9.078
4	destination 4	23.932	13.419	5.336	7.31	0	4.411
5	destination 5	26.954	12.598	10.801	9.076	4.305	0

Data sheet | Array selection sheet

Fig 1: Array selection sheet

As a sample of spreadsheet, a small matrix processing sheet was created taking 19 places and distance between each of them. The starting point was taken at Kathmandu Durbar square. The distance again was taken from distance matrix between each nodes. The optimal solution is given as:

3. Result



E45 =SUM(E24:E42)

A	B	C	D	E
14	Casino Royale, Lal Durbar Marg, Kathmandu 44600	14	3.379	6.127
15	Taudaha, Kirtipur 44600	15	8.686	6.646
16	Dhulikhel, Nepal	16	29.804	27.021
17	Chisapani Taal, Haibung	17	36.294	37.507
18	Namo Buddha, Kathmandu 45200	18	40.883	38.1

	Nodes	Distance
Kathmandu Durbar Square, Kathamndu 44600	0	2.829
Casino Royale, Lal Durbar Marg, Kathmandu 44600	14	1.061
Thamel, Kathmandu 44600	11	0.793
Narayanhiti Palace Museum North Gate Rd, Kathm	6	3.649
Shree Pashupatinath Temple - Gwola Mahadyo, Pa	9	2.388
Boudhha, Kathmandu 44600	7	10.857
Shivapuri Nagarjun National Park Hiking Trail, Budh	8	33.895
Chisapani Taal, Haibung	17	34.806
Nagarkot,Nepal	3	27.237
Dhulikhel, Nepal	16	12.248
Namo Buddha, Kathmandu 45200	18	27.261
Bhaktapur Durbar Square, Durbar square, Bhaktapu	2	12.026
Patan Durbar Square, Patan 44700	1	22.696
Phulchowki, Ryale 45200	13	11.5
Godawari Botanical Garden, Godawari 44709	10	15.936
Taudaha, Kirtipur 44600	15	11.287
Chandragiri,Nepal	4	13.083
White Monastery, Nagarjun 44600	12	4.951
Swayambhunath Stupa, Kathmandu 44600	5	3.684
Kathmandu Durbar Square, Kathamndu 44600	0	0
	Total Distance	252.187

small matrix processing

Fig 2: Small matrix processing sheet

The mathematical model can be summarized as:
Min: Total distance (Sum of the distances)
Subjected To
Changing variables = all different

The all different constraint can be applied to a range of N changing cells and instruct solver to use a permutation of only the set of integers from 1 to N in those cells. Thus the nodes in the sheet are started from 0 rather than 1. The starting point is given node 0 and thus all other nodes act as changing variables.

4. Result

Considering the locations:

1. Sundarijal, Nepal
2. Godawari Botanical Garden, Godawari 44709
3. Shree Pashupatinath Temple - Gwola Mahadyo, Pashupati Nath Road 44621, Kathmandu 44600
4. Swayambhunath Stupa, Kathmandu 44600
5. 4.UN Park, Park Ln, Patan 44700
6. Nepal Mediciti Hospital, Nakhkhu Ukalo Road, Nakhkhu Patan, Karyabinayak 44600
7. Sundarijal, Nepal

5. Result

If a tourist travels from Sundarijal as the order given above then he will have to travel a distance of 110.121 km on returning back to Sundarijal. The solution in such case is given by below figure:

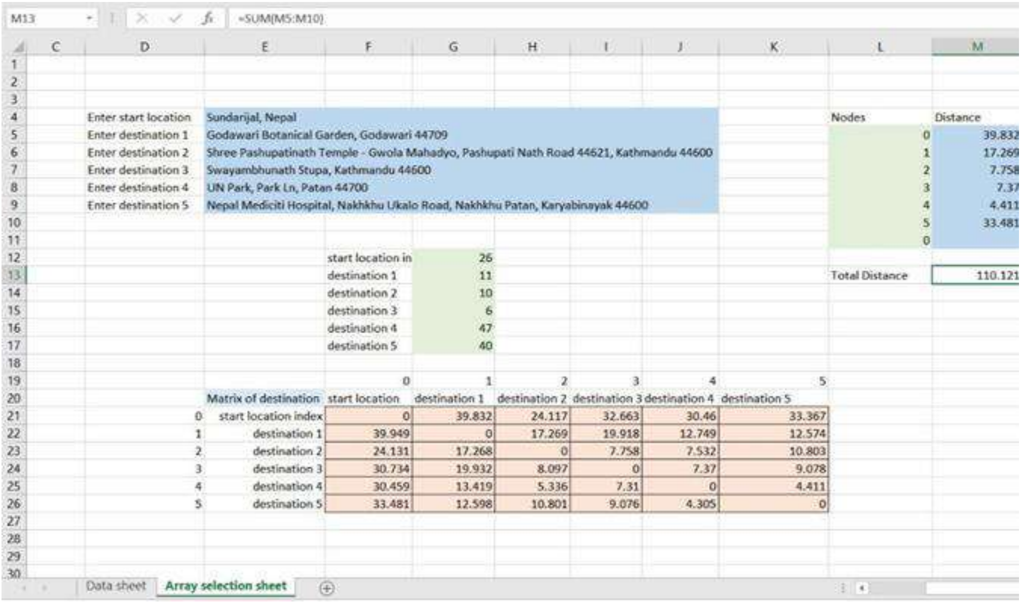


Fig 3: Result without optimal solution

After the solver has found the optimal solution, the route to travel is given by:

1. Sundarijal, Nepal
2. Shree Pashupati Nath Temple - Gwola Mahadyo, Pashupati Nath Road 44621, Kathmandu 44600
3. Swayambhunath Stupa, Kathmandu 44600
4. UN Park, Park Ln, Patan 44700
5. Nepal Mediciti Hospital, Nakhkhu Ukalo Road, Nakhkhu Patan, Karyabinayak 44600
6. Sundarijal, Nepal

The total distance for optimal route was found to be 96.203 km as shown below:

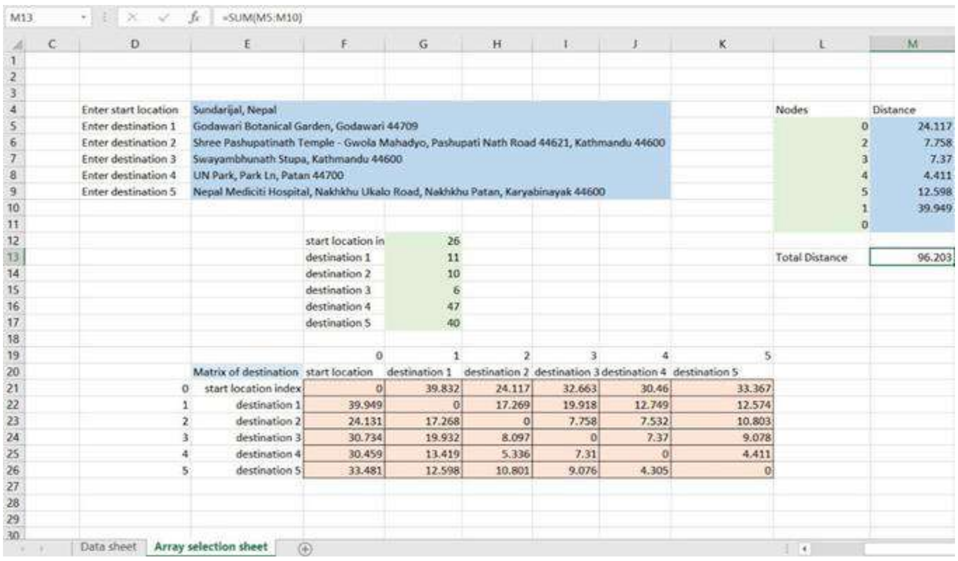


Fig 4: Result with optimal solution

With the optimal route, the saving up to 13.918 km was done which is quite an achievement.

6. Conclusion and Remarks

The Kathmandu valley being one of the main tourist area, the optimal distance to travel can save a lot of time for the tourist. The project done is a basic approach to uplift the tourism industry of Nepal thereby providing the optimal route to the tourist. The use of evolutionary algorithm helps to reduce the localization of the solution thereby giving more accurate result than the non linear approach. On further accounting the traffic system of the valley and the time spent in the area, a more refined optimal route can be established. The further development of this project can be quite helpful to Nepal to ease the visit of tourist and thus attract more and more tourists.

7. References

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