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A Comparative Study of the Brute Force Approach with the Hungarian Method of Solving the Travel Distance Problem of Travelling Salesman Problem from Vijayawada to Mangalagiri (Via Tadepalli) to Reach within the Allotted Time

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Abstract: ***This paper deals with the comparisons of the Travelling Salesman problem with the Hungarian method and the Brute force Approach for solving the travel distance problem from Vijayawada to Mangalagiri (Via Tadepalli). In this paper we had to observe the travel distance from Vijayawada to Mangalagiri (Via Tadepalli) by Bus, Car and Auto to reach within the allotted time. We will use a Brute force Approach and the Hungarian method to study which ride is better to reach Mangalagiri (Via Tadepalli) from Vijayawada.***

Keywords: Travelling Salesman problem, Brute force Approach, Hungarian method

1. Introduction

Travelling Salesman problem is used to find the optimal route for an unlimited no of Distant Locations. The main goal is to find the Travelling distance from one area to another area to reach within the allotted time. The TSP used various methods to select the shortest route to cover all the areas.

In this paper, we deal with the main problem of transportation from Vijayawada to Mangalagiri (Via Tadepalli). This route is one of the busiest area where so many students and job holders travel. So the data was collected from these persons about their Travel Distance problems to reach within the allotted time. They are using 3 modes of Transportations to reach their destination i. e., Autos, Cars and Buses, to reach within the allotted time.

Then we had to compare two methods ie., the Brute Force Approach and the Hungarian method of the Travelling Salesman problem from Vijayawada to Mangalagiri (Via Tadepalli). We will use these two methods to reach which ride is better to reach the destination.

This Table discusses the travel distance timings from Vijayawada to Mangalagiri (Via Tadepalli) by using 3 modes of Transportations i. e., Autos, Buses and Cars.

Table 1

Modes of Transportation	Vijayawada (Starting point)	Tadepalli (from Vijayawada)	Mangalagiri (Ending Point) (through Tadepalli and vijayawada)	Vijayawada (again starting point) (Through Tadepalli and Mangalagiri
Autos	0 min	10min or 15 - 20 min	15 - 20 min and 20 - 30min	15 - 20 min and 20 - 30min
Buses	0 min	15 - 20 min	20 - 30min and 30 - 45min	20 - 30min and 30 - 45min
Cars	0 min	15 - 20 min	15 - 20 min and 20 - 30min	15 - 20 min and 20 - 30min

Travelling salesman problem definition

The Travelling Salesman Problem (TSP) is an algorithm problem tasked with finding the shortest route between a set of points and locations that must be visited within allotted time. In the problem statement, the points are the cities a salesman might visit. The Salesman goal is to keep both the travel costs and distance travelled as low as possible within the allotted time.

2. Methods and Approaches

The Comparative study is done by using two methods:

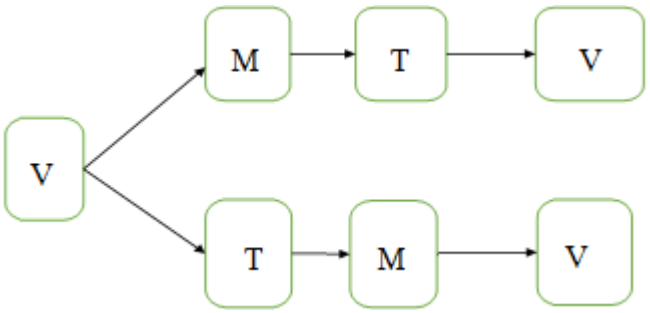
- The Brute Force Approach
- The Hungarian Method

The Brute Force Approach

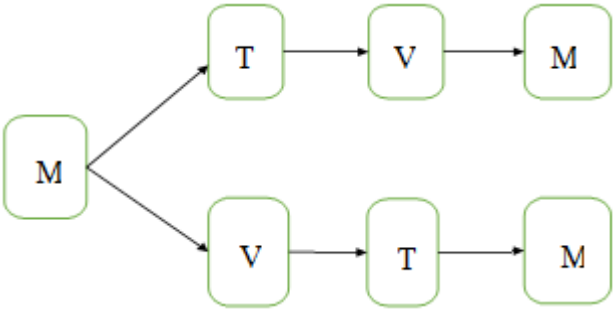
- It is used to organize the daily visiting schedule of a salesman
- The salesman schedule is based on the permutations and combinations of locations

Brute force approach calculations to estimate the daily visiting schedule timings from Vijayawada to Mangalagiri (Via Tadepalli) by using 3 modes of Transportations ie., Buses, Cars and Autos (from table 1)

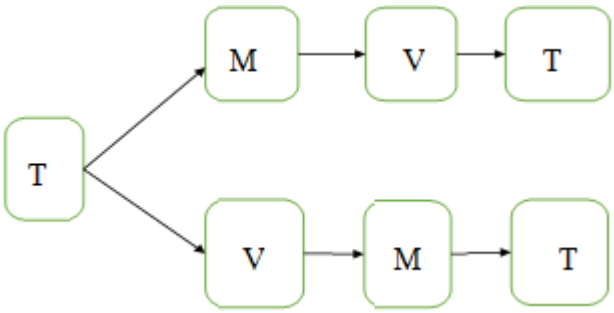
For Auto



V - >M - >T - >V = 25+14+14=53min
V - >T - >M - >V = 15+15+26=56min

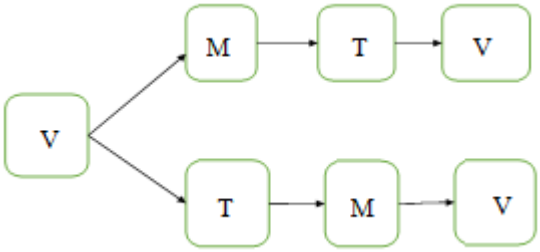


M - >T - >V - >M = 14+14+25=53min
M - >V - >T - >M = 26+15+15=56min

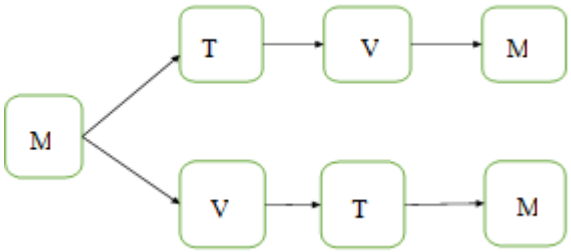


T - >M - >V - >T = 15+26+15=56min
T - >V - >M - >T = 14+25+14=53min

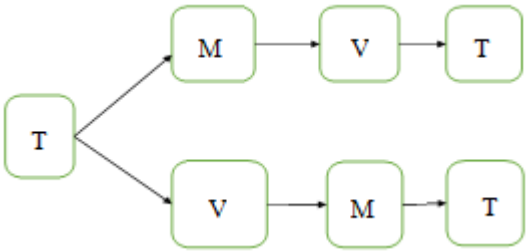
For Car



V - >M - >T - >V = 28+18+13=59min
V - >T - >M - >V = 16+16+28=60min

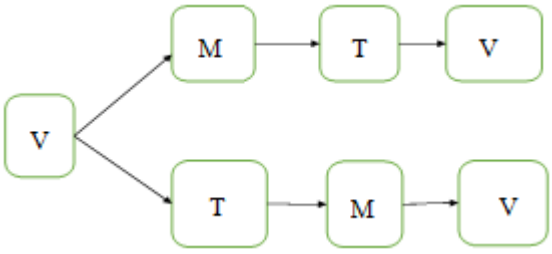


M - >T - >V - >M = 18+13+28=59min
M - >V - >T - >M = 28+16+16=60min

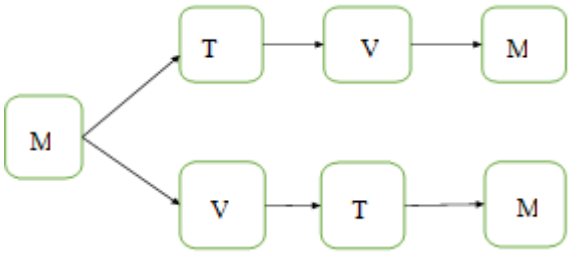


T - >M - >V - >T = 16+28+16=60min
T - >V - >M - >T = 13+28+18=59min

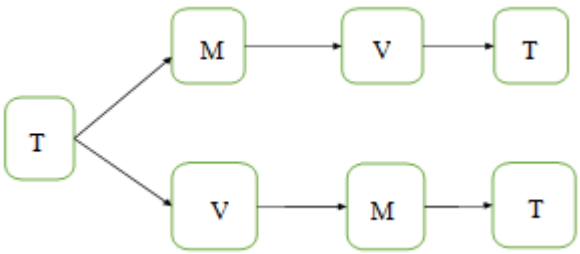
For Bus



V - >M - >T - >V = 45+20+15=80min
V - >T - >M - >V = 15+20+45=80min



M - >T - >V - >M = 20+15+45=80min
M - >V - >T - >M = 45+15+20=80min



T - >M - >V - >T = 20+45+15=80min
T - >V - >M - >T = 15+45+20=80min

Note: Green color represents least time min to reach the ending point (destination). Here V means Vijayawada, M means Mangalagiri, T means Tadepalli.

The Correct sequence for the shortest route is from Vijayawada to Mangalagiri (Via Tadepalli) to reach within the allotted time through the auto is
V - >M - >T - >V = 25+14+14=53min

The Hungarian method
The **Hungarian method** is a computational optimization technique that addresses the assignment problem in polynomial time and foreshadows following primal - dual alternatives. In 1955, Harold Kuhn used the term "Hungarian method" to honour two Hungarian mathematicians, Dénes Kőnig and Jenő Egerváry

The algorithm is
- Rows is equal to column for every Travelling salesman problem matrix.
- If rows are not equal to columns, we had to add dummy rows or columns.
- Find out the minimum for each row and subtract it from that row.
- Find out the minimum for each column and subtract it from that column.
- Make the assignment () in the matrix according to the matrix order and cross off (x) the remaining zeroes.
- Then select the correct sequence according to the assignment.
- If the sequence is not in order, select the non - zero element for assignment () and cross off (x) zeroes according to the non - zero element rows and columns.
- Then put the box on zeroes for assignment and crossed off the remaining zeroes.
- Repeat the process until we get correct sequence of order for travelling salesman problem shortest route.

The Hungarian method calculations to estimate the correct sequence of order for travelling salesman problem's shortest route to reach within the allotted time from Vijayawada to Mangalagiri (Via Tadepalli) through Cars, Autos and Buses (from table 1)

For Auto (This matrix is taken from table1)

Area \ Area	A	B	C
A	x	25	15
B	26	x	14
C	14	15	x

The correct sequence order is after solving this matrix through Hungarian method is

Optimal solution is

Area	Area	Time
A	*B*	25
B	*C*	14
C	*A*	14
	Total	53 min

Therefore the shortest route to reach Mangalagiri from Vijayawada (Via Tadepalli) is
A - >B - >C - >A = 53 min

For Bus (This matrix is taken from table 1)

Area \ Area	A	B	C
A	x	45	15
B	45	x	20
C	15	20	x

The correct sequence order is after solving this matrix through Hungarian method is

Optimal solution is

Area	Area	Time
A	*B*	45
B	*C*	20
C	*A*	15
	Total	80 min

Therefore the shortest route to reach Mangalagiri from Vijayawada (Via Tadepalli) is
A - >B - >C - >A = 80 min

For Car (This matrix is taken from table 1)

Area \ Area	A	B	C
A	x	28	16
B	28	X	18
C	13	16	x

The correct sequence order is after solving this matrix through Hungarian method is

Optimal solution is

Area	Area	Time
A	*B*	28
B	*C*	18
C	*A*	13
	Total	59 min

Therefore the shortest route to reach Mangalagiri from Vijayawada (Via Tadepalli) is
A - >B - >C - >A = 59 min

Note: A for Vijayawada, B for Mangalagiri, C for Tadepalli. Green color represents least time min to reach the ending point (destination).

Pros of a Brute - Force approach
- This approach finds all the possible solutions, and it also guarantees that it finds the correct solution to a problem.
- This type of approach is applicable to a wide range of domains.
- It is mainly used for solving simpler and small problems.
- It can be considered a comparison benchmark to solve a simple problem and does not require any particular domain knowledge.

Cons of a Brute - Force approach
- It is an inefficient approach as it requires solving each and every state.
- It is a very slow approach to find the correct solution as it solves each state without considering whether the solution is feasible or not.

- The brute force approach is neither constructive nor creative as compared to other methods.

Pros of a Hungarian method

- This method was capable of **reducing the cost matrix such that at least one zero in each row and column will be obtained.**
- Thus optimal assignment will be made possible where opportunity cost is zero.

Cons of a Hungarian Method

- **It can only solve a balanced assignment problem,** that is, the machines and the assignments have the same number.
- In order to solve the unbalanced assignment problem, it is necessary to add dummy machines which we will then ignore the work assigned to these machines

3. Conclusion

The Hungarian Method is the best method to select the ride to reach within the allotted time. The Brute Force approach is a highly tedious model to select the daily visiting schedule according to the permutation and combinations from city to city. The Hungarian method will follow the same algorithm to select the correct sequence of order of the shortest route to reach within the allotted time.

From this paper, the route is selected to reach within the allotted time is V - >M - >T - >V = 53 min by Auto. Theauto is selected as the best ride to reach the route within the allotted time from Vijayawada to Mnagalagiri (Via Tadepalli). The result comes from these two methods indicate that Hungarian method is most useful to solve TSP for the correct sequence of shortest route.

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