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Shortest Path Algorithms : Review

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Abstract: *This paper aims at being knowledge to understand the various types of fuzzy transportation problems by presenting shortest path's and algorithms used in different types of fuzzy numbers as well as shortest path algorithms. Shortest path's is one of the most challenging tasks in transportation problem. In this paper review shows that the majority of studies in shortest path's algorithms. Total 30 publications have been taken for review. All of them attempts for applied aspects of shortest route. The objective of this review paper is to present an updated shortest path's algorithms which helps in transportation problems*

Keywords: Shortest path algorithm, Optimization techniques, Fuzzy approach, Literature review.

I. INTRODUCTION

In day to day life management of shortest route is becoming a challenging task for everyone who lives in high density areas. Development of transportation is very interesting part of study. The first earth tracks were created by human beings. Tracks would be naturally created at points of bulk traffic. Main elements of track creation are nothing but domesticated animals like horses, oxen and donkeys. Animal drawn wheeled vehicles were probably developed in the ancient near east and spread to Europe and India in 5th millennium BC.

In the modern civilization efficient transportation is indispensable component. The economic development of a country completely depends on adequate system of transport. In the transportation problem shortest path takes place important role because it gives good results in supply chain management. Shortest algorithms reduce distribution mileage and improve the distribution efficiency, reducing distribution costs and relieving traffic pressure. Sometime there are specific cases we deals with uncertain data, that we are fail to consider them in the calculations over usually used graphs. Fuzzy logic gives to us proper tools to use in those cases.

This paper aims to be a guide to understand shortest path algorithms by presenting a review research articles. Section 2 presents the fuzzy transportation problem, section 3 the shortest path, section 4 the algorithms used to solve the shortest path algorithms, and the last section presents the conclusions.

II. FUZZY TRANSPORTATION PROBLEM

2.1 Mathematical Formulation of Fuzzy Transportation Problem

Consider a fuzzy transportation problem with m sources and n destinations in which all the decision parameters are expresses as fuzzy numbers. Let $\tilde{a}_i$ $(\tilde{a} \geq \tilde{0})$ be the availability at sources i and $\tilde{b}_j$ $(\tilde{b}_j \geq \tilde{0})$ be the requirement at destination j. Let $\tilde{c}_{ij}$ be the unit fuzzy transportation cost from units to be transported from source i to destination j. Let $\tilde{x}_{ij}$ denote the number of fuzzy units to be transported from source i to destination j. Now the problem is to determine a feasible way of transportation so that the total transportation cost is minimized.

Min $\tilde{Z} = \sum_{i=1}^{m} \quad \sum_{j=1}^{n} \tilde{c}_{ij} x_{ij}$

Subject to $\sum_{j=1}^{n} \tilde{x}_{ij} = \tilde{a}_i$, $i = 1,2, \dots, m$,

$\sum_{i=1}^{m} \tilde{a}_i = \sum_{j=1}^{n} \tilde{b}_j$, Where $i = 1,2, \dots, n$,

and $\tilde{x}_{ij} \geq \tilde{0}$, for all i, j.

The fuzzy transportation problem is explicitly represented by the following fuzzy transportation table

$origin(i)$	D_1	D_2	...	D_n	$Supply$
S_1	$\tilde{c}_{11}$	$\tilde{c}_{12}$	...	$\tilde{c}_{1n}$	$\tilde{a}_1$
S_2	$\tilde{c}_{21}$	$\tilde{c}_{22}$	...	$\tilde{c}_{2n}$	$\tilde{a}_2$

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...	...	...	...	...	...
S_m	$\tilde{c}_{m1}$	$\tilde{c}_{m2}$	...	$\tilde{c}_{mn}$	$\tilde{a}_m$
$Demand$	b_1	b_2	...	b_n	

III. BRIEF REVIEW OF VARIOUS SHORTEST PATHS' (TRANSPORTATION PROBLEMS AS A MAIN APPROACH BY USING FUZZY)

Table. 1

Title	Concept of Shortest Path	Contribution
Solving the shortest path problem with integral arcs[2]	Dijkstra's algorithm	Presents an algorithm for the shortest path problem. Connected arcs in a transportation network represented as interval networks. Defines a solution procedure to solve shortest path by using Dijkstra's algorithm. Human decision maker is a subjective interaction.
Solving best path problem on multimodal transportation networks with fuzzy costs[4]	Path algebra and diode of k-shortest fuzzy paths.	Addressed the problem of fuzzy costs in a single mode network. The main contribution of the present work is to solve the optimum path problem in a multimodal transportation network. They track the problem by using algorithm step by step and applied a pseudo-multimodal network.
A novel approach for finding a shortest path in a mixed fuzzy network[5]	Novel approach for computing a shortest path in a shortest path in a mixed fuzzy network.	Present dynamic programming method for finding a shortest path in the network. Four examples worked out.
A fuzzy topsis approach for finding shortest path in multimodal transportation networks[10]	Fuzzy logic and aggregated using the technique for TOPSIS	Present a fuzzy shortest path algorithm in multimodal transportation network (MTN). An innovative framework is presented to extend the classical problem of shortest path. Delays at mode and arc switching points, costs, viability of the sequence and number of modal transfer used as additional constraint.
Interval type 2 fuzzy set in fuzzy shortest path problem[15]	Incorporate the uncertainty in Dijkstar's algorithm	Investigate the FSPP. Modification of Dijksta's Algorithm to incorporating the uncertainty using IT2FS for SPP from a single source to single destination. They study the path algebra and the corresponding generalized algorithm of the FSPP. This work is contributed for transportation problem, supply chain management and other fields.
A bio- inspired method for the constrained shortest path problem[12]	Internal mechanism of the adaptive amoeba algorithm.	Proposed the innovative method to solve CSP which is employed to get the internal mechanism of the amoeba model. They combine the physarum algorithm with a bio inspired rule to deal with the CSP. Contribution is to reduce the executing time of the proposal method.
An improved bio-inspired algorithm for the directed shortest path problem[11]	Novel Algorithm	Determine the shortest path according to the current environment. Improved bio-inspired algorithm by integrating the original model with analog circuit. Contribute algorithm for shortest path and satisfies the

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		direction constraint.
The time varying shortest path problem with fuzzy transits costs and speed up[17]	Time varying shortest path	Considered one class of the time varying shortest path where the transists costs are fuzzy numbers. They proposed the algorithm for solving the problem.
Estimation of optimal path on urban road networks using AHP algorithm[20]	Optimal route selection problem	Descrribes a real urban road network and find out the optimal path by developing mmulti-criteria decision based methodology, They modeled shortest path over specified zones. They found out optimal paths of Nagpur city.
Roulette ant wheel selection (Raws) for genetic algorithm fuzzy shortest path problem[14]	Roulette ant wheel selection	Provides the selection of best solution through natural selection. Contribute to obtained along various numbers of vertices is more important and increases the selection pressure.
Solving multi objective interval transportation problem using grey situation decision making theory based on grey numbers[22]	Multi objective interval transportation problem	Present the compromise solution of multi objective interval transportation problem. They obtained by using grey situation decision making theory. This theory mainly based on objective heights. This work contribute in transporting product.
An optimization path problem on a network: A Review[23]	Network model	Tool to motivate all researchers working in the field of network optimization
Tree of fuzzy shortest paths with the highest quality[7]	Tree of fuzzy shortest paths	Studied a fuzzy shortest paths tree model in a network. They interpreted as the shortest path with the heights quality .They defined on a network with some other factor also .Their main agenda is to develop the model as a other network optimization problem such as minimum spanning true maximum flow and transfer problem.
A Heuristic graph based shortest path algorithm for optimizing routing problem[16]	Route optimization	Concerned mainly in Nigeria tourism by using optimal route director. They used computer based tools for evaluating and estimate public transits routes .Contribute to provide solution in real live problem. This work benefits road transits and reduce overhead road traffic.
A priori least expected time paths in fuzzy, time variant transportation networks[13]	Tabu search algorithm	Computationally this work is very effective. Considered as link travel time. They dependent within one zone in most urban transportation network.
Multi objective fuzzy shortest path selection for green routing and scheduling problems[24]	The green routing and scheduling problem	Study the green routing and scheduling problems. By expressing the edges they computed the shortest paths. Methods helps to reduce complexity ad observed that shortest path length in bellman method is same with the optimal value in the multi objective trapezoidal fuzzy shortest path method. Contribute to design efficient plans for sustainable transportation.
Application of fuzzy optimal path algorithm for bus route expansion in thai ngugen city[18]	Fuzzy optimal path algorithm	Apply expansion problem in thai ngugen city of Vietnam.

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Network routing problem in multigraph[19]	Muligraph	Deriving a simple graph from multigraph and easily implement on computer network.
Shortest path: Dynamic and extensible indicator for geographical search on road networks[21]	Fuzzy logic guided genetic algorithm	Proposed the model on road network FLGA algorithm solved for optimal path and used for generating shortest pathway possible.
Z-dijkstra's algorithm to solve shortest path problem in Z graph[26]	Shortest path problem in a Z graph	Slight adjustment in classical dijkstra's algorithm which is helpful in Z shortest path. The network of z dijksta's algorithm for performing fuzzy in many cases.
Shortest route algorithm using fuzzy graph[9]	Fuzzy shortest path	Described the uncertain fuzzy shortest route among the cities from Chennai to kanyakumari. The shortest path algorithm is found efficiently and complete fuzzy graph for uncertainty are available.
Dijkstras shortest path algorithm and its application on bus routing[31]	Dijkstras algorithm	Practical algorithm is proposed for the shortest path problem in transportation network. The calculation for the shortest path has been simplified.
A new time-dependent shortest path algorithm for multimodal transportation network[27]	Time dependent shortest path algorithm	Present an overview of the existing solutions for shortest path problem in multimodal networks and a description of the problem to finally propose the algorithm with illustrative examples
Shortest path algorithms in transportation models: Classical and innovative aspects[28]	"Ad hoc" algorithm	Described the important algorithmic approaches proposed in the literature for different kinds of shortest path problems, both on graphs and on hyper graphs. Particularly interesting in the transportation framework.
Optimal mathematical model of delivery routing and processing time of logistic[29]	Ant colony algorithm	Established VRPTW model and designed the PSOAS algorithm based on ACA and PSA and performed analysis and solution. PSOAS algorithm is a brand new heuristic algorithm which is the route selection and distribution time issues in the field of logistic.
Solving the shortest path problem with imprecise arc lengths using a two stage two population genetic algorithm[8]	Fuzzy shortest path problem	Investigated the use of a two-stage two-population GA approach to solve the shortest path problem with imprecise arc lengths.
Heuristic shortest path algorithms for transportation applications: State of the art[3]	Shortest path algorithm	Surveyed various heuristic search strategies developed in the past to identify shortest paths in a transportation network.
An application of dijkstra's algorithm to shortest route problem[30]	Dijkstras algorithm	Discussed the problem of finding the shortest route motivated by the need to minimize the distance and time of transporting goods from the company's production plant to seven different dealers in the road network k given by the data

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Classical and contemporary shortest path problems in road networks: implementation and experimental analysis of the TRANSIMS Router[1]	Shortest path algorithm	Describe and analyze empirically an implementation of some generalizations of Dijkstra's algorithm for shortest paths in graphs. The implementation formed a part of the TRANSIMS project at the Los Alamos National Laboratory.
Multi-objective fuzzy shortest path selection for green routing and scheduling problems[25]	Green Route	The Green Routing And Scheduling problems are mainly included in to study ecological problem. By using mathematical approach they study ambiguity, uncertainty, fuzzy logic and imprecision.

IV. ALGORITHMS TO SOLVE SHORTEST PATH ALGORITHM

Various algorithms to solve the shortest path algorithms (Table 1) may be found in the literature. We mention some of the most popular algorithms which are finally affected nicely on transportation problem.

V. CONCLUSION

The paper review mathematical models and algorithms used to solve different types of shortest paths. We present the fuzzy transportation problems, and some parameters of the transportation problems. We propose to investigate the shortest path algorithms which are needful in logistic, time management, waste management, supply management etc. New creations are always helping for the society, here we confirm that the mathematical treatment always create a good result in human being environment which is necessary.

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