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A Fuzzy Reasoning Approach to Determine Various Optimize Paths between Two Locations on a Transport Network Including Nature's Condition as Factor

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Abstract: ***In current world of technology, geospatial applications play a significant role in finding route information between source and destination. Various works has been carried out to find optimal path, between two snow covered geographic locations. Other than finding shortest path, several applications have contributed effort on finding optimal path by considering temporal factor such as traffic condition. The traffic of a route depends on certain time slot, events occurring in the city and one important factor is weather condition.. This paper provides an approach to determine optimal path between two locations that considers the current weather condition. One of the important factors is snow falls on the hilly roads due to snowfall, and icebergs. A fuzzy logic based approach has been used to find out severity of the Snow Mountains over the roads. In the proposed approach, a set of paths between two locations is determined using spatial topological reasoning. The optimal path from the available set is determined based on shortest distance and severity of snow density. A case study focused on Himalayan Region of India has been presented to show the efficacy of the proposed approach is determined using spatial topological reasoning.***

Keywords: Fuzzy Logic, Route finding, Geospatial, snow density, snow body.

1. Introduction

The increasing demand for geospatial information for various development and fast moving business transaction has increased to great extend in recent time. Nowadays, due to tourism the population is increasing in heritage cities. With increasing rate of population the transport modes have increased too, it in return results in growing traffic. Most of the applications that provide information about route between two locations are attempting to consider these facts. Wiener et al. in 2008 presented study forplannedderived path under spatial uncertainties [5].A hierarchical planning scheme was used to navigate the shortest possible path to find an object hidden in one of four places and to bring it to the final destination [5]. Mao et al in 2008 designed different paths and compared it with different path finding algorithms for a graph whose edge weights are mutating randomly to a significant extent [3]. Although the route navigators provide a general idea about what constitutes optimal route but it is difficult to express in search interfaces [7]. The traffic in a path varies with respect to time and the algorithm calculates shortest path in a dynamic fashion. Google Map have implemented in providing route information considering the traffic. The traffic of a route is triggered by several factors like, festival, rally, peak hours etc. One of the important feature is weather condition, a slow moving traffic is caused due to fog. One of the key factor form traffic can be Snow Mountains, landslides on the routes due to heavy snow fall and flood. The water clogging over the routes may result on increased traffic jam. In this work, a framework has been proposed that finds route between two geographic locations considering traffic occurred due to snow fall on the roads. The Snow Mountains and landslides is a key factor which is followed by heavy snowfall. The traffic condition of the route changes with respect to *severity* of the snow density. The density of snow clogging is determined based on fuzzy logic based approach. Based on the density of snow logging the feasibility of route between source and destination has been decided.

2. Literature Review

All prior studies on path finding and path planning behaviour assumed that all required spatial information was available but in real life navigators deal with incomplete or imprecise spatial knowledge resulting in spatial uncertainties [5]. Wiener et al. in 2008 presented experiments studying path planning under spatial uncertainties. In those researches a hierarchical planning scheme was used to navigate the shortest possible path to find an object hidden in one of four places and to bring it to the final destination [5]. Mao et al in 2008 designed and compared different path finding algorithms for a graph whose edge weights mutate randomly to a significant extent [3]. Nikolova et al. in 2006 presented new complexity results and efficient algorithms for optimal route planning in the presence of uncertainty. They employed a decision theoretic framework for defining the optimal route and identified a family of appropriate cost models and travel time distributions that were closed under convolution and physically valid [4]. Cornelis et al. in 2004 showed which criteria must be met for path finding algorithm correctness and explained an efficient method, based on defuzzification of fuzzy weights, for finding optimal paths [2].

3. Related Search

In a given transport network, several paths may connect two geographical locations. Google Earth can determine the shortest path between two geographical locations. However, for traveling from one location to another, shortest path may not be the only criteria. Some other properties have to be taken into consideration, viz. traffic condition of the path, quality of the path. Many research has been done regarding these topics even now a days Google earth is also providing the traffic condition of the road in three manner heavy, medium and minimal but the climatic condition is not taken as one of the factor for finding optimal route(s)/path(s) between source and destination. So here we are trying to consider these factors in our research. For example,[1] a given route is suitable, if *length* of the route is short and quality of the path is *good*. Again the *quality* of a path is *good* if the route is wide and texture of the route is smooth. And after all these condition there is another important factor that we have taken in consideration i.e. climatic condition means after finding the optimal path(s) ,the climatic condition will be checked and according to that we will decide whether it is the optimal path or we have to go for another. Therefore, it can be shown as follows [6]

Path risk ←− ((path length (P*L*), *path thickness* (P*R*)) *path quality* ←(path width (P*L*), normal roughness (R*a*), snow density (*SD*)) path density)

4. Route Finding Algorithms

There are different algorithms used to find an optimal path for transmitting through network is proposed to handle the special characteristics of transit networks such as tourist visits, city emergency handling and route guiding system, in where the optimal paths have to be found. As the traffic condition among a city changes from time to time and there are usually a huge amounts of requests occur at any moment, it needs to quickly find the best path. Therefore, the efficiency of the algorithm is very important [7, 9 and 10]. The algorithm takes into account the overall level of services and service schedule on a route to determine the shortest path and transfer points. There are several methods for path finding:

In Dijkstra's algorithm the input of the algorithm consists of a weighted directed graph G and a source vertexes in Graph. Let's denote the set of all vertices in the graph G as V. Each edge of the graph is an ordered pair of vertices (u, v) representing a connection from vertex u to vertex v. The set of all edges is denoted E. Weights of edges are given by a weight function w: E → [0, ∞]; therefore w (u, v) is the non-negative cost of moving from vertex u to vertex v. The cost of an edge can be thought of as the distance between those two vertices. The cost of a path between two vertices is the sum of costs of the edges in that path. For a given pair of vertices s and t in V, the algorithm finds the path from s to t with lowest cost (i.e. The shortest path). It can also be used for finding costs of shortest paths from a single vertex s to all other vertices in the graph.

Best First Search (BFS) algorithm has some estimate (called a heuristic) of how far from the goal any vertex is,instead of selecting the vertex closest to the starting point, it selects the vertex closest to the goal. BFS is not guaranteed to find a shortest path and runs much quicker than Dijkstra's algorithm because it uses the heuristic function.

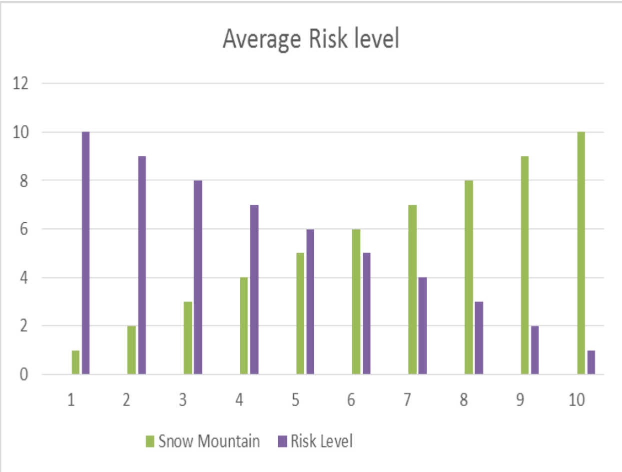
A* was developed in 1968 to combine heuristic approaches like BFS and formal approaches like Dijsktra's algorithm and can guarantee a shortest path.The A* algorithm integrates a heuristic into a search procedure [8]. A* is the most popular choice for path finding, because it's fairly flexible and can be used in a wide range of contexts [9]. Therefore, this research uses A* algorithm to perform path finding in the case study network.

5. Overall Architecture

When we choose optimal path we are considering the following conditions, we have done all the research on the city Himachal, India, by studying various articles [11] and history [12] of the city reference with the climatic condition:

Nearest Mountain Body

After finding the optimal path we need to take in consideration these climatic factors, if the route is nearer to any Snow Mountain body then the risk is high and it goes far from the Snow Mountain body the percentage of risk is decreased .We have taken



The risk of a route with respect to Distance of Water Body and path quality is deter- mined by membership value. The fuzzy membership functions for path risk [μR (DSMB)] with respect to the Distance of Snow Mountain Body (DSMB) from the path can be described as: Universe of dis-course of distance of Snow Mountain Body in μR (DSMB) is 0-30 in metres. Therefore, the risk membership value (μR) falls with decrease in distance from snow mountainbody. The path risk membership function [μR (DSMB)] w.r.t distance of snow mountain body in (DSMB) is given in equation 1.

$\mu R\ (DSMB) = (DSMB)/\ \alpha$ if $0 \leq DSMB \leq \alpha$
1 if $DSMB \geq \alpha$

Where α=40(distance from where the risk is minimal in meters).
μR=risk of path

Snowfall level

The below graph shows the percentage of risk according to the snowfall in the city ,as the snowfall increases the level of 450mm in a 24 hr., the risk of snow logging increases. For the testing purpose we have took 7m as discrete distance of road from Mountain body ,the complete concept is shown in the following fig(b) :

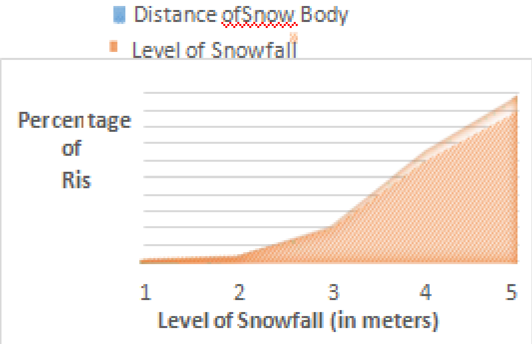


Figure b: Level of rainfall

The fuzzy membership functions for path risk [μR (SFL)] with respect to the snowfall Level in the area of path can be described as: Universe of dis- course of snowfall Level μR(SFL) is 0-4500 in millimetres. Therefore, the risk membership value (μR) falls with increase in level of snowfall. The path risk membership function [μR (SFL)] w.r.t snowfall Level (SFL) is given in equation 2.

Path risk	
Poor	αcut
Medium	0≤min($\mu R(SFL)$,$\mu R(DSMB)$)<0.4 0≤min($\mu R(SFL)$,$\mu R(DSMB)$)<0.7
Good	0.7≤min(($\mu R(SFL)$,$\mu R(DSMB)$)≤1.0)

$$\mu R(SFL) = \left\{1 - \left(\frac{SFL}{\beta}\right) \; if \; 0 \le SFL \le \beta \; 1 \text{ if SFL } \ge \beta\right.$$

Where β=450mm (snowfall level in metres)

Nearest Mountain Body(in metres)	Snowfall Level	Path Quality
7	0.5	Medium
15	5	Good
25	40	Poor
7	30	Poor
15	35	Medium
25	45	Poor

The fuzzy membership functions, given in equations 1 and 2, can be expressed through other commonly used membership functions (Gaussian MF, Bell MF) or mathematical expression depending on change of risk with respect to optimal path and climatic conditions. The *α- cuts* offer a way to limit attention to a subset of a fuzzy set and also offer a complete characterization of a fuzzy set that can be easily compared to other fuzzy sets [13].

Determining Path Risk

In a given transport network, routes connecting two geographical locations are determined (refer Fig. 2). For example (refer Fig. 2), given two locations S and D, there are three paths, namely path a, path b, path c.

- Path a: (a1, a2, a3, a4, a5)
- Path b: (b1, b2, b3, b4)
- Path c: (c1, c2, c3, c4)

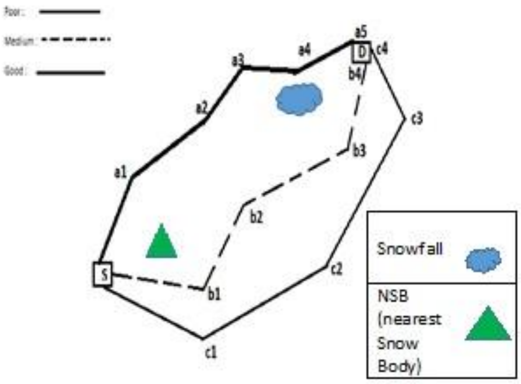


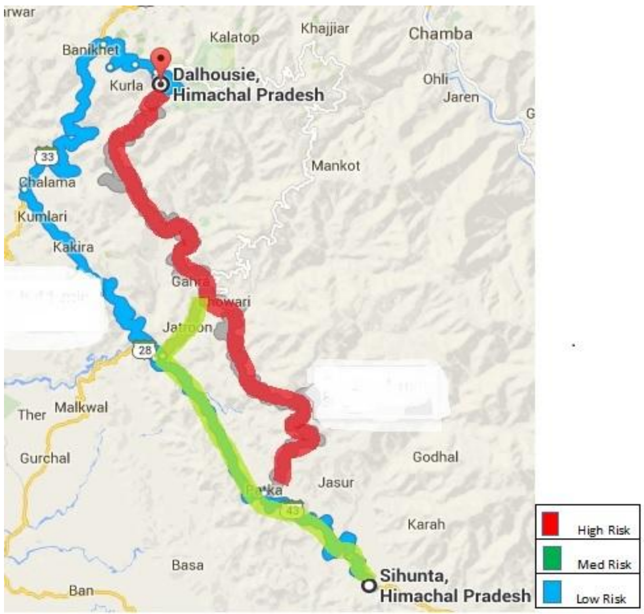
Figure 2: Transport Network

Case Study

The following case study was carried out in Dalhousie area of Himachal city, calculated paths are according to our algorithms.
Source: It's the starting point of a commuter.
Destination: It's the destination of a commuter.

A random selection of source and destination was done to show feasible path within reachable source and destination. According to normal algorithm maps shows multiple paths which are most short distance and easily reachable, but a commuter requires most feasible path to reach the destination. So according to fuzzy logic and climatic factors maps shows path which reach destination but with most feasibility.

Following map shows three routes within source (Dalhousie) and destination (Sihunta) Where Red path is shortest but most worst path to travel as mountain is very near and current snowfall has caused the place to overflow from danger level , Green path is medium but due to some local traffic problems that's road to is not feasible ,but Blue coloured road is long but at current time it's best way to travel , so it is suggested that a commuter must choose for the third option and travel along to reach destination.



6. Conclusion

In this paper we have explained the concept of solving the problem while determining the optimal path for transformation. There are many researches done on finding optimal path but we have defined the problem related to the climatic condition (Snow Fall), so the problem of Snow Fall, Avalanche and Landslide can be pre-determined before choosing a path for transformation. We consider the Nearer Snow Body (NSB) from the route/path that is been selected as optimal path. And also the level of snowfall so we would get to know the chances of snow mountains. We have tried to accumulate most of the existing ideas on comparison of quadratic fuzzy numbers and proposed a new approach to imprecise number.

References

[1] http://www.mapquest.com
[2] http://www.maps.yahoo.com
[3] http://www.earth.google.com
[4] Cornelis, C., Kesel, P. D. and Kerre E. E. (2004).*Shortest Paths in Fuzzy WeightedGraphs*.International journal of inelegance system, 19, pp. 1051-1068.
[5] Mao, H. (2008). *Path finding Algorithms for Mutating Weight Graphs:* Project Proposal.
[6] Nikolova, E.,Brand, M. and Karger, D.R. (2006). *Optimal Route Planning under Uncertainty*. American Association for Artificial Intelligence.
[7] Wiener, J. M., Lafon, M. and Berthoz, B. (2008). *Path planning under spatial uncertainty*. Memory & Cognition, 36 (3), pp. 495-504.
[8] Indira Mukherjee and S K Ghosh A Fuzzy Reasoning Based Approach for Determining Suitable Paths between Two Locations on a Transport Network, School of Information Technology Indian Institute of Technology, Kharagpur 721302, India
[9] Chouy, Y.L., Edwin Romeijnz Robert, H. and Smithx, L. (1998). *Approximating Shortest Paths in Large-scale Networks with an Application to Intelligent Transportation Systems.*
[10] Dai, L. (2005). *Fast Shortest Path Algorithm for Road Network and Implementation*. Carleton University School of Computer Science.
[11] Shad, R., Ebadi, H. and Ghods , M. (2003). *Evaluation of Route Finding Methods in GIS Application.* Dept of Geodesy and Geomatics Eng. K.N.Toosi University of Technology, IRAN.
[12] Willhalm, T. (2005). *Speed Up Shortest-Path Computations*.
[13] http://www.mpi-sb.mpg.de/~sanders/courses/algen04/willhalm.pdf
[14] Times Of India , 29-July-07
[15] Hindustan Times ,3-Aug-07
[16] Clark, T., Larson, J.M., Mordeson, J.N., Potter, J.D., Wierman, M.J. In: Fuzzy Set Theory. Volume 225. Springer Berlin Heidelberg (2008) 29 – 63