Optimization of Vehicle Routing on Road Network

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ABSTRACT

The optimization of vehicle routing is a process of restricting the total traveling time in a time window constraint and is also accountable for restricting the total cost due to the total traveling distance. In order to get an optimized route, an efficient algorithm is devised known as GSA (Graph Search Algorithm). The various queries have been employed in location-based systems such as KNN, Path Query and Keyword-based KNN. The role of fuzzy logic is to calculate the distance of available routes and dynamically adjust the crossover rate and mutation rate occurring in the road network. The use of genetic algorithm escalates in selecting the best possible route among various available routes by taking into consideration the road and traffic conditions. A number of benchmark problems are scrutinized for their search performance to demonstrate the potency of the algorithms used. Also, various search methods are acquired in order to compare with the GSA such as branch and bound, standard GSA, simulated annealing and tabu search. The overall comparison is done over randomly selected data sets. The results if the simulation reveals clearly that GSA outperforms other search methods.

Index Terms: Path Query, KNN, Keyword-based KNN, Fuzzy Logic, Spatial Database and Road Network.

I. INTRODUCTION

Data mining is the procedure of extricating the useful information and knowledge from the already collected data. Data mining is the innovative idea of applying computer-based methodology which includes various new techniques for the extraction of useful information and knowledge from already collected data. The discovery of knowledge provides a substantial information that is obtained from the known data. Data may be unknown, but it is precisely assisted by recorded facts. The prediction of useful information uses known data to foretell future trends, events such as Stock market predictions. Whether knowledge discovery or knowledge prediction, the technique of data mining extracts the useful information that was once quite arduous to recognize and presents it in an easily comprehensible pattern or format such as graphical or statistical. The enormous amount of data that is present in the database is both useful and superfluous. Therefore, to get the relevant information it is extremely arduous to know their relative information. The inclusive goal of the data mining process is to extricate information from a large data set and renovate it into an explicable structure for further use. In recent years, new techniques of accumulating data have stemmed in a need for applications which work excellently and proficiently with data streams. The most significant problem in the data stream is that of classification, clustering and association. Today various organizations such as retail, financial, communication and marketing predominantly use data mining with a sturdy consumer emphasis. It facilitates these organizations to discern associations among "internal" factors such as cost, product orientation or staff adeptness and "external" factors such as economic gauges, competition, and customer demographics. It enables companies to regulate the influence on sales, customer contentment, and commercial revenues. Finally, it helps companies to summarize total information to

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outlook transactional data. Web content mining is mostly the second stage in web data mining. Content mining is the perusing and mining of text, pictures and graphs of a web page to govern the germaneness of the content to the search query. This examining of data is accomplished after the assembling of web pages through structure mining and provides the outcomes based on the level of significance to the suggested query. With the gigantic volume of information that is accessible on the World Wide Web, content mining suggests the outcomes to search engines in order of highest significance to the keywords in the query. Web mining is the technique of data mining and it is used to mine and reveal knowledge from web documents and services like maps, foursquare etc. The examples of web mining are Facebook recommendations, places, pages, and friends. Web mining permits observing for a pattern in data through content mining, structure mining and usage mining. One of the applications of data mining technique is the web usage mining. This technique is used for discerning fascinating usage patterns from Web data in order to apprehend and better aid the needs of Web-based applications. Web structure mining is the method of using graph theory to scrutinize the node and configuring connections of a website. Web content mining is the mining, excavating and integration of valuable data, information and knowledge from Web page content. One of the applications of web mining is optimization of vehicle routing on road networks using Google maps. The beneficial information can be quarried from the Google maps and with the help of certain procedures and algorithm valuable results and patterns can be determined. The objective is not only to reduce the cost due to the total traveling distance but also the cost due to the total traveling time. In order to solve this problem a Graph search technique called GSA is used. This helps to identify the various available routes between two locations. The broadly used queries in location-bases systems are Path query, k nearest neighbor query, and keyword-based kNN. These queries help in extricating the valuable information from the Google maps. The queries deliver the additional conditions for carrying out the process. The several other algorithms used on road networks include Dijkstra's algorithm, Fuzzy Logic algorithm, Genetic algorithm etc. The fuzzy logic plays an important role in dynamically adjusting the crossover rate and mutation rate. It is used to compute the exact distance between two locations. The Genetic algorithm is used for getting information in real-time conditions e.g. considering the traffic flow in road networks. The final outcome is the shortest route between two selected locations considering the conditions of road and traffic.

II. RELATED WORK

The optimization of routes for vehicles in road network has become a very interesting field of research to optimize the overall traveling distance and time in today's world. This system focuses on source and destination locations to devise a route which has the shortest distance considering the traffic and road conditions. This system is useful for transportation and logistics to overcome various problems related to it by devising an efficient route from source to destination. There are various innovative queries and algorithms that are used to search the best feasible routes in a road network. The algorithm used to find the shortest distance is mostly restricted to Dijkstra's algorithm which works by traveling to all the nodes in the network and then compute the shortest distance between two given nodes. KNN algorithm is used to look for all nearing nodes around the source as well as the destination locations. Keyword based KNN is used to locate the intermediate location on the route to make the devising of route more accurate. These all algorithms work together to devise an optimized route from source to destination. The road and traffic conditions are considered for the optimized and feasible route. These conditions change with time and are highly dynamic so it is required to update the conditions of traffic and route regularly in the control center of each location. These values are then used to calculate the optimal value for each of the routes available and then all the routes are compared for optimal values and the route with least optimal value is provided as the best route. Factors that affect this are road and traffic conditions which change with time. [1] Provides algorithms to calculate the shortest path between two given locations using the bidirectional concept of path search. All the important nodes are visited during the forward search and the links from important nodes are used in the backward search. This technique is based on the concept of node contraction and the ordering of nodes

is done on the basis of the importance of nodes. This leads to the formation of shortcuts to derive the shortest path. [2] There are various algorithms that have been explored by the researchers that work on the principle of partitioning of graphs into multiple levels. They have average computational complexity and provide sublime partitioning of graphs. The analysis of this concept helps in deriving good results which are the potential of multilevel graphs. [3] Uses set of smaller sized nodes called as transit nodes. These nodes have the property they cover the Euclidean distance which is small and also pass through one of these nodes to determine the shortest path. The idea is to preprocess transit nodes and edges of the road network in order to showcase the shortest path in a very short span of time. [4] Emphasis on moving objects which are considered to be constrained by a road network. The KNN algorithm is used for moving an object in the road network in order to find a path to the destination. [5] Concerned with the partitioning of the road network which is of equal size. The network consists of a number of border nodes which are smaller in size. This, in turn, results in the formation of fewer shortcuts and can generate equal sized networks which are used for computing shortest paths in distance.

III. PROPOSED SYSTEM

Web data mining is a technique derived from the data mining which deals with the extrication of useful and vital information from the web pages and other dynamic resources available through the web. Fuzzy logic is considered as a more proficient technique for organizing and managing data. This has proven to be an exceptional alternative for applications that are based on the control system because it copycats to the reasoning of humans and parodists human control logic. The fuzzy logic genetic algorithm is used to evaluate dynamic traffic data from the spatial database to showcase interesting patterns and observations.

(A) Node Initialization

In the proposed system the source and destination locations are set as input for finding the best available route. These locations are to be selected from a list of locations present in the drop down menu.

(B) Finding Possible Routes

After the input locations are submitted, these locations will be cross-verified with the available locations in the database for the verification process. Based on the input data, all the possible routes are identified between the two locations and distance is calculated for each route using the fuzzy logic. Now all the available routes with the exact distance are used as input for the next step to check for the more feasible route.

(C) Compute the Shortest Path

In this step, each and every route is provided as an input separately to the genetic algorithm to check for the dynamic road and traffic conditions that are updated from time to time in the control center. Based on these conditions optimal value is calculated for each and every available route. These optimal values are then compared to themselves and the route with the least optimal value gets the highest priority among all other routes and is considered to be the best feasible route to reach the destination.

The whole procedure is illustrated as below:

The procedure that extricates the overall flow of control for finding feasible and optimized route in a road network is shown in the Fig. 2. The diagram explains the step by step procedure of using the system in an efficient way. The first step is to select source and destination places and check for their availability. Next step of the process showcases the operator available routes with their respective distances and that is followed by an exhibition of the best route. The best route is the one which has least optimal value; i.e. road and traffic conditions are more operator friendly than other available routes.
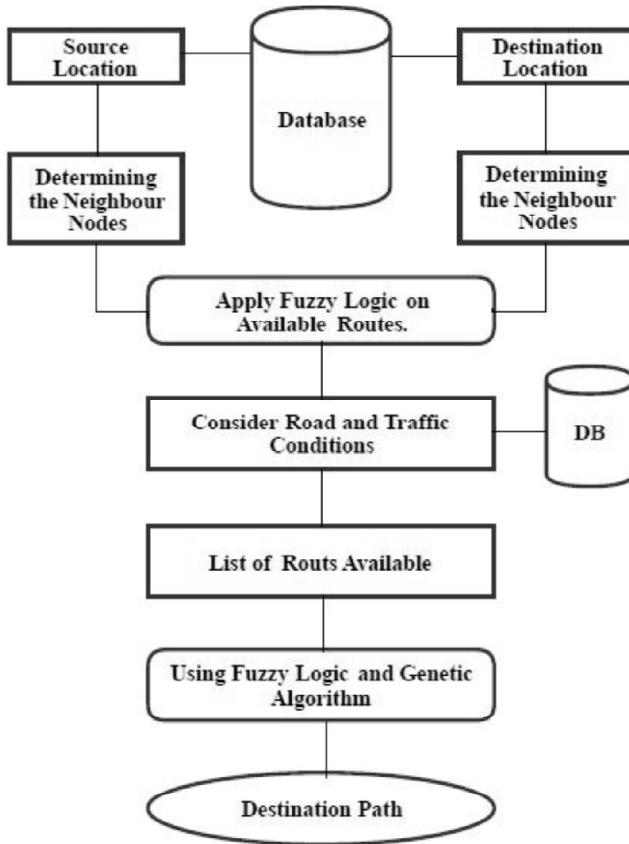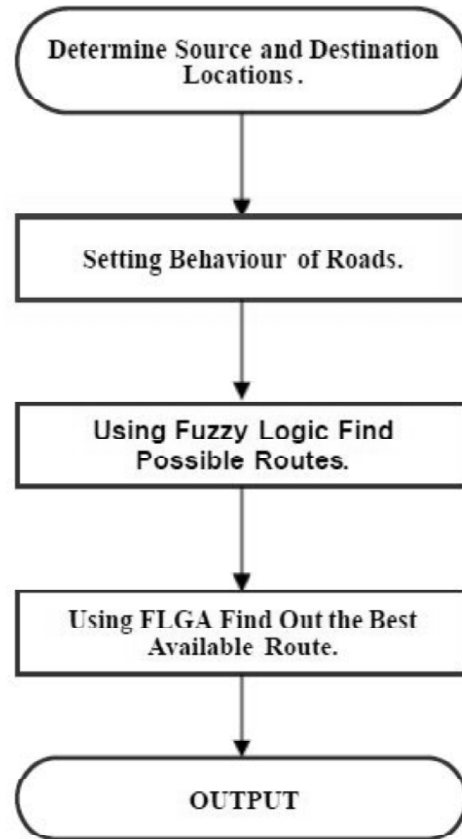
Figure 1: Architecture diagram

Figure 2: Data-Flow diagram

IV. IMPLEMENTATION AND EXPECTED RESULTS

The inputs are the source and destination locations. All nearing nodes respective to these locations are identified. These nodes are traversed using GSA algorithm to reveal all possible routes. The fuzzy logic is used to calculate the exact distance of available routes and eventually genetic algorithm approach is used to dynamically check for road and traffic conditions. Finally, an optimal value is calculated based on the conditions a route with least optimal value is labeled as the best available route.

The following explains the graph search algorithm:

Inorder Traversal:

    Procedure inorder(input: K)

    begin

        if K = nil then

        return;

    endif

        inorder(K —> left>;

    Recursively traverse the left subtree

        visit(K);

    Process the root

        inorder(K —> right>;

    Recursively traverse the right subtree

    end

Preorder Traversal:

```
Procedure preorder(input: K)
begin
        if K = nil then
        return;
endif
        visit(K);
Process the root
        preorder(K —> left>;
Recursively traverse the left subtree
        preorder (T —> right>;
Recursively traverse the right subtree
end
```

Postorder Traversal:

```
Procedure postorder(input: K)
begin
        if K = nil then
        return;
endif
        postorder(K —> left>;
Recursively traverse the left subtree
        postorder(K —> right>;
Recursively traverse the right subtree
        visit(K);
Process the root
End
```

Fuzzy Logic is a proficient reasoning technique that resembles human reasoning. This approach deals with the decision-making system in humans that puts emphasis on all intermediary options among digital standards of YES and NO. The defuzzification is a method that is performed on a set of fuzzy values in order to transform the results in conclusion to more crisp values. This is done with the help of finding the center of gravity as follows:

$$COG = \sum lx = c\mu H(Y)x \sum lx = c\mu H(Y)$$

Once all the calculations and procedures for all available routes are done. The final optimal values of all the available routes are compared and the route with least optimal value is selected as the best route.

V. FUTURE WORK

This technology can be used by any person who has access and knowledge about this technology. This will help improve the GPS system and will allow taking better decisions in selecting a route to reach the destination. Further this technology can be enhanced by using google maps and considering the traffic conditions in real-time. The result will be more accurate and reliable.

VI. CONCLUSION

Fuzzy logic is considered as a better method for sorting and handling data. The procedure starts with the selection of source and destination locations in order to identify the best route. All possible routes are recognized and scrutinized for road and traffic conditions. Based on these conditions optimal value is calculated and the route with the least optimal value is showcased as the best feasible route to reach the destination.

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