

A SURVEY ON OPTIMAL ROUTE QUERIES FOR ROAD NETWORKS

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Abstract

In daily life the need to find optimal routes between two points is critical, for example finding the shortest distance to the nearest hospital. Internet based maps are now widely used for this purpose. Route search and optimal route queries are two important classes of queries based on road network concept. Route search queries find the route according to the given constraints. The optimal route queries find the optimum route from a set of specifications by a user. In road map queries, users have to give the specification of starting point and ending point of their travelling with or without constraints. Some spatial features about the categories and the different locations should be specified along with this. If the travelling constraints are given then it should be unique. These constraints may be either total order or partial order. In this specification order there should be information about both starting point and destination point of the travelling. The optimal route queries optimize the possible routes and give the optimal route that satisfies all the constraints. This paper describes the survey on optimal route query processing, two categories namely optimal route query processing and spatial search with categorical information have been considered, a discussion on technique for optimal route query with constraints and without constraint is also included. The total order needs a specification of list of points and in the same order that they should be visited but that is not required for partial order constraints. Finally this paper concludes with pros and cons of different techniques under optimal route queries.

Keywords: Query processing, optimal route queries, Spatial search, Categorical information, Constraints.

1. INTRODUCTION

Query processing is the efficient retrieval of desired information from the database system. The various phases of query processing system are shown in the Fig 1. Four main steps are there in the query processing where first three steps are executed in compile time and last one in the runtime. The route queries obtain the route from the spatial data with categorical information stored in the database. The optimal route queries find the optimal route from the given set of information. The users have to give query starting point and some travelling rules or constraints [4], [7] along with the database which contains the categorical information about the road map. Various techniques are used for the processing of route queries. The some of the techniques used travelling rules which are either total order or partial order and some other without any specification. The given constraints may be either total order or partial order.

Optimal route query processing finds all the possible routes and then optimizes these possible routes. For that, route queries operate on the spatial data with categorical information [5], [8]. The goal is to find the optimal route from the given queries.

In this paper, we discuss about various techniques in optimal route queries. There are two main approaches: query processing for optimal route [2], [3], [4], [7] and queries that operate on spatial data [5], [6], [8].

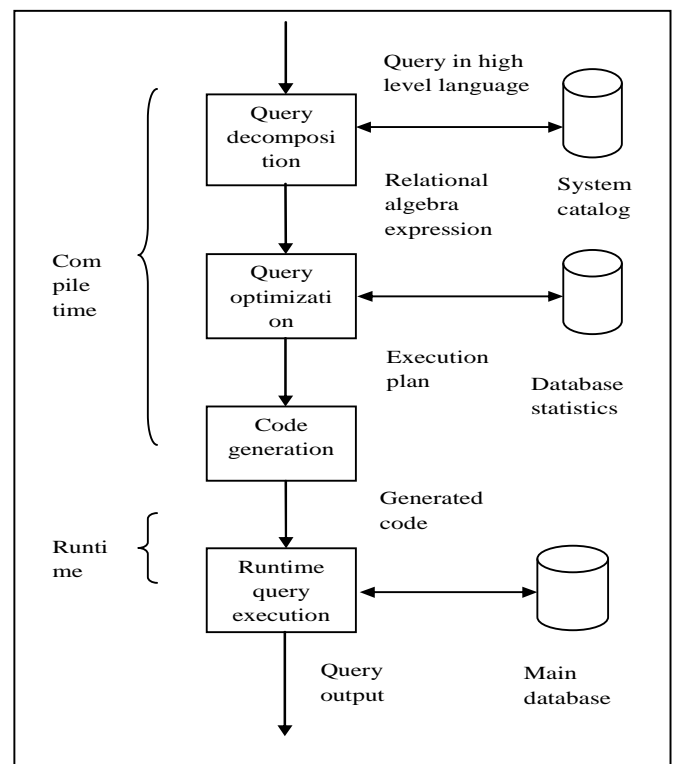


Fig -1: Various Phases of query processing system

The paper is organized as follows: section 2 presents the problems in the optimal route queries. Section 3 and 4 classifies the optimal route query processing and the queries related to spatial search with categorical information. The advantages and disadvantages of each scheme are also specified in this section.

2. PROBLEM STATEMENT

The optimal route query processing is mainly used in the road network. The very first solution of the optimal route query is based on the greedy strategy [1]. The first approaches considered only the end points. The later approaches used some category sequences as the input for the optimal route queries that is some of the constraints are considered. Different types of constraints are combined with the query. Apart from the optimal route query some of the categorical information is needed to consider for better surroundings and facilities. For the effectiveness of some clustering techniques are also discussed. Most of the techniques have limitations in some particular area. The main problems are some of the techniques may produce optimal route and others not. Among this some may consider constraints and others without consider the constraints and these are the main problems to consider.

3. OPTIMAL ROUTE QUERY PROCESSING IN ROAD NETWORK

3.1 On Trip Planning Queries (TPQ) in Spatial Database

On Trip Planning Queries [3] are the efficient and exact solutions for the general optimal route queries. A set of point of interest (POI) of different categories, starting point and destination point is given and TPQ [3] finds the best trip starting from the specific source and will ends on the destination through some POI. There are no ordered constraints here in this method. The existence of multiple choices per category is the main difficulty of this technique and for solving this some of the approximation techniques are used.

Mainly two greedy algorithms are available with the tight approximation ratios with respect to the total number of categories. The first algorithm is the nearest neighbor algorithm. This algorithm find the best trip by visiting the nearest neighbor of the last category to be added and that have not been visited at that particular moment. The route thus formed from source to destination point which is specified by the user. The second one is the minimum distance algorithm which introduces a novel greedy algorithm and while comparing with the first one this is having the better approximation bound [3]. This will find the set of vertices with minimum cost. In this paper the nearest neighbor algorithm is used to finds the better route starting and ending

at specific points. The advantages of the On Trip Planning Queries include 1. Approximation ratio is high, 2. Minimum cost for route finding. The disadvantage includes 1. No user defined constraints in the TPQ.

3.2 The Optimal Sequenced Route (OSR) Query

The Optimal Sequenced Route Query [7] is a type of Nearest Neighbor query and it finds the optimal route that starts from a specific location and passed through a number of typed location in some specific order. The shortest path problem is the basics of this technique. First of all the OSR problem is transformed into a simple shortest path problem in large planar graph. For that the Dijkstra's algorithm [7] is used. The OSR query is given with starting point, a set of intermediate points and the sequence of the locations. The weighted directed graph is constructed from the given network. The starting point is connected to all the other vertices and the weight assigned to each edge of graph is the distance between two end vertices. From this the optimal route of the OSR query is the route or set of points with minimum length. The shortest path finding is by travelling from starting point to all other points and returning the minimum path length and this is done by the Dijkstra's algorithm. But this classic Dijkstra's algorithm is impractical due to the following reasons. The first one is, in the real world dataset millions of possible edges have to be handles so the time complexity is very high. Thus the complexity of the algorithm is also very huge.

To improve the problem occurred due to the Dijkstra's algorithm the range query can be used. Even then the problem cannot be overcome. Therefore Light Optimal Route Discover (LORD)[7] algorithm developed for handling OSR queries. This is an iterative and a light threshold based algorithm, which uses different thresholds to filter out the points that cannot be the optimal route. The memory requirement for LORD is very much less than Dijkstra's algorithm therefore it is named as light. First this algorithm generates a set of partial sequenced routes in the opposite order. That is from the destination point to the starting point. Attach each point to the recently added one and finally forms the optimal route.

The next one is R-LORD [7] algorithm which is an enhanced version of LORD algorithm. It is based on R-tree and it calculated the threshold value more efficiently. This is the first correct solution for the optimal route queries with total order travelling rules. R-LORD uses the greedy algorithm to find the optimal route and the threshold value. From the end category, finds the optimal points in the sequence and within the threshold distance to the query point. Iteratively finds the optimum route.

3.3 The Multi-Rule Partial Sequenced Route Query

The optimal route computation is purely based on greedy [1] solutions in the earlier stages. This uses two approaches. The first one is Nearest Neighbor Partial Sequenced Route

(NNPSR)[2] which works similar to greedy approach. This will start from the query start point and find the point which is nearest to the start point and forms the edge. Then using the newly added point finds the nearest point and forms the route. The final route will be optimal through this greedy approach. That is it finds the best at that moment. The second approach will find all the nearest points from each and every category and forms the route. This is also optimal route with in a particular range.

Then another approach is the combination of NNPSR and R-LORD [7]. The NNPSR is used to obtain the greedy route. From that it obtains the category of each and every point. This total order of categories is the input of R-LORD. And it will output the suboptimal routes.

4. SPATIAL SEARCH WITH CATEGORICAL INFORMATION

4.1 Top-K spatial Preference Queries

The spatial preference query [8] is used to rank the objects from the feature qualities of the neighborhood objects. Generally Top-K spatial preference queries are used to rank the spatial objects effectively. Different types of algorithms are used for this ranking. First one is a baseline algorithm named simple probing algorithm and which applying the spatial queries on feature dataset and calculate the scores for every object. Thus the ranking is done. The incremental computation techniques are used to optimize the simple probing algorithm and which minimizes the number of computations of component scores.

A variant of simple probing algorithm [8] is the group probing algorithm and which computing the object scores in the particular leaf node repeatedly and thus reduces the I/O cost. Branch and Bound algorithm [8] is the enhanced version of group probing algorithm, which removes the entries other than the leaf nodes in the object tree that cannot produce better performance. For this a new method is used by accessing feature trees and deriving upper bound scores for the entities. The last one is feature join algorithm [8] which performs over the feature tree by multi-way join used to find the group of feature points and then search for the objects using this grouping.

4.2 Categorical Range Queries (CRQ) in Large Databases

The categorical range queries [5] in the large database are handled through the paper. Mainly it is related to the spatial data like geostationary information systems. For this technique a multi tree indent is used and which is associated with an effective way of categorical data and spatial information. The main concept is the augmentation [5] of categorical points with some information to accelerate the queries.

The technical parts are a new method for spatial data structure and R-Tree based on the query processing of CRQs in the context of large databases. The new method is compared with two baseline algorithms. The first one is the regular range query [5] which handles the query for the particular range of lower and upper boundary. The second one is the construction of R-Tree [5] which contains the nodes that are the categorical attributes.

4.3 Query Processing in Spatial Network Databases

The query processing in spatial database [6] is mainly based on Euclidean spaces. But in this paper a new architecture is proposed in which the road network is separated from the datasets. To gather connectivity and location, a disk-based representation is used. For handling the dynamic updates and Euclidean queries the spatial entities are scored by some of the corresponding spatial access methods. Based on the above architecture two techniques are developed which are Euclidean restriction and network expansion. The most common spatial queries are the range search queries, nearest neighbor queries, closest pair queries and distance join queries. These are processed by using the above mentioned frameworks. By using the location information and connectivity, the efficient pruning of the search space is possible. Through this the traditional processing methods can be expanded by the new algorithms. The query processing in the Spatial Network Databases (SNDB)[6] in efficient and this paper introduces this advantage.

4.4 Optimal Route Query with Arbitrary Order Constraints

The optimal route query considers the partial order constraints for finding the optimal route. The user wants to specify starting point, destination point and a set of arbitrary order constraints [4]. This is different from the total sequenced rules. The example for the partial order constraints is “visit the pub before hotel”. Therefore any other categories can be included in between these two categories. But total order is the sequenced route conditions.

For considering the partial order constraints two different types of techniques are developed namely Backward search and Forward search [4]. Both the methods will take the same inputs and will produce the same output. The backward search algorithm finds the optimal route in the reverse manner that is starting from the destination and ends at the query starting point. This is similar to the R-LORD algorithm [7]. First select the destination point and as per the partial sequenced route find out all the possible edges to the second last point. Then find the optimum edge from these and attached to the destination. Then repeat the process until the query starting point encountered.

The second one is Forward search algorithm and which is similar to the greedy algorithm [1]. First select the query starting point and then find the nearest neighbor point which satisfies the given constraint. The process repeats and finally one optimal route is obtained. Then this forward search algorithm will use the backward search algorithm for the backtracking process. This will eliminate the demerits of the greedy algorithm. That is it eliminates some points that will not be a part of the optimal route. Both the algorithms find the optimal routes and which satisfies all the given partial order constraints. The memory usage is reduced by using some pruning techniques. Thus the number of categories from the dataset is reduced and the memory usage will be reduced.

This paper which uses both the optimal route query processing in road network and the spatial search with categorical information. Thus the methods used here is included in both the classifications. This technique solved the problem of optimal route query with partial order constraints [4]. Another advantage is that several sub routes also can be obtained and are optimal. Therefore in the real world application some of the category points can be omitted to meet the particular cost or the time.

5. CONCLUSIONS

The optimal route queries find the optimal route and this has greater applications in the road network. The spatial search with categorical information is used to consider the categorical points to be visited with better facilities. The initial solution of the optimal route query is based on the greedy solution. Some of the techniques considered total order constraints. The recent solutions of the optimal route query handle the arbitrary order constraints. All the methods will result in the optimal solutions with the given the starting and destination points. But many of the techniques do not consider constraints. Some may consider the total order constraints and some others use the partial order constraints. In future, some of the timing constraints can be included to the optimal route queries.

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BIOGRAPHIES



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