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AUTHENTICATION OF K NEAREST NEIGHBOR QUERY ON ROAD NETWORKS

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Abstract— **A k nearest neighbor (kNN) query on road networks retrieves the k closest points of interest (POIs) by their network distances from a given location. Today, in the era of ubiquitous mobile computing, this is a highly pertinent query. While Euclidean distance has been used as a heuristic to search for the closest POIs by their road network distance, its efficacy has not been thoroughly investigated.[1] The most recent methods have shown significant improvement in query performance.**

This work specifically focus on the k-nearest-neighbor (kNN) query verification on road networks and design verification schemes which support both distance verification and path verification. That is the k resulting objects have the shortest distances to the query point among all the objects in the database, and the path from the query point to each k nearest- neighbor result is the valid shortest path on the network.

I. Introduction

GEOSPATIAL TECHNOLOGY

Geospatial technology has advanced significantly over the past decades, especially since the introduction of geospatial technology and location-based services on mobile devices like smart phones. [2] The combination of mobile devices and Cloud based solutions is creating a versatile ecosystem for reshaping the way geospatial data are stored, managed, served and shared. In this new ecosystem, also known as database outsourcing, the data owner (DO) delegates the management and maintenance of its database to a third-party Cloud service provider (SP), and the SP server is responsible for indexing the data, answering client queries, and updating the data on requests from the DOs. Mobile clients, which used to send their queries to the DO, now submit queries to SP and retrieve results from SP directly. [4]

Fig (1) Database outsourcing architecture.

However, as the Cloud service provider (SP) is not the real owner of the data, it might return dishonest or suboptimal results to clients out of its own interests intentionally. For example, an SP which hosts a collection of restaurants might favor some restaurants who pay more advertisement fees. On the other hand, although commercial SPs are generally unlikely to provide unfaithful results to users, they could act malicious involuntarily and serve false results unintentionally to the end users, e.g., when SP is under attack, or while the communication channel is compromised between SP and clients.

II. ROAD NETWORKS USING ALGORITHM

Related work (Road segment distance)

The road network is represented as a graph where a vertex is an intersection on the road network and an edge is a road segment. We give a formal definition of the road network as follows.

Definition 1 (Road network). *A road network* RN *is defined as a graph* GRN = (V,E)*, where* V *is a set of intersections of the road network, and* E *is a set of road segments* Ri ∈ E *such that* Ri = (ri,s, ri,e), where ri,s, ri,e ∈ V and there exists an road between ri,s and ri,e. [4] We assume a trajectory is given as a *connected* sequence of road segments, which is obtained by map matching algorithm, such that each road segment of a trajectory should be connected to the next road segment in the sequence. That is, the ending position of each segment is the starting position of the next segment in the sequence.

Definition 2 (Trajectory). Given a road network GRN = (V,E) and a set of trajectory T, a trajectory of length l is defined as TRi = _ti 1, . . . , ti l_, where ti j ∈ E, 1 ≤ j ≤ l, and ti j and ti j+1 are connected. For a given set of trajectories T = {TR1, · · · , TRn} on a road network RN, our clustering algorithm reports a set of clusters C = {C1, . . . ,Ck}. which is defined as follows. [6]

Definition 3 (Cluster). Given input trajectories T, a cluster Ci ∈ C is a set of trajectories .

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III. DISTANCE MEASURE (ROAD SEGMENT DISTANCE)

The distance d(Ri,Rj) between two road segments Ri and Rj , based on which we will define the distance between the trajectories later on. The road segment distance between Ri and Rj , is defined as follows:

Definition 4 (Road segment distance).

Definition 5 (One-way road segment distance) [5].

Trajectory distance

Definition 6 (Trajectory distance). *Given two trajectories* TRi = [t^i_1, . . . , t^i_n]*and* TRj = [t^j_1, . . . , t^j_i], *the distance.* [6]

Definition 7 (One-way trajectory distance). *Given two trajectories* Tri *and* TRj , *the one-way trajectory distance is defined by*

One-way trajectory distance finds the road segment t^i_a that is the farthest from road segments of TRj , and calculates the distance from t^i_a to its nearest road segment in TRj [7].

IV. CONCLUSION

In this paper, we studied the query integrity problem for *k*-nearest-neighbor queries on outsourced road networks and points of interest databases. While existing approaches proposed in this domain cannot verify both the distance and the shortest path to the *k*NN results.

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