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Editorial

A continuous reverse skyline query processing method in moving objects environments

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ABSTRACT

Many studies on reverse skyline query processing have been done for various services. The existing reverse skyline query processing methods are based on dynamic skylines. There are no reverse skyline query processing algorithms based on metric spaces for location-based services. The existing methods for processing a reverse skyline query have the limitation of service domains and require the high costs of computation to provide various location-based services. In this paper, we propose a new reverse skyline query processing method that efficiently processes a query over the moving objects. In addition, the proposed method processes a continuous reverse skyline query efficiently. In order to show the superiority of the proposed method, we compare it with the previous reverse skyline query processing method in various environments. As a result, the proposed method achieves better performance than the existing method.

1. Introduction

With the development of mobile devices such as smart phone and tablet, various applications for the mobile devices have been released. In this situation, one of the most important services for the mobile devices is location-based services (LBS) [1,2]. LBS provides the useful information based on the locations of mobile users. To provide LBS, various query processing techniques over moving object environments have been widely studied [3–10]. To provide location-based services, we need efficient query processing methods for various query types such as a point query, a range query [3,4], a *k*-nearest neighbor (*k*NN) query [5–7], and a top-*k* query [8–10].

Many studies for skyline queries which consider multi-attribute values have been done [11,12]. With the development of various skyline query processing techniques, it becomes possible to provide various services considering multi-attribute values such as the cheapest and nearest restaurant. In the past, most of the services considered the type of information to be provided to the customers. The services must consider the kind of target objects or the efficiency of a query processing method when providing information. In addition, the skyline is a useful query type for customer-oriented services, but it is not suitable for company-oriented services. As the variant of the skyline query processing, a reverse skyline query has been studied for company-oriented services [13–20]. The reverse skyline query is a query type returning a set of objects that includes the query object as the result of the skyline query. For example, the restaurant is able to retrieve the customers that consider it to be the cheapest and nearest one by the reverse skyline query. We can also provide more useful services through the reverse skyline query.

Recently, various reverse skyline query processing methods have been studied. But, they are based on dynamic skyline [21]. The traditional skyline to retrieve skyline points usually assumes static data objects in the database. However, the dynamic skyline focuses on skyline queries with dynamic attributes. The dynamic skyline is the specific skyline to process a similar query. Thus, the existing reverse skyline methods have the limitation of service domains and require the high costs of computation to provide various

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location-based services. In this paper, we propose a new reverse skyline query processing method that efficiently processes a query over moving objects. In addition, the proposed method also processes continuous reverse skyline queries efficiently. The proposed method makes the verification range to guarantee the result of a reverse skyline query. Therefore, the proposed method does not need to implement final verification when the new objects appear or the moving objects move. In order to show the superiority of the proposed method, we compare it with the previous reverse skyline query processing method in various environments. As a result, the proposed method achieves better performance than the existing method.

The rest of this paper is organized as follows. Section 2 reviews related works. Section 3 illustrates our proposed method. Section 4 presents the performance evaluation results of our proposed method. Finally, Section 5 concludes this paper.

2. Related work

2.1. The skyline query

A skyline query that has been widely studied is a specific example of multi-attribute queries. The result of a skyline query is a set of objects in the database whose attribute values are not dominated by any other objects. For example, if a customer wants to find the cheapest and nearest restaurant, the location of the customer is a query point in the space and the restaurants are the target objects of the query. The attributes of the objects are the price and the distance.

Fig. 1 shows how to process a skyline query. As shown in Fig. 1(a), there are certain objects, p_1, p_2, p_3, p_4, p_5 and p_6. In this case there are no objects satisfying the customer's requirements. However, the customer will want some restaurants whose conditions are close to their expectations. In other words, the customer does not consider the objects which have a higher price and greater distance than another object. After removing the objects dominated by other objects on all dimensions, the remaining objects are the result of the query. p_3 and p_4 are removed, since they are dominated by other objects. That is, p_3 is dominated by p_2, p_4 and p_5, and p_4 is dominated by p_5. The result of the query is shown in Fig. 1(b).

2.2. The reverse skyline query

The reverse skyline query is a query type returning a set of objects that includes the query object as the result of the skyline query. For example, when a restaurant wants to advertise a bargain day, the advertisement is more impressive to customers who think that the restaurant is cheaper and closer than other restaurants. In this case, the restaurant is a query object issuing a reverse skyline query and the customers are the target objects for the query. Fig. 2 shows the skyline of target objects. Fig. 2(a) shows the skyline of c_1. c_1 is the reverse skyline. In this case, query q is the skyline. Fig. 2(b) shows the skyline of c_2. c_2 is not the reverse skyline. In this case, query q is not the skyline.

The naive method to process a reverse skyline query is Greedy Reverse Skyline (GRSL) [13], which finds target objects including the query object as a result of a skyline query for each target object. However, the method requires a lot of computation time to process the reverse skyline query. Recently, various reverse skyline query processing methods have been proposed. E. Dellis proposed a reverse skyline query processing method using the Branch and Bound Skyline (BBS) algorithm, and Reverse Skyline Computation Using Skyline Approximations (RSSA) to reduce the quantity of a range query [13]. X. Lian proposed a Reverse Skyline Search over Uncertain Databases [14]. L. Zhu proposed Reverse Skyline on Data Stream [15]. Y. Park proposed Reverse Skyline with MapReduce [16]. And Y. Gao proposed Reverse Skyline over multidimensional datasets [17].

However, they are not exactly reverse skyline algorithms. They are based on dynamic skyline algorithms [21]. We call them reverse dynamic skyline. Fig. 3 shows the dynamic skyline and reverse dynamic skyline. The dynamic skyline focuses on skyline queries with dynamic attributes. The dynamic skyline is the specific skyline to process a similarity query. Therefore, the existing dynamic skyline

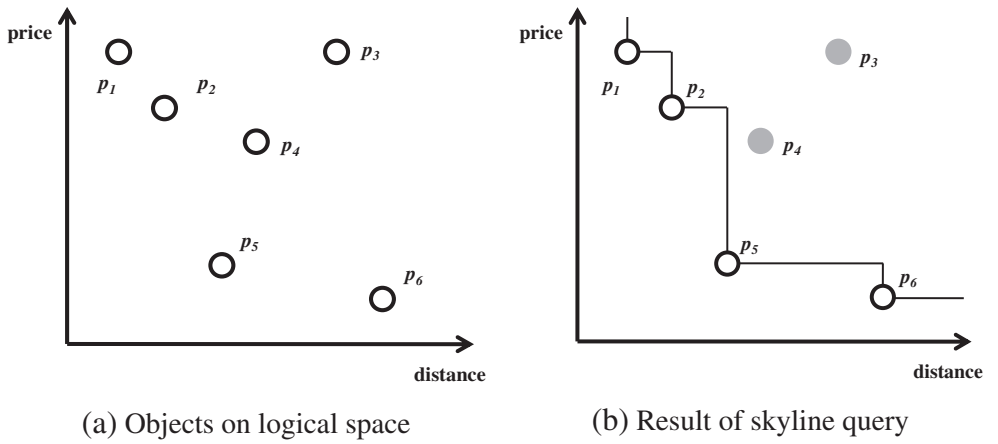

Fig. 1. Example of skyline query processing.