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RT-LARS*: Real-Time Location-Aware Recommender System

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***Abstract* — A location-aware recommender system that uses location-based ratings to produce recommendations, this paper proposes RT-LARS*. RT-LARS*, on the other hand, supports a taxonomy of three novel classes of location-based ratings, namely, spatial ratings for non-spatial items, non-spatial ratings for spatial items, and spatial ratings for spatial items, traditional recommender systems do not consider spatial properties of users nor items. A technique that influences recommendations with ratings spatially close to querying users in a manner that maximizes system scalability while not sacrificing recommendation quality, RT-LARS* exploits user rating locations through user partitioning. A technique that favors recommendation candidates closer in travel distance to querying users in a way that avoids exhaustive access to all spatial items, RT-LARS* exploits item locations using travel penalty. Depending on the type of location-based rating available, RT-LARS* can apply these techniques separately, or together. from both the Foursquare location-based social network and the Movie Lens movie recommendation system reveals that RT-LARS* is efficient, scalable, and capable of producing recommendations twice as accurate compared to existing recommendation approaches, experimental evidence using large-scale real-world data.**

***Keywords*— Recommender system, spatial, location, performance, efficiency, scalability, social.**

I. INTRODUCTION

To help users identify useful items from a considerably large search space (e.g., Amazon inventory, Netflix movies1), RECOMMENDER systems make use of community opinions. Which analyzes past community opinions to find correlations of similar users and items to suggest k personalized items (e.g., movies) to a querying user u, the technique used by many of these systems is collaborative filtering (CF). Community opinions are expressed through explicit ratings represented by the triple (user, rating, item) that represents a user providing a numeric rating for an item.

Currently, myriad applications can produce location-based ratings that embed user and/or item locations. For example, location-based social networks (e.g., Foursquare2 and Face book Places) allow users to "check-in" at spatial destinations (e.g., restaurants) and rate their visit, thus are capable of associating both user and item locations with ratings. Whereby the recommender system exploits the spatial aspect of ratings when producing recommendations, such ratings motivate an interesting new paradigm of location-aware recommendations. Thus are ill-equipped to produce location aware recommendations, existing recommendation techniques assume ratings are represented by the triple. To produce high-quality location-based recommendations in an efficient manner, In this paper, we propose RT-LARS*, a novel location aware recommender system built specifically. RT-LARS* produces recommendations using a taxonomy of three types of location-based ratings within a single framework:

(1)Where location represents a user location, for example, a user located at home rating a book, spatial ratings for non-spatial items, represented as a four-tuple (user, ulocation, rating, item).

(2)Where ilocation represents an item location, for example, a user with unknown location rating a restaurant, non-spatial ratings for spatial items, represented as a four-tuple (user, rating, item, ilocation).

(3)Spatial ratings for spatial items, represented as a five-tuple (user, ulocation, rating, item, ilocation), for example, a user at his/her office rating a restaurant visited for lunch. Traditional rating triples can be classified as non-spatial ratings for non-spatial items and do not fit this taxonomy.

II. CONTRIBUTION

We provide a novel classification of three types of location-based ratings not supported by existing recommender systems: spatial ratings for non-spatial items, non-spatial ratings for spatial items, and spatial ratings for spatial items.

We propose RT-LARS*, a novel location-aware recommender system capable of using three classes of location-based ratings. Within RT-LARS*, we propose:

(a) User partitioning technique that exploits user locations in a way that maximizes system scalability while not sacrificing recommendation locality

(b) Travel penalty technique that exploits item locations and avoids exhaustively processing all spatial recommendation candidates.

• RT-LARS* distinguishes itself from LARS [8] in the following points:

(1) RT-LARS* achieves higher locality gain than LARS using a better user partitioning data structure and algorithm.

(2) RT-LARS* exhibits a more flexible tradeoff between locality and scalability.

(3) RT-LARS* provides a more efficient way to maintain the user partitioning structure, as opposed to LARS expensive operations.

• We provide experimental evidence that RT-LARS* scales to large-scale recommendation scenarios and provides better quality recommendations than traditional approaches.

III. LITERATURE SURVEY

A. Location-Based Services.

Current location based services employ two main methods to provide interesting destinations to users. (1) KNN techniques and variants (e.g., aggregate KNN) simply retrieve the k objects nearest to a user and are completely removed from any notion of user personalization. (2) Preference methods such as skylines (and spatial variants) and location-based top-k methods require users to express explicit preference constraints. Conversely, RT-LARS* is the first location based service to consider implicit preferences by using location-based ratings to help users discover new items. Recent research has proposed the problem of hyper-local place ranking. Given a user location and query string (e.g., “French restaurant"), hyper-local ranking provides a list of top-k points of interest influenced by previously logged directional queries (e.g., map direction searches from point A to point B). While similar in spirit to RT-LARS*, hyper-local ranking is fundamentally different from our work as it does not personalize answers to the querying user, i.e., two users issuing the same search term from the same location will receive exactly the same ranked answer.

B. Traditional Recommenders.

A wide array of techniques are capable of producing recommendations using non spatial ratings for non-spatial items represented as the triple (user, rating, item). We refer to these as “traditional" recommendation techniques. The closest these approaches come to considering location is by incorporating contextual attributes into statistical recommendation models (e.g., weather, traffic to a destination). However, no traditional approach has studied explicit location-based ratings as done in RT-LARS*. Some existing commercial applications make cursory use of location when proposing interesting items to users. For instance, Netflix displays a “local favorites” list containing popular movies for a user’s given city. However, these movies are not personalized to each user (e.g., using recommendation techniques); rather, this list is built using aggregate rental data for a particular city. RT-LARS*, on the other hand, produces personalized recommendations influenced by location-based ratings and a query location.

IV. SYSTEM ANALYSIS

A. Location-Aware Recommenders

The City Voyager system mines a user’s personal GPS trajectory data to determine her preferred shopping sites, and provides recommendation based on where the system predicts the user is likely to go in the future. RT-LARS*, conversely, does not attempt to predict future user movement, as it produces recommendations influenced by user and/or item locations embedded in community ratings. The spatial activity recommendation system mines GPS trajectory data with embedded user-provided tags in order to detect interesting activities located in a city (e.g., art exhibits and dining near downtown). It uses this data to answer two query types: (a) given an activity type, return where in the city this activity is happening, and (b) given an explicit spatial region, provide the activities available in this region. This is a vastly different problem than we study in this paper. RT-LARS* does not mine activities from GPS data for use as suggestions for a given spatial region.

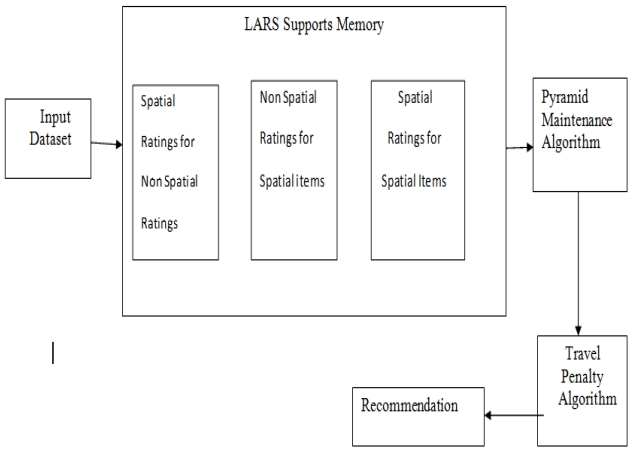

Fig 1. Architecture of Location-aware Recommender System

Rather, we apply RT-LARS* to a more traditional recommendation problem that uses community opinion histories to produce recommendations. Geo-measured friend-based collaborative filtering produces recommendations by using only ratings that are from a querying user's social-network friends that live in the same city. This technique only addresses user location embedded in ratings. RT-LARS*, on the other hand, addresses three possible types of location-based ratings. More importantly, RT-LARS* is a complete system (not just a recommendation technique) that employs efficiency and scalability techniques (e.g., partial pyramid structure, early query termination) necessary for deployment in actual large-scale applications.

V. CONCLUSION

RT-LARS*, our proposed location-aware recommender system, tackles a problem untouched by traditional recommender systems by dealing with three types of location-based ratings: spatial ratings for non-spatial items, non-spatial ratings for spatial items, and spatial ratings for spatial items. RT-LARS* employs user partitioning and travel penalty techniques to support spatial ratings and spatial items, respectively. Both techniques can be applied separately or in concert to support the various types of location-based ratings. Experimental analysis using real and synthetic data sets show that RT-LARS* is efficient, scalable, and provides better quality recommendations than techniques used in traditional recommender systems.

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