Knowledge Based Keyword-Aware Representative Travel Route Recommendations

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Abstract: Online Social Networks (OSNs) are widely used by people to share their activities related to travelling, check-in and others. People often have travel plans with preferences. Maintaining travel histories of people with personalization can help in making future decisions with ease. However, it is non-trivial to have queries processed with the help of previous history of knowledge and to produce more useful personalized representative travel recommendations. The notion of point of interest apart for giving search keywords can help users express more skyline options in order to help in effective processing. The concept of finding representative travel recommendations that consider POIs and other user parameters besides historical skylines is an important research to be carried out. In the proposed system, the keyword-aware representative travel route recommendation system is further improved to support the use of previously repeated queries and to learn the approximate parameters automatically. Thus the system becomes a knowledge based keyword-aware representative travel route recommendation system to reduce computational cost and improve response time. An algorithm by name Knowledge based Query Processing (KQP) is used to achieve this. We built a prototype application with web interface to demonstrate proof of the concept.

Keywords – Online social network, location-based OSN, text mining, recommender system.

1. INTRODUCTION

Location based services and location based queries are important in the real world. These services in the social media are able to capture the movements of users in terms of check-in and travel details. The travel routes of users are updated in social media to provide data for mining travel route recommendations. Trip planning is one of the fundamental activities carried out by humans. However, it is not simple as one thinks. It needs to consider many parameters. An application that can help in geographical location based queries or skyline queries can help them to understand the routes and plan trips with ease. Travel route finding with given keywords and user point of interests is essential. Many researchers contributed towards trip planning and other tourism activities as explored in [1], [3], [5], and [8].

In this paper we prefer extending the approach provided in [1] for better personalized skyline representative travel route recommendations that consider historical recommendations. This approach is known as knowledge based keyword-aware representative route recommender system. Our contributions are as follows.

1. We proposed a methodology to achieve knowledge based keyword-aware travel route recommendations that are representative to given query. It is achieved by considering historical skyline representative recommendations.
2. We proposed and implemented an algorithm known as Knowledge based Query Processing (KQP) to generate personalized skyline representatives that provide user desired recommendations.
3. We built a prototype application to demonstrate proof of the concept. The experimental results revealed that the proposed system is able to provide personalized skyline representatives with better accuracy.

The remainder of the paper is structured as follows. Section 2 presents review of literature. Section 3 presents the problem formulation. Section 4 presents the proposed methodology. Section 5 presents implementation details. Section 6 provides experimental results. Section 7 concludes the paper besides providing directions for future work.

2. RELATED WORK

This section provides review of literature on travel recommender systems and other related aspects. Keyword-aware travel recommendations are studied in [1]. Recommendations related to time-sensitive routers is explored in [2] with availability of large-scale check in data. Geo-tagged photos associated with generation of travel routes for trip planning [3]. By taking geo-tagged social media trajectory pattern ranking is performed in [4] for better recommendations. In the same fashion, pattern-aware trajectory search is explored by defining a framework in [5]. Mining is studied for extracting interesting locations from GPS trajectories. It is also possible to obtain travel sequences that help in making well informed decisions [6].

Trip planning with skyline travel routes is explored in [7]. Skyline travel routes are used to understand routes and plan for trips. Time-aware travel routes mining is performed in [8] from check-in data for trip planning. Distant time locations are inferred from the trajectories [9]. A mobile recommender system is explored in [10] for prediction of user activities in social networks that are location-aware. A mobile recommender system with energy aware approach is studied in [11]. Discovering semantic locations is done from the GPS data [12]. Location based social networks are studied for extracting social influence is made in [13].

POI based recommendations that are graph-based are explored in [14] with temporal and geographical influences. Approximate keyword search [15], optimal route search with key-word awareness [16], search for activity trajectories [17] are other techniques used in extracting travel related knowledge. Social influence for recommendations [18] and extracting skyline travel routes for trip planning [19] are also found in the literature. From the review of literature it is understood that knowledge based approach for

generating representative travel routes is the desired area of research. This is the motivation behind this research.

3. PROBLEM DEFINITION

Tourism industry has become very important to assist people travel across the globe. Due to the availability of transport and its affordability, tourism has become an industry that provides many business models. Customers in tourism domain will have to face many problems for every move unless there is guidance properly. Therefore it is essential to have travel recommendations or route recommendations to help them. Building a knowledge based representative travel recommender system is very challenging as it has to reuse previous knowhow on the travel route recommendations. The aim of this paper is to support personalized travel route recommendations that contain representative routes.

4. PROPOSED METHODOLOGY

We proposed a methodology with an underlying algorithm to support knowledge based keyword-aware representative travel route recommendations. It makes use of keywords given in search query, user point of interests (POIs) and historical records that contain similar recommendations. It makes use of keyword extraction and also sometimes there might be edit distance for accuracy of making queries. When routes are recommended they are saved with personalization. After that the history may be reused to solve further query. When a search keyword is given, the application takes care of semantic meanings of given word. Lexical dictionary such as WordNet is used to find the synsets and improve query processing. The concepts of point of interest are incorporated for better results that satisfy user needs.

4.1 Knowledge Based Approach

Every time recommendations are produced by the system, they are maintained in the form of history that is in a personalized fashion. Then the history containing personalized representative route recommendations against given query are reused to save time and computational cost. Therefore the knowledge based query processing can make use of heuristics in order to provide better travel recommendations.

4.2 Knowledge Based Query Processing Algorithm

This algorithm is meant for producing representative skyline recommendations that are personalized and knowledge based. It takes set of skyline queries, query history database and skyline representative skyline history database to produce desired personalized and knowledge based representative recommendations.

Algorithm: Knowledge based Query Processing (KQP)

Input: Set of skyline queries Q={q1, q2, …, q_n}, query history database QHD, skyline representative history database SRHD
Output: Skyline representatives

```
01  Initialize vector for skyline representatives S
02  Initialize skyline representative vector SR
03  Initialize frequency threshold th
04  Initialize query history vector H
05  Initialize skyline representative history vector SRH
    Load Query History
06  For each query q in QHD
07  Add q to H
08  End For
    Load Skyline Representative History
09  For each skyline s in SSRHD
10  Add s to SRH
11  End For
    Query Processing
12  For each query q in Q
13  IF q is in SRH THEN
14  Add skyline representative to SR
15  Add q to H
16  END IF
17  IF q is in H and frequency is >=th THEN
18  Process query and add skyline representative to SR
19  Add skyline representative to SRH
20  Add q to H
21  END IF
    Synchronize DBs and Return SR
22  IF SRH is not in sync with SRHD THEN
23  Synchronize SRH with SR
24  END IF
25  IF H is  not in sync with QHD THEN
26  Synchronize QHD with H
27  END IF
28  Return SR
```

Algorithm 1: Knowledge based Query Processing

As shown in algorithm 1, the KQP algorithm has many activities to be performed. They include loading query history, loading skyline representative history, query processing and synchronize databases and return final skyline representative travel recommendations.

4.3 Datasets Used

Synthesized data set is used for experiments. In addition to this two datasets explored in [1] are used. They are known as FB and CA. These datasets when used the proposed system has produced results that are comparable with existing system.

5. PROTOTYPE IMPLEMENTATION

We built a prototype application to demonstrate proof of the concept. The application supports both synthetic data to be generated and queried and also real datasets as mentioned earlier. Java is the platform for building the application that provides web based interface. There are many roles in the application. Users of the application can be of in any role. The roles include user, admin, system and personalized travel server. Administrator can perform various activities like adding locations, sequential travel route directives, view similar interested routes from history, and view other tourism related details. End users can view his profile details, make search queries to find travel routes that are representative and

perform other social activities. The main activity of end user is to search for travel routes and obtain representative routes with points of interest.

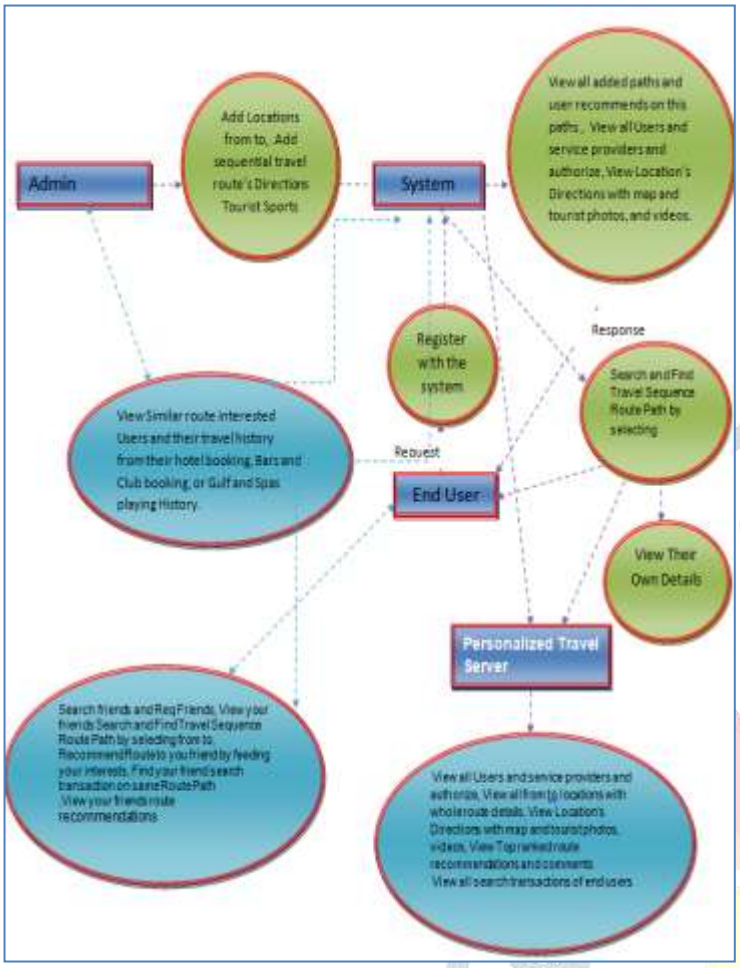

Figure 1: Roles in the application and their activities

In the same fashion system module has its own activities. It coordinates to coordinate functionalities of other users. For instance users can register with the system by invoking system functionalities. Personalized travel server is the role in which the server remembers the identity and conversation of users and provides personalized representative routes against a query. The server takes care of various activities including viewing all users, viewing service providers, searching and finding travel routes and so on. The interaction among different roles in the system is presented in Figure 2.

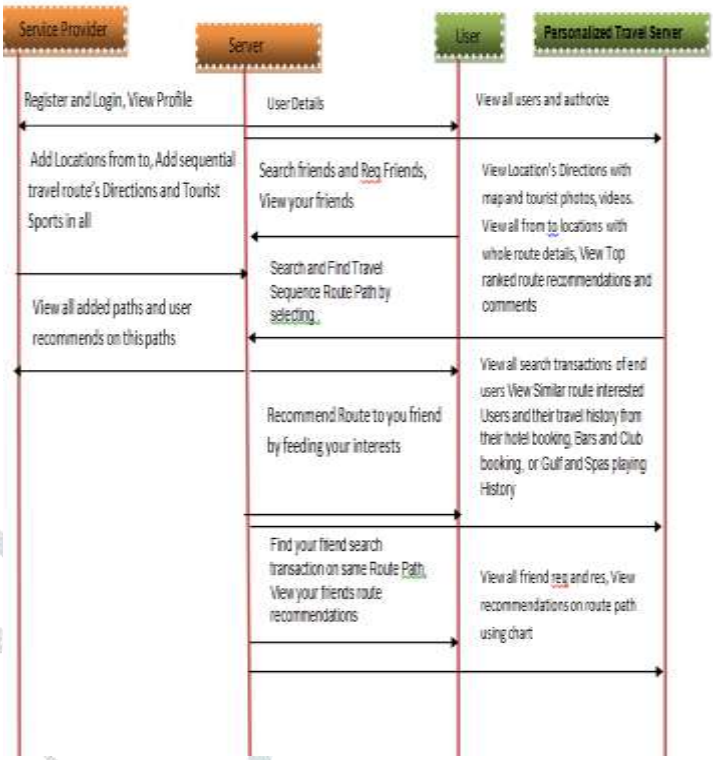

Figure 2: Dynamic interaction among the roles in the system

The sequence diagram shows runtime interactions among different objects involved in the system. The objects include service provider, server, user and personalized travel server. The overall objective of the system is to provide personalized representative travel route recommendations effectively. The web based application is deployed in the web server and evaluated its functionality. The activities associated with the user role are presented in the UI as shown in Figure 3.

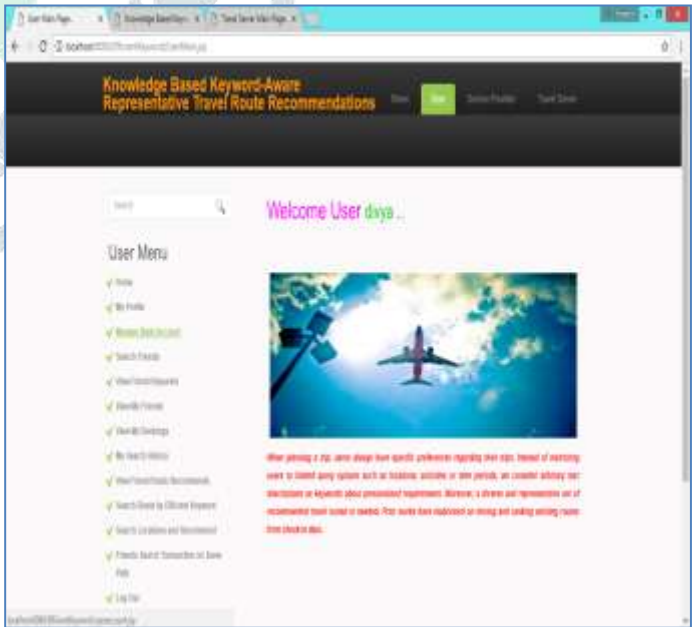

Figure 3: UI showing activities of authenticated user

As due authentication user is able to get his main UI that has provision for making various activities. The activities are presented as User Menu on the left part of the window. The options include viewing profile, managing account, performing social interactions,

viewing search history, finding personalized route recommendations and so on. When a search is made the results are presented with representative routes based on POI specified by users. A sample query and outcome are as shown in Listing 1.

From Bangalore To Pune

Direction1 ---TA(Like Hubli)------ Tourist sport ---- TA ------ Show packages ---
Place name, topical interest, Cost for visiting, Time, Season, Show Geo
Tagged Photo , Show Related Video,View Route path from name to Direction1 ,show other tags with address

Direction2 ----- TA ---- Tourist sport ----- TA ----- ---- Show packages ---
Place name, topical interest, Cost for visiting, Time, Season, Show Geo
Tagged Photo , Show Related Video,View Route path from name to Direction2, ,show other tags with address

Direction3 ---- TA ----- Tourist sport ---- TA ------ ---- Show packages ---
Place name, topical interest, Cost for visiting, Time, Season, Show Geo
Tagged Photo , Show Related Video,View Route path from From name to Direction3, ,show other tags with address

Direction4 ---- TA ----- Tourist sport ---- TA ------ ----- Show packages ---
Place name, topical interest, Cost for visiting, Time, Season, Show Geo
Tagged Photo , Show Related Video,View Route path from name to Direction4, ,show other tags with address

Listing 1: Representative routes given based on user query

The results can also be mapped to Google Maps. The representative travel routes are recommended by the system. However, it can be viewed through Google Maps for more sophisticated directions related to route recommendations. That kind of mapping result is shown in Figure 4.

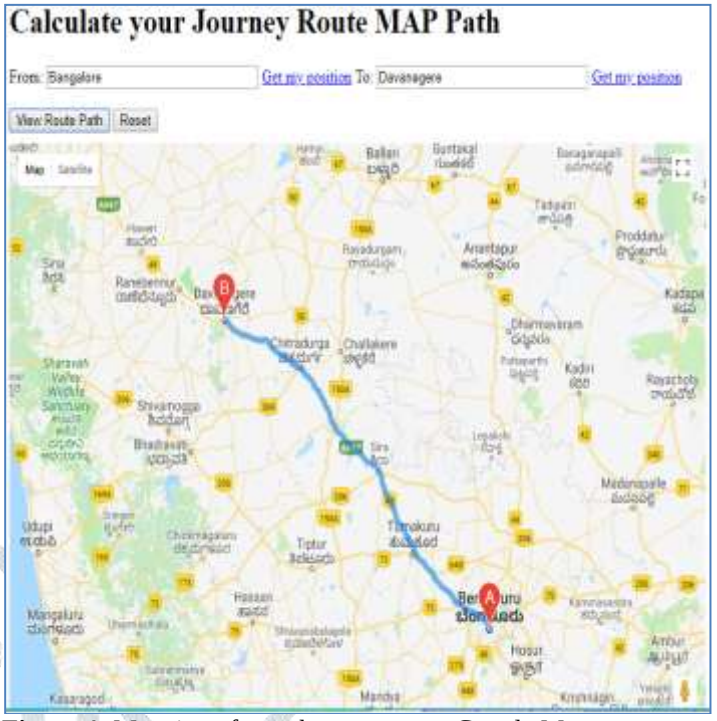

Figure 4: Mapping of search outcomes to Google Maps

As presented in Figure 4, Google Maps is the application that provides street maps, satellite imagery, real time traffic conditions, and provides travelling route directions. It can guide novice drivers by showing directions to reach desired destination. By integrating the search results the application adds more value to end users as they can comprehend the results with ease.

6. EXPERIMENTAL RESULTS

Experiments are made to view the performance of knowledge based approach where history of previous recommendations are mined and reused for better accuracy and speed of execution. The results are understood in terms of edit distance of queries, cover ratio and Cosine category of similarity. The results are as shown in Figure 1 and Figure 2.

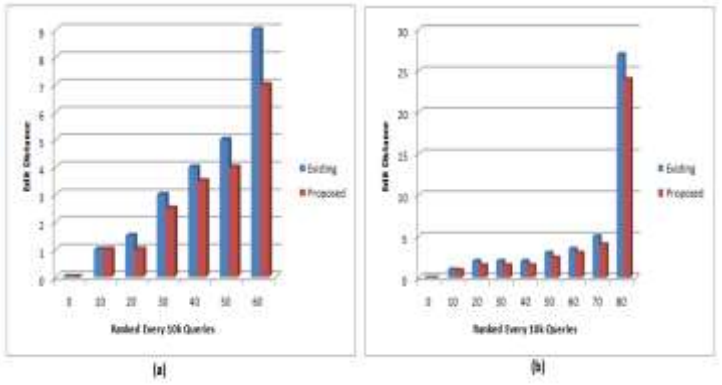

Figure 5: Edit distance with FB (a) and CA (b) datasets

As presented in Figure 5, it is evident that the proposed system has equal or better performance when compared with the existing system. The horizontal axis shows values that are ranked for every 10,000 queries while the vertical axis shows edit distance. The results revealed that there are influences of values in X axis on the edit distance. The proposed system has better performance over the existing system.

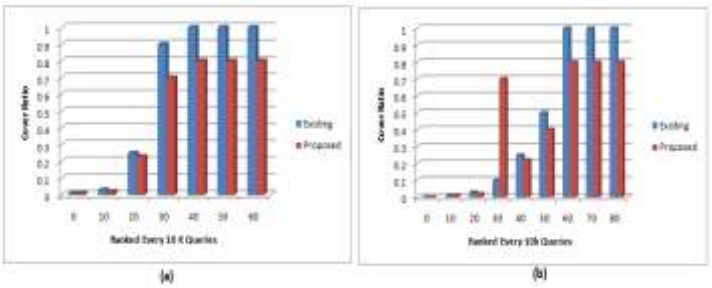

Figure 6: Cover ratio with FB (a) and CA (b) datasets

As presented in Figure 6, it is evident that the proposed system has equal or better performance when compared with the existing system. The horizontal axis shows values that are ranked for every 10,000 queries while the vertical axis shows cover ratio. The results revealed that there are influences of values in X axis on the edit distance. The proposed system has better performance over the existing system.

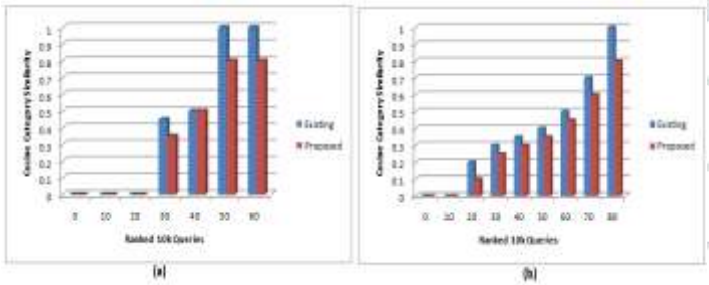

Figure 7: Cosine category similarity with FB (a) and CA (b) datasets

As presented in Figure 7, it is evident that the proposed system has equal or better performance when compared with the existing system. The horizontal axis shows values that are ranked for every 10,000 queries while the vertical axis shows cosine category similarity. The results revealed that there are influences of values in X axis on the edit distance. The proposed system has better performance over the existing system.

7. CONCLUSION AND FUTURE WORK

In this paper we proposed a methodology for discovering personalized representative travel route recommendations. The proposed system makes use of knowledge based approach that mines history of queries and history of skyline representative reconditions. Thus it provides better means of producing accurate results. In the existing approaches skyline queries are made with keyword queries. In the proposed system keyword-aware query is made with personalized travel route recommendations that are representative and involves the usage of historical knowledge. We proposed an algorithm known as Knowledge based Query Processing (KQP) to achieve this. We built a prototype application with web interface to demonstrate proof of the concept. The experimental results revealed the utility of the proposed solution. In future we continue our research on alternative approaches for generating travel route recommendations.

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