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Location-Based Recommender System for Mobile Devices on University Campus

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Abstract**:** *Mobile computing systems and applications are continuously gaining much interest from academia and industry given their impact on people's daily lives and given the technological advances in artificial intelligence. Particular applications that are capturing a lot of attention are recommender systems due to their importance in helping people with their life-related decisions such as: what book to read, what movie to watch, what music to listen to, where to eat, which links to visit on the web and several other situations where a decision is required. Increase demand to modern technologies and interest in utilizing geospatial information servers to provide useful information and services to mobile users though wireless networks plays a very important factor to location-based services advancement. This research will propose location-based recommendations for university campus information. Seminar and event recommendations are presented as location based service. Combination of Demographic and Collaborative Filtering algorithms is used to recommend the seminars and events. It will also show the direction to the required department or library based on user's current location by GPS. Android application development is used for developing mobile application of location based services.*

Keywords: *Location-based recommender systems, Mobile application, Hybrid recommender system, Campus information, Shortest Path.*

1. Introduction

Visitors around the university campus often find it difficult where to go or what new events or seminars are held on the campus. Advanced tourist information systems should deliver more than static information. The system should also recommend sights that match the user's context and interest. User context may be their location, their interest major at their current position, their means of travel, and the current time. The user's interests are captured in their profile, their travel history, and by giving feedback about items in their travel history around the campus.

Typically, the recommendations are based on rudimentary information such as the opening time or the physical proximity of sights to the user. Research areas that evaluate methods for user recommendations are recommender systems. These systems use a database about user preferences to predict additional topics or products a new user might like. Travel decision-making is one of the most comprehensively investigated areas in tourism research.

Recommender Systems RSs are decision support tools aimed at addressing the information overload problem, providing product and service recommendations personalized to the user's needs and preferences at a particular request context [10] [4]. However, existing recommendation technologies have not been developed specifically for mobile users; and this paper shows that recommendation techniques developed for the web must be adapted to the mobile environment in order to better exploit the available information, and provide software tools usable on mobile devices.

The evolution of mobile devices (e.g., PDAs and mobile phones), wireless communication technologies (e.g., wireless LAN and UMTS), and position detection techniques (e.g., RFID beacon-based and GPS), have created favorable conditions for the development and commercialization of a large number of location-based mobile services [8] [9] i.e., information services accessible by mobile devices through the mobile network, and utilizing the geographical position of the mobile device. As a consequence, many location-based mobile services have been introduced in the recent years, including emergency services, information services, navigation support services, etc.

The contributions of this paper are: (1) a thorough requirements analysis for recommendations in a visitor's mobile environment; (2) a comprehensive analysis of the state of the art in tourist information systems and research in recommender systems; (3) the design of location based recommendation methods by combination of Demographic and Collaborative Filtering approaches.

2. Background Theory

Recommender Systems (RSs) are software tools and techniques providing suggestions for items to be of use to a user which relate to various decision-making processes. Hybrid recommendation systems are mix of single recommendation systems as sub-components. Four major recommendation techniques constructing hybrids are collaborative filtering (CF), content-based (CN), demographic, and knowledge-based (KB).This hybrid approach was introduced to cope with a problem of conventional recommendation systems. Two main problems have been addressed by researchers in this field, cold-start problem and stability versus plasticity problem. Stability/plasticity problem means that it is sometimes hard to change established users' profiles which have been established after a given period of time using the systems. The former problem can be solved with the hybrid approach because different type of recommendation technique like knowledge based algorithm can be less affected by the problem. Therefore, various hybrid recommendation techniques have been introduced and tested. This system will implement collaborative recommendation over demographic approach. Collaborative approach has cold-start problem and demographic filtering addresses these problems by filtering with user's profile and preferences with history.

Problems to be solved: This system will help people getting update information on campus, seminars to attend and events around the campus based on his/her interest or research area. For the visitors, it will also recommend places to go such as meeting and seminars. For the students, it will recommend their exam timetables, exam room, seminars, etc. It will also help new students and teachers to find routes such as where is the department or library. This research can easily be used from mobile devices as well as web application from computers to help visitors and students feeling convenient around campus.

2.1.Demographic Filtering

The demographic filtering approach [6] uses the stereotype reasoning which is mainly the classification of a problem, in its recommendations. It is based on the information stored in the user profile that contains mainly in different demographic features to generate initial predictions about the user. This approach is widely used in recommendations systems and marketing, recommending items based on user's demographic profile. The user profile is based on demographics data, such as number of times a user view or visit a particular item/place according to his / her country, language, age or gender. A demographic recommender provides recommendations based on a demographic profile of the user. Recommended products can be produced for different demographic niches, by combining the ratings of users in those niches.

2.2.Collaborative Filtering

Sarwar et al. presents in [1] a technique that makes use of collaborative filtering. This technique assumes a list of m users $U = \{u1, u2, \ldots, um\}$ and a list of n items $I=\{i1, i2, \ldots, in\}$. Each user *ui* has rated a list of items noted by *Iui*. The purpose of this technique is to predict the ratings of unrated items by a given user and recommend the Top-N items. Two approaches for collaborative filtering, user-based and item-based.

- Item-Based Nearest Neighbor

Item-based collaborative filtering makes use of the similarity available between two items. The similarity measures rely on the ratings available for two queried items. Prediction for a user *u* and item *i* is composed of a weighted sum of the user *u*'s ratings for items most similar to *i*.

$$pred(u,i) = \frac{\sum_{j \in ratedItems(u)} sim(i, j) \cdot r_{ui}}{\sum_{j \in ratedItems(u)} sim(i, j)} \quad (1)$$

- User-Based Nearest Neighbor

User-based collaborative filtering utilizes the similarity computed between the active user and all other users. Generate a prediction for an item *i* by analyzing ratings for *i* from users in *u*'s neighborhood.

$$pred(u,i) = \bar{r}_u + \frac{\sum_{n \subset neighbors(u)} sim(u,n) \cdot (r_{ni} - \bar{r}_n)}{\sum_{n \subset neighbors(u)} sim(u,n)} \quad (2)$$

2.3.Hybrid Recommender System

First assume that the active user's neighborhood has been already constructed. Before any of the data could be utilized for the calculation of demographic correlations, via vector similarity and it needs to assign a demographic vector for each user in the data set. Once the demographic vectors were constructed for all users, it could proceed and calculate the proximity between the active user, u_a and the user u_i, for i= 1, 2,…. , l, belonging to his neighborhood as it was defined by their registered demographic data. Their demographic correlation, $dem\_cor_{ai,}$ was calculated by applying the vector similarity formula. The final step in the recommendation procedure was perdition generation. It was executed in plain user-based Collaborative filtering, being enhanced by demographic correlation factor.

2.4.Dijkstra's Shortest Path Algorithm

The Dijkstra's shortest path algorithm [11] is the most commonly used to solve the single source shortest path problem today. This system uses binary heap to implement Dijkstra's algorithm although there are some data structures that may slightly improve the time complexity, such as Fibonacci heap.

Let the node at which we are starting be called the initial node. Let the distance of node *Y* be the distance from the initial node to *Y*. Dijkstra's algorithm will assign some initial distance values and will try to improve them step by step.

1. Assign to every node a tentative distance value: set it to zero for our initial node and to infinity for all other nodes.
2. Set the initial node as current. Mark all other nodes unvisited. Create a set of all the unvisited nodes called the *unvisited set*.
3. For the current node, consider all of its unvisited neighbors and calculate their *tentative* distances. Compare the newly calculated *tentative* distance to the current assigned value and assign the smaller one. For example, if the current node *A* is marked with a distance of 6, and the edge connecting it with a neighbor *B* has length 2, then the distance to *B* (through *A*) will be 6 + 2 = 8. If B was previously marked with a distance greater than 8 then change it to 8. Otherwise, keep the current value.
4. When we are done considering all of the neighbors of the current node, mark the current node as visited and remove it from the *unvisited set*. A visited node will never be checked again.
5. If the destination node has been marked visited (when planning a route between two specific nodes) or if the smallest tentative distance among the nodes in the *unvisited set* is infinity (when planning a complete

traversal; occurs when there is no connection between the initial node and remaining unvisited nodes), then stop. The algorithm has finished.

6. Select the unvisited node that is marked with the smallest tentative distance, and set it as the new "current node" then go back to step 3.

3. Related Works

Several systems have tried to combine information filtering and collaborative filtering techniques in an effort to overcome the limitations of each [7] maintains user profiles of interest in web pages using information filtering techniques, but uses collaborative filtering techniques to identify profiles with similar tastes. It then can recommend documents across user profiles. Basu, Hirsh, and Cohen [2] trained the Ripper machine learning system with a combination of content data and training data in an effort to produce better recommendations.

CityGuide [3] is designed for PalmOS devices and helps tourists in finding attractions (such as restaurants) around a city. This recommender system uses the constraint-based filtering approach to control which attractions are shown on the map. In particular, the user, through the system's map interface, is asked to specify constraints on attraction type, restaurant cuisine and price. The system retrieves from the database only those attractions that satisfy the user's indicated constraints, and then ranks these retrieved attractions according to their match to the preferences stored in the user's profile. The system builds and updates the user's profile, which maintains her long-term preferences, by mining and interpreting the user's actions (such as writing a restaurant review, reading a review, viewing a restaurant's details, etc.) and collecting the user's ratings to the restaurants.

Burigat et al. [12] illustrates a system running on PDA devices that supports tourists in searching for travel products (i.e., hotels or restaurants) in a geographic area that best satisfy their needs and preferences. The system builds the user-query used to search in the services repository by asking the user to indicate her constraints on the service attributes, e.g. the facilities offered by the hotel or the restaurant. However, the system does not employ the constraint-filtering approach or a multi-attribute utility function. Instead, the system constructs the recommendation list by ranking the services according to their satisfaction score. A service's satisfaction score is measured by the number of constraints (indicated in the user's query) that are satisfied by the service. It was observed that this system does not reuse the knowledge derived from past user interactions to provide better recommendations.

4. Proposed System

This section presents the design of the proposed system. The main objective of the proposed system is the design of location based recommender system for upcoming seminars and events for university campus. Combination of Demographic and Collaborative filtering is used for generating recommendation sets. Location based recommender system is a useful application that provides mobile data services. Visitors can get location based recommendation through their mobile devices. Direction to required destination is also searched by using Dijkstra's shortest path algorithm.

Recommendation set is mainly generated for seminars and events. Android based system is also developed for detecting current position and other location services. In generating the recommendation set; similarity of active user is computed with other users. In computing similarity between students, age, major, session presented seminar similarity and attended seminar similarity features are used. Semantic data dictionary is also used for computing semantic similarity for the words with the same sense with different spelling. Detail recommendation process is as follows:

1) Combination of Collaborative and Demographic Filtering approaches
2) Similarity Computation of User Profile

Two types of user profile:

- Demographic Profile
- Behaviour Profile

3) Similarity Computation of User's Seminar and other Seminar
    - Cosine Similarity is used in title matching
    - Semantic Similarity is added for words with different spelling, sharing the same sense; for example (GPS and location based service) share the same sense but different similarity computation.
4) Demographic Profile Similarity
5) Compute similarity on
    - Age – distant method
    - Session (first year, second year, and so on) – direct match
    - Major – direct match
    - Seminar Titles – (cosine similarity and semantic similarity)

    Using Cosine Similarity Algorithm,

$$w(a,i) = \sum_j \frac{v_{a,j}}{\sqrt{\sum_{k \in I_a} v_{a,k}^2}} \frac{v_{i,j}}{\sqrt{\sum_{k \in I_i} v_{i,k}^2}} \quad (3)$$

where,

$v_{i,j}$= attribute value of other user ;

$v_{a,j}$= attribute value of active user.

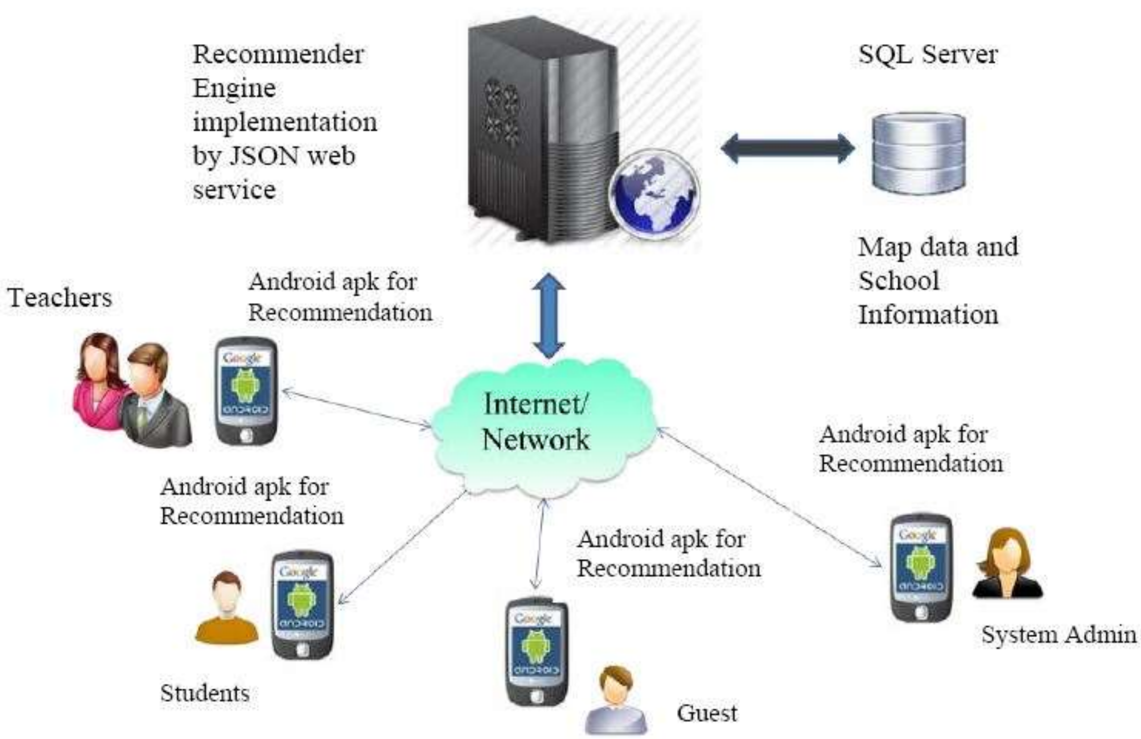

Fig. 1: System Architecture Design

5. System Implementation

This system is implemented as web services in web server and android application in mobile devices. Web service is implemented using REST web service and web service is parsed with JSON parser. JSON objects are sent across communication channel to mobile device application. Android application development is used in mobile device application as front end program. Microsoft SQL Server Express is used to store campus information and user data.

- If the user is a new guest, he/she needs to register to enter the system.
- If the user is a student or a teacher, the user has to login with his/her username and password given by the admin
- Then the system will authenticate the user.
- User has to type where he or she wants to go in the Campus.
- Then the system tracks whether user is on Campus or not.
- If user is not on campus, the system ends.
- If user is on the campus, this system computes user's current position and then computes the route to destination department.
- It will also generate recommendations (places user should go such as seminars, exam room, time table and events) for other related information.
- Finally, routes to destination and related recommendations are shown to user.
- In this system, campus map information and department information are stored in the server database.
- Android application on Mobile devices accesses server database through web service technology.

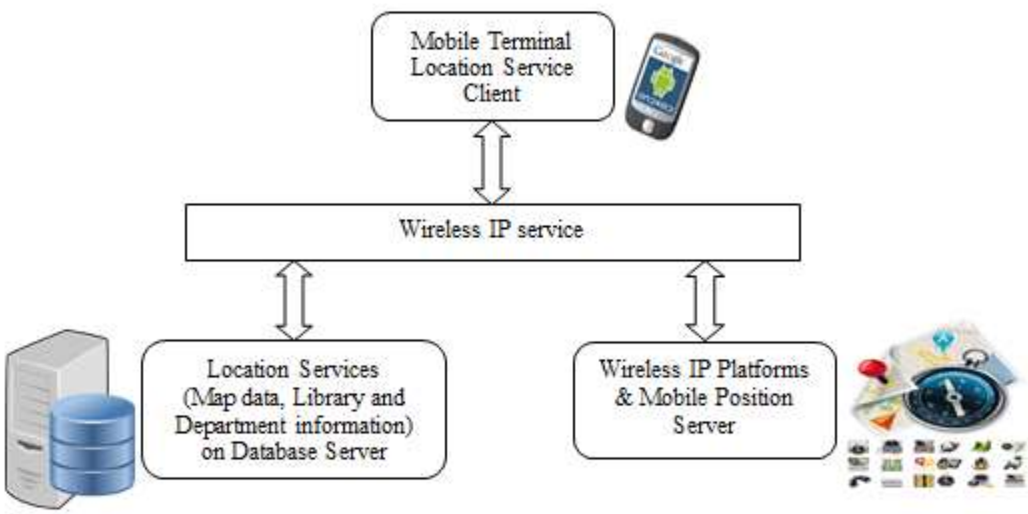

Fig. 2: System Block Diagram

6. Conclusion

This system presents the location-based recommendations and campus directions using mobile device applications. For the location based direction service, Dijkstra's shortest path algorithm is applied to find the path to destination. User's current location is computed based on his / her current coordinates via GPS. Then route to destination is displayed to user. Recommendation of events such as seminars, workshops, and so on around campus is also added. Users can be teachers, students and visitors. Teachers and students must be registered for the recommendation process. Hybrid recommender system [5] is used. Recommendation is processed based on the user's interest and his / her current status. Because of the recommendation process, user can know current events which are related to his / her interests. This system also helps the user and saves time in finding routes to required destination.

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8. References

[1] Badrul Sarwar , George Karypis , Joseph Konstan , John Riedl, "Item-based Collaborative Filtering Recommendation Algorithms", *2001.*

[2] Chumki Basu, Haym Hirsh and William W. Cohen, "Technical Papers Recommendation: A study in combining multiple information sources", Journal of Artificial Intelligence Research, 2001.

[3] Dunlop, Mark D. and Ptaskinski, Piotr and Morrison, Alison and McCallum, Stephen and Risbey, Chris and Stewart, Fraser, *Design and development of Taeneb City Guide*, 2004.

[4] Gediminas Adomavicius, Member, IEEE, and Alexander Tuzhilin, Member, IEEE, "Toward the Next Generation of Recommender Systems: A Survey of the State-of-the-Art and Possible Extensions", IEEE Transactions On Knowledge And Data Engineering, Vol. 17, No. 6, June 2005.

http://dx.doi.org/10.1109/TKDE.2005.99

[5] Jae-wook Ahn, "Hybrid Web Recommender Systems".

[6] Janusz Sobecki, International Journal of Computer Science & Applications, *Vol. 3 Issue 3, pp 52 – 64.*

[7] Marko Balabanovic and Yoav Shoham, "Content-based, collaborative recommendation", *Communications of the ACM March 1997 v40 n3.*

[8] Mohapatra & Suma, "Survey of Location based wireless services,personal wireless communication,2005.

[9] Nicole B. Ellison, Charles Steinfield and Cliff Lampe, "The Benefits of Facebook "Friends:" Social Capital and College Students' Use of Online Social Network Sites", Journal of Computer-Mediated Communication; Volume 12, Issue 4, pages, 23 AUG 2007.

[10] Paul Resnick AT&T, Labs-Research, Murray Hill, N.J. and Hal R. Varian, "Recommender Systems", Communications of the ACM, Volume 40 Issue 3, March 1997.

[11] Pooja Singal DCSA, MDU, Rohatk, R.S.Chhillar HOD, DCSA, MDU, Rohatk, "Dijkstra Shortest Path Algorithm using Global Positioning System", International Journal of Computer Applications (0975 – 8887) Volume 101– No.6, September 2014.

[12] Stefano Burigat and Luca Chittaro, "A visual preference-based search tool for tourist decision support",2005.