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Meta-Heuristic Approach for Recommending Routes in Map Using Hybrid Recommender System

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Abstract: ***This paper demonstrates that ant colony optimization can improve map routing efficiently. This paper presents a recommender system that provides personalized information about locations of potential interest to a tourist. The system generates suggestions, consisting of touristic places, according to the current position and history data describing the tourist movements. For the selection of tourist sites, the system uses a set of points of interest a priori identified. A Dynamic Travel Path Optimization System based on Ant Colony Optimization (ACO) is proposed for the prediction of the best path to a given destination. The concept relies on the hybrid recommender system for map routing which can be used as the alternative to the current systems. This system implements hybridization of content and collaborative-filtering. This system also optimized the retrieved results by using proposed heuristic approach. The proposed system has also taken care of the cold start problem for new users. Simple GUI is developed to manage all these approaches.***

Keywords: Recommender system, collaborative tagging, content filtering, heuristic approach, cold start problem

1. Introduction

Recommendations basically are the suggestions we came across from others in our day to day life. Actually we all depend on suggestions from others to do our daily work for example choosing dress to wear we ask others for suggestions. And the best recommender systems are those which provide the related recommendations to the users which are beneficial for them for example if we are watching cartoon video then ads or recommendations should be related to the kids. Recommender Systems (RSs) are software tools and techniques providing suggestions for items to be of use to a user and the suggestions relate to various decision-making processes, such as what items to buy, what music to listen to, or what online news to read [1].These days recommender systems play an crucial role in highly rated e-commerce and Internet sites like Amazon.com, Flipkart.com, Myntra.com, Jabong.com, YouTube, Yahoo, Netflix. As more and more research papers are publishing exponentially yearly, hence it is very difficult for the researcher to find the related research paper. This difficulty and time taken is partly caused by the increase in publications and also due to the inefficiency of the recommender systems which failed to provide related recommendations to the researchers.

This paper presents recommender system which is based on content filtering and collaborative filtering. In content based recommender system recommendations are provided on basis of description of items and the user profile, keywords are used to describe the items in content based recommender systems. Set of terms describes the content of each item, usually the words that occur in the document. Recommendations are made when user profile matches with the same terms. There are several issues associated with implementation of a content-based filtering system. First, terms can either be assigned automatically or manually. When terms are assigned automatically a method has to be chosen that can extract these terms from items. Second, the terms have to be represented such that both the user profile and the items can be compared in a meaningful way. Third, a learning algorithm has to be chosen that is able to learn the user profile based on seen items and can make recommendations based on this user profile [2]. Content filtering approach is mostly used with the text documents.

The purpose of this paper is to build a system for web and mobile based applications that combine Google Maps with the idea of recommending parameters like food, hospitals, ATMs etc. according to users' current location, preferences and past visits by using Hybrid approach.

Heuristic approach is used to optimize the results. Heuristic approach is used provide the accurate, precise and quick results for the particular problem i.e. recommending exact route.

Biologically: Ants use to find the shortest path between their nest and food source using pheromone trails. ACO is the population based search technique for the solution of the combinatorial optimization problems which is inspired by this behavior.

The ant colony optimization algorithm (ACO) is a probabilistic technique for solving computational problems which can be reduced to finding good paths through graphs.

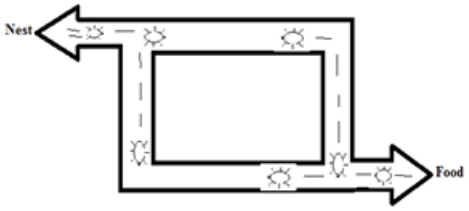

Figure 1: Ants searching food

The proposed system also provides solution to the cold start problem for the new items i.e. research articles. Cold start problem is very common in recommender systems. Cold start problem occur when new item or new user is added i.e. we do not know how to recommend that new

item or what to recommend to that new user added to the system. The proposed system also has taken care of this problem.

The paper itself is structured as follows. Section II provides the related work of content based recommender systems and work done in field of collaborative tagging. Section III provides methodology used by us to recommend the routes along with the result obtained. Section IV provides discussion and future work. Finally, Section V summarizes the results and points out future work.

2. Related Work

This section of this paper has highlighted some previous work done in the field of recommender systems and collaborative tagging. However in this section complete list of related work is not presented. There is not much work is done in the field of recommender systems for map routing. Different authors suggest the use of content and collaborative filtering for recommendations. The strength of currently used academic search engines lies in finding documents containing specific keywords. Due to synonyms and unclear nomenclatures, this approach delivers in practice, often unsatisfying results [4]. When we do text based analysis there are many problems pop like unclear nomenclatures, synonyms or context depending on the meanings of words. If different words or terms are used then it is difficult to relate similar research articles.

When using collaborative filtering for the recommending routes then there can be cold start problem for new users because it is highly rely on the rating from different users, but if there will be no user or user do not rate any item then there will cold start problem for sure. Collaborative filtering used in the field of recommender system is criticized for various reasons. Some authors claim that collaborative filtering would be ineffective in domains where more items than users exist. Others believe that users would not be spending time for explicitly rating [4].

Several authors via research papers documented the benefits of use of collaborative tagging. Vander Wal [8] and Mathes [9] have discussed the potential benefits of tagging for personal information management. Vander Wal [8] has observed that in tagging systems there exists a powerful tool, allowing users to index their information resources with their own keywords [3]. Collaborative tagging technique follow the bottom up approach for the recommender system which simply means that tagging a research articles is not done by the system administrator only, user or author of the research articles have authority to tag their own research articles.

Nan Zheng, Qiudan Li [5] proposed the recommender system based on tags and time information. They show empirically using data from a real-world dataset that tag and time information can well express user's taste and we also show that better performances can be achieved if such information is integrated into CF [5].

Another Collaborative filtering recommender system based on tag information is proposed by author [6]. This paper explores the utilization of tagging information to provide the related recommendations. This is based on the distinctive three dimensional relationships among users, tags and items, a new user profiling and similarity measure method is proposed. Author experiments suggest that the approach proposed is better than the traditional collaborative filtering recommender systems using only rating data [6].

Several author also proposed the incorporation of different filtering techniques with the meta-heuristic techniques to provide accurate and precise results. Punam Bedi, Ravish Sharma [7] has proposed the trust based recommender system using ant colony optimization. They incorporated the collaborative filtering technique with the ant colony optimization.

From the literature survey we concluded that there are few recommender systems are exists for recommending routes in maps. Those who are exists currently using content and collaborative filtering techniques and provide insufficient results. Both the techniques have their own limitations. Also from the literature survey we found that the accuracy and precision of the results can be improved by the use collaborative tagging and heuristic techniques.

3. Proposed Work

This paper proposed the recommender system for routes based on content filtering and collaborative tagging. In addition recommender system provides the simple GUI to handle all the user queries. The methodology to recommend routes follows steps are mentioned and explain as follows.

1) New user: For the new user, the system requests to register him/her for an account to gather his preferences.

2) Map database: Collect the information for recommendations in map such as routes, shortest path, parameters like hospitals, restaurants, doctor, cafe etc.

3) Information collected: Analyze the collected information by filtering component that whether it is likely to be of interest to the active user by comparing features in the item representations to those items stored in the user profile.

4) Map route recommender: This phase recommend routes to the user and use following steps:

Content – Collaborative Hybrid (Steps)

1: **Start**
2: New User SignUp
3: Enter details to database
4: **if** $(U_n = 1)$, where U_n is new user
5:Recommend Most Searched Parameter
6: **else**
7: Recommend last Searched Parameter
8: **end if**
9: $\mathbf{S} \leftarrow \mathrm{Sel}(n_s, n_d)$, Select source and destination
10: $\mathbf{N_p}$ and $\mathbf{A_r} \leftarrow S$,
where N_p is the number of points and
A_r is the Average Rating
11: $\mathbf{S_d} \leftarrow \mathrm{SD}(N_p, A_r)$,
Standard Deviation between points of reference
12:$\mathbf{H_{Algo}} \leftarrow \mathrm{Input}(N_p, A_r, S_d)$,
input Number of points, Average Rating and SD to Proposed Algorithm
13: **Route** $\leftarrow \mathrm{Output}(H_{Algo})$,
Recommend Route based on Output
14: **end**

Proposed Algorithm based on ACO: Recommending Routes

Ant Colony Optimization
1: **Start**
2:
Set initial Pheromone to all points on the basis of dataset
3: **for** $i = 0$: N, where N is the total number of points
4: $P_i \leftarrow$ Probability of point i
5:
if P_i is maximum,
consider the maximum probability point
6:
$\mathbf{R} \leftarrow$
$\mathrm{Route}(n_i, n_d)$, include node in route from source to destination
7: **end if**
8: $\mathbf{U_i} \leftarrow$ Update Pheromone
9: **end for**
10: **end**

How it works?

Real ants find shortest routes between food and nest as shown in figure above. They are almost blind and hardly use vision. So they lay to leave some chemical left on ground commonly known as pheromone trails, which act as a signal to other ants. If an ant decides, with some probability, to follow the pheromone trail, it itself lays more pheromone, thus reinforcing the trail. The more ants follow the trail, the stronger the pheromone, the more likely ants are to follow it. Pheromone strength decays over time (half- life: a few minutes). Pheromone builds up on shorter path faster; it doesn't have so much time to decay, so ants start to follow it.

i) For probability calculation use

$$p_{i,j} = \frac{(\tau_{i,j}^{\alpha})(\eta_{i,j}^{\beta})}{\sum(\tau_{i,j}^{\alpha})(\eta_{i,j}^{\beta})}$$

where τ is the pheromone on edge i, j
η is the desirability of edge i, j
α and β are controlling parameters

ii)For pheromone updation

$$\tau_{i,j} = (1 - \rho)\tau_{i,j} + \Delta\tau_{i,j}$$

where ρ rate of pheromone evaporation

$$\Delta\tau_{i,j} = \begin{cases} \frac{1}{l_k} & \text{if ant travels on edge} \\ 0 & \text{otherwise} \end{cases}$$

where l_k is the length

5) Cold start problem: Cold start problem is very common problem in recommender system where we do not know how to recommend that new item or what to recommend to that new user added to the system. This system provides equal chance to all new research articles to come to the recommendation list by updating the weight of the research articles in the database.

6) Performance measurement- Performance of the system [3] [10] can be measure using two parameters.

- **RECALL** is the ratio of the number of relevant records retrieved to the total number of relevant records in the database. It is usually expressed as a percentage.

$$\text{Recall} = \frac{\text{No. of target research parameter retrieved}}{\text{No. of target research parameter}} \quad (3)$$

- **PRECISION** is the ratio of the number of relevant records retrieved to the total number of irrelevant and relevant records retrieved. It is usually expressed as a percentage.

$$\text{Precision} = \frac{\text{No. of target research parameters retrieved}}{\text{No. of research parameter s retrieved}} \quad (4)$$

X= No. of relevant records retrieved
Y= No. of relevant records not retrieved
Z= No. of irrelevant records retrieved

$$\text{RECALL} = \frac{X}{X+Y} * 100$$

$$\text{PRECISION} = \frac{X}{X+Z} * 100$$

Figure 2: Precision and Recall

4. Discussion and Future Work

To find out related content is very difficult task in current scenario where there are huge amount of data is stored in the databases. Recommender systems are solution to this problem and attracting researchers to explore this area in past few years. In this paper we introduced the concept of "smart routing"- a hybrid recommender system for map routing which recommend accurate route to the user according to their current location, preferences and past visits. Wrong recommendations assigned to the user tend to decrease the efficiency of the system but this problem is reduced by using content and collaborative approach and optimal recommendations are provided to the user. This concept also have taken care of the cold start problem for

new items where we do not know how to recommend new item or what to recommend to that new user added to the system by using content and collaborative filtering approach.

In this paper we introduced the concept where system recommend items to users that are similar to those that a user liked in the past on the basis of users likings in content approach and in collaborative we are recommending items to the user on the basis of ratings and reviews given by the user. The application gives path recommendations based on parameters selected by user. This approach has its root in information retrieval and information filtering research. The system is functional as well as user-friendly. The simplicity of the design prevents any confusion. Layouts and menu are fluid and easy to use. The system becomes self-learning as more people use the system and gives their knowledge to the system and ultimately its capability to return related research parameters helps to solve users' problems.

5. Conclusion

This paper proposed the system to recommend research routes to the user based on bottom-up approach i.e. collaborative tagging and content filtering. This paper also proposes the heuristic approach to provide accurate, precise and optimized results by eliminating the cold start problem for new items. This paper proposed the technique which can be easily integrated to the current systems. Also this system can be further improved by combining collaborative and content filtering techniques with collaborative tagging.

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