Context Aware Decision Support Mobile Application for Recommendation in The Domain of Hotels

Vedika Prasad Kulkarni¹ Prashant Vishnu Nathe² Shubham Satish Kale³

¹,²,³Department of Computer Engineering
¹,²SKNCOE Pune, Maharashtra

Abstract—In any application, the recommender system plays a main role. These systems assist the users to make a proper decision on the basis of the recommendations provided by the application. Recommender systems provide the personalized recommendations based on the users interest and preferences. Users have to search number of pages on internet to find appropriate information on any particular topic. It is difficult to process such a big data and also very time consuming. There are many recommendation algorithms currently used by many applications, e-commerce websites like collaborative filtering, knowledge based filtering, etc. Here we have proposed a recommender system which uses Context aware graph based recommendation algorithm to provide relevant, personalized recommendations which overcome the drawbacks of both the techniques, thereby increasing accuracy. Context-aware recommender systems adapt the contextual situations of the user and generate more effective recommendation. A graph based approach is proposed to assist the decision support to users and accept contextual information like day time, location, day type, company involved, etc. and process it in an advantageous manner. Here, we have described the application of such system within the domain of hotels.

Key words: Context Aware Graph Based Recommmender, Collaborative Filtering, Data Mining, Knowledge Based Filtering, Context Awareness

I. INTRODUCTION

Context Aware graph based recommending technique is introduced to overcome the problems of existing recommender systems. This filtering technique generate more relevant and effective recommendations by adapting the context like time, location of the user and have become one of the most effective in recommender systems. To assist use of context aware recommendations and its development CGR i.e. Context Aware Graph Based measure is proposed which incorporate contextual information in an effective and advantageous way. This approach provides potential similarity between items and target user to provide the further recommendations of items. The challenging part of this algorithm is to use the contextual information to provide intelligent and useful recommender systems. This approach is much superior to the traditional filtering methods like collaborative and knowledge based approaches

II. RELATED WORK

In the rapid expansion of the internet which have increased the necessity of filtering the huge amount of data which is available to users. Because of this it is required to build the recommendation systems. These systems will provide users recommendations which are relevant to their interests and the past preferences which will help users to go through large amount of information and ignore the irrelevant data. There exist several approaches to create personalized recommendation to users. There are two most common filtering algorithm used nowadays. Collaborative filtering and knowledge based filtering. These both approaches make predication based on knowledge base of the product domain and users interest.

Existing Recommender systems:

A. Collaborative Filtering:

This filtering technique is one of the oldest technique. This method mines the data by recognizing the pattern among user’s ratings, similarity, data sources, viewpoints, etc. It identifies the users or items which are more similar to the target user and then use the ratings of those similar users to generate recommendations to this target user.

There are various advantages as well as disadvantages. Prediction quality of this filtering technique improves as their database of users preferences increases day by day.

The main problem in this technique is when new items gets added to the system. Before they should be recommended these items are required to be given ratings by the users. Then users having the similar taste these items are recommended.

As this algorithm makes recommendation based on users past preference it gives problem when users interest changes.

B. Knowledge Based Filtering:

This filtering technique is based on knowledge of the items. It makes recommendation based on users past preferences and behavioral patterns. The user first is asked to give his favorites or mostly used items. Based on the user’s behavioral data, on his input items matched are provided as recommendation. It is represented in the form of tree data structure where nodes which are old are already present data and the ones which are leaves are the recent recommendations. This technique is very sensitive to users preference and does not require and previous knowledge of new user. It just needed to understand the domain of items very well. In this data does not change and can be used again when considering users choices.

By comparing these both existing techniques many problems were observed like recommendations are static, quality of recommendations is mostly dependent on huge dataset based on user history. The data may subject to anomalies like statistical data, and most of the recommendations are insensitive to user preference.

III. CONTEXT AWARE GRAPH BASED MODELLING

Context Aware Graph Based Modeling: CARS predict user’s preferences and tastes by adapting contextual information in recommending items. These preferences are generally shown in the form of ratings and are modeled as a part of not only
users and items but also of context. Recommender process is
defined by \( R = U \times I \times C \), where \( R \): Ratings \( U \): User
\( I \): Items \( C \): Context. Highest rated items are recommended to
the user which is calculated by the function \( R \). Context factors
included can be anything related to user which can be
accepted by user’s mobile device like location, day type, day
time, companions involved at that particular time. The
recommendation problem is examined as a searching problem
to find appropriate items based on the give context.

![Fig. 1: A Context-aware and Social Graph based Hotel
Recommender System](image)

As Context Factors often change, over various
ratings we separate the contextual information with the static
information like users and hotels. Example, \( U \times I \) represents
that users have accessed hotels, \( U \times A \) connects users with
their attributes, \( U \times C \) shows users activities and their
contextual condition. We can represent it in adjacent matrix
\( M \).

<table>
<thead>
<tr>
<th>Users</th>
<th>Hotels</th>
<th>Contexts</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users</td>
<td>( UU )</td>
<td>( UI )</td>
<td>( UC )</td>
</tr>
<tr>
<td>Hotels</td>
<td>( II )</td>
<td>( IC )</td>
<td>( IA )</td>
</tr>
<tr>
<td>Contexts</td>
<td>( UC )</td>
<td>( IC )</td>
<td>( 0 )</td>
</tr>
<tr>
<td>Attributes</td>
<td>( UA )</td>
<td>( IA )</td>
<td>( 0 )</td>
</tr>
</tbody>
</table>

Table 1: Adjacent matrix showing relationship between
different nodes in CGR

Nodes in the graph are searched randomly from
node \( i \) in \( G \), the neighborhood node \( j \) having the probability
proportional to the weight of the edge \( S_{ij} \). We can obtain the
steady probability by using the following equation.

\[
P(n) = d*S^{n-1}P(1) + (1-d)e
\]

(1)

Where \( S \): Row normalized transitivity matrix, vector
\( e \) is personalized vector which represent the interest of a
particular user in that item. The relationship from the source
node \( i \) with the target node \( j \) and the weight of the relationship
\( L \), the transitivity matrix is

\[
S_{ij} = \frac{Sijd}{\sum_k S_ik}
\]

(2)

Weight is calculated using two contexts first is
instead of checking ratings online user might wanted to ask
his/her friends and secondly weights are assigned by
considering the factor like how many times user have selected
that particular item. For recommendation to find the
likelihood of new items \( i \) in \( I \) to be accessed by \( u \) in \( U \), by
biasing two personalized vectors the two probabilities are combined.

\[
P(ij) = P1(i) + P2(i) \text{ where } P1(i) \text{ and } P2(i)
\]

is the ranking values of \( i \) with respect to \( e \). \( P1 \) represents current
user’s \( (u) \) neighborhood interest in items whereas \( P2 \)
represents the items which are similar to the set \( I \).

Relevance of Context aware graph based approach
can be found by the following algorithm.

Input: \( U \): User, \( I \): Items, \( A \): Attribute, \( C \): Context, \( d \): day type,
Empty Graph \( G \); \( V \): Vertex, \( E \): Edges

Output: The vector of \( G \);

1. Add all the elements in \( U \), \( A \) and \( C \) as graph nodes to
\( G \).
2. Assign unique indexes for each node.
3. Add edges to \( G \) and assign a type label \( T \) for each edge.
4. For all \( i \) in \( V \) do
   For all \( j \) in \( V \) do
      If (there exists and edge from \( i \) to \( j \) then
         Get the edge type \( T \) and weight \( w(L) \);
         \( S_{ij} = w(L)w(i,j,T) \) for all \( k \): \( \sum_m w(k,i,T) \);
      End if
   End for
   For all \( j \) in \( V \) do
      \( S_{ij} = S_{ij} \) for all \( k \): \( \sum_m S_{ik} \);
   End for
5. For all \( j \) in \( V \) do
   If \( j \) is \( \text{index}(u) \) then \( E_j = 1 \);
   Else \( E_j = 0 \);
6. Compute \( P1(n) = d*s*P1(n-1) + (1-d)e' \);
7. For all \( j \) in \( V \) do
   If \( j \) is \( \text{index}(u) \) then \( E_j' = 1/|Iu| \);
   Else \( E_j' = 0 \);
8. Compute \( P1(n) = d*s*P2(n-1) + (1-d)e'' \);
9. Return \((P1+P2)/2\);

IV. ARCHITECTURE

![Fig. 2: Architecture Overview](image)

In architecture diagram user is authenticated first
and then user’s choice of Hotels is accepted according to his
preference. User’s context is accepted using the mobile
device of the user with the help of GPS. User’s context
consists user’s location and the time. The accepted choice is
passed to the similarity matching module where hotels
database is compared with the users choice .In this module
first criteria search is performed and then on selected hotels
collaborative filtering is used to get hotel that are booked by
similar user based on user age group and user type such as
single or with family. With the help of similarity factor
generated above similarities between two hotels is found
between users is found with the help of the past choice of
hotels. Context based graph formation takes place at this step.
Then the output is transferred to the filtering module. In
filtering Module the users past preferences is compared and
by using the filtering algorithm above on the graph formed in
the before step a list of hotels is recommended .In this module
hotel similar to hotel booked by user in history are consider
for recommendation. Here hotels with same rating that user
booked previously are filtered. In recommendation module the sorting factor for current choice is retrieved and the hotels are displayed accordingly.

V. CONCLUSION

We proposed a graph based approach is proposed to assist user by accepting the contextual information like day time, location, day type, company involved, etc and process it in an advantageous manner using item based collaborative filtering as well as user based collaborative filtering for the recommendation of hotels. Using this approach most relevant hotels are recommended than traditional approaches such as collaborative filtering and knowledge based filtering. Also, performance of system can be improved by taking more contextual factor and using large database.

REFERENCES

[1] Hao Wu, Kun Yue, Xiaoxin Liu, Yijian Pei, and Bo Li, “Context-Aware recommendation via Graph-Based Contextual Modeling and Postfiltering” School of Information Science and Engineering, Yunnan University, Kunming 650091, China, 2015.