Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 09, September-2021

Tourism Recommendation System: A Systematic Review

Homaira Amzad
Department of Electrical and Communication Engineering,
National University of Science and Technology,
Muscat, Sultanate of Oman.

K. Vijayalakshmi
Department of Electrical and Communication Engineering,
National University of Science and Technology
Muscat, Sultanate of Oman.

***Abstract*— In the era of technology, information or data is an important factor to do any kind of task. However, due to the rapid expansion of internet, users are in an information overload state where there is a need for a system that provides related and useful information from the big pool of information. This kind of system is needed in tourism sector. Many researches have been done in this sector and researchers have developed different kinds of recommendation system to solve multiple tourism related problems. In this journal paper the different recommendation algorithms and approaches introduced in the industry so far has been discussed.**

***Keywords*— Recommendation System, Tourism Industry**

I. INTRODUCTION

Recommendation system is defined as an information filtering system that is used to recommend the users items based on their previous history or their preferences. To develop a recommendation system first we need to be familiar with the concept of artificial intelligence and machine learning.

According to (ZDNet, 2020), the concept artificial intelligence was first introduced in the 1950s by the scientist Minsky and McCarthy. They described artificial intelligence as a machine performing a new or modify a task that would need human intelligence to complete. Today the scientist defines artificial intelligence as the efficiency of a machine to learn a new task and how effectively it completes the task. Artificial Intelligence (AI) is classified into 3 types based on their ability to perform a task.

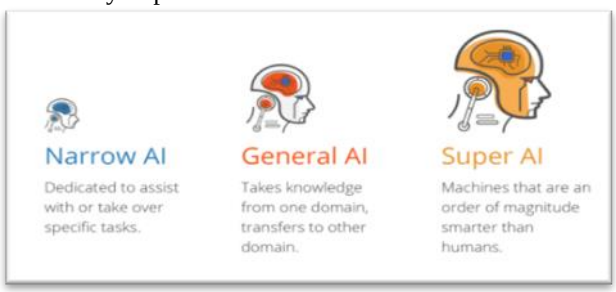

Fig 1: Types of AI (Apro Software, 2020)

Narrow AI: From the name it can be understood that the AI has a narrow range of capabilities. It is also known as weak AI. It has been designed to perform only one task. (Codebots, 2020) This kind of AI is not as intelligent as humans. **General AI:** This kind of AI has the capability and intelligence as of human. They will be able to perform more than one task at a time like humans. However, the scientists are still researching on this topic as human intelligence is complex and difficult to understand (Apro Software, 2020).

Super AI: It is the future AI, where their intelligence surpasses human.

In the broad science of AI, machine learning could be defined as a subset of AI which uses data to train the machine to do a specific task (SAS, 2020). In machine learning the machines are provided with data and by studying and modelling data, the machine learns to perform a specific task.

In the current time, the rapid growth of internet has made the users overload with information. Therefore, in this era of "Information overload" (Li et all, 2019) there is a need of a system which will filter the relevant information from the big pool of information. Thus, the recommendation system has been introduced in mid-1990 to help users select the useful information or product from a number of available options (Sharma & Singh, 2016). The development of recommendation system is possible only by applying machine learning.

Recommendation system has also been introduced in the tourism industry to help the tourist by providing information related to their tourism destination. Researchers have introduced many recommendation systems so far, each having different purpose. Some of the system aim to recommend tour packages, some recommend the best destination place according to user preference, some recommend the best travel routes etc. In this paper some of the recommendation system introduced in the industry so far have been reviewed.

II. REVIEW OF LITERATURE

Recommendation system could be defined as a method of providing options to the users based on their own preferences. To do so information needs to be filtered. There are many filtering approaches used previously by the scientists. Therefore, Kumar & Sharma (2016) performed a survey, "**Approaches, Issues and Challenges in recommendation system: A systematic review**", where they studied 66 journal papers related to recommendation system that were published between 2001 to June 2016 and classified recommendation system into following kinds based on their approaches:

1. **Collaborative Filtering (CF)** approach uses the preferences of users with similar choices as of the targeted user to recommend an item.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 09, September-2021

2. **Content Based Filtering (CB)** approach creates a profile for each user that stores the distinctive characteristics of the users which can be used to recommend the items. The characteristics determines the user taste which is gathered from the user's past choices.
3. **Social Filtering (SF)** approach collects the information on the user's profile and their social content/network. That is the recommendations are made based on the targeted user's friend's preference. It is also called as Community Based approach.
4. **Demographic Filtering (DE)** approach uses demographic information such as age, country, location etc. To make the system work it is compulsory to gather demographic information.
5. **Knowledge based Filtering (KB)** approach uses mapping technique to provide recommendation. The user preferences are mapped with the item features and then the system decides whether the item is worth recommending to the user or not.
6. **Utility based (UB)** approach is similar to KB where according to the utility of the item, it is matched with the user's requirement and then recommendation is made.
7. **Hybrid Recommendation (HR)** approach uses two filtering approach in the system. The aim of this is to mask the disadvantages of one filtering approach with the advantages of the other approach.

More over the authors have discussed some of the evaluation methods in the journal paper. This is to evaluate the quality of the system; that is how accurate the recommendations are or whether the recommendations are useful to the user or not.

- The first method discussed is the **probability metric** where the reliability of the prediction by the RS is measured
- Ranked matrix is another method where how well is recommended items are ranked and measured. It is to measure the quality of this rank. To do this the measures that are generally used are Precision, Recall, Mean Average Precision etc.
- If the recommendation system aims to reduce the number of errors then **qualitative metric** is the best choice. It measures accuracy, F-measure, kappa statistic, coverage etc. to achieve the aim
- To measure the user satisfaction level the **user satisfaction metrics** is used. This is done by collecting assessing the user feedbacks.

Manjare et al. (2016), proposed an online application in the journal paper **Recommendation System Based on Tourist Attraction** which is a location-based Travel recommendation system. In the proposed system the authors proposed to use collaborative filtering recommendation system and different data mining techniques to provide better recommendation to the users.

In the proposed application, after login, the user can either search for a tourist location or they can just follow the recommended locations. The user can enter their feedback and reviews through the application. To recommend the locations the system uses user based collaborative filtering method. It means that based on the similarity among the user profiles recommendations are made to the target user. The details of each user's preferences, their travel history and their search history are stored in database and from the dataset recommendations are made. To provide the recommendation, the system first would have to identify the neighbor user who has the similar preference as of the target user. This is done with the help of neighborhood estimator which uses the user profile data from the user database and the rating data from the rating database.

With the help of data mining techniques, the visiting history of users are analyzed and then patterns are found among them. Using these patterns, the system can perform further activities such as re-ranking the tourist locations, search city wise tourist location etc. In this system the authors have proposed to use a pattern matching algorithm to find the pattern by filtering the user information. The pattern is found by analyzing the user profile and the user search history. Moreover, association rule data mining is used to find frequent patterns, associations, correlations and casual structures in the large volume to database. This technique also helps in finding the relationships between the items.

According to the author the system will recommend the Top-N attraction based on the visiting history of the neighbor.

Other than this the user can review and rate hotels. Using the ratings, the system will rank the hotels in a particular location that will be useful for user to find a hotel during their stay.

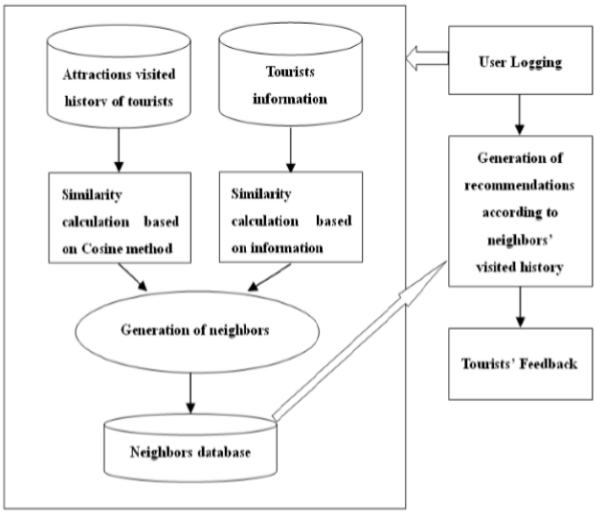

Fig 2: Generation of recommendation (Manjare et al, 2016)

The recommendation system proposed by Li et al. (2019) is used to recommend tourist spots with the help of Hierarchy Sampling Statistics (HSS) and SVD++ algorithm. The proposed system uses a dataset - "Smart Travel", HSS model, SVD++ algorithm and a hybrid recommendation system to gather information and provide accurate recommendation to the users.

In the first step the system collects user travel preferences through a well-designed questionnaire. Then the ratings of the tourist spots are obtained from different tourism websites which are discretized between 0 to 5 to represent the user

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satisfaction level, where 0 is the lowest and 5 represent the highest. This forms the dataset known as "Smart Travel". In order to find the user preferences, the HSS model is used. To do so first three target variables- travel season, travel interest and travel method, have been chosen. They help to identify the user preferences where each variable further contains 6 population attributes- gender, district, age, wage, education and job. In the proposed system the authors used only 4 population attributes which are gender, district, age and wage.

The target samples are divided into several subsets (hierarchy) based on the three target random variables. With the help of HSS model and the survey questionnaires the sample numbers in each hierarchy are obtained. Next the proportional value of each attribute in the hierarchy is calculated and then the relative importance of each attribute is found with the help of subjective weighing method and a discriminating matrix. All the population attributes are ranked based on their weights and finally based on the population ranking, the recommendation list *L*A is generated.

The authors have introduced a new algorithm known as the SVD++ based collaborative filtering algorithm which is used to predict the rating of a certain location and then to generate another recommendation list known as *L*B. The algorithm uses a matrix R which maps all the tourist spots and all the users in *K* dimensional space. By merging the two-recommendation list *L*A and *L*B, the hybrid recommendation list for the tourist spot has been obtained.

To test and train the system, first 5000 user ratings and 60 tourist spots, which are categorized into 8 parts, are obtained from the website. Among them 4000 ratings are used to train the dataset whereas 1000 ratings are used to test the system. An appropriate questionnaire was prepared to collect user preferences from the diverse population. Using the result from the questionnaires the HSS model was made and then recommendation list was generated. To evaluate the rating accuracy the author used the Root Mean Square Error (RMSE) and Mean Absolute Error (MAS) methods and compared the

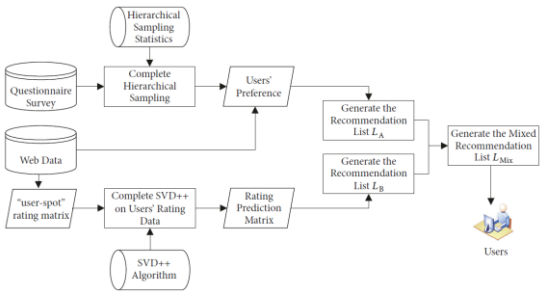

Fig 3: hybrid recommendation system framework (Li et al, 2019)

results with other algorithms such as SVD, BPR, NMF, Slope One etc. It was found that the proposed SVD++ algorithm provided better accuracy that the recommendation list generated was more accurate compared to other algorithms.

To solve the problem related to the finding the suitable destination for vacation, the author Alrasheed et al. (2020) proposed a recommendation system in the journal paper "**A multi-level Tourism Destination Recommendation System"**.

The proposed system uses hybrid recommendation system-collaborative based recommendation to find destination based on similar user preferences and knowledge-based recommendation to match the user preferences with the characteristics of the destination. The system uses two level of recommendation process where the first level recommends the destinations based on the user preferences and the second level the recommendation is made based on the user preferences and constraints. When the user first register to the system, the user would be asked to enter their preferences. In the current framework the available user preferences are weather and attraction types. To obtain user preferences the system uses image-based approach where the system would display a set of images of different weather and the user would be choosing their preferred weather. With the help of clustering algorithm, the system will identify other users with similar preference as of the current user and analyzing their profile the system will generate a recommendation list based on the popular destination among the other users.

In the second level recommendation process, the recommended list can be ranked based on the user constraints provided by the users. In the current framework the constraint attributes are travel dates, budget and kid-friendly plans. Once the constraints are applied the system takes these as an input and then with the help of web scrapers the system collects information about the constraint on each destination. By comparing the retrieved information with the user preferences and constraints the recommendation list is ranked.

Once a user provides rating for any particular destination, the user preferences automatically get updated followed by the recommendation list. Moreover, when a user selects or enters a destination it gets saved in the user profile which later could be used to recommend other user with similar preferences.

In the future the authors plan to test the efficiency of the system along with accuracy of the system compared with other recommendation approaches.

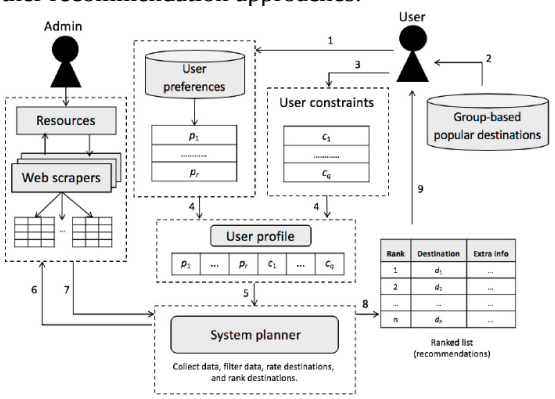

Fig 4: System architecture (Alrasheed et al, 2020)

To make a recommendation system efficient and to improve the satisfaction level for the users, the researchers Hassannia et al, (2019), developed a web application named ITRS (Intelligent Tourism Recommendation Agency) using an innovative technology- Multi Agent System (MAS) to collect, process and then provide recommendation to the users. The aim of the research, "**Web based Recommendation System for Smart Tourism: Multiagent**

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Technology", was to develop a smart recommendation system in tourism sector that would be an advancement towards the smart tourism goals.
The system consists of five agents who are responsible for doing different kinds of task including real-time data communication and filtering information. The advantage of using this kind of technology is to make agents expert in specific task which in turn will improve the quality of the system. The five agents are Tourist Supply Chain Agent (TSCA), TPA (Tour Package Agent), Recommendation Agent (RA), User Agent (UA), and Broker Agent (BA).

At first when a new user visits the system a set of questionnaires are asked to obtain demographic information about the user. Then from the tour evaluation, data is sent to the system. Using these two sets of data and the information from the TSCA, suitable recommendation is provided to the customers.

The web application was implemented using Java Agent Development Framework (JADE). The development of agent-based application includes the communication channel for agents, agent management system and the life cycle of the system, was supported using HTTPS and JADE framework. The user interface was developed with the help of HTML and AJAX platform. The broker agent used contract net protocol to assign task among the agents. To develop the ontology model Web Ontology Language was used with the help of Protégé tool.

The system was tested with real time information. 70 tour packages were made using demo information, considering the variety of possibilities with different hotel types, airlines, cities, prices etc. to make it more challenging for the system. Using real-time data exchange by hotel manager and real-time communication between the agents two scenarios were made. In the first scenario all the 70 tour packages were available. However, in the second scenario 5 packages were deleted. 100 customers of different nationality were divided into 10 groups. Each customer used the system and then it was evaluated based on two factors: precision, which is the ratio of selected relevant packages to number of retrieved packages, and recall, which is the ratio of selected relevant packages to total relevant packages. These two factors were measured on both the scenarios and then the results were compared with two other systems that uses two different filtering algorithms. One of them uses CF and the other uses CB filtering algorithm only. Based on the recall factor, the first scenario, the acceptable recommendation for the proposed system was approximately 20%, whereas based on the precision factor, in the second scenario, the acceptable recommendation is approximately 30%.

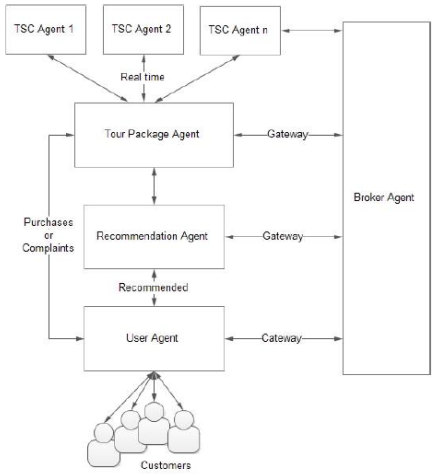

Fig 5: Multi agent Systems in ITRS (Hassannia et al, 2019)

In the journal paper "**An Agent Framework of Tourism Recommendation System**" the author (Jia, Gao & Shi, 2016) developed a framework using agent technology to provide better recommendation to the users. The approach used by the authors is different from the previously discussed approach. In the proposed system by the authors uses three filtering approaches: content-based recommendation, collaborative filtering and Constraint-based filtering approach. These three approaches were developed in three different agents which are Content-based Agent, Collaborative Filtering-based Agent and Constraint-based Agent.

The aim of each agent is to provide recommendation according to the user's preferences. Then these recommendations will be sent to another agent known as recommendation agent. A part of the recommendation sent by each agent will be collected and send to the tourist agent. Initially this agent collects 1/3 of the recommendation made by each agent. However, according to the user feedback this weight changes. Tourist agent provides the user interface and collects the feedbacks from the users. Other than this, the framework has another agent known as the Collector Agent. This agent contains web crawlers that travels through different websites and stores information. The crawlers can also identify tourism related webpages and extract the textual information after downloading the webpages.
The content-based agent uses machine learning algorithms to learn the user profiles. If a document has the similar keyword as of the user profile, then that document is taken as a relevant document. However, the drawback of this method is the natural language ambiguity. Due to the use of synonyms a relevant document could be missed. In the proposed architecture the agent uses VSM (Vector Space Model) and the user profile and the items are represented as weighted term vectors. The working principal of this model is that every document is presented as a vector. The vector will have n-dimension where every term in the document maps to a dimension. The vector value is non-zero if a term is encountered in the document. This is known as weighted term vectors. In this system the authors have used TF-IDF (Term Frequency-Inverse Document Frequency) scheme to find the similarity.

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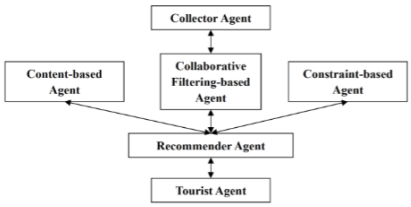

Fig 6: Agent Framework (Jia, Gao & Shi, 2016)

The aim of collaborative-filtering agent is to find the users with similar interests. They are known as the user's neighbors and they are considered as having same preferences. At first the tourist information is analyzed and modelled. Tourist information includes their tour history. Then according to the visiting history and using the collaborative filtering method the neighbors are found. According to the similarities the neighboring tourist list will be calculated. Finally, the top similarities will be recommended to the user. This can be done only if the user has previous tour records. However, if the user is new or has no previous records then according to their basic information such as gender, profession etc. the similarities will be found. Other than that, the data will have to be pre-processed every time before generating the neighbors. This process includes data cleaning, data integration, data conversion and data reduction. This is done to remove any user with void or null information.

Previous two papers by Jia, Gao & Shi (2016) and Hassannia et al (2019), multiagent technology was applied. This method was found efficient in recommendation system. However, the method of finding the trusted agent is not mentioned in the research paper. Agents should only share information if it is requested from a trusted agent. How the trust is formed or the methods followed by the agents to develop this trust is not explored by the researchers. Therefore, the author Selmi, Brahmi and Gammoudi (2017), developed a new approach called **PACT (Predicting Agent using Collective Trust)**. The aim of this approach is to find the trusted agent so that agents can collaborate with each other and share information.

In order to find the reliable agent, the system carries two phase – modeling phase and decision-making phase. Fuzzy Formal Concept Analysis (FFCA) is used to model the trusted networks among the agents. On the other hand, Theory of Belief Function is used to help agents decide the most trusted agent. The authors considered 5 agents which are- a_1, a_2, a_3, a_4, a_5 and developed a trust relation network with each other. In the modeling phase the agents are organized as groups along with their trust relationships. Fuzzy Formal Context is used to do this. Next, using Fuzzy Formal Concept the concepts are obtained.
In the decision-making phase the authors developed a new algorithm known as *Pred_Agent* which is used to recommend a list of agents that can be trusted for the agent who wants to collaborate and share information. The algorithm allows the agent for example, a_1 to create a trust relation between all the other available agents. From the extracted concepts that share a trust relationship with the agent, the highest degree of association for each agent is found and then according to the trust level the suitable and most trusted agent is chosen.

To test the credibility of the approach the authors have used the *Adovogato* dataset that consists of approximately 6541 users and 51127 relationships. To evaluate the algorithm the authors found the precision, recall and FScore of the system. The authors decided that the threshold value should be 0.5, that is if an agent scores more than or equal to 0.5 then the agent will be trusted otherwise it will be rejected.
The proposed algorithm was compared with two other trust evaluation strategies which are known as, Min-Max and Multi-Max. At the end of the evaluation, it was found that the new approach, PACT, have an accuracy of 73% compared to other approaches. Also, runtime for the prediction is found for all the three approaches and compared.

In the journal paper ***e-tourism:* A tourist recommendation and planning application,** the authors Sebastia et al.(2019), proposed a web application which at first recommends the places that the user can visit based on their preferences and then in the second phase the application organizes the recommended places and make a plan for the user visits. The application has three major modules which are: control subsystem, GRSK (Generalist Recommender System Kernel) and planning subsystem. This personalized application was developed for tourist tors in the city of Valencia (Spain).

In the first phase the application analyzes the user profiles and their preferences and then recommends a list of places that the user can visit. The user profile is created while registering and to do so the personal details and the general preferences need to be specified. The application updates the user profile every time when the user provides feedback. Moreover, the user can provide with specific preferences for each trip and accordingly the recommendation will be made. The control subsystem is responsible for developing the user profile. The application organized the user preferences and the places in the city in a hierarchy containing nodes and edges where the nodes contain the user preferences and the edges resembles the degree of interest between the preference and the places. Based on the degree of interest the recommendation is made.

With the help of user's general and specific preferences the GRSK subsystem generates a list of places that the user might like. This subsystem contains an engine module that translates the query received from the control module so that it can be understandable by the recommendation system and vice versa. The GRSK uses hybrid recommendation technique to make recommendation. The GRSK uses the demographic technique to analyze the user profile and recommends based on the demography, content-based RS technique which uses the user's previous selection to make recommendation, general-preference based technique which filters information based on the user's general preferences and current-preference base filtering which analyzes the specific preferences based on the current trip. A list is generated from each technique and then the hybrid recommendation technique sets priority to each item in the list and finally organizes the list according to descending order in the priority.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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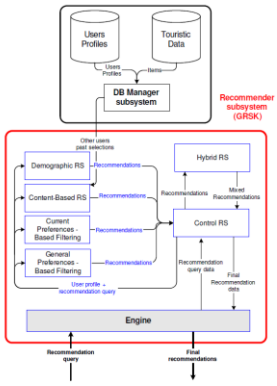

Fig: GRSK subsystem (Sebastia et al., 2009)

After the recommendation list is made the user is asked to mark the places that they wish to visit and accordingly the planning subsystem, along with the user specific preferences, a plan is made. For planning, the subsystem takes the information about each place/activity into account such as, location, opening and closing time etc. Considering this information, the subsystem plans accordingly with the help of two techniques- Constraints Satisfaction Problem (CSP) and Partial Satisfaction Planning (PSP).

The researchers Bin et al, (2019) developed a recommendation system that recommends the travel route to the user in a given point of interest (POI) based on the user travel behavioral data with the help of smart phone and IoT technology. The system collects the onsite user behavioral data. There is a Bluetooth low energy (BLE) beacon, which broadcasts their positional information, installed in every tourist spot that will help to locate the tourists. In this case the researchers used the iBeacon devices to perform this task. The location of the tourist is obtained with their smart phone and using this information the phone will identify whether the tourist reached the spot or not. A positional mechanism is installed on the smart that helps to calculate the distance between the spot and the tourist. Once the tour of a particular place is over the user behavioral sequence and their profile information will be uploaded to the server. This process is done by the client application installed on the client phone.

Next the server first preprocesses the uploaded tourist behavioral sequence. In this step the travel behavioral sequences are analyzed and transformed into the Tourist-Behavioral (TB) pattern. This pattern is then stored in the TB database according to their respective profiles. To remove the noise travel behavior the researchers developed an algorithm TB PrefixSpan algorithm, that analyzes and discovers the frequent TB patterns and then construct the Tourist Behavior sequential travel route.

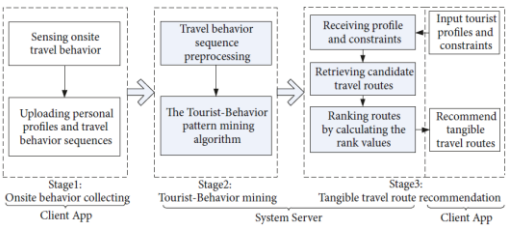

Fig: System workflow (bin et al, 2019)

In the next step the travel routes are ranked and then recommended to the users. To do so the researchers designed a ranking method to search for reasonable route. The ranking method first uses the tourist personal profile and a route constraint as an input and retrieves the judging the personal profile the TB sequential travel route is obtained. The server then filters the routes according to the constraints and recommends the Top-K routes to the tourists.
The system was tested in a small exhibition hall with 20 exhibits where 20 students volunteered to visit (10 male & 10 female). According to the result obtained it was found that the recommended route made based on the tourist profile matches the tourist interest which indicates that the system is effective and efficient.

It is true that people love to travel in group instead of solo. However, it is hard to find a tourist destination that all the group members are satisfied with. Therefore, in the paper **TravelWithFriends: A Hybrid Recommender System for Travel Destination,** the researchers Pessemier et al, (2016) proposed a system that suggests the destinations based on the group member's preferences, ratings and demands.
To make accurate recommendation the system first needs the travel destination and user ratings. To do so some open-sourced datasets were used. The researchers used the dataset WikiVoyage (licensed by Wikimedia Foundation) which contains information about more than 26,000 locations and tourist information pages. To select the pages that contains information only about a particular destination, the dataset is filtered using a database named GeoNames, which contains more than 100,000 location names from all over the world. As a result of this filtering 6,900 places were selected. But this list of places still contains a few places which are not suitable for recommendation. Therefore, another filter was done with the help of popular destination (determined by the user ratings) on the TripAdvisor website. If the rating of a place is more than 25,000 then the destination is considered otherwise it is ignored. As a result of this filtering 685 destinations were selected. To make the tourist profile for each destination the Gogobot website is used where the tourist profiles are differentiated by their tribes (e.g.: Backpackers, family-travel, adventure travel etc.). More than 300,000 ratings from 175 users were imported from this website.
The application is a web application where the user can log in and rate the previous destination travelled which will reduce any data sparsity problem. The user can provide the system with their interest and constraints for their trip. Judging from the provided information a user query is created and the destination is shortlisted based on the constraints in the constraint pre-filter step. Next the rating prediction is done with the help of recommendation algorithms. In this system the researchers used three algorithms- collaborative, content-based and knowledge-based recommendation system. The rating prediction from each algorithm is obtained and merged together to a hybrid recommender and finally the highest rated destinations are recommended to the tourist.

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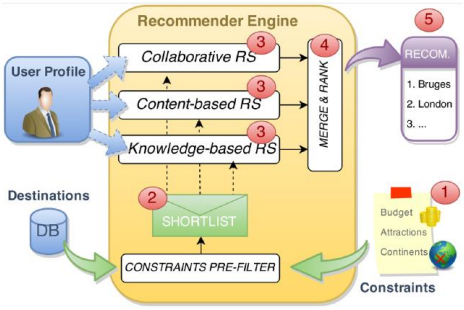

Fig: System architecture of TravelWithFriends (Pessemier et al, 2016)

The collaborative filtering uses the ratings of destinations from Gogobot and the user feedback, i.e., whether they have visited the destination, as inputs and finds the destination similar to the ones that the user has visited before and the ratings will be predicted for these destinations. The content-based approach uses the characteristics features of a destination and the user profile to recommend the destinations. The knowledge-based approach uses the domain knowledge such as, geographic information, travel cost, attraction types and tourist profile along with the user specific constraints to generate recommendations and the destination ratings are predicted.

The group recommendation is made in two phases, firstly a shortlisted destination is made by analyzing the individual group member recommendation list and next from this list, all the members are asked to rank the destinations and provide feedback. Then the system generates the final list by choosing the destination of the highest ranking. While making the group recommendation in the first phase, recommendation aggregation technique is used to ensure all the members are satisfied a threshold rating of 50% that has been set for the destinations. That is if a destination has rating below 50% by any of the member then that will be eliminated.

The researchers developed a prototype of the web application and tested with 16 users. Two factors has been evaluated by the researchers. First to find the general quality of the recommender system which is done using a questionnaire. It was found that users found the system easy to use and it provided suitable destinations and all the users were satisfied with the system. Secondly the user's opinion on the quality of the recommendation algorithm has been found. To do this all the algorithms were compared with a static, non-personalized top most-popular destinations (TOP). According to the result it was found that user appreciated the hybrid algorithm the most.

III. CONCLUSION

In this paper the working of different recommendation systems has been discussed along with the recommendation algorithms and filtering approaches. All the system had a unique aim to solve the problems related to the tourism industry and make tourism more user friendly and hassle free. Moreover, the different kinds of evaluation techniques often used by the researchers has been discussed.

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