Real Estate Recommender System Using Case-Based Reasoning Approach

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Abstract— **The huge amount of data available on the Internet has lead to the development of online systems. This paper proposes a Real Estate Recommender System using Case-Based Reasoning Approach which can help customers to find a desired property. This proposed system uses a recommendation approach during search for property which assists the customers to find appropriate property and make decisions where they need the required knowledge to judge a particular property. Furthermore information available is very huge, so the recommender system assists the user to filter the available dataset according to user needs. Recommendation methods used for the search engine is Case-Based reasoning approach which can solve a new problem by retrieving the same problem that has been solved before and reuse the information that used to solve this new problem. Also system uses collaborative filtering approach which filters the properties based on other user rating for properties; the system will do recommendation based on the top rated properties. furthermore system will recommend the user based on the most visited properties, where the system will count the number of visit to the database, then based on the property with highest number of visit system will recommend appropriate property to users.**

Index Terms— **Case-based reasoning (CBR); Collaborative filtering; Real estate.**

I. INTRODUCTION

Real Estate systems have been expanded recently, generally each company built its own website to advertise its products and perform online buying and selling. Therefore, consumers can get lost in searching among those all websites and it became more conflict and time consuming. For that reason, building Real Estate Recommender System using Case-Based Reasoning Approach to be used as base for many user of one product became more desirable.

Recommendation systems assist the user to get the information that required and help him to make decision. Although the database for system can be huge and it will take time to get the information, the recommendation systems here assist the user to filter the information according to users' needs [1].

People these days tend to invest in a business not only to obtain profit, but also knowledge and expertise. In order to meet the demands of customers, a company must sell the product that they really want or need. Real Estate Recommender System using Case-Based Reasoning Approach is a perfect example. The system will act as the mediator between buyer and seller. In addition to the system concept will be categorized, such as houses, apartment and shop. Recommendation system will help the user to make the decision; therefore, the user can easily go through and find their needs based on their preference.

As the result of the growth in number of real estate property suppliers which almost each one has its own website. Most consumers if not all maybe aware of the specific real estate company or agent website, hence this can be time consuming for them to search the internet or information about the property they are interested to purchase. And the search in these websites doesn't benefit the buyer in term of search time flexibility, and intuitive result. These websites still ask buyer to search more to get the result needed, where it's a waste of more time and energy.

To avoid the traditional search engine, we will develop Real Estate recommender system and implementing case-based reasoning approach for the search engine which will improve the recommendation accuracy during search for a property. Also we will be implementing Collaborative filtering approach which will recommend properties to the buyer based on the top rated property by other users.

II. RECOMMENDER SYSTEMS

Recommender Systems are software tools and techniques gives a suggestions for items to be used by users [2]. The system suggest items relate to different decision-making processes, for instance what product the user would like to purchase and the type of music user would to listen [3]. Furthermore the recommendation systems assist the user to access a complicated information, where the system help the user to decide which property to choose based on their needs and preference [4]. The recommender system is considered as basic technology for E-commerce websites [5]. Recommender mechanism is helpful to decide information overload by give certain target (such as information, books, music) that user might like. However, the recommender system is not the heart of websites for sell, but it is becoming necessary for information technology infrastructure. One example of the recommendation system when a user accesses an online

system such as real Estate system to look for a house or an apartment, recommendation system will assist the user to find the suitable house based on their preference (Price, location) Recommendation systems are described as ''people providing recommendations as inputs, which the system then aggregates and directs to appropriate recipients'' [6]. When a user wants to look for a house with specific preference for example with price of 100,000$ and location near to city center, it's believed that it's hard and time consuming to find such a house in Real Estate online systems. Many Real Estate online systems allow user to browser the online system to find the suitable house based on the user preference. During the browsing if you choose a house that you don't prefer and try to select another one, these for the online system that doesn't provide search engine. But for most of online system they provide search engine where user can key in the query they need (e.g. "House, city center, 100,000") then the result showing a list of houses which user might prefer, but the result didn't come with query needed. Browsing the content of online system and searching are helpful information for the user, but no one of these options provide user with flexibility that the user looking for. One of the most disappointing aspects during the search that these online systems didn't know anything about user preference over time, these system should have a recommendation system which can know the user needs and suggest the product to the user based on their preference that they searched for, this can reduce time to look for a product [7].

We have two categories of recommender system, content-based recommender, and collaborative recommender. Content-based recommender applies similarity calculation based on the user profile and content resource preferred in recommending [8]. Collaborative filtering makes recommender result based on other users rating for the product. Initially, the interests of the customers were obtained. Based on these data, the similarity of the objectives was calculated. The objective customer's interests on particular products could be known by other users rating of the product. The user here indicates the customers who have the same interests that match customer interest. To develop the quality of the recommender system, different algorithms were developed to finding the nearest neighbor [9]. Most of the useful recommender systems used content recommender algorithms and collaborative algorithms.

III. METHODS OF RECOMMENDER SYSTEMS

Recommender systems have many recommendation methods, the most well-known and used nowadays in the recommender systems are these three following general methods: content based filtering, collaborative filtering, and case based filtering. Every method has different effectiveness and accuracy regarding recommendation based on the applying areas and the activity levels. So, it is important to find the best method to implement in our system based on the characteristic of each method, we need to find one or two of these methods to be useful for our Real Estate Recommender system.

A. Cased-Based Reasoning Approach

The case-based reasoning technique for solving problem is to reuse solution for the previous problem to solve the new problem [10]. The solution for the previous problem is stored as case in the case-based, each case has a solution and specification part which stored in the database. The case specification explains the problem, and the case solution explains the cause of the problem. CBR can be used when a problem solving vocabulary is not appropriate. Therefore in using CBR instead of trying to find the cause of the problem during the solving of new problem, CBR idea is to retrieve and adapt cases to solve new problems
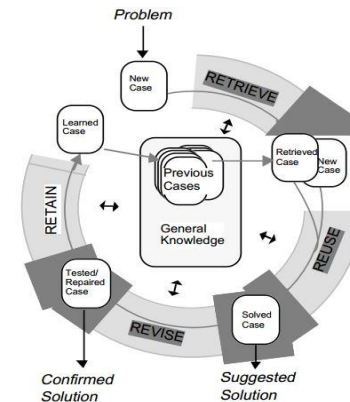

Figure 1: Case-Based Reasoning Cycle (Aamodt 1994)

More details in Figure 1 where it shows the SP (specification problem) which is the specification of the problem that we need to solve, SL (solution) in Figure 1 is the solution of the problem and FP is the first principle reasoning which indicate the suitable solution for SP problem description. The CBR concept here is to avoid modeling the first principal, so instead of that to retrieve the case that have similar description SP and adapt the solution to that case (SL) to fit the current problem in hand.

The cycle of Case-Based reasoning can generally described by the following processes:

1. Retrieve process: which can look for similar case or cases.
2. Reuse Process: which can reuse the information that used in the previous case to solve the current problem.
3. Revise Process: which can adjust the proposed solution.
4. Retain Process: which can save the case solution for future work.

A problem can be solved by Retrieving similar case that used before, and then Reuse the information for that problem to solve the current problem. And revise the used solution based on reusing the previous case. Then retaining the new experienced by including it into the existing knowledge-base (case-based). The 4 processes each have a number of more detailed steps, Figure 1 shows the detailed steps [11].

The Solution we propose is to use Case-based reasoning approach which includes four steps of solving problem, first one is retrieve from the case base (database), then reuse, adapt and retain [7]. Ultimately this work is focused on the application of CBR concepts and techniques to support recommender system. Of course researchers have already

recognized the opportunity for case-based techniques to improve the effectiveness of recommender engine. For example, the work of [12] and [13] looks at the application of CBR in recommending search context for social web search.
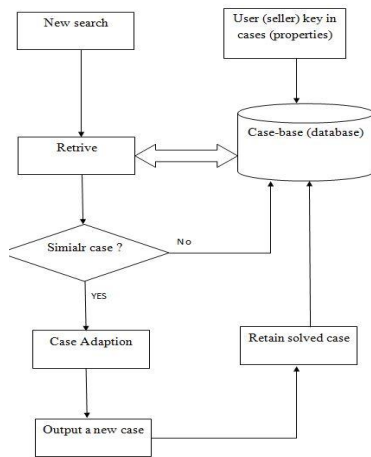

Figure 2: Frame work of the proposed CBR Recommender System

We can see in Figure 2, the first step is to retrieve solution (result) for search process done by the user (buyer); the retrieving is from the database (case base), before retrieving we need to key in the cases to the database (case base), so the user as a seller will key in advertisement for his property in the system and it will be saved in the database, with each advertisement the user (seller) will include Tag (keywords) information for his post to ease the search process for his property.

This Tag information will be saved in table called (Tag_estate), which include all the tag (keywords) for all the advertisements or properties. Once the user (buyer) search for property in the system, the system will retrieve the information from the database (case base) especially from the Tag table in the database, system will start looking for similar keyword in the Tag Table. Once we have similarity the system will reuse it as solution for the problem, the reuse process is the combination of new solution and retrieved solution to form a proposed solution. Once the solution proposed, then we come to the next process.

Revise process in Figure 2, checks whether this proposed solution is correct, this process is responsible for checking the correctness of the proposed solution. Once the solution is checked, we come to the last process.

Retain process, which is responsible for saving the solved case for future work, the solved case will be save in the database in table called (Tag_estate). This step can assist the system to auto-learn from real experience.

If the solution is not found means there is no similarity in the database, the system will recommend the user (buyer) using alterative an approach which is Collaborative filtering approach.

B. Collaborative Filtering Method

Collaborative filtering is very well-known technique which has been implemented by some recommender systems. In general, collaborative filtering is the process of filtering for information or patterns using techniques involving collaboration among multiple agents, viewpoints, data sources, etc [14]. Applications of collaborative filtering typically involve extremely huge data sets. This approach has been implemented to E-commerce and web applications where the focal point on user data, etc.

In narrow way Collaborative filtering is producing suggestions (filtering) based on the user interests by gathering other users' preferences or rating information for items (collaborating). The fundamental theory of the collaborative filtering approach is that if a user 1 has the similar taste as a user 2 on an item, user 1 is possibly has user 2's opinion on a different item x than to has the taste on x of a person chosen randomly.

For example, a collaborative filtering recommendation system for television tastes could make suggestions which television show a user should like given a limited list of that user's tastes (likes or dislikes) [15]. Keep in mind that these suggestions are specific to the user, but use information collected from many users. This varies from the easier approach of giving an average (non-specific) score for each item of interest, for example based on other users rating.

Figure 4 shows that two buyers like the same products, where both like Pizza and salad, and one of them like soft drink, so the system recommend that soft drink to other buyer.

The idea of collaborative filtering is that people obtain the most excellent recommendations from someone with same tastes to they have. Collaborative filtering finds methods for comparing people with same interests and provide recommendations based on this. Collaborative filtering techniques involve users' active participation, and a simple way to represent users' interests to the system, also techniques would be able to match people with the same interests.

Collaborative filtering approach works by building the database of preferences for items by users. A new user is matched against the database to find out neighbors (other users) who have previously had the same interests as the new user. Items that the neighbors like are then recommended to the new user, as he will most likely also like them.

In the system we propose, the item is the property the users have rated in the real estate system, each user in the system is able to rate the property in 5 scale rating, based on that rating the system recommend the new user who is searching for property with the property with high number of rating. The collaborative filtering approach in my system is to find what other user rated for the property and store in the database to recommend it to the user.

To store the property rating in database we need to have the number of each property rated and the IP address of the user did rate the property, we need the IP address to keep record of the user who did rate the property, so he can only rate the property one time only. Also we need the number of the stars the property has got by the user who did rate the property, finally the date of rating the property. In conclusion the rating process is based on the following:

1. Number of property
2. IP address of the user
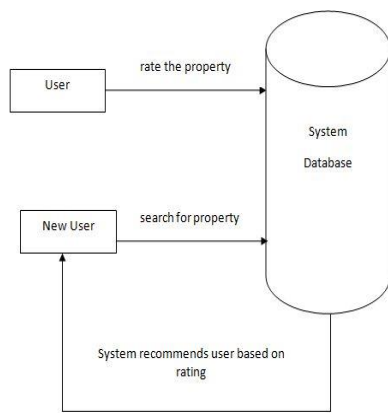3. Number of stars for the property
4. Date of rating

Figure 3: User recommendation Based on Rating

From Figure 3 above, users do rate the property and the rating information is stored in the database in the rating table we create in the database. When other user retrieves or search for property, the system recommends the user with property advertisement with highest rating scale.

The system will filter property advertisements based on the rating by users, this is what we call collaborative filtering, each user will be able to rate the property and that rating can help the other user to find best property based on the rating.

IV. RECOMMENDATION ENGINE

Making a recommendation search engine to your system could be great compare to traditional search engine. Usually only technically advanced sites like Amazon were able to offer this service but with ever increasing processing power and simple open source software, now we be able to add recommendations search engine to the system [15].

Recommendation systems are very helpful for users to get access to the data from large information database. Otherwise it will be difficult for them to find the information needed without wasting time. Recommendation engine considered to be the heart of any recommendation system. Recommendation Systems are based on a variety of approaches like Content-Based, Collaborative-Based and Hybrid Approach which they are used in the recommendation engine [1].

V. RELATED WORK

A. Amazon.com

In Amazon.com there is the variety of books that the website offer and they can be categories like adventure, comedy, science and fiction stories. And the books can be categories by Author, rating of the books. All of these features can used to find the similarity among items.

Amazon.com shows the real time scenario on how Content-Based Filtering work. System illustrates an example, when computer science student user would like to buy a comedy book, "Geek Love". Later on when user login; he sees a list of recommended books. Amazon,com did apply the recommender system and it was very successful to improve their sale quantities. Usually, recommender system is built derived from content-based filtering and collaborative filtering

Recommendation systems are designed to solve the problems mentioned above which they can provide users a more smart and intelligent approach to navigate and search for complicated information spaces [17]. Many Ecommerce domains benefit from using recommendation technology to help buyers to get product suggestions [18].

B. Tripbase.com

Tripbase.com assist users to find vacation places that match their personal preference. Tripbase.com creates a search engine which will scan the web for suitable travel information. Tripbase.com aggregated more than 11 Million of data from different sources that would match the user preference and include the suitable travel information which the review of travel's and rating for visited places. The data analysis used in Tripbase.com is an artificial intelligent technology which analyses the data fast and accurate which would match the user preference with correct and suitable travel information from web. Tripbase.com offer a travel recommendation which collect all the data that related to user searching and provide a fair recommendation for personalized vacation , which include the most suitable places, flight and accommodation.

VI. RESEARCH METHODOLOGY

In order to carry out the system development with fewer problems and difficulties, several systems development methodologies such as Waterfall approach, Prototype approach, Joint Application Design (JAD) and System Development Life Cycle (SDLC) can be used. In this system we will use the System Development Life Cycle (SDLC) as method to develop and implement the Real Estate system. SDLC conducts several phases on processing [19].

VII. RESULTS (IMPLEMENTATION DESIGN/ INTERFACE DESIGN)

The interface of Real Estate Recommender System using Case-Based Reasoning Approach is the most important part. Nowadays, people are concerning with software interface design before looking for the functionalities of them system. Thus, to make our system more attractive and dynamic in appearance, we have used graphical user interface as the interface of choice for designing our system. Here in this part we will be show the most important functions of the system.

A. Home Page of the system

Figure 4 is the home page which can be viewed by any users including admin, sellers or buyers. This page includes search engine for the buyer to search for property where he/she can key in keywords and specify the preference such as (Bedrooms, Bathrooms, and Max Price).

B. Property Search

Figure 5 shows where user can search his/her preferred property, where he/she can key in the preference of the property such as (City, State and ZIP), also user can key in the Tags (keywords) regarding any property to ease the search function, these Tags are the cases for the case-based approach, these cases will be saved in the database for future work by

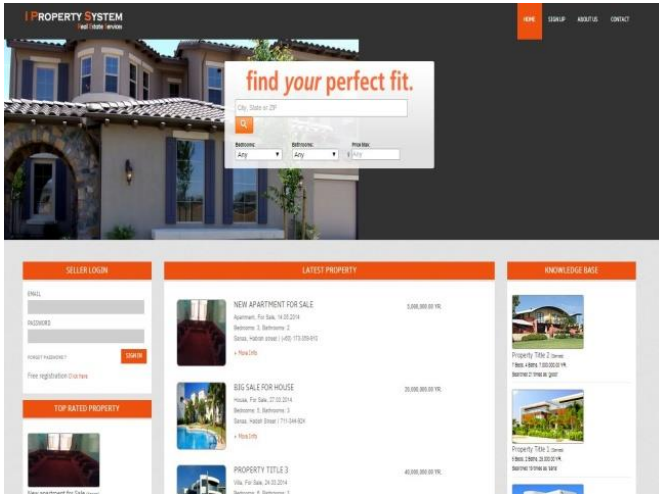other user looking for the search preference.
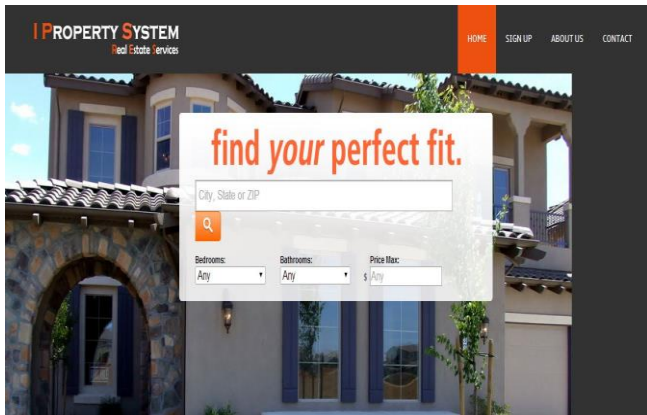

Figure 4: System Home Page

Figure 5: Property Search

C. Search Results

The search engine is our main mission for this project, after the user click the search button the result showed are from both the case-based reasoning and normal search function, the case-based reasoning filter the best result for the user and recommend these results to the user, if there is no result for the case-based reasoning, the system will show the result for the normal search function, where all available properties will be list it for the user. Figure 6 shows the result for the search, where the result priority is given first for the cased-based reasoning.

We can see in Figure 6 in the right side the system recommends properties to the user form the knowledge base table in the database, which users' previous search, the system is learning from previous user search which similar to the current user search and match it and recommend it to the user.
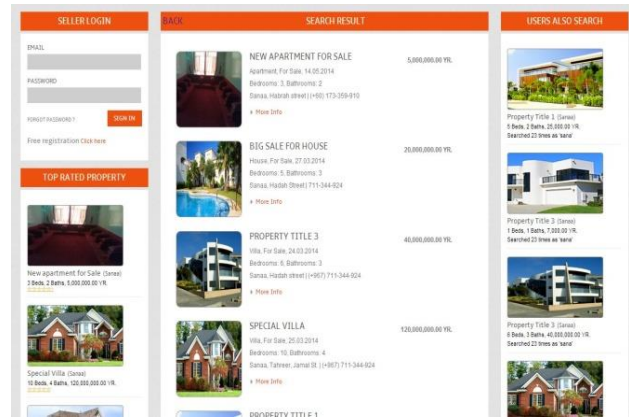

Figure 6: Search Result

VIII. CONCLUSION

Real Estate Recommender System implemented by using Case-Based Reasoning Approach that assists users to buy/rent properties in very simple way by recommending the user with suitable property that meets the user's interest. This paper proposes a Real Estate Recommender System using Case-Based Reasoning Approach which can help the customer to find a desired property. This proposed system uses a recommendation system during search for properly which assists the users to find an appropriate property and make decisions where they need the required knowledge to judge a particular property. Furthermore information available is very huge, so recommendation system assists the user to filter the available dataset according to user needs. Recommendation method used for the search engine is Case-Based reasoning which can solve a new problem by retrieving the same problem that has been solved before and reuse the information that used to solve this new problem. Also the system uses collaborative filtering approach which filters the properties based on other user rating for properties; the system will do recommendation based on the top rated properties. Also system will do recommend the user for properties based on the most visited properties, where the system will count the number of visit for each property by all users.

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