Recommendation System for Education Service Using Multi Agent

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Abstract

Nowadays, the world is in knowledge age. Variety of new technologies and supports are being evolved for education. One of the most well known systems is recommendation system. Recommender system uses the opinions of a community of users to help individuals in that community more effectively. In this paper, the system propose a multi agent recommendation system for education service mainly on information retrieving and recommending course (subject) lists. This recommendation system is based on item-based collaborative filtering method for recommending related subjects on user's interested subjects and multidimensional association rule method for providing knowledge about the relationship between the users and degree courses. These techniques made as a form of agent and perform separately in its corresponding sections. The system provides agent based information extraction by user's preferences. This system provides information and recommendation to users to help them to decide which are interested or to be chosen.

1. Introduction

The explosive growth of the World Wide Web and the emergence of e-commerce have led to the development of recommender systems. Recommendation systems are best known for their use on e-commerce web sites and services. Recommender systems use historical data on user preferences and other available data on users and items to predict a new user might like.

The vast amount of information following on the web has given rise to the need for information filtering techniques. Browsing and searching are expensive activities because extensive time is required to find the appropriate information. Multi agent technology can solve for this problem, time consuming of information retrieval system. Agent based technology can potentially solve complex dynamic online decision support tasks. Multi agent approach has been widely used in the development of large complex systems.

Recommendation agents are extensively adopted by both research and electronic commerce recommendation systems in order to provide an intelligent mechanism to filter out the excess information available and to provide customers with the prospect to effortlessly find out items that they will probably like according to their logged history of prior transactions [11]. Recommendation agents need to employ efficient recommendation algorithms as to provide accurate recommendations to users.

In this paper, the system proposes a recommendation system for education service using multi-agent technology. This recommendation system combines information retrieval system and recommender together as a form of cooperative working system. The system encapsulates these two sub-systems in a multi agent system. The users can retrieve information they preferred by means of information retrieval agents and users can request recommendations for subjects and get knowledge about the relationship between users and courses by means of recommender agents.

For recommender agents, the system uses item-based collaborative filtering techniques and multidimensional association rules mining techniques. Item-based collaborative filtering agent is used for recommending subjects depending on user's interested subjects. Multidimensional association rule agent is used for providing knowledge about what kinds of user interest in what types of course.

There are no public or private schools categories in this system. And this system is intended only for Computer Science field. This recommendation system supports users by providing information, knowledge and recommendation.

1.1 Related Works on Recommender System and Multi-Agent System

Item-based method has been developed for finding efficient solution requiring smaller computational efforts in [1]. A usage based Web personalization system, [5] makes the personalization process automatic, and dynamic separating the offline tasks of data preparation and Web usage mining, and the online recommendation engine.

In [2], the author describes the multi-agent system for distance education system to suggest the agent systems by intelligence and adaptability properties in distance learning environment. The suggested system

has flexible, agile, intelligence and cooperation features.

The voluminous information available in the education management field has given rise to the exploration of agent technology to analyze data and make critical business decisions. [3] proposes a framework of an intelligent multi-agent based information retrieval for education management. The system helps school administrators to search for information precisely and rapidly and searches for relevant documents from various databases, parses and presents them in an XML format.

A web-based multi-agent architecture for learning environments, [4] presents its application to the teaching of geometry proof. It develops an educational community composed by human and no human agents, for teaching geometry proof.

2. Background Knowledge of the System

This section describes the theories that are applied to the system.

2.1 The Nature of Agent and Multi Agent System

Software processes that act on behalf of the user are known as agents. An agent is situated in some environment and capable of action in this environment.

$$Ag: E \longrightarrow Ac$$

Let us assume that environments may be in any of finite set of E of discrete, instantaneous states:

$$E = \{e, e', \ldots\}.$$

If transform the state of environments, agent is assumed to have possible actions.

$$Ac = \{\alpha, \alpha', \ldots\}$$

A run, r, of an agent in environments is thus a sequence of interleaved environments state and actions:

$$r : e_0 \xrightarrow{\alpha 0} e_1 \xrightarrow{\alpha 1} e_2 \xrightarrow{\alpha 2} e_3 \xrightarrow{\alpha 3} \ldots \xrightarrow{\alpha u-1} e_u.$$

Intelligent agent is a computer system capable of flexible autonomous action in some environment. Flexible means autonomy, reactive, proactive and social.

Autonomy – An agent encapsulates some states of its environment and makes decision about what to do base on that state.

Reactivity – an agent perceives its environment and responds to changes that occur in the environment.

Pro-activeness – an agent can exhibit goal directed behaviors by taking the initiative to satisfy the given design objective and

Social ability – an agent interacts with other agents and engages in social activities in order to achieve goals or cooperate [6].

A software agent is autonomous or at least semi-autonomous, meaning it can perform task in pursuit of a goal with minimum of no direct supervision or direct control, but can interact with another entity to obtain guidance or output results. A software agent is referred to a component of software or hardware which is capable of acting exactingly in order to accomplish tasks on behalf of its user.

Multi agent systems are computational systems in which two or more agents interact or work together to perform some set of tasks or to satisfy some set of goals.

2.2 Recommender System (RS)

Recommendation systems provide to predict (movies, music, books, news and web pages and so on) that a user may be interested in, given some information about the user's profile. RS try to recommend items of potential interest to a user with respect to the user's individual preferences. Such recommender systems are the focus of current interest in part.

Recommender systems usually take two steps.

1. Look for users who share the same rating pattern with the active user (the user who the prediction for).
2. Use the ratings from those like minded user found in step 1 to calculate a prediction or recommendation for the active user.

Recommendation systems work by collecting data from users, using combination of explicit and implicit methods.

The recommendation system compares the collected data to similar data collected from others and calculates a list of recommended items for the user. One of the most successful technologies for recommender systems is collaborative filtering [13].

2.3 Traditional Collaborative Filtering

Collaborative filtering uses pattern-matching techniques to determine correlations between products that customers have purchased and potential future items of interest, and between the buying choices of similar customers.

There are two types of collaborative filtering, user-based and item-based. User-based filtering examines and then leverages the history, preferences, and similarities among a current online customer and previous consumers. Item-based filtering identifies similarities among items, rather than users.

Item-based filtering is generally more scalable than the user-based technique [7].

2.4 Item based Collaborative Filtering

Item based techniques first analyze the user-item matrix to identify relationships to indirectly compute recommendations for users.

Item based Collaborative filtering is a model based method. The similarities between different items in the dataset are calculated by using one of a number of similarity measures and then these similarity values are used to recommend.

Item-to-item collaborative filtering matches each of the user's purchased or chosen and rated items to similar items, then combines those similar items into a recommendation list.

In short, item based collaborative filtering algorithm proceeds in two steps.

1. Build an item to item matrix determining relationships between pairs of items
2. Using the matrix and the data on the current user, infer his taste.

Item- to- item collaborative filtering scales to massive data sets and produces high quality recommendations in real time.

2.5 Multi-dimensional association rules (inter -attributes)

Multi dimensional association rule is finding associations between values of different attributes. Mining multi dimensional association rules usually uses relational database or data cube. In this rule mining, attribute values are significantly considered. There are two types of attribute values, quantitative attributes and categorical attributes. Quantitative attributes are too many distinct values. Therefore, we transform quantitative attributes to categorical attributes via discretization.

The number of possible association rules grows exponentially with the number of products in a rule but constraints on confidence and support reduce the effective search space. Association rules can form a very compact representation of preference data that may improve efficiency of storage as well as performance [8].

3. Overview System Architecture

This system uses agent based technology in information extraction and recommendation subjects and providing knowledge as a form of multi agent system. Multi agent system technology can be used to develop agents that act on behalf of a user and are able to negotiate with other agents in order to achieve their goals.

The proposed system combines multi agent information retrieval system and recommender agents as a form of cooperative recommendation system. This system is the purpose of enabling requesting recommendations while viewing the searched page. The aim of the system is an easy and useful system for not only recommendation but also retrieving information.

The system first built a similarity model of subjects to recommend subjects for the active user. In the computational approach, data analysis uses the implementation of algorithmic approaches to handle heterogeneous data and multi data stores. For this implementation, the agent technology has also been considered.

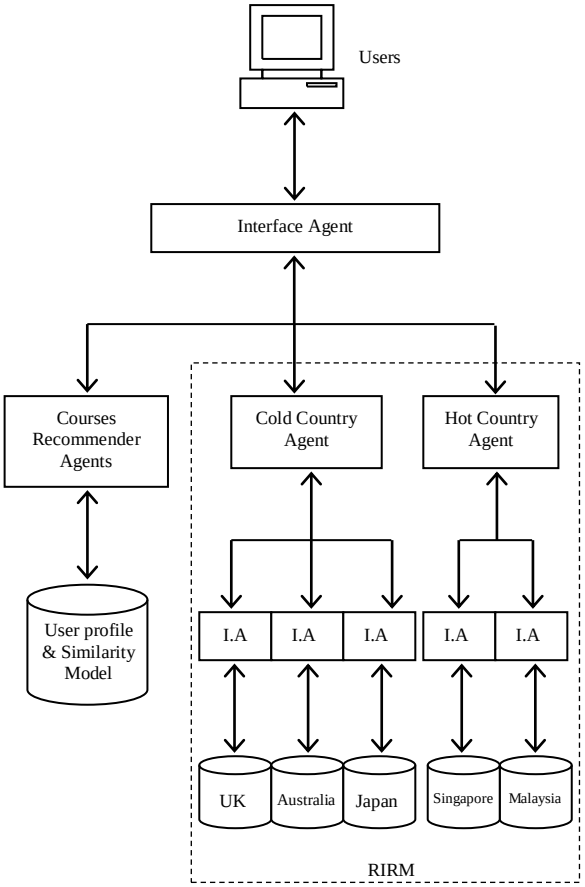

Figure1. System Architecture of Multi-agent Recommendation System

The system consists of three main components. These are Related Information Retrieval Module (RIRM) for information retrieving based on user preferences, Subject Recommendation Module (SRM) for recommending subjects of a specific degree course and Courses-User Related Information Retrieval Model (CURIRM) for providing knowledge about the relationship between users and degree courses.

In RIRM, many agents work together to achieve the information for the user’s preferences on degree course and country. This module is intended for the user to browse quickly without information overload.

Recommendation of subjects for a degree courses in SRM and providing knowledge of relationship between users and degree courses in CURIRM are performed by courses recommender agents.

Recommending subjects is performed by subject-based collaborative filtering agent based on the user's interested subjects. In this case, the system first builds a similarity model of subjects from previous user's data to recommend related subjects for the active user. This agent will give the users the related subjects of their choices for the help in choosing more subjects.

Knowledge about the relationship between users and degree courses is given by the association rule agent. This agent gives the relationships of users and degree courses in the most frequent patterns of IELTS score, background degree and interested degree or viewed degree.

The working process flow of the system is presented in the figure 2.

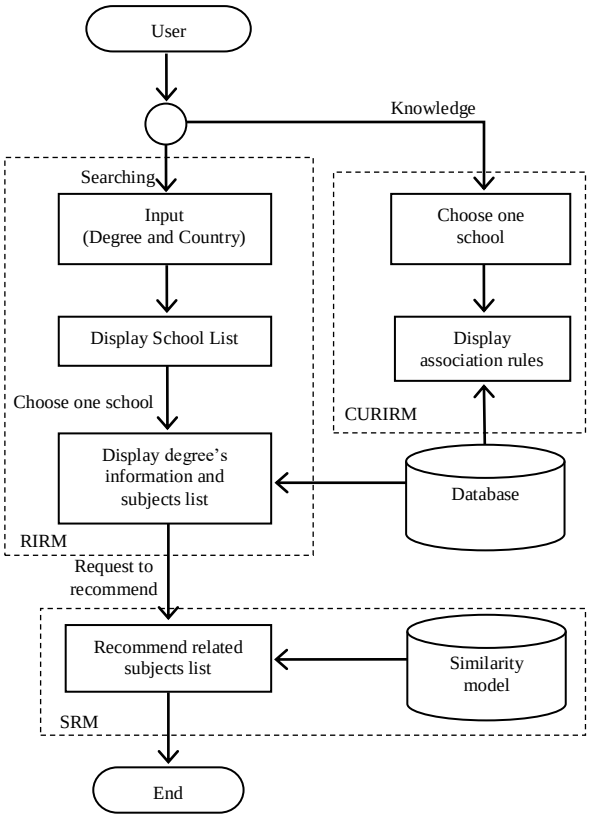

Figure2. Flow Chart of the System

When the user arrives to the system, the user can do two thing first, retrieving information and viewing knowledge about users and courses. In the process of retrieving information, the user will meet with RIRM and the user can retrieve information by inputting degree and country.

In the page of retrieved information, the user can request recommendation for related subjects to the user's interested ones. Recommending related subjects are performed by SRM (Subject Recommendation Module) of the system.

In the Knowledge part, the relationship between the users and courses are retrieved by CURIRM (Course-User Related Information Retrieval Module) with the form of association rules. These knowledge are the frequent patterns of what types of users interested in or viewed what types of courses in past.

The detail processes of these three main components of the system are explained in the following.

3.1 Related Information Retrieval Module on User Preferences (RIRM)

In this module, there are a number of information repositories. These information repositories are databases that store of school information for each country. Beside this, there are another three types of agents; interface agent, cold country agent and hot country agent are as middle agents and information agent (I.A) for the purpose of retrieving or browsing information of each country.

Interface agent is capable of communicating with internal (e.g. with other agents) and external (e.g. human being) entities. It manages the presentation of information and elicits input from the user, maintain user profiles, and in general represent the end user's interests in the system.

Cold country agent and hot country agent are used as middle agents or brokers to find agents in an environment. They are simply matchmakers or yellow page agents, which match advertisements to requests for advertised capabilities. Cold country agent and hot country agent are specialized in different areas of expertise. In the system, cold country agent knows about three repositories that have cold weather condition and hot country agent knows about two repositories of hot seasoned countries.

Information agents (I.A) are able to provide access to the repositories. They are experts about their associated repositories.

When the user issues a query to an interface agent that is an agent on their local machine, the interface agent then contact a middle agent, which is skilled at their appropriate type of request. If the query of user is of a cold country, then the interface agent contact to cold country agent. If not, the interface agent will contact to hot country middle agent. When there is a condition that a user does not specify cold or hot country or specify both, the interface agent will contact both the cold country and hot country middle agent.

The corresponding middle agent then contacts a number of information agents, asking first whether they have the correct skills and then issuing specific queries. The I.A that matches the property of query searches and retrieves pages from the repository. And then found pages are given back to the user

from one agent to another of upper level. Finally, the interface agent gives the result to user.

3.2 Courses Recommender Agents

There are two kinds of courses recommender agent, subject-based collaborative filtering agent and association rule agent. First agent is for recommending subjects of a specific course in the SRM. Another is implemented for providing knowledge about relationships between users and courses in CURIRM. The system regards each subject as an item in computation of related top-N subjects list and limits N as five. This means that the system will give the users five recommended subjects related to their interested subjects. The architecture of courses recommender agents is shown in figure 3.

3.2.1 Subject-based Collaborative Filtering Agent

Subject-based collaborative filtering agent is in the SRM of the system and used model based technique. In this filtering, agent uses model-based top-N recommendation algorithm [9] is used. This algorithm first determines the similarities between the various items and then uses them to identify the set of items to be recommended. So, agent first builds a similarity model. The method used to compute the similarity between the items is in the following.

To determine the most similar match for a given item, the algorithm builds a similar-items table by finding items that students tend to choose together. The approach is calculating the similarity between a single subject and all related subjects which are chosen together. To compute similarity, Pearson Correlation method is used.

$$sim(i,j) = corr_{i,j} = \frac{\sum_{u \in U}(R_{u,i} - \bar{R}_i)(R_{u,j} - \bar{R}_j)}{\sqrt{\sum_{u \in U}(R_{u,i} - \bar{R}_i)^2}\sqrt{\sum_{u \in U}(R_{u,j} - \bar{R}_j)^2}}$$

The set of users who both rated ***i*** and ***j*** (subject ***i*** and ***j***) is defined as ***U***. $R_{u,i}$ is the rating of user u on subject ***i***. And the average rating of the i^{th} subject is defined as the symbol of R_i. $R_{u,j}$ is the rating of user u on subject ***j***. And the average rating of the j^{th} subject is defined as the symbol of R_j.

The method used to combine these similarities in order to compute the similarity between a basket of subjects and a candidate recommender subject is to build item-to-item similarity model.

Given a similarity model, the algorithm finds subjects (of candidate recommended subjects) similar to each of the user's choices/interests and ratings (a basket of subjects). To compute recommendation list, the algorithm aggregates those items and then recommends the most popular or correlated items.

From the interface agents, the system will get explicitly the interested subjects and rating of user on specific degree course. Rating ranges from ***1*** to ***5*** with ***1*** expressing greatest aversion to the subject and ***5*** expressing greatest liking to that subject.

The key to scalability and performance of item-to-item collaborative filtering is that it creates the expensive similar-items table offline. The algorithm's online component - looking up similar items for the user's choices and ratings – scales independently of the catalog size or the total number of customers.

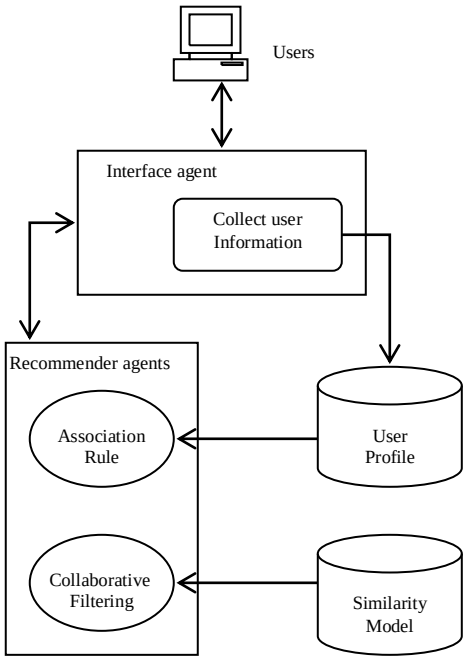

Figure3. Architecture of Courses Recommender Agents

3.2.2 Association Rule Agent

Association rule agent is in the CURIRM of the system. The agent used multi-dimensional association rule method for providing knowledge to the user based on the data of previous users.

The relational table of the system has three attributes (predicates) such as IELTS score, Background Degree and Interested Degree. The agent first maps the categorical attributes to the Boolean attributes representation and stores it in to the relational table. The table may have as many as field corresponding to < attribute 1, value 1>, which would be '1' if attribute 1 had value 1 in the original record and '0' otherwise.

The agent regards each tuple in the table as a transaction. Then the agent apply apriori algorithm

[10] to the Boolean table to find all frequent itemsets. The itemsets will be in the form of < IELTS Score, Background Degree, Interested Degree>. From the frequent predicates sets, strong association rules are generated. These strong association rules are the ones that satisfy minimum support and minimum confidence.

Data collection for information of further users is implicitly. The rules may be in the form of showing the frequent pattern of IELTS score, Background Degree and Interested Degree.

4. Experimental Result

To test the recommendation system is correct or not, collecting data of user satisfactions is performed. The data for counting user satisfactions is collected from the 100 students of Computer University (Taunggyi). To measure the user satisfactions, the system specify the percentage of that the users like the recommended related subjects associated with their interested subjects.

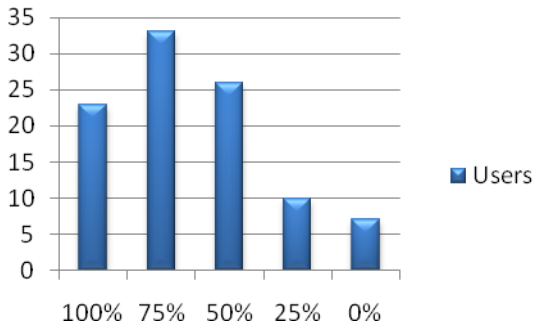

Figure4. Bar Chart of the Experimental Result

In measuring, the system separates the types of users with the percentage of their likeliness. If a user like all five recommended subjects, that user will be in the 100% group. If user likes four subjects, user will be in 75% group. If user likes three or two subjects, user is in 50% or 25% group respectively. If users do not satisfy recommended subjects, they will be in 0% group. The test result of the system is presented in figure 4 as in bar chart.

5. Conclusion

This paper briefly describes the cooperative multi-agent recommendation system which will perform information retrieving and recommendation. This recommendation system will have to increase personalization by collecting and processing additional data without being intrusive and time consuming. A good recommendation algorithm is scalable over very large databases, requires only subsecond processing time to generate online recommendation and is able to react immediately to changes in user's data. Item based collaborative filtering is able to meet this challenge. The system aims to find quickly the information the user like and get faster recommendations.

6. References

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