Personalized Desire2Learn Recommender System based on Collaborative Filtering and Ontology

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***Abstract*—In this century, attention has grown to recommendation systems (RS), especially in e-learning, to solve the problem of overloading information in e-learning systems. E-learning providers also play a major role in helping learners to find appropriate courses that fit their learning plan using Desire2Learn at Majmaah University. Although recommendation systems generally have a clear advantage in solving problems related to overloading information in various areas of e-business and making accurate recommendations, e-learning recommendation systems still have problems with overloading information about the characteristics of the learning recipient Such as the appropriate education style, the level of skills provided and the student's level of education. In this paper, we suggest that a recommendation technique combining collaborative filtering and ontology be introduced to recommend courses for learning recipients through Desire2Learn. Ontology involves the integration of the characteristics of the learning recipient into the recommendation process as well as the classifications, while the liquidation process cooperates in the predictions and generates recommendations for e-learning. In addition, ontological knowledge is employed by the educational RS in the early stages if no assessments can be made to mitigate the cold start problem. The results of this study show that the proposed recommendation technique is distinguished and superior to the cooperative liquidation in terms of specialization and accuracy of the recommendation.**

***Keywords*—Collaborative filtering; Desire2Learn; ontology; recommender system (RS); personalized Desire2Learn; PDRS**

I. INTRODUCTION

Recommendation systems - enables users and experienced people to benefit from other experts with the same specialization and exchange notes, knowledge, and cooperation among them [9]. Recommendation systems were used to support users ’decisions about their choice of information that they benefit from and who face multiple options and do not have the most appropriate option for them. The recommendation system was the solution in helping them to make the most appropriate decision from the available options [1].

In the late twentieth century, the technique of recommendation developed widely on the methods of book recommendation systems such as Amazon.Com and the Coursera recommendation system to address the issues faced by the company when overloading the information [2]. E-learning is also facing the same problems in downloading the information within Desire2Learn provider systems to solve this problem through the automatic RS for appropriate courses for learners based on the learner's preference for the courses he/she enrolls in the semester and his or her academic record [10]. The RS is important to supporting learners through Desire2Learn providing customized recommendations for student courses and thus achieving the high potential for advanced customization [3].

The specialists in the field of RS are to make recommendations with multiple techniques, but provided that it is with the same area and related to the liquidation of information other than information about the subject matter [11]. Some researchers also said that special recommendation techniques such as collaborative filtration and duration on content could be more effective in some (traditional) cases because they rely on user entities and elements and do not take into account other user information to make additional recommendations [4].

In the Desire2Learn scenario, recipients of education have qualitative characteristics such as the nature of knowledge, the level of educational attainment, and the level of academic advising that affect the recipients of education [12]. Therefore, the traditional recommendation system that combines collaborative filtration and filtering on content cannot provide accurate recommendations to recipients of knowledge because it is not connected with the characteristics of recipients of further education. To provide excellence in specialization and accuracy in Desire2Learn proposals, the Recommendation system should contain the attributes of the recipient [5].

In this paper, we recommend the Desire2Learn recommendation technique to recommend Desire2Learn learning courses by combining collaborative filtering and methodology, with the primary objective being to improve the specialization and accuracy of recommendations. Anthropology is used to integrate the characteristics of the learner such as the nature of culture, the level of educational attainment, and the level of academic advising that affect the recipients of knowledge.

The rest of has been structured as follows: In Section II, we present the Literature survey, Related Work, RS techniques. Section III offers a framework of PDRS, Section IV discusses the Drsire2Learning RS method based on Ontology-CF. Section V Discussion and Result; and Section VI presents the conclusion and future work.

II. Literature Survey

A. Previous Related Studies

Most recent studies have focused on recommendation systems by combining recommendation techniques as a way to develop effective, high-impact recommendations. This combination of techniques requires combining at least two techniques to develop performance more effectively. For instance, John et al. 2017, proposed the technique of recommendation, which proposes combining the cooperative liquidation and the ontology to recommend courses and various training courses through the Internet. To integrate the characteristics of learning recipients in the recommendation process with classifications with phytology, on the other hand, the filtering feature cooperates in classifying the exact assessment process and generating recommendations. The study showed that the accurate evaluation proposed recommendation progresses in the performance of the cooperative liquidation directly in terms of the allocation and process of evaluation accuracy of the recommendation [6]. Wei et al. describe an approach for technical recommendation containing CF and deep education to alleviate the cold startup problem of renewable elements. The study showed that the technique of the recommendation significantly improved performance and alleviate the problem of cold start [7]. Da Silva et al. used technology to develop that incorporates CF-based recommendation techniques and their integration with genetic algorithms. The results of the study indicate that performance has improved [15]. Saman et al. 2010, describes an approach for an electronic recommendation, whereby the system helps the recipient of the education the ability to research and choose the appropriate educational courses in their field of specialization. This web-based system includes presence language and Web (OWL), which is used to filter the language base as a recommendation method. The modules of the subsystem have an observer, a metafile, education, caches recommendations, and user interface [9]. Ting et al. propose a recommendation technique based on weblog exploration and a two-slide diagram, the conclusion of the study the combination of weblog and graph increases performance and improves recommendation results [14]. Yu 2008 presented Recommendations in Ontology to Promote CF's Social Building Recommendation, the results of the study showed that CF-based community-based recommendation techniques offer better performance than the conventional method [17]. Leyla 2010, presents a system based on a multi-model methodology to infer the educational content of the D2L base in universities. This multi-model acts as a model based on content and another model based on the recipient of knowledge. The oncology model is also used to represent courses through the hierarchy of definitions and sub conceptions. This combination of the learning recipient's epistemology and subgroup and the database used for mixed recommendations provides each of the rearrangements of files retrieved at different weights [13].

Qwaider 2017, The study presented an application on the D2L portal based on the database of the admission and registration system at Majmaah University, where EPERS can help students choose the courses in line with their educational level and the previous requirements for studying the course they wish to study, in this framework the developed D2L rules related to Registering students with the courses they want to study that meet their needs [2]. This paper discusses the recommendation technique the necessity of Personalized Desire2Learn materials RS Based on CF algorithm and Ontology. Furthermore, there are many several problems for new items forecast with collaborative filtering algorithm and Ontology (CFO) recommendation technique based on issues. Compared with the filtering and ontology (Ontology-CF) and (algorithm-CF).

B. Recommendation Systems Techniques

Recommendation systems - enables users and experienced people to benefit from other experts with the same specialization and exchange notes [6], knowledge and cooperation among them, and it can be determined as any system that produces individual recommendations as a product that has an impact on directing the user in a way that is dedicated to the things of interest or useful purposes in the areas available options. Recommender systems were developed to support Internet users in the decision-making process by selecting information that would be useful to them when faced with situations where they did not have sufficient experience in the available alternatives. Collaborative filtering (F) does not rely on satisfaction analysis by the computer [15].

There are many algorithms used to measure the similarities of users' tastes in the proposed systems, including k-nearest neighbor k-NN and Pearson Correlation, It assumes that users will be similar in their choices as before and with the same amount of love for the same things. There are three major problems faced by the collaborative filtering system: cold start, expansion, scattering in the early stages [7].

In the content-based (CB) approach, Content-based filtering is the filtering method based on the content that describes the product and the user's preferences. Use keywords to describe this product and build a user account to identify the type of product they like [14]. In the knowledge-based (KB) technique, and recommends elements based on the comparison of the satisfaction of the features and the profile of the user's needs and preferences. In the Desire2Learn context. The satisfaction of each component is a set of learning materials constructed by analyzing the satisfaction of the elements that the user may see applied in the recommendation process [8].

Knowledge management is scientifically based because knowledge is categorized and based on predefined Ontology-based recommenders theory in structures or semi-data bases and KB recommender systems bases for use in so-called expert systems, knowledge-based systems, databases, case-building systems, etc. Where the computer uses the rules of reference to answer the questions of the investor, which reduces the problem of cold start, expansion, and scattering. In contrast, a hybrid recommender system approach combines collaborative filtration with content duration and can be more effective in some cases [9].

III. Our Recommendation Approach for DESRS

Fig. 1 shows outlines of the general recommendation of e-learning (DESRS). The model contains the following main components: Student Profile, Learning Object Ontology, Student Database Preprocessing, Recommendation incentive,

(DKM), (LMT), Portal D2L. The flowing explain recommendation model works:

1) Student profile: The student's file contains all the information about the student. This information is obtained from the student, placed in his/her data, and stored. The student file includes the following information (student's name, gender, nationality, age, educational level, and cumulative average). The collaborative filtering recommendation engine has been done to take advantage of this information on student Ontology to make the expected recommendations [16].

2) Learning object ontology: Once the student has accepted the course, the next stage, learning resource ontology containing the name of the classes and the information about the educational material, has stored. The class that the student wishes to register for is the content format, such as text, image, etc.

3) Student database preprocessing: Database from both the student and learning object ontology and processed in a positive format for the recommendation incentive. The student's primary data processing component and the learning Ontology component.

4) Recommendation incentive: After data processing is completed, the drive calculates predictions of the target learner's assessment based on ontology. Finally, the Recommendation incentive creates customized recommendations for the target learner through D2L [14].

5) Domain knowledge management (DKM): The teacher can provide the scientific material through the content icon and upload the classes online through the establishment of LMT.

6) Learning Material Tree (LMT): In the curriculum tree, the name of the course or code where the tree of the curriculum is split into chapters and each chapter is split into study units and then sub-presented in different ways on the Internet such as PPT.

7) Portal D2L: The University uses the D2L program in the e-learning department where the teacher uploads the scientific material or training course on the D2L system and also contains the duties and tests, attendance system, absence, forums, meetings, virtual classes, and more.

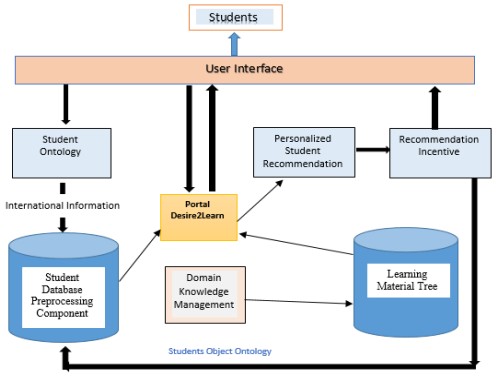

Fig. 1. Ontology-based Recommendation Desire2Learn Model.

The greater the similarity in the matrix the more similar the learning objects (the nearest neighbors). the learning objects are, Prediction based on mathematical models is computed using the k most similar LO (k nearest neighbors) who characterized by the most similar LO I, Using the most similar learning objects in the classification and evaluation process, the following mathematical formula was used:

$$sim(i,j) = \frac{\sum(r_{l,i} - \bar{r}_l)\ (r_{l,i} - \bar{r}_l)}{\sqrt{\sum(r_{l,i} - \bar{r}_l)^2}\sqrt{\sum(r_{l,i} - \bar{r}_l)^2}} \quad (1)$$

where $r_{l,i}$ is the rating given to learning object i by learner I, $\bar{r}_l$ is the mean rating of all the ratings provided by I based on ontology knowledge.

$$P_{l,i} = \frac{\sum_{t \in N}\ (Sim(i,t)\ X\ (r_{l,t})}{\sum_{t \in N}\ (|Sim(i,t)|)} \quad (2)$$

A. Recommendation Algorithm

For Fothehe conceptual recommendations (top $r_{l,i}$) for the determined learner based on the ontology and the forecast estimate (2), we use an algorithm (Algorithm 1).

Algorithm 1: Recommendations D2L ($I_{l,}\ o, rit$)

Input
learning objects of D2L
LO = $\{i1, i2, i3, \ldots\ldots, in\}$
Ontology
O = $\{student, LO\}$
Output
Foresee ratings and top N recommendations D2L
Procedure: Generate_ Desire2Learn _Path
Method
1: for each, I ∈ *LO*, o ∈ O, do
2: Compute ontological likeness Sim (iq, o, i) using (1)
end
3: Compute foresee ratings $P1, i$ using (2)
4: Generate learning top N recommendation for target $Student$ |t.

IV. Applications and Evaluation

The study was conducted at the Majmaah University, MU-CSHSG. Table I presents a course entitled "Management Information Systems" (MIS), which is offered to non-specialized students who come from many other colleges. The number of students participating in the registration of the course 84 students using the electronic learning system D2L to reach them during the process of education for the second semester of the academic year 2018/2019. The D2L system allows students to register for the MIS course from various relevant scientific disciplines. Students have evaluated concerning whether the course is a mandatory requirement or a choice from other academic departments. The recommended system to identify students who study the course as the masters of the subject and students other than the students of specialization according to the MIS curriculum according to the appearance of the personal student obtained through the similarity in classification and ontological knowledge.

The algorithm based on ontology has been evaluated. The participating students were divided into the first group with the specialization and the second group that did not specialize in the course.

TABLE I. MU-CSHSG - MIS

No. of students pertinent	No. of students not pertinent	Total students	No. of ratings
32	52	84	33,124

A. Experimental Results

Two experiments have been used for the same students involved to extract algorithm performance evaluation. The first experiment is a set of CF and Ontology-CF. Experiment number two is algorithm-CF. Moreover, the results have been compared from the two operations.

1) Accuracy experiments: The MAE has been used to assess the accuracy of the algorithm in the application of this experiment. Mean absolute error (MAE) can predict accurately used rates, error assessment, and actual and predicted deviations of the proposed algorithms.

The results of the evaluation of the accuracy of the experiment showed that prediction in the Ontology-CF algorithm is more accurate than the conventional Algorithm-CF results. Ontology-CF and algorithm-CF results are more relevant to the number of neighbors (84). Outcomes Ontology-CF were generally superior to Algorithm-CF as illustrated in Fig. 2.

$$\text{MAE} = \frac{1}{n} \sum_{i=1}^{n} | p_{i-r_i} | \quad (3)$$

2) Performance measure: Fig. 3 shows the comparison of algorithms based on Ontology-CF and the Algorithm-CF algorithm. The F1 scale has been used to compare measurement (4).

$$F1 = \frac{2 \times precision \times recall}{precision + recall} \quad (4)$$

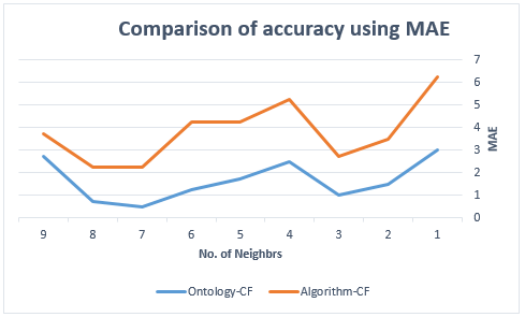

Fig. 2. Accuracy using MAE Measure.

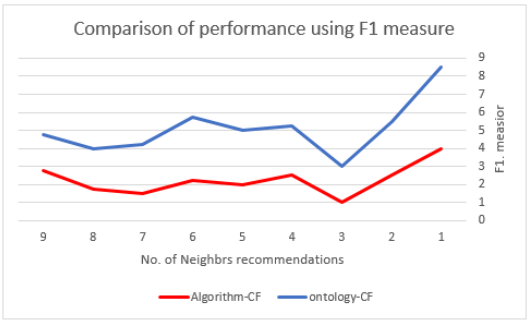

Fig. 3. Performance F1 Measure.

The F1 scale is accurate and recalls one value, which facilitates comparison and gives equal weight. As shown by the figure, Ontology-CF performance achieves the best performance in accuracy and recall from Algorithm-CF.

V. Discussion and Result

To evaluate the performance and accuracy of Ontology-CF compared to the same algorithm CF for the same students, the results of the experiment showed that the prediction of the Ontology-CF algorithm is more accurate than the traditional algorithm-CF results, Ontology- CF, and algorithm-CF are more accurate when the number of neighbors (84). Outcomes Ontology-CF are superior to algorithm-CF on their own. The reason for the superiority of Ontology-CF. One of the most critical advantages of Ontology-CF is generally the integration of student or learner characteristics, such as the nature of education, the level of educational attainment, and the level of academic advising that affect the recipients of training, the recommendation process using the knowledge of the field of ontology. Also, it helps to mitigate the problem of cold start through expansion, scattering the early stages of the Desire2Learn Recommender System in the deprivation of adequate valuation.

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VI. Conclusion and Future Work

The Desire2Learn recommender system has played an essential role in solving the problems of downloading information that increases educational resources through the Desire2Learn system. It is also possible for recipients of education to find the required educational courses within multiple and broad areas. However, conventional education techniques such as CF and CB continue to challenge by recipients of knowledge in different disciplines such as the nature of education, the level of educational attainment, and the level of academic advising that affect the recipients of education. In this study, the researcher presented a recommendation technique combining cystic fibrosis and ontology to recommend the use of courses in different disciplines for learners through Desire2Learn taking into account the features of the recipients of education. In this technique, no presence is used to integrate the characteristics of the learning recipient into the recommendation process. Results showed that the technology based on Ontology-CF outperformed the traditional performance of the CF algorithm on its own regarding performance and accuracy of prediction in the recommendations system. Also, it helps to mitigate the problem of cold start through expansion, scattering the early stages of the Desire2Learn Recommender System in the deprivation of adequate valuation. For future work, we will incorporate some courses and courses for the recipients of education. By establishing the science of existence using one of the programming languages such as the language Visual Basic (VB) and based on the database and ontology. Taking

into account the factor of time, location, and method of education.

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