RECOMMENDER SYSTEM: COLLABORATIVE FILTERING OF E-LEARNING RESOURCES

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ABSTRACT

The significant amount of information available on the web has led to difficulties for the learner to find useful information and relevant resources to carry out their training. The recommender systems have achieved significant success in the area of e-commerce, they still have difficulties in formulating relevant recommendations on e-learning resources because of the different characteristics of learners. Most of the existing recommendation techniques do not take these characteristics into account.

This problem can be mitigated by including learner information in the referral process. Currently many recommendation techniques have cold start problems and classification problems. In this paper, we propose an ontology-based collaborative filtering recommendation system for recommending learners' online learning resources based on a decision algorithm (DA).

In our approach, ontology is used to model and represent domain knowledge about the learner and learning resources. Our approach is divided into four parts: (a) the creation of an ontology for the representation of the learner's knowledge and learning resources (b) the calculation of the similarity of the assessments according to the ontology and the prediction for the learner concerned; (c) generating the K best items by the collaborative filtering recommendation engine and (d) applying the DA on the proposed items to generate the final recommendations for the targeted learner.

KEYWORDS

Collaborative Filtering, e-Learning, Ontology, Recommender System, Decision Algorithm

1. INTRODUCTION

In recent years, there has been a significant growth in the use of e-learning tools. This growth has led to an exponential increase in the amount of learning resources available online. With this increase in volumes of e-learning resources, learners have difficulty in choosing relevant and useful learning resources. Recommender systems can overcome the problem of information overload by filtering out irrelevant learning resources and automatically recommending relevant resources for learners based on their personalized preferences (D. Horowitz et al., 2018).

Learner preferences are relevant learning resources that respond to the learning needs and interests of the learner. A recommender system refers to the tools and techniques of the software. The primary goal of e-earning advocacy systems is to predict a target learner's preference or grade on object learning in order to generate recommendations (M. Erdt, et al., 2015). Traditional recommender systems such as Collaborative Filtering (CF) and Content base (CB) have been used in different areas. Recommendation for books in the Amazon and movies in Netflix are examples of the application areas of recommender systems (G. Linden, B. Smith, J, 2003). In the context of e-learning, CF (Feng Zhang et al., 2018) recommends to the target learner learning resources that other similar learners have liked in the past. The similarity of taste of two learners is calculated on the basis of similarity in the learners' rating history.

However, previous studies have shown that traditional recommendations suffer from cold-start problems (I. Barjasteh et al., 2016). The cold boot problem occurs in the recommender system due to an initial lack of ratings for new users who have not noticed any articles or new articles that have not been rated by any users, so it becomes impossible to make reliable recommendations (I. Portugal et al., 2018).

In this paper, we propose an CF based knowledge-based approach based on ontology and DA to recommend learning resources to learners. In the proposed approach, the ontology will be used to represent the learner knowledge and learning resources while the DA algorithm will be applied to discover the learner's historical learning patterns. On the other hand, the CF will be used to calculate the similarities of the assessments and make predictions for the target learner. The main advantage of these techniques is to leverage the strength of each particular technique while overcoming the limitations of individual techniques (Z. Liu, et al., 2010). Although some of the previous studies have used a variety of techniques in their recommender systems, the novelty of our work is to integrate CF, ontology, and DA in our recommender system.

2. CONTRIBUTION

This work makes a significant contribution to research on recommender systems for e-learning. As a first step, we proposed a knowledge-based CF recommendation approach to recommend learning resources to learners, taking into account ontology knowledge about the learner and learning resources as well as learning patterns. Aggregating this additional information into the recommender system will result in generating more personalized recommendations for the learner. Secondly, by calculating the similarity of the learners and generating predictions, the knowledge of the ontological domain is considered alongside the evaluations, thus improving the precision of the predictions.

In Section 3, we discuss the existing work in Section 4, our approaching recommendation and model recommendation are explained. Finally in section 5, the conclusion and suggestions for future work are described.

3. RELATED WORK

This section provides a brief overview of the recommendation techniques relevant to this work, and recommender systems to learning.

3.1 Recommender System for e-Learning

The application of recommender systems in the field of e-learning has become an important area of research. The notion of combining recommendation techniques to improve performance has been a growing trend in this area. Studies such as (Chen et al., 2014) proposed a system for recommending learning materials in an e-learning environment, and their results showed a significant improvement in performance. On the other hand, Pukkhem (N. Pukkhem, 2014) has used ontology in his learning recommendation tool which allows machines to interpret and process learning objects in a recommender system. In their system, the ontology object of learning. In addition, Mota, de Carvalho and Reis (D. Mota et al., 2014) propose a knowledge-based recommender system, supported by an ontological modeling approach to help educators design teaching and learning activities. In addition, (Cobos et al., 2013) present a system that allows speakers to define their best teaching strategies for use in a specific class.

The literature review on this area of study revealed that although many studies on the recommendation of e-learning resources have been made using different techniques, a more poldrecise recommendation approach remains to be made. Our approach is different from previous studies because we have aggregated ontology for domain knowledge representation and DA to capture the learning patterns of the target learner in the recommendation process.

3.2 Ontology-based Recommender Systems

Ontology is an explicit specification of a conceptualization (T.R. Gruber, 1993). It contains a set of concepts, namely, entities, attributes and properties related to a domain as well as their definitions and relations between them (L. Bajenaru et al., 2015). Domain ontologies can be created manually or automatically and these ontologies can be integrated with Web-based data mining tools(T.S.Nguyen, H.Y.Lu, J.Lu, 2014).

Most ontologies are created using ontology representation languages such as the Web Ontology Language (OWL) and the Resource Description Framework (RDF). Protocols are useful because they allow you to reuse domain knowledge. The reuse of ontologies saves time and promotes quality ontologies since the components of the ontology have already been tested. In addition, ontologies can be used with other tools and techniques such as data mining and machine learning tools to provide better results (B. Amini, R. Ibrahim, M. Shahizan, M. Ali, 2015). Due to the utility of ontology as a tool for knowledge representation, it has been widely adopted by researchers in the fields of information retrieval and recommender systems.

Ontology-based recommendations are knowledge-based advocacy systems that use ontology for the representation of knowledge (J.K.Tarus et al. 2017). Ontologies are used to determine user interests and to improve the user's profile in the area of recommender systems. In the ontology-based recommendation scenario, learner assessments are coupled with knowledge of the ontological domain to improve similarity matching. Once the ontological concepts are fully mapped, normal recommendation approaches can be applied (E. Middleton et al., 2009).

In the context of e-learning recommender systems, ontology is used to model learner knowledge and learning resources (S. Shishehchi et al., 2012). Like knowledge-based recommender systems, ontology-based systems note most of the problems associated with traditional recommender systems such as cold start, lack of data, and excessive specialization due to the use of knowledge ontological domain. Personalization of the learner profile using the ontology makes the recommendations more adapted to the preferences of the target learner.

The structure of the first-level ontology of e-learning presented includes two classes, namely the ontology of learners and learning resources. The learner class covers learner knowledge, including personal data, learning style and level of knowledge. The Learning Resource Class represents knowledge about learning materials such as the type of learning resource and the format of learning resources audio or video. In this work, the learning resource recommender system is based on an ontology model in which additional learner characteristics derived from knowledge of the ontological domain are incorporated into the recommender system.

3.3 DA for Recommender Systems

In recommender systems, the set of entries for the construction of the decision tree is composed of evaluations. Evaluations can be described as a [ItemID, UserID, Rating] relationship in which [ItemID, UserID] is assumed to be a primary key. Attributes can describe users, such as age, gender, occupation of the user. Attributes can also describe items, such as weight, price, dimensions. The notation is the target attribute that the classifiers of the decision tree. Based on "training set", the system tries to predict the items for which the user does not have an evaluation, and recommends to the user the items with the highest score.

The construction of a decision algorithm is performed by a recursive process. The process starts at the root node with a training set. At each node, an item attribute is selected as a division attribute. For each possible value (or set of values), the child nodes are created and the parents are divided between the child nodes so that each child node receives as input set all elements that have the appropriate value(s) corresponding to that child node. Split attribute selection is done heuristically because we cannot know which division will produce the best tree (the tree that produces the best results for future inputs), for example the popular C4.5 algorithm (J. R. Quinlan et al.1993) uses a heuristic division that produces the greatest gain of information on all possible divisions. One of the attributes is predefined as the target attribute. The recursive process continues until all elements of the entire node share the same target attribute value or the number of elements reaches a certain threshold. Each leaf node is assigned a label (classifying its set of elements), this tag is the value of the shared target attribute or the most common value in case there is more than one such value.

Decision trees can be used for different approaches to recommender systems. But we are interested in the case of a collaborative filtering approach.

Breese (S. Breese et al. 1998) used decision trees to build a collaborative filtering system. Each instance of the training set refers to a single user. The attributes of the training set refer to the feedback provided by the client for each element of the system. In this case, a dedicated decision tree is created for each element. To this end, the feedback provided for the targeted item is considered the decision to be predicted, while comments are provided for all other items. is used as input attributes (decision nodes).

The proposed approach is a knowledge-based recommender system for ontology-based e-learning resources. The approach is summarized in the recommendation model.

4. OUR APPROACH

The model contains five main components namely the learner model ontology, the learning resource ontology, the recommendation engine, the DA algorithm and the final recommendations component. In our recommendations, our approach involves major steps as shown. Create an ontology to represent knowledge of the learner domain and learning resources; (2) calculating similarities and note predictions for the learner based on knowledge of the ontological domain; (3) generating the best K items of learning by the CF recommender system; and (4) applying the DA to the best learning sources to generalize final recommendations for the target learner.

4.1 Learner Ontology and Learning Resources Ontology

The ontology of the learner model represents the learner, such as their demographics (first name, last name, age, level of education), the learning preference, and the level of education. The lower levels of the learner contains more specific information about the learner. In this study, only students learning edge level were considered additional features of the learner. Whereas more additional information can be incorporated recommendation process to improve the learner's personalization recommendations, the invisibility angle increases resources as well as the complexity of the time. To obtain the learner's learning style, an online questionnaire "Index of Learning Styles Questionnaire"(B. Soloman et al., 1996) will be used to administer to the learner during the account registration process.

The ontology of learning resources represents knowledge of learning resources. The knowledge represented in this ontology includes types of learning resources such as quizzes and documentations as well as a learning resource format that can be in pdf (written), image, audio or video format. In this model, the ontology has been used for the personalization of the learning profile as well as for the modeling of the ontology of the learning resources. By developing the ontology of the learning model and the ontology of learning resources, concepts and their relationships, the recommendation engine will use ontology domain knowledge and learning resources as well as similarities and predictions for the learner. Subsequently, after creating the learners' ontologies and learning resources, these are prepared and processed in a first wave along with the web data in a format required by the CF recommendation engine.

5. CONCLUSION

We propose modeling of an ontology-based recommendation system and the use of the decision algorithm to recommend learning resources to learners in a learning environment. to represent the learners' knowledge and learning resources while the DA algorithm is used to discover the learner's learning patterns. The implementation of this modeling is ongoing, the proposed algorithm can achieve better performance and better accuracy than other related algorithms.

Future work will focus on harnessing the results achieved in implementing our model presented in this paper and integrating other smart tools and technologies, such as data mining and machine learning.

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