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A review on Recommender Systems for course selection in higher education

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Abstract. Recommender systems are widely used in many fields. These systems work by recommending a personalized list of items to users based on their interests and thus helping users to overcome excessive information offered to them. For users such as students, selecting the right courses is a very challenging task while joining a new academic level. Picking the wrong courses may affect a student's academic life as well as their future career. This paper aims at exploring the use of recommender systems to assist students in selecting courses that correspond to their abilities and interests. The results from this review showed that the Hybrid recommendation approach/system could be the best method to help students to choose the right courses in preparation for their future careers.

1. Introduction

Recommender Systems are programs specially designed to suggest to the user the next activity to indulge, based on a variety of factors such as preferences and the user's history. In other words, these systems or programs help people to make choices of the things they like. Generally, all recommender systems aim at generating meaningful recommendations to users for items that might be of interest [1]. Therefore, recommender systems must be able to figure out what features users like and group each element in a group of similar features. Recommender Systems are widely used in many fields such as education, medicine, movie, music, e-commerce, TV programming, and Tourism to fulfill users' needs. In today's world, the recommender system technology can be categorized under the applications of artificial intelligence [2].

In this era, higher education institutions are facing several challenges such as a competitive education market, reductions in government funding, increases in student numbers, and a diversity of study fields. Despite all these issues, education leaders need to continue to maintain adequate and efficient student support services such as curriculum support, learning support, and career counseling [3]. The number of courses in the framework of smart education today has dramatically increased; thus, the corresponding course selection issue is playing a significant role in the process of modern learning [4]. Some researchers have found out that thousands of students all over the world face the challenge of choosing their most suitable University/college courses [5]. To help students select courses of their ability and interest, the Recommender Systems can be used. These save time by providing students with expert advice using their knowledge base component. Expanding the students' knowledge, acquiring experience, and increasing chances of success can be achieved by knowing the student's needs [6]. This study focuses on the recommender systems used in education to assist students who cannot make proper decisions in course selection.

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2. Understanding theory

2.1. Recommender Systems and their general applications

Recommender Systems are information search tools that have been proposed to solve information overload problems and help people to make decisions or remain informed about a particular topic [7]. In history, modern recommender systems appeared during the last decade of the 20th century and have proved their importance in solving information overload and content personalization in today's modern big-data world [1]. Recommender systems can be used in web recommendations based on web usage data. In recent times, there exist intelligent systems that correctly use both combined contents, and even structural information of the usable data. Websites have been developed and come out with superior results concerning web page recommendation issues faced by the users [8].

In online news websites, News Recommender Systems (NRS) make reading suggestions to users in a personalized way [9]. Movie recommendation systems such as "MovieLens," an online recommender system, are also used to recommend movies to users. After entering the site, the user is asked to rate certain movies he watched before, and then ratings are used to suggest other films to the user that he or she has not watched before [10]. Mobile users can now avoid information overload by using mobile application recommender systems to help them in selecting the best and trusted mobile applications [11]. Besides, people can now decide which jobs to take up using job recommendation systems. Most of the time, some employees face difficulties in choosing the right positions. Some researchers have considered the above problem of matching a user with a job and developed a recommendation approach to recommend workers to the right jobs [12]. RS benefits banking sectors by bringing about loyalty among customers as there are numerous sources for banking products and also saves the banks the expense of attracting new customers for each product [13]. However, system designers or companies that wish to employ Recommender Systems must choose between many approaches, which approach suits them [7]. Various approaches to recommender systems are discussed below.

2.2. Classification of Recommender Systems

Generally, Recommender Systems are classified according to the methods they use. These methods are grouped into four major broad categories. The basic models work with two types of data for their prediction process, i.e., 1) User-item interactions, e.g., ratings or user behavior, and 2) Users-items attribute information like textual profiles or relevant keywords. Besides, Techniques in Recommender Systems are also graded in two groups, that is, memory-based and model-based algorithms. In this manner, Memory-based algorithms work on the overall user-item rating matrix. In contrast, model-based techniques work by using the rating data to train a model which model is then used to produce recommendations. The different types of recommendation approaches or methods are briefly discussed below:

2.2.1. Collaborative Filtering (CF) methods. CF is among the commonly used recommendation methods. It deals with recommending items to target users by identifying users with similar interests. This approach aims at helping users to obtain the appropriate recommendations via individuals or groups with the same preferences or behaviors.

2.2.2. Content-Based (CB) methods. This content-based approach recommends items to users based on their historical data. For example, before recommending to the user, the approach first learns the products the user has searched and bought before to suggest related items. Rating is a powerful attribute used in this method. It is more likely to be applied in fields of commerce, information, and education [14].

2.2.3. Knowledge-based recommender methods. These are recommender methods that are used to guide users to make the right decisions when buying items whose item domains tend to be complex in terms of their various properties. The user may only be interested in an object with specific features like car

model, engine type, and interior house design. In some business situations where items are not bought at a high demand because of their high prices, it is challenging to find ratings to rely on for a recommendation. Therefore, these methods can be used since they work well in cold-start situations.

2.2.4. Hybrid recommender methods. These methods work by bringing together the strengths of different types of recommender systems. The objective is to create recommender systems with techniques that are more efficient and effective in performance [15].

2.3. Applications of Recommender Systems in education

In Higher Education, Recommender Systems can be significantly applied in many areas, as discussed below. E-Learning RS: Recommender Systems can be applied in e-learning today to generate relevant materials to learners due to an increase in online learning resources [16]. Library service RS: These can be used in the University education library websites to help students, readers, and researchers to easily find appropriate books according to their faculties and book categories [17]. Research and publications field RS: New ideas make a profound impact on our daily lives. Some designers have come up with publication recommender systems that can recommend suitable journals and conferences to authors [18]. Faculty RS: In Institutes of higher education, Faculty Recommender Systems can be applied to recommend faculties to the students, management, lecturers, and other workers in institutions [19].

3. Course selection

Decision making plays a significant role in students' academic life. The decision the student takes about which course to major in, in his/her university studies, may determine their future. However, there are several factors, both individual and course factors that may lead students to choose the courses they want to enroll in when joining institutions of higher education. The factors include; 1) Future career goal, most students choose courses because it's the field they desire to work in after their studies. 2) Simplicity, some students may choose a course just because it is not difficult and so they can quickly get good grades without stress. 3) Personal interest, others choose courses related to topics which they want to learn. 4) Social status, some students prefer to select courses that their friends have chosen, for purposes of doing assignments together and sharing ideas. 5) University's examination protocol, some students do not like majors whose result is determined by their performance in written exams, so they opt for courses where assignments and classroom exercises count towards the final mark. 6) Timetable schedule, some students choose and or do not choose courses because of the timetable. 7) Lecturers' conduct, some students may choose courses because the department has excellent lecturers .8) Course format, some students also mind about the number of course units or the number of lectures per week and organizational course features. Below is a simple structure to explain how course selection is influenced by different factors briefly.

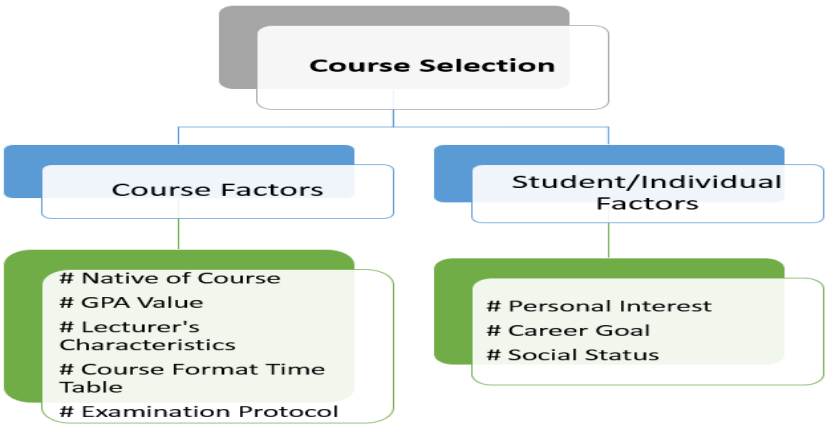

Figure 1. Factors influencing course selection.

All the factors mentioned above vary from student to student while joining higher education. Students usually run for the first options in their minds. Although some students may be successful in choosing their careers without guidance, it is also possible that others may end up making wrong choices because of following some of the above factors. Due to a change in demand for skills in the job market and increased development in the social economy today, it is therefore very essential for graduates to begin their job search with enough skills and potential. However, to attain these excellent skills is not a one-day simple task; it is a long process gain achieved from the student's study life. It is, therefore, essential which course the student chooses to major in.

3.1. Challenges facing students in course selection

Despite the great importance of selecting the right course, most students are facing a lot of problems when it comes to deciding which course to choose. This problem is also partially due to many courses existing in universities today, which confuses students. Due to digitalization, most universities open their admissions online, and the student is required to apply online. Within this process, the students have no guidance and yet, have inadequate knowledge about the courses. Besides, some of the existing course selection procedures and instructions are given by the universities cannot meet the students' needs [20]. Yet, course selection is an essential part of the successful completion of their studies.

3.2. Using Recommender Systems in course selection

Course Recommender systems are computer programs designed by experts considering general details, backgrounds, and aptitudes of students to help students find their corresponding study fields. When joining institutions of higher education, students are always unable to make the right decisions by themselves about which courses to choose. However, these students still have the fields they are interested in, but because they have inadequate information about them, they stay confused. In this manner, therefore, recommender systems could be a better advisory tool to help students to make informed course selections. These expert systems can apply data mining techniques to students' data and discover the relationship between courses selected by students. The experience of graduates can be used to find out exciting results and which can then be used by the Recommender System to recommend the most appropriate courses to new students [21].

3.3. Common Recommendation approaches used in education for course selection

Designers have proposed several approaches for course recommendations in higher education. Before employing recommender systems, users must first know the kind of advice they want these systems to generate. Some recommender systems aim at creating all viable suggestions while others aim at giving a few but accurate results. Table 1 summarizes the reviewed articles, which applied recommendation approaches for course selection.

Table 1. Research papers that used recommender approaches for course selection.

Recommendation Approach	Reference
Hybrid Recommendation	[22-25]
Knowledge-Based Recommendation	[5]
Content-Based Recommender methods	[18,26]
Collaborative filtering (CF)	[12,19,27-30]

3.4. The advantage of Using Recommender Systems in course selection

Course recommender systems are very advantageous in many ways. First, they give relevant results, i.e., using Recommender Systems for course selection such as CB methods. The system will give results that are highly relevant as they rely on characteristics similarity and are highly relevant to the student's unique future job interests. Second, they give clear results; The process of generating any recommendation can be transparent, and this increases students' trust in their recommendations. Third, the system allows students to discover their skills, helps lecturers to understand education trends, and

also helps future employers to recruit future workers. Last, Institutions of Higher education are also provided with an encouragement to offer courses associated with the job market, thus keeping the standards and value of institutions. In addition to that, the Recommendation System benefit lecturers by easing the process of finding suitable materials for online course preparation.

4. Conclusion

This paper was aimed to review the recommender systems used in higher education by students for course selection. Several recommendation approaches, such as content-based, collaborative filtering, hybrid recommendation approach, and content-based approaches, were all found out to have ever been used at one time for course selection. However, the Hybrid recommendation approach was concluded to be the best approach that can be used by students for effective course selection. This approach combines all the strengths of all other approaches to make a powerful approach that can give excellent recommendations. This can help students to reach their career goals successfully.

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