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A Comprehensive Review of Relevant Techniques used in Course Recommendation System.

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Abstract - *Through a variety of internet venues, there has been a significant increase in online learning tools in recent years, and COVID lockdown was the cherry on top, making us more web friendly for learning things through the web, therefore defining a course recommendation system has never been more important. Course recommendation systems try to simplify the difficulty of identifying relevant courses based on ranking and set criteria. Despite all of the advantages, we encounter several difficulties and complexities, such as accuracy, time consumption, and insufficient data. This research examines online recommendation systems using a variety of methods, including Content-Based, Collaborative Filtering, Knowledge-Based, and Hybrid Systems. Datasets, methods, evaluation, and outputs were discovered to be necessary components during the research. And the proposed way of recommendation system in this paper will be highly beneficial in recommending courses to students.*

Keywords: - e-learning, content based, collaborative filtering, machine learning, online course recommendation

1. INTRODUCTION

Since evolution, Humans have been building things or machines that accomplish various tasks in very simple ways. There are concepts of learning and making others learn or train to make people or machines useful. Like, how we train any algorithm to carry out tasks that are performed naturally and effortlessly by machines as humans do. As, Machine Learning enables computers to think and decide on their own like humans do. This is to be one of the noteworthy and most significant developments in the field of computer science.

As we move toward a data-centric society, there has been a massive data explosion in recent years. And a large amount of data is meaningless unless it is analysed for hidden patterns. Machine learning approaches allow us to uncover hidden patterns and information about an issue that may be utilised to forecast the future and assist us in different decision-making processes. Learning has undergone a significant transition, moving from the conventional classroom to an online learning environment. Consequently, demonstrating a recommendation system for an online learning environment is a necessity of the hour. Similarly, high-speed internet encourages us to study over the internet; there are a variety of platforms selling a variety of courses, but advising which is most suited to one's personality will make the process go more smoothly. The concept of a recommender system arose from the idea that people rely on others to make routine decisions in their lives. The explosion in the volume and diversity of information available on the internet has aided the development of recommender systems, which has resulted in a rise in profit, user benefits, and industry applications. In order to locate relevant courses for the users, a recommendation technique must establish that a course needs to be suggested. The most common recommendation algorithm techniques are Content Based, Collaborative Filtering, and Hybrid Systems.

The popularity of E-learning has resulted in an abundance of courses, making it difficult to choose ones that are appropriate. In contrast to typical learning settings, E-learning allows for the personalization of the learning experience. Traditional learning often accommodates just one learning experience, because in a typical classroom setting, a teacher is frequently dealing with several pupils at the same time in the same area. As a result, each student is forced to get the identical course materials, regardless of their own requirements, traits, or preferences. Furthermore, determining the optimum learning technique for each learner and implementing it in a real classroom is exceedingly challenging for a teacher. One approach is to leverage recommender system (RS) approaches to personalise the learning process according to each learner's interests and goals.

This paper presents a comprehensive overview of current courses recommendation methodologies as well as machine learning algorithms employed in RS. In order to identify research contributions and limits, the emphasis is on creating categorizations of recommendation approaches, ML approaches, as well as methodologies employed, application domains, datasets, evaluation, and input/output data.

We used the queries "e-learning recommendation system," "course recommender," "online course recommendation system," "recommendation system," and "e-learning" to find relevant publications. We found 30 publications from journals that were relevant between 2018 and 2020. The availability of a recommendation system served as the sole selection criteria at this stage. 'E-learning,' 'course suggestion,' and 'aims' that addressed one of RS's remaining issues were the requirements for stage two (i.e., cold-start,

data sparsity etc.). Twenty articles were discarded since none of the stage-2 requirements were met. The final studies indicate an RS for e-learning system.

1.1 Inclusion and Exclusion criteria:

Papers were chosen for evaluation based on the following criteria:

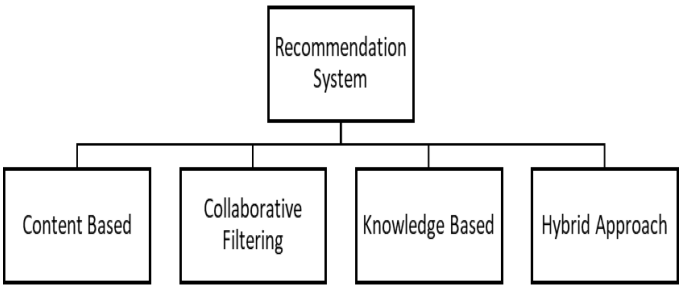
1. Papers presenting algorithms for online platform recommendation.
2. Publications outlining plans to use Machine Learning to develop RS.
3. Papers containing the outcomes of the technique's evaluation.

The following were used as exclusion criteria:

1. Papers to which full access was not granted;
2. Papers that lacked detailed discussion and appraisal of the issue were all eliminated;

2. BACKGROUND DETAILS

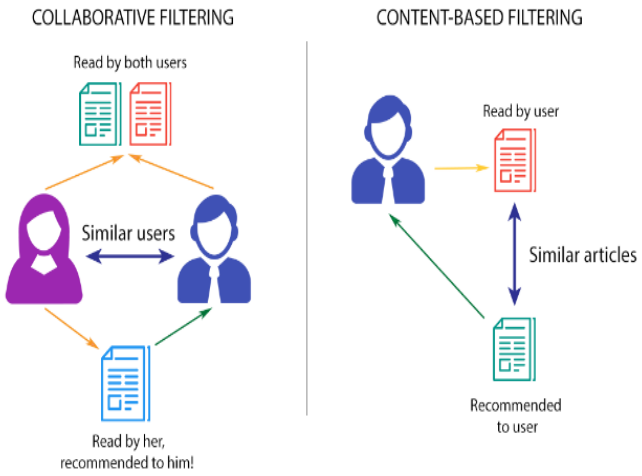
Online learning with virtual assistance is in increasing demand, and the ed-tech industry has taken full advantage. Personalizing quizzes, courses, and assessments for students makes the whole process more convenient, as it overcomes the dilemma of picking courses by defining our own criteria. As a response, researchers classified recommendation systems into four categories: CB, CF, knowledge-based, and hybrid. It is not, however, highly optimized, but there is still much opportunity for improvement.



Content Based: It is based on user's past activities and likes in order to recommend things. By categorizing items using particular keywords, content-based filtering aims to learn what the student like, search up those terms in the database, and then offer related courses. Two different sorts of data are employed in this filtering. First, the user's preferences, areas of interest, and personal data like age or, occasionally, history. The user vector is used to represent this data. Second, a subject-related piece of information is referred to as an item vector. The item vector includes all of the attributes that may be used to compare things to one another. Through Cosine Similarity, Recommendation would be determined. If 'A' is the user vector and 'B' is an item vector then cosine similarity is given by

$$cos(\theta) = \frac{A \cdot B}{\|A\| \, \|B\|} = \frac{\sum_i A_i B_i}{\sqrt{\sum_i A_i^2}\sqrt{\sum_i B_i^2}}$$

Collaborative Filtering: Recommendations are made in accordance with user behavior. The user's past is crucial. It is predicated on the idea that related users and projects may be prioritized. [1]. The CF system looks for courses that are comparable based on user feedback. User may provide explicit or implicit feedback, such as a numerical rating to reflect how much users valued a certain course, such as 1 for dislike and 5 for extremely like, or implicit, such as internet browsing history or reading time for a particular course. Memory-Based and Model Based algorithms are two forms of collaborative filtering algorithms. In the first, items and user data are saved in memory, and then calculations are used to provide estimates based on the data. The Bayesian network, rule-based, and clustering approaches are only a few of the ML algorithms that are used to build the model process.



Knowledge Based: A recommender system is considered to be knowledge-based when it delivers recommendations based on particular queries instead of a user's rating history. Context-based and ontology-based are two of the knowledge-based techniques.

Hybrid Model: Hybrid RS incorporates features of both CB and CF by combining individual forecasts into one, adding relevant data to the CF model, or generating final recommendations based on the collective ranks.

Recommender systems (RS) built on one of the aforementioned architectures, are prevalent in all recommenders, and serve as a baseline for addressing

specific recommendation tasks. They should be using ML techniques, and datasets, be susceptible to monitoring and feedback, have output, according to us. Each of these components is covered in further detail in the following sections.

2.1 Data Used

Data is gathered implicitly or explicitly by recommendation systems. Implicit data is raw data that may be divided into two types: those that are purposefully obtained from available data streams and those that are by-products of user activity and it might be utilized or not. Through registration forms and profile information are used to obtain as explicit data from users. They can also be obtained through internet user reviews.

3. RELATED WORKS

The major goal of classifying and categorizing previously completed work is to have a thorough knowledge of the recommender system's deployment in various domains. The purpose of this paper is to explain how course recommender systems have improved performance in the current day. The current research has been divided into four categories: Collaborative, CB, Hybrid Solutions, and Knowledge-Based.

3.1 Content- Based Research

Content-based recommendations are based on a user's previous choices, which are used to provide suggestions to other users who have similar likes and dislikes. It made use of historical student data to make predictions regarding learning materials. Using fuzzy clustering and decision trees, learners are categorized as beginner, intermediate, or master depending on their academic history and learning habits. The pattern discovered during categorization also reflects the amount of interest in taking specific courses.[4] Also, based on a set of rules in [5], Learners are presented with learning components and learning objects via adaptive user interface based on rules presented by author. The CB technique has the drawback of relying on previous user experience and being unable to offer fresh content, which may demotivate users and lead to an unwelcome restricted focus.

3.2. Collaborative Filtering Based Research

Collaborative filtering (CF) is a way of combining crowd consumption patterns to generate a mathematical model of all students and courses. To put it another way, it's a method of identifying a group of people who have similar tastes and filtering things based on the opinions of other users. By looking at their favorite themes and incorporating them into a categorized list of ideas, the approach gets over the limitations of content-based strategies. There are two strategies from the perspective of students and courses. The first, known as User-based CF, analyses all students data to identify comparable customers and anticipate their preferences for various courses, a process known as Social Recommendation. The second technique, known as Item-based CF, begins with course similarities, then analyses recent best-sellers and offers discounts to target customers. The Item Recommendation is what it's called. [3] The CF technique viewed lack of data as a major drawback. As it can commonly result in the cold start problem, which explains the difficulty of offering recommendations when the students or courses are fresh.

3.3. Knowledge Based Research

Knowledge-based recommendation systems offer recommendations based on information about students and courses. Knowledge-based suggestions aren't based on a student's rating, and they don't require any information about that user to make recommendations. To produce appropriate learning material from the web based on learners' needs, researchers utilized an Ontology-Based model with dependency ratios and parse trees. [7] It comprises several layers, methodologies, and algorithms that are not ideal for all sizes of e-learning systems, Recommendation System Content Based Collaborative Filtering Knowledge Based Hybrid Approach Consequently, the knowledge-based strategy is both time- and money-consuming.

3.4. Hybrid Model Based Research

A hybrid model framework based on three models was presented by the researchers: CF, Content-Based, and CF with a Self-Organizing map. The approach's main advantage was that it included all of the scores from all of the models, allowing you to take advantage of all of their advantages. Despite the fact that the technique takes longer to suggest than previous models, the accuracy and performance improvements were considerable. [6] The researcher designed a learner learning object predicted (LLOP) matrix and used collaborative filtering to choose the most acceptable learning objects. They then used the SPM method to identify the most often occurring sequence of learning objects in the matrix. [2]

The drawbacks of CB and CF are eliminated by this approach. Despite being more time consuming and more expensive, the hybrid procedure is now the best option because to all the benefits listed above.

Categories	Techniques	Drawbacks	Benefits
Content Based RC	Utilizes historical student data and provide predictions	Depends on the user's history.	Recommendations are very relevant and transparent.
Collaborative Filtering	Clustering similar users based on their similar likes and dislikes	Data sparsity, Cold start Problem	Student can get broader exposure to the courses.
Knowledge Based	Ontology based Models	Time Consuming, Expensive	It is not based on user rating
Hybrid Model	Combination of CB and CF	Time Consuming, Expensive	Overcome the disadvantages of CF and CB

Table 1. Shows techniques and Drawbacks

4. DISCUSSION, CHALLENGES AND ISSUES

We evaluated the methodologies and benefits addressed by researchers and classified the recommender systems reported in study. The issues of the categorized recommendation systems were then analyzed and graded as follows:

i. Cold Start issue: This problem is generally handled by freshman or courses. This problem develops due to a main lack of rating, which implies that a freshman may not have rated any items, or that any new item may not have been rated by any students. As a result, making the best recommendations in this circumstance is difficult.

ii. Data Sparsity: Due to the fact that active users only evaluated a tiny number of things, data sparsity refers to the difficulty in locating enough reliable similar users. It's tough to deliver an appropriate suggestion list to the target user if the learning item has a low rating. The learner does not rate existing learning items, resulting in data sparsity.

iii. Privacy: The privacy hazards of collecting and processing personal data, on the other hand, are frequently underestimated or neglected. Many users are unaware of if and how much of their data is gathered, whether or not it is sold to third parties, or how safely and for how long it is held.

4.1 Machine Learning Algorithms

Machine learning and Data Mining employ a variety of statistical approaches and techniques, as well as diverse algorithms such as classification models, clustering, and regression models, to extract insights from massive sets of data. It allows us to forecast the result based on previous events. Various fusions of data mining methods, such as classification and association rule algorithms, clustering and association rule algorithms, excreta were compared. were compared.

They compared the results and discovered that the optimal mixture includes Clustering, Classification, and Association Rule Algorithms.[8]

According to the research paper studied, clustering algorithms were the most popular, along with partitioning approaches such as k-means and k-nearest neighbour. Researchers evaluated several combinations of data mining techniques, including classification and association rule algorithms, clustering and association rule algorithms, integrating clustering and classification algorithms into an association rule algorithm, and solely association rule algorithms. [9]

Researchers discovered that the optimal combination is clustering with classification and an association rule approach.

In [10] researcher proposed a framework where clustering algorithm were applied to the dataset, and then frequent pattern mining algorithm applied which recommend the courses based on historical data.

4.2 In-depth analysis of chosen publications

We have provided brief information of the chosen publications in Table 2 below, including recommendation systems, technology employed, target user groups for whom the proposed RS was produced, nation of study, data used in the assessment of the RS, and the proposed system's application area.

It also demonstrates the programming language used in developing RS, with innovation-based learning systems as the primary application. The target demographics were schools, universities and their students. Foreign data was used by all systems to evaluate their systems.

References	RS System	Technology used	User group to be targeted	Area of application	Studying country	Data Collected
[1]	Optimized Collaborative Filtering based on text similarity	N/A	Universities and Colleges Students	Optimizing algorithm	China	Real world data
[2]	Learner learning objects recommendation (LLOR)	Sequential pattern mining	Students	Optimized learning algorithm	Saudi Arabia	Real world data
[3]	Online Course Multimedia Learning System (OCMLS)	MATLAB, Matrix	Students	Optimized learning path	Taiwan	Real world data
[4]	Personalized group-based recommendation system	PHP, Java and MySQL	Student, Academic Institutions	Web search in e-learning	Malaysia	Learning management System
[5]	Rule-based adaptive user interface	N/A	Students	Learning portal	India	Learning Management System
[6]	Hybrid model with CB, CF and CF with self-organizing map	Python	Students	Optimizing algorithm	Morocco	User's rating
[7]	Adaptable and personalised e-recommendation	PHP, HTML	Students	Web based learning portal	N/A	Data extracted from web searches
[8]	Combination of clustering with classification and association rule mining	N/A	Students	Optimizing algorithm	India	Learning Management System, i.e., Moodle
[9]	Customised clustering algorithm	N/A	Students	Optimizing algorithm	N/A	Real world data
[10]	Customised e-recommendation based on grades	N/A	Students	Web based learning	India	University databases, online registration form

Table 2. In-depth analyses of chosen journal articles

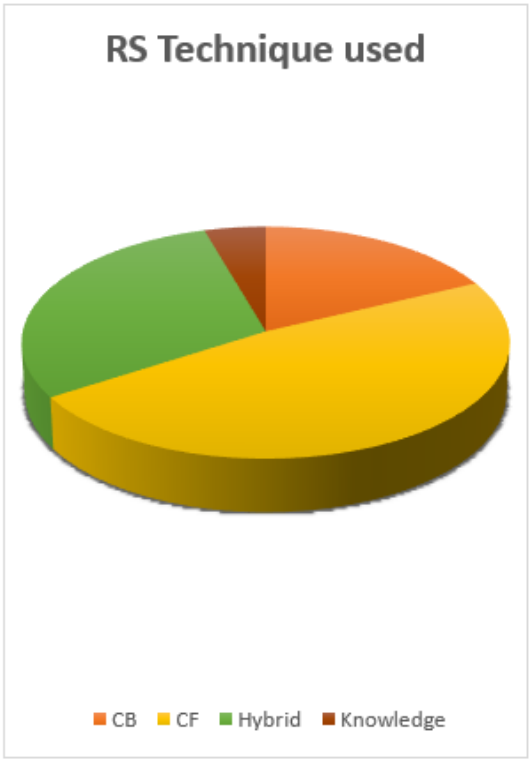


Fig. 2

Based on the search queries and research papers studied, fig. 2 demonstrates an assessment of the popularity of various RS approaches. CF approaches are utilised in roughly 48% of papers, whereas CB and Knowledge-based are used in around 18% and 14% of papers, respectively, and hybrid models are employed in around 20% of papers, despite their significant benefits.

6. CONCLUSIONS AND FUTURE WORKS

The fulfilment of personalised educational resource recommendations has become the key challenge that has to be solved in intelligent education. This review is based on e-learning publications that deal with Recommendation System. This paper's key contribution is, different ML methods and a taxonomy of RS systems are presented, assessment measures, and insights into obstacles and concerns that need to be considered in future study. This study found that CF is a common recommendation strategy in e-learning, with the majority of studies seeking to increase suggestion quality.

Hybrid approaches provide a competitive advantage over the other four strategies, but their popularity is modest.

Personalization and adaptive user interface have become important features in e-learning as it will be engaging and interesting to learn through the web, and the research obtained from the exploratory study reported that learners in group four benefited the most from the individualized recommendation links provided by the personalised web-based system. [4] They had much superior learning comprehension than the other three groups since they had more Web search experiences.

Data sparsity and latency are major challenges that still need to be addressed with RS, as well as privacy and shilling threats. The hybrid model has been proved to tackle the majority of contemporary system issues. Furthermore, much research is necessary to improve user confidence and facets of user engagement.

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