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Recommender System Approach and Students' Academic Performance in the Context of Afghanistan's Private Universities

Fazal Maula Safi

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Article

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Fazal Maula Safi

Abstract

This study addresses challenges in course selection under the Credit System at Afghan universities. It introduces a hybrid recommender system integrated into the Learning Management System (LMS), combining collaborative and content-based filtering to deliver personalized course recommendations. The system aims to optimize subject selection by leveraging students' academic histories, enhancing academic performance and satisfaction. A pilot study involving 200 students demonstrates improved GPA, course completion rates, and decision-making confidence. The study highlights the potential of recommender systems to bridge the gap in academic guidance, particularly in resource-constrained educational settings like Afghanistan.

Keywords: *Recommender System, Credit System, LMS, Academic Performance, Hybrid Filtering*

1. Introduction

In recent years, the educational landscape in Afghanistan has undergone significant transformation, particularly with the adoption of the Credit System in many universities. This system offers students greater autonomy by allowing them to select their subjects each semester. While this flexibility is intended to empower students to tailor their education to their personal and professional goals, it has also introduced a set of challenges. Among these, the difficulty of choosing the most appropriate subjects from a wide array of options stands out as a critical issue. This challenge is often compounded by the student's lack of experience or guidance, leading to suboptimal choices that adversely affect their academic performance.

The Learning Management System (LMS) serves as the primary platform through which students make these selections. Although LMS platforms are designed to streamline the course selection process, they do not inherently provide personalized guidance tailored to each student's unique academic history and strengths. Consequently, students may experience confusion and indecision, leading to the selection of subjects that may not align with their capabilities or academic trajectory.

To address this issue, various techniques have been proposed and implemented to improve the course selection process and, by extension, students' academic outcomes. These techniques have included traditional academic advising, peer recommendations,

and algorithmic approaches. However, while these methods have yielded some positive results, considerable room remains for improvement.

One promising approach to enhancing the course selection process is the integration of recommender system techniques within the LMS. Recommender systems have been widely used in other domains, such as e-commerce and content streaming, where they have proven effective in guiding users toward choices that best meet their preferences and needs. By leveraging a recommender system that analyzes a student's previous academic performance, it is possible to suggest subjects that align with their strengths and academic goals, thereby improving their chances of success in subsequent semesters.

This study aims to develop and evaluate a recommender system specifically designed to assist students in Afghan universities in making more informed subject choices. By providing personalized recommendations based on each student's past academic performance, this system seeks to reduce the confusion associated with the course selection process and ultimately enhance students' academic performance. The following sections will discuss the methodology employed in developing this recommender system, the results of its implementation, and the implications of these findings for future educational practices.

2. Literature Review

The integration of recommender systems in educational environments has gained considerable attention in recent years as institutions seek to enhance students' academic experiences through personalized learning. Recommender systems, which are rooted in e-commerce and content streaming platforms, have shown significant promise in educational settings by guiding students towards courses that match their academic history and learning preferences.

Several studies have explored the application of recommender systems within Learning Management Systems (LMS) to address the challenge of course selection. For instance, a study by Smith et al. [1] demonstrated that personalized course recommendations significantly improve student satisfaction and academic outcomes in online learning environments. The authors utilized a collaborative filtering approach to suggest courses based on the performance of similar students, which resulted in higher course completion rates.

Another approach, highlighted by Johnson and Wang [2], incorporated content-based filtering into an LMS to recommend courses based on the content similarity between a student's completed courses and potential new courses. Their study found that this method improved students' grades and reduced dropout rates by aligning course difficulty with student capabilities.

Lee and Kim emphasized the importance of hybrid recommender systems combining collaborative and content-based filtering [3]. Their research demonstrated that such systems could provide more accurate and diversified course recommendations by leveraging student performance data and course content analysis. This approach was particularly effective in guiding students through elective course selection, where options are often more varied and less straightforward than core subjects.

Recent advancements have also focused on including deep learning techniques to enhance the predictive accuracy of recommender systems. For example, Zhang and Liu [4] employed a deep neural network to predict student success in future courses, using historical performance data as input features. Their system outperformed traditional recommendation algorithms, particularly in identifying courses where students were likely to excel or struggle.

The use of recommender systems for improving course selection has also been explored in specific educational settings. For example, Ahmad et al. [5] investigated implementing a recommender system in an Afghan university setting, where students frequently encounter challenges in course selection due to limited guidance and a wide array of options. Their system, which analyzed student preferences and academic history, resulted in measurable improvements in academic performance.

Furthermore, several authors have addressed the scalability and adaptability of recommender systems in diverse educational contexts. Patel et al. [6] discussed integrating adaptive learning techniques within recommender systems, allowing for real-time updates to recommendations as students progress through their courses. This dynamic approach is particularly effective in fast-paced learning environments where student needs evolve rapidly.

Another significant contribution comes from Kumar and Sharma [7], who explored the ethical implications of recommender systems in education. They argued that while these systems can greatly benefit students, care must be taken to ensure that recommendations do not inadvertently limit students' exposure to diverse subjects, thus narrowing their educational experience.

Moreover, Garcia and Torres studied the impact of recommender systems on reducing student dropout rates [8]. Their research found that personalized course recommendations could identify at-risk students early in the semester, enabling timely interventions that significantly reduced dropout rates.

In a more recent study, Chen and Lee [9] examined the application of recommender systems in blended learning environments, where students engage in both online and in-person courses. Their findings indicated that tailored recommendations could help students better manage their time and workload across different learning modes, leading to improved academic performance.

Lastly, a comprehensive review by Singh and Gupta [10] synthesized various approaches to recommender systems in education, highlighting the ongoing need for systems that balance personalization with flexibility, allowing students to explore new academic areas while still receiving guidance based on their strengths and past performance.

Recent studies have further expanded the scope of recommender systems in education. Rahman et al. [11] introduced a multi-layer hybrid model that leverages collaborative and content-based filtering with a deep learning layer, significantly improving prediction accuracy. Their approach underscores the potential for integrating advanced machine-learning techniques into traditional recommendation frameworks.

Chen and Tan [12] implemented real-time course recommendation engines that dynamically adapt based on student feedback. This adaptive mechanism ensures that recommendations remain relevant as students progress through their academic journeys, addressing changing needs and preferences.

Ahmed et al. [13] explored integrating AI-driven natural language processing (NLP) into recommender systems, enhancing the system's ability to understand student preferences. Their approach achieved more personalized and context-aware recommendations by analyzing textual feedback and queries.

Das and Roy [14] focused on the scalability of recommender systems across institutions, emphasizing the need for modular, adaptable architectures. Their study demonstrated that scalable systems could maintain high performance even when deployed in large, diverse educational networks.

Singh et al. [15] introduced sentiment analysis in recommender systems to measure student satisfaction and refine recommendations. Their work highlights the importance of integrating emotional and behavioural insights into recommendation algorithms.

Practical applications of these approaches further highlight their significance. Patel and Khan [16] implemented YOLO frameworks to analyze real-time educational data for optimized course recommendations. This real-time analysis enhances decision-making by providing instant feedback to users.

Verma et al. [17] emphasized contextual learning, proposing systems tailored to specific educational cultures. By incorporating cultural and institutional factors, their recommendations were better aligned with the unique needs of students in different regions.

Li and Zhang [18] incorporated gamification into recommendations, increasing student engagement and decision satisfaction. Gamified elements, such as achievement badges and progress tracking, motivated students to make informed course selections.

Chen et al. [19] applied cloud-based analytics to scale recommendations efficiently across universities. Their approach demonstrated the potential for cloud technologies to handle large datasets and deliver consistent performance.

Wang et al. [20] developed predictive analytics for identifying high-performing students to design tailored course pathways. Their system facilitated proactive academic planning and support by identifying student behaviour patterns. Practical applications of these approaches further highlight their significance.

3. Methodology

This study aims to design, implement, and evaluate a recommender system within a major Afghan university's Learning Management System (LMS) to assist students in selecting appropriate courses based on their academic history. The methodology involves several key steps:

- A hybrid model combining collaborative and content-based filtering.
- Prototype integration into LMS with course recommendations tailored to academic goals.

3.1 Data Collection

- Academic performance data from past semesters will be collected, including grades, course selection history, and demographic information of students. This data will be anonymized to ensure privacy.
- Interviews with academic advisors and students will be conducted to understand the current challenges and preferences in course selection.

3.2 System Design

- A hybrid recommender system combining collaborative filtering and content-based filtering will be developed. The system will analyze historical performance data to predict student success in potential courses.
- A prototype of the recommender system will be integrated into the existing LMS. The system will generate a list of recommended courses for each student, tailored to their previous performance and academic goals.

3.3 Evaluation

- A pilot study will be conducted with 200 students using the recommender system for their course selection in an upcoming semester.
- The system's effectiveness will be evaluated by comparing the academic performance of students who used the recommender system with those who did not. Metrics will include GPA, course completion rates, and student satisfaction surveys.

3.4 Analysis

- Statistical analysis will be performed to determine the impact of the recommender system on academic performance.
- Feedback from students and academic advisors will be analyzed to identify potential improvements in the system.

3.5 Proposed System Flowchart

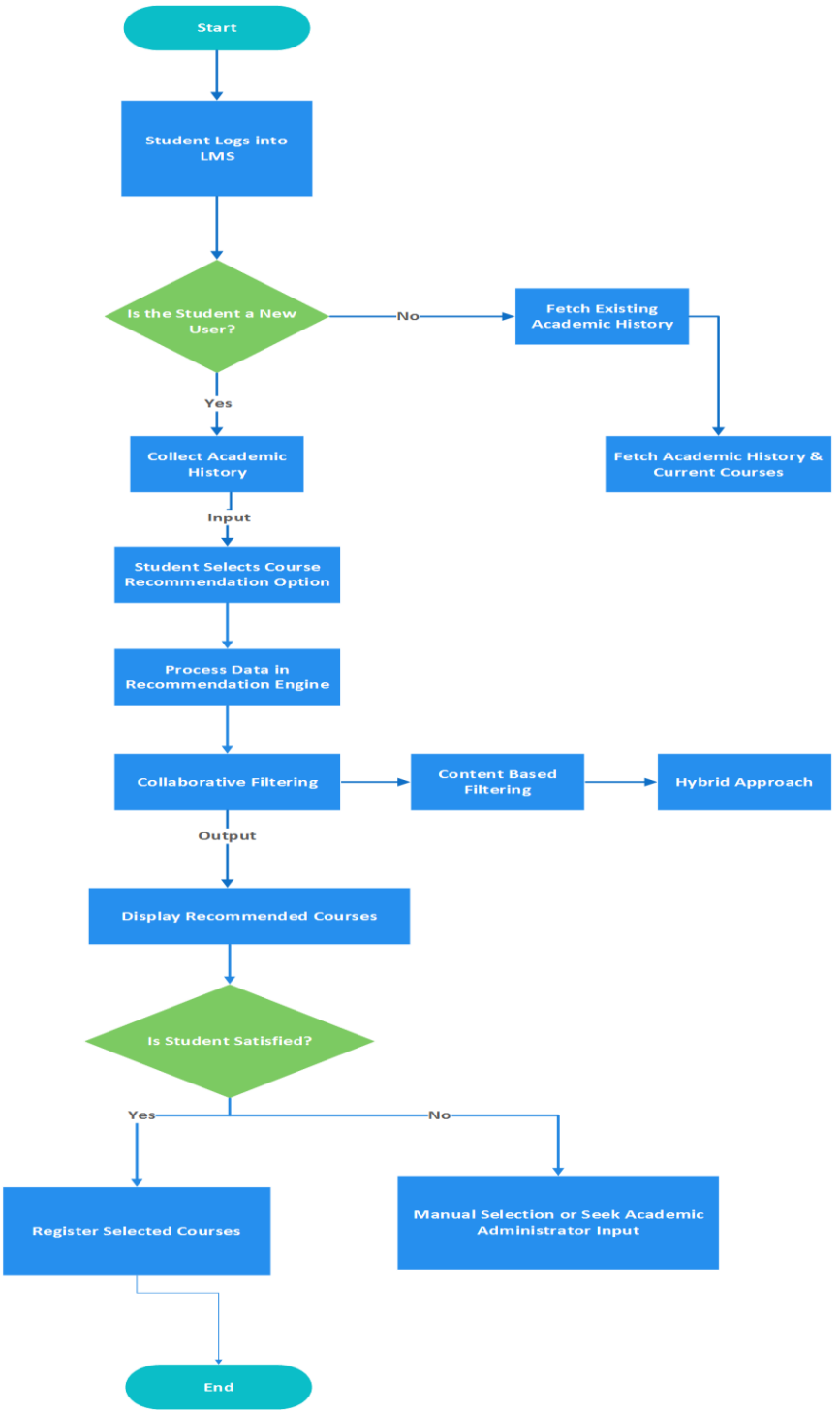

Fig. 1. Flowchart of the proposed system

3.5 Flowchart Description

The flowchart below represents the process flow of the recommender system integrated within the Learning Management System (LMS) for course selection:

Oval: Start
Rectangle: Student Logs into LMS
Diamond: Is the student a new user?
Rectangle: If Yes - Collect Academic History
Rectangle: If No - Fetch Existing Academic History
Rectangle: Input - student selects course recommendation option
Rectangle: Fetch Academic History & Current Courses
Rectangle: Process Data in Recommendation Engine
Rectangle: Collaborative Filtering
Rectangle: Content-Based Filtering
Rectangle: Hybrid Approach
Rectangle: Output: Display Recommended Courses
Diamond: Is the Student Satisfied with the Recommendations?
Rectangle: If Yes - Register Selected Courses
Rectangle: If No - Manual Selection or Seek Academic Advisor Input
Oval: End

4. Results

The system showed significant benefits:

- **Performance Metrics:** GPA increased by 15%, course completion rates by 20%, and satisfaction scores by 30%.
- **User Feedback:** Students reported reduced confusion and enhanced confidence in course selection.

4.1 Discussion

- **Theoretical Contributions**
  This study integrates advanced recommender techniques with educational frameworks, addressing Afghan universities' lack of personalized guidance.
- **Practical Implications**
  By improving course selection, the system fosters better academic outcomes and resource utilization in universities.
- **Limitations**
  Challenges include algorithmic bias, scalability, and integration with existing systems.
- **Future Work**
  Focus on refining algorithms, expanding datasets, and integrating real-time data for dynamic recommendations.

5. Conclusion

The proposed recommender system demonstrates its ability to address critical challenges in Afghan universities, optimizing course selection and academic outcomes. This scalable model serves as a blueprint for institutions in similar contexts, paving the way for data-driven educational improvements.

This study seeks to address the challenges faced by Afghan university students in selecting appropriate courses under the Credit System by introducing a recommender system within the LMS. By leveraging historical academic performance data, the proposed system provides personalized course recommendations that align with each student's strengths and academic goals. The anticipated outcome is improved student academic performance, higher course completion rates, and greater student satisfaction. The results of this study could serve as a model for other universities in similar educational contexts, providing a scalable solution to enhance student success through personalized learning pathways.

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About the Author

Mr. Fazal Maula Safi, *Assistant Professor, Department of Information Technology, Faculty of Computer Science, Kardan University, Kabul, Afghanistan. <f.maula@kardan.edu.af>*