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AI-Driven Zero-Shot Learning for Personalized Student Course Recommendations

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A B S T R A C T

Selecting the correct course is an important milestone in determining the future career of a student. Nevertheless, most students tend to select courses that are not suitable to their aptitude, interest, or attitude, resulting in confusion, course drop-out, and uncertainty of their career. In an effort to correct this situation, the Student Course Selection Support System will attempt to lead students to courses that are actually suitable for their abilities and interests. Instead of following intuition or pressure from others, this system will make recommendations based on a student's inherent interest and psychological predisposition. By doing so, it will lead students to make the right choice, and their career paths will be determined by interest and suitability, not speculation.

Keywords: Course, Decision Support, Zero Shot

1. Introduction

Psychology plays a significant role in decision-making, particularly in choosing one's career of a lifetime. Based on the psychological reaction of a student to a series of situations, the Student Course Selection System or the Course Recommendation System recommends courses that align with their strengths and interests. In today's competitive age, making good academic decisions has become more important than ever. This chapter presents the relevance of a course recommendation system and provides an overview of its research goals in steering students in the right direction towards academic and career aspirations. In today's world where students are exposed to lot of options and career choices, it is very crucial to have a system like Course Recommender, that will guide students by analysing their interest and aptitude. Following is the need for such a system:

- **Better Course Selection:** By connecting course recommendations to students' abilities and interests, recommender systems enhance satisfaction and academic achievement.
- **Efficiency:** Students save valuable time by being provided with personalized course recommendations rather than searching through large course catalogues.
- **Multidisciplinary Learning Paths:** Students discover interdisciplinary or non-traditional courses that suit their special career goals and learning style.
- **Fewer Dropouts:** By allowing students to select courses that best suit their interests and abilities, recommender systems reduce dropouts due to poor course fit or disengagement.

2. Literature Review

(da Silva et al., 2023) provides an extensive analysis of the current state of educational recommender systems (ERS). The authors conducted a systematic literature review (SLR) of 16 primary studies published between 2015 and 2020, focusing on how recommendations are produced, evaluated, and the limitations and opportunities for future research in the field. The review highlights that hybrid approaches are the predominant method for generating recommendations, while the evaluation of these systems primarily centres on accuracy, with fewer studies addressing their pedagogical effectiveness. This indicates a significant gap in understanding the impact of ERS on learning outcomes, suggesting a need for multidimensional evaluation frameworks that encompass both technical performance and educational effectiveness. The authors also identify various challenges faced by ERS, including the alignment of user expectations with system recommendations, the diversity of learners' needs, and common technical issues such as

cold start and data sparsity. These challenges complicate the design of effective recommender systems tailored to individual learning preferences. Overall, the paper underscores the importance of advancing research in ERS to enhance personalized learning experiences. It calls for more comprehensive studies that explore the interplay between recommendation techniques, evaluation methods, and their implications for teaching and learning. The findings aim to guide researchers and practitioners in addressing existing limitations and leveraging opportunities for future advancements in educational technology.

(Majjate et al., 2024) proposed intelligent recommendation system leverages AI to enhance academic advising by analysing student records and providing personalized study plans. It addresses the challenges posed by the explosive growth of educational data and the limitations of traditional counselling methods. The system consists of two main modules: a recommendation module that suggests universities based on students' interests and profiles using popularity-based and content-based recommendations, and a prediction module that uses the Huber Regressor model to calculate the likelihood of admission. Developed using data from 500 graduates across 12 public high schools in Morocco, the system demonstrates high predictive accuracy and reduces the need for direct counsellor interaction, making counselling more accessible through a user-friendly web interface. The AI-powered system significantly enhances educational counselling by offering personalized recommendations and high predictive accuracy for university admissions. It provides tailored guidance aligning with students' academic strengths and interests, addressing the challenges of limited resources and lack of personalized support in traditional counselling. However, the system relies on historical data, which may not fully capture the dynamic nature of university admissions, necessitating continuous updates to data and algorithms. Despite these limitations, the study advocates for adopting AI in educational counselling to improve decision-making for students, with further research needed to refine AI models and explore ethical considerations in education.

The article (Li & Kim, 2021) discusses the development of a novel deep learning-based course recommender system (DECOR) aimed at enhancing online education, particularly in the context of the increased demand for online learning platforms due to the COVID-19 pandemic. The authors highlight the challenges users face in selecting courses from a vast array of online educational resources, primarily due to information overload and the limitations of traditional recommendation systems, such as Collaborative Filtering (CF). These traditional systems often struggle with data sparsity and cold-start problems, making it difficult to provide personalized recommendations. The DECOR model is designed to address these issues by effectively capturing high-level user behaviours and course attributes. It integrates user behaviour features and course attribute information through a modular approach, comprising a User Behaviour Extraction (UBE) module, a Course Attribute Extraction (CAE) module, and a Preference Information Regression (PIR) module. This structure allows the system to provide more accurate and relevant course recommendations tailored to individual users' needs. Experiments conducted using real-world datasets demonstrate that the DECOR model outperforms traditional recommendation methods, showcasing its ability to reduce information overload and enhance the learning experience. The study emphasizes the importance of leveraging deep learning techniques to improve the effectiveness of course recommender systems, ultimately aiming to facilitate better educational outcomes for users navigating the increasingly complex landscape of online courses. The findings contribute to the growing field of educational technology, offering insights into how advanced AI methods can support personalized learning.

The paper (Cha et al., 2024) explores how artificial intelligence (AI) can enhance the course-selection process for university students. The authors, Seungeon Cha, Martin Loeser, and Kyoungwon Seo, emphasize the importance of effective course selection, which significantly influences students' academic and career trajectories. The study employs a novel research method called "speed dating with storyboards" to gather insights from 24 students about their expectations of AI-based course-recommender systems (CRS). The findings reveal that students anticipate these systems to assist them primarily during the search phase by streamlining the process of finding relevant courses. In contrast, during the evaluation phase, students expect the CRS to take a more dominant role, providing benchmarks to help them assess course suitability and value. The authors highlight the limitations of traditional data-driven recommendation algorithms, which may lead to issues like filter bubbles and algorithmic bias. They advocate for the integration of advanced AI techniques, such as Large Language Models (LLMs), to create more adaptive and context-aware recommendations that align with students' evolving needs. The paper concludes by stressing the necessity for AI-based CRSs to support meaningful collaboration between students and AI, ensuring that the systems are user-centered and effectively enhance the course-selection decision-making process. The insights gained from this research aim to inform the development of more effective AI-based educational tools that can better meet the diverse needs of students in higher education.

(*An Intelligent Recommendation System for Automating Academic Advising Based on Curriculum Analysis and Performance Modeling*, n.d.) proposed AI-powered academic guidance and counselling system aims to address the limitations of traditional counselling methods by providing personalized, data-driven recommendations for high school seniors. By leveraging AI techniques such as popularity-based and content-based recommendations, as well as the Huber Regressor model for predicting university admission likelihood, the system offers tailored advice based on students' academic histories and preferences. The system was developed using data from 500 graduates across 12 public high schools in Morocco, with a focus on admission criteria from 31 institutions, and it significantly enhances the counselling process by offering high predictive accuracy and reducing the need for direct counsellor interaction. While the AI system provides valuable, personalized guidance and makes educational counselling more accessible through its user-friendly web interface, it does have limitations. It relies on historical data, which may not fully capture the dynamic nature of university admissions and requires continuous updates to maintain effectiveness. Despite these challenges, the integration of AI into educational counselling has the potential to improve decision-making for students, enhancing their academic experiences and outcomes. Further research is necessary to refine AI models and address ethical considerations in their application within the educational sector.

The research paper (Hou et al., 2024) explains how the AI that is Artificial Intelligence is integrated in Psychology. The research paper mainly focuses on the area such as health diagnosis, cognitive assessment and behaviour prediction. Also, it tells the potential of AI in research by analysing complex

data and improving diagnostic tools. The research paper also tells the few drawbacks of AI in psychology which are model interpretability, bias and ethical concerns. It specifies the need of different methodologies, guidelines and stakeholder engagement to avoid risk. To sum up, the paper basically tells how AI plays a specific role in psychology and eventually dealing with its limitations and ensuring responsible use in the field.

3. Research Methodology

The superficial working of the Course Recommendation System can be explained with the help of below flow chart (Figure 1).

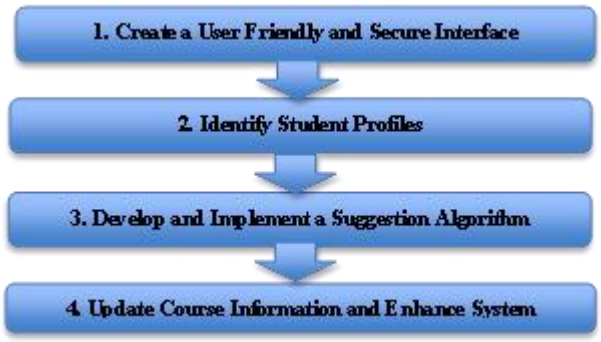

Figure 1: Outline of this research

The system is going to use LLM -Large Language Models which will help decision-making easy. LLM is a type of artificial intelligence algorithm that applies neural network techniques with lots of parameters to process and understand human languages or text using self-supervised learning techniques. The LLM used that will be used in this project is BERT by Google. Basically, the system would give certain situation that the student needs to answer based upon his or her aptitude, attitude and interest. The LLM would process the given input as per question asked using prompt engineering. Figure 1 shows various stages involved in proposed methodology Internal working of course recommender system with zero-shot is shown in figure 2.

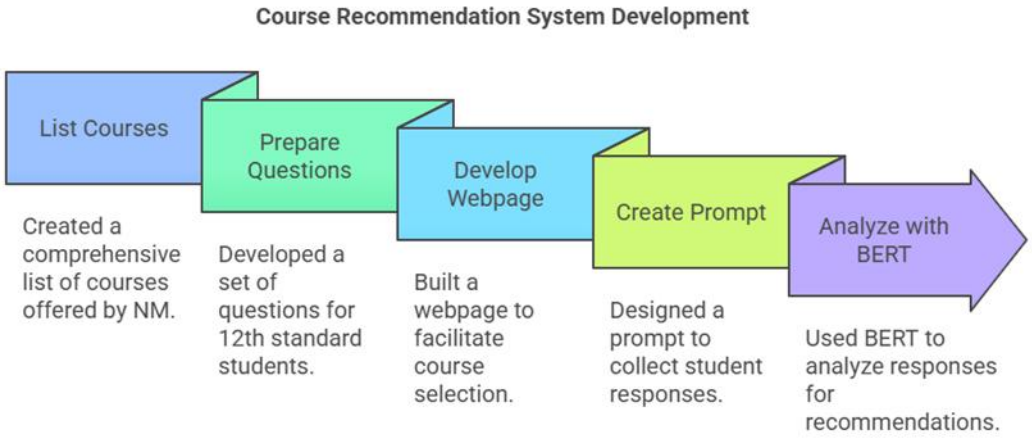

Figure 2: Course recommendation workflow.

1. List Courses
    - In this initial stage, all the courses offered by Narsee Monjee College of Commerce and Economics are collected and compiled in a excel sheet.
    - This excel is then converted into the CSV format for further use in coding.
2. Prepare a Questionnaire
    - Here, the questions that are to be asked to students are created.
    - Questions are formulated keeping in mind the key requirements for a particular course and this would help to identify the interest.
3. Develop Webpage

- Here, two webpages are being created. First one is the home page where the users are motivated to participate and answer the questions.
- Second webpage has the questionnaire with MCQs. Users are expected to select one of it and submit the response to get the recommendation.
- This is the user interface (UI) of the system.

4. Create Prompt
   - Prompts would help the BERT to give appropriate results.
   - Hence such short keywords (prompts) are being created.
5. Analyse with BERT
   - BERT, a LLM is trained for generating the results by analysing the CSV file created in stage 1.
   - Prompts are supplied to BERT by users when he responds and submits.

4. Implementation

For all this work, MERN stack development is used.

- The sample dataset used to feed BERT is shown in Table 1
- The backend that includes the training BERT, giving recommendation according to response is done using Express. Express provides the backend framework.
- The frontend part will be taken care by the React. It is a frontend library that provides JavaScript libraries for building user interfaces.

Table 1: Sample dataset

Course	Semester	Sr no	Course NAme	C ode	Attribute	Credits	Discipline
bscit	sem1	1	Programming Logic And Techniques	NHPLT101	MAJ	3	ITS
bscit	sem1	2	C Programming LAB	NHCPL107P	VSEC	1	ITS
bscit	sem1	3	Notion Of Operating Systems	NHNOS103	MAJ	3	ITS
bscit	sem1	4	Electronics And Communication Technology I	NHECT102	MIN	2	ITS
bscit	sem1	5	Electronics And Communication Technology I LAB	NHECT108P	VSEC	1	ITS
bscit	sem1	6	Discrete Mathematics	NHDSM109	VSEC	2	MAT
bscit	sem1	7	Cyber Crime And Laws	NHCCL104	OE	2	LAW
bscit	sem1	8	Digital Marketing	NHDMK106	OE	2	CMM
bscit	sem1	9	Orgnaizational Behaviour	NHORB105	OE	2	CMM
bscit	sem1	10	Communication Skills I	NHENG110	AEC	2	ENG
bscit	sem1	11	Environmental Studies	NHEVS114	VAC	2	EVS
bscit	sem1	12	Chanakya Neeti	NHCKN112	IKS	2	FC
bscit	sem1	13	Indian Knowledge Systems	NHIKS113	IKS	2	FC
bscit	sem2	14	Object Oriented Concepts	NHOOC151	MAJ	3	ITS
bscit	sem2	15	C++ Programming LAB	NHCPL157P	VSEC	1	ITS

5. Results

Figure 3 and presents implemented model of the course recommender system

Figure 3: Home screen

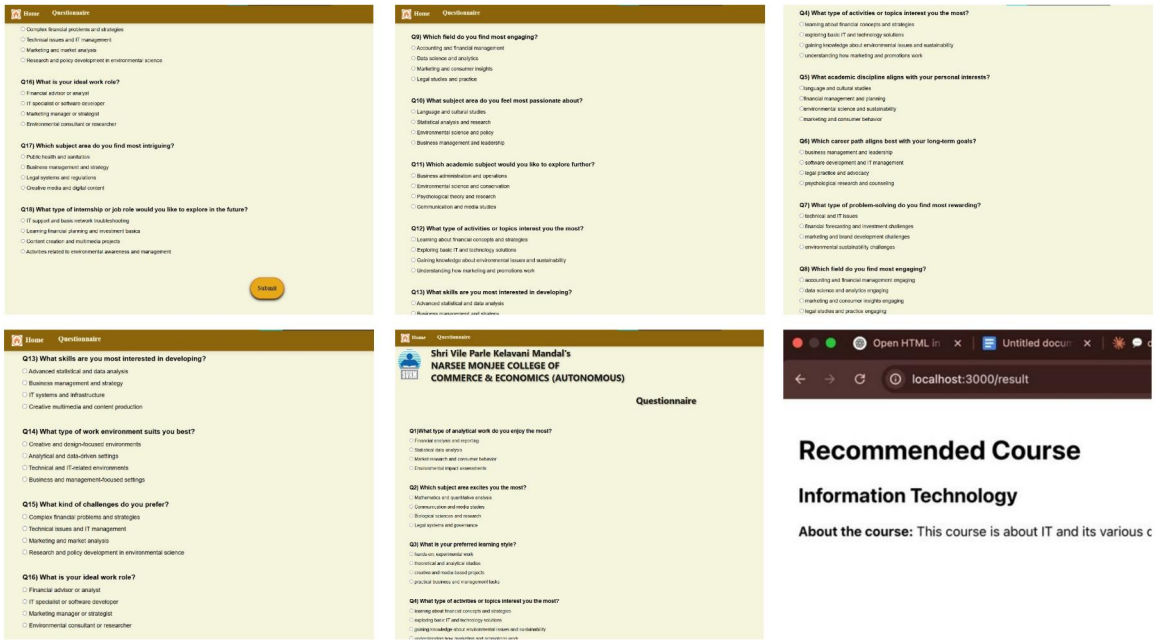

Figure 4: Questions and results

7. Conclusion

The proposed Course Recommendation System is a valuable community outreach project, which attempts to bridge the gap between students and well-informed career choices. With the integration of psychological insight and artificial intelligence, the system will suggest courses to students based on their interests, strengths, and future career goals. The project not only enhances educational attainment and satisfaction but also fosters community involvement by engaging students, parents, teachers, and career counsellors in positive discussion regarding future opportunities. The project seeks to reduce dropout rates, enhance student motivation, and create a more supportive learning environment, ultimately enabling students to make well-informed and confident career choices.

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