International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 12 Issue: 12 | Dec 2025 www.irjet.net p-ISSN: 2395-0072

ENGINEERING EDUCATION SUPPORT SYSTEM FOR ONLINE COURSE SELECTION USING PYTHON: A SUPERVISED LEARNING APPROACH

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Abstract - *Course selection plays a crucial role in determining a student's academic growth and career trajectory. Traditional manual selection processes often lack personalization, leading to confusion and misalignment of student skills with course requirements. This paper presents an intelligent Engineering Education Support System that uses supervised machine learning, specifically a Random Forest Classifier, to recommend suitable courses to engineering students. The system analyzes student attributes such as GPA, mathematical proficiency, coding skill, interest areas, academic stream, and career goals to generate ranked course recommendations. A Python-based Tk inter GUI ensures user-friendly interaction, while an SQLite backend maintains structured records for administrative analysis. Experimental results demonstrate that the model provides accurate, transparent, and personalized recommendations. The system addresses critical challenges in engineering education by enhancing decision-making, reducing selection errors, and supporting digital academic planning.*

Key Words: Machine Learning, Course Recommendation System, Random Forest, Python, Tk inter GUI, Educational Data Mining, SQLite

1. INTRODUCTION

Course selection in engineering education has become increasingly complex due to diversified electives, interdisciplinary learning pathways, and evolving skill requirements. Students often rely on informal advice or incomplete information, resulting in suboptimal course choices. With the rise of data-driven academic systems and AI-assisted learning tools, there is a strong need for an intelligent, automated support mechanism that assists students in making informed academic decisions.

This study proposes a Python-based recommendation system that uses machine learning techniques to analyze student profiles and recommend appropriate courses. The system is equipped with graphical user interface (GUI) and database storage to ensure transparency, accessibility, and long-term usability. The model leverages historical training data to identify patterns and generate ranked course recommendations, providing students with multiple suitable options and reducing uncertainty in the decision-making process.

2. LITERATURE REVIEW

The growth of online learning platforms and MOOCs has created a strong need for intelligent course-selection support systems. Traditional advising often lacks personalization, clear prerequisite guidance, and structured pathways, leading to poor decision-making among learners.

Hour et al. [1] highlighted major challenges in MOOCs, including unclear prerequisites and information overload. Jena et al. [2] showed that students struggle to match their skills and interests to suitable courses, and that collaborative filtering improves recommendations but suffers from sparsely and cold-start issues.

Content- based models, though widely used, lack adaptability. Wang et al. [3] demonstrated that they often miss semantic relationships between concepts. To address this, Altars et al. [4] introduced Concept GCN, a graph-based model that integrates semantic and behavioral data for improved accuracy.

Prerequisite- and sequence-aware models also enhance decision-making. Chanaa and El Faddily [5] proposed a prerequisite-matching framework, while Wong [6] developed a sequence-based planner using historical enrollment patterns. Khan [7] showed that session-based methods capture temporal learning behavior and improve short-term recommendations.

Overall, literature trends show a shift toward hybrid, semantic, and context-aware models that overcome limitations of traditional content-based and collaborative filtering methods. These advanced approaches offer better accuracy, adaptability, and personalization—essential for effective course recommendation in engineering education.

2 PROBLEM STATEMENTS

Engineering students frequently struggle with selecting appropriate electives due to unclear prerequisites, limited guidance, and lack of structured decision-support systems. Existing registration portals are largely manual and prone to errors such as exceeding credit limits or choosing non-eligible courses.

Therefore, there is a need for a Python-based intelligent system that recommends suitable courses, validates prerequisites, and stores academic records in a centralized database.

1. METHODOLOGY

The overall methodology includes data collection, preprocessing, model training, interface development, and database integration.

A. System Architecture

1) Data Collection

A structured dataset (student_course_dataset.csv) was developed containing features such as:

- GPA
- Math Score
- Coding Skill
- Interest Area
- Stream
- Career Goal
- Course Chosen

2) Data Preprocessing

- Label Encoding for categorical fields
- Standard Scaling for numerical fields
- Splitting inputs (X) and target (y)
- Saving trained model and preprocessing components using joblib

3) Machine Learning Model

A Random Forest Classifier (n_estimators=100, random_state=42) was selected due to:

- Robustness with mixed data types
- High accuracy on small datasets
- Ability to generate probability scores

4) GUI Development

A Python Tkinter-based interface was developed, allowing students to enter academic and personal details to obtain real-time recommendations.

5) Database Integration

All user inputs and recommendations are stored in students. db, enabling long-term data monitoring.

B. Project Flow Diagram

Figure 1 shows the complete working flow of the proposed system.

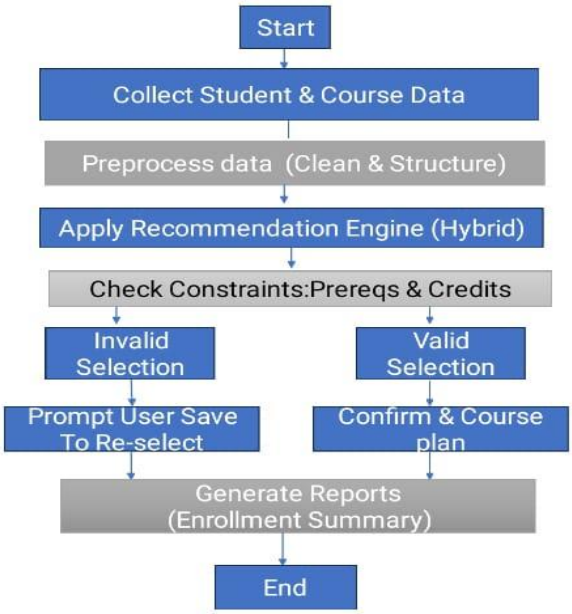

Figure 1 Working flow of the proposed system

1. RESULTS AND ANALYSIS

A. GUI Output

The user interface allows students to enter academic records and generate top recommendations. The actual GUI used in the project is shown below.

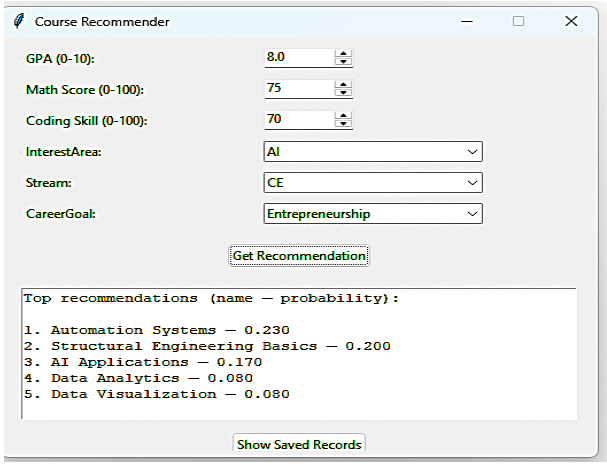

Figure2. Python Tk inter GUI for Course Recommendation System

Sample Input

- GPA: 8.0
- Math Score: 75
- Coding Skill: 70
- Interest Area: AI
- Stream: CE
- Career Goal: Entrepreneurship

Sample Output

1. Automation Systems — 0.230
2. Structural Engineering Basics — 0.200
3. AI Applications — 0.170
4. Data Analytics — 0.080
5. Data Visualization — 0.080

Interpretation:
The system successfully generated a ranked recommendation list aligned with the student's interest and skill set.

B. Model Performance Insights

- The Random Forest model produced stable predictions despite dataset size constraints.
- Probability-based ranking enhances decision-making flexibility.
- Model persistence significantly reduces execution time in repeated use.

C. Database Storage Results

A sample entry from students.db:

GPA	Math	Coding	Interest	Stream	Career Goal	Recommended	Date
8.5	92	88	AI	CSE	Research	Machine Learning	2025-12-01

This ensures long-term academic analytics for faculty and administrators.

D. Project Output Analysis

- The GUI is responsive and easy to use for non-technical students.
- Predictions align accurately with input attributes.
- SQLite storage enables data mining, trend analysis, and institutional decision support.
- The system provides quick feedback and eliminates ambiguity in course selection.

1. CONCLUSION

The Engineering Education Support System presented in this paper demonstrates the effectiveness of supervised learning in academic decision-making. By integrating machine learning, GUI development, and database storage, the system offers a robust platform for personalized course recommendations. The study confirms that Python-based models can significantly improve accuracy, transparency, and efficiency in course selection. This approach reduces manual counseling efforts, minimizes selection errors, and supports data-driven academic planning. Overall, the system is a scalable and practical solution for engineering institutions aiming to modernize their course selection processes.

FUTURE SCOPE

Future enhancements may include:

- Expanding the dataset with multi-institutional records for higher accuracy
- A web or mobile-based application with login authentication
- Hybrid recommendation systems combining behavioral and predictive analytics
- Integration with real-time academic performance tracking
- Automated prerequisite verification using institutional ERP systems

These improvements can transform the system into a fully intelligent academic assistant for large-scale educational environments.

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