Intelligent Career Prediction and Course Recommendation

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ABSTRACT

Constructing a successful academic and career path is crucial for students, and informed decision-making during schooling significantly impacts their future prospects. This paper presents a machine learning-based recommendation system designed to assist students in selecting suitable subjects and career paths by analyzing various attributes such as demographics, academic performance, interests, and extracurricular activities. Utilizing a Random Forest Classifier, the model is trained on historical student data to predict personalized academic recommendations. The system incorporates data preprocessing techniques including label encoding and feature selection to optimize model performance. Evaluated on accuracy and classification metrics, the model demonstrates effective prediction capabilities. Additionally, the system features interactive roles for administrators and users, facilitating course management and personalized guidance. This intelligent recommendation framework aims to empower students, parents, and educators with data-driven insights, thereby enhancing educational and career decision-making processes for long-term success.

Keywords: *Career, Random Forest Classifier, Student Data, Course Recommendation.*

I. INTRODUCTION

Constructing a successful academic and career path is one of the most critical challenges faced by students today. The choices made during schooling—such as selecting subjects, engaging in co-curricular activities, and setting career goals—play a vital role in shaping a student's future prospects. However, these decisions are often complex and overwhelming due to the wide variety of options available and the limited guidance accessible to many students. Traditional counseling methods, while helpful, are frequently constrained by subjective judgment and insufficient data analysis, which may lead to suboptimal recommendations. In this context, the integration of data-driven technologies, particularly machine learning, offers a promising avenue to enhance the decision-making process by providing personalized, evidence-based academic and career guidance.

Machine learning techniques have demonstrated significant potential in extracting meaningful insights from large and complex datasets. By analyzing patterns in student data—such as demographic information, academic performance, interests, and extracurricular activities—these methods can generate tailored recommendations

that align with individual strengths and aspirations. This approach not only improves the relevance and accuracy of guidance but also empowers students, parents, and educators to make informed decisions with greater confidence. Among various machine learning algorithms, the Random Forest Classifier stands out due to its robustness, ability to handle diverse feature types, and strong predictive performance, making it well-suited for classification tasks in educational recommendation systems.

The objective of this study is to develop an intelligent recommendation system that leverages the Random Forest Classifier to forecast academic and career pathways for students based on their unique profiles. The system utilizes a comprehensive dataset containing attributes such as age, gender, academic level, grades, subject interests, voluntary activities, parental occupations, and future expectations. These features serve as inputs to the model, which is trained on historical student data with clearlydefined academic recommendations. The development process includes data cleaning, encoding of categorical variables, feature selection, model training, and evaluation using standard classification metrics. The final system is designed to predict personalized recommendations for new students, thereby assisting them in selecting suitable subjects and career paths.

In addition to the predictive model, the system incorporates an interactive platform with two primary roles: admin and user. The admin role facilitates management functions such as adding course details, monitoring user registrations, and responding to user queries, ensuring that the system remains updated and supportive. Users, on the other hand, can register, log in, input their personal and academic information, and receive customized career recommendations. They can also communicate with the admin for further guidance, fostering an engaging and supportive environment. This dual-role architecture enhances the system's usability and ensures that students receive timely assistance alongside automated predictions.

The significance of this work lies in its ability to provide personalized, data-driven academic and career guidance that can scale to accommodate a wide range of students. By moving beyond traditional counseling methods and harnessing machine learning, the system addresses the challenges of subjective bias and limited resource availability. It offers a scalable, accessible, and accurate tool that can help students navigate the complex decision-making processes associated with education and career planning. Ultimately, this approach aims to improve student satisfaction, academic performance, and long-term career success by aligning educational choices with individual capabilities and goals.

This paper is organized as follows: after this introduction, a review of related work in educational recommendation systems and machine learning applications is presented. The methodology section describes the dataset, preprocessing steps, model training, and evaluation metrics. Experimental results and analysis are provided to demonstrate the system's effectiveness. The discussion section explores the implications, limitations, and future directions of the research. The paper concludes with

a summary of key findings and recommendations for further study.

II. RELATED WORK

1. Career Compass: A Career Path Recommender using Machine Learning, Authors: Umesh Guru Sai Guntupalli, Madhavi Latha Pandala, Dharma Teja Veeranki, Pramodhini Kumbha.

The paper presents a personalized career recommendation system titled "Career Compass," which uses machine learning models like Random Forest and Support Vector Machine to suggest suitable career paths based on an individual's skills, interests, and personality traits. Recognizing that traditional career guidance methods are often static and generalized, this system introduces a dynamic, user-centric approach facilitated through a mobile application built using Flutter. By incorporating continuous user feedback, the model adapts to evolving market demands and offers tailored career advice, thereby aiming to reduce mismatched career choices and improve individual satisfaction and productivity.

2. Student Career Prediction Based on Student Performance Using Machine Learning, Authors: V. Murali Bhaskaran, Sudharsan V, Solaiyappan A.T.

This research introduces a machine learning-based system to predict suitable career paths for students by analyzing their academic performance, extracurricular activities, and subject proficiency. With students often facing confusion over career choices, the system aims to provide data-driven guidance using Naive Bayes and K-Nearest Neighbors (KNN) algorithms. By aligning educational achievements with potential career opportunities, the model supports informed decision-making for both students and educational institutions. This approach not only aids in improving placement outcomes but also helps students pursue careers aligned with their strengths and interests.

3. The Application of Data Analytics to Career Choice Prediction: A Literature Review, Authors: Shaikha Al-Dhari, Adel Ismail Al-Alawi.

This literature review explores the application of data analytics in modern career guidance, emphasizing how artificial intelligence and machine learning are revolutionizing career prediction and recommendation systems. By analyzing a range of studies, the paper identifies commonly used algorithms such as Naive Bayes and Random Forest as highly accurate in predicting career paths. It provides a comprehensive synthesis of methodologies, datasets, and analytic techniques, offering valuable insights for educators and career counselors. The review also highlights the need for future research to evaluate the long-term effectiveness of these predictive systems in guiding individuals along sustainable career paths.

4. Skill Based Course Recommendation System, Authors: Viddhesh Sankhe, Janice Shah, Tejas Paranjape, Radha Shankarmani.

This paper presents a skill-based course recommendation system aimed at guiding students toward suitable online courses that align

with their career goals and interests. Addressing the challenge of overwhelming course choices, the system maps current students to alumni using multiple criteria and applies fuzzy clustering (c-means) instead of traditional k-means to improve recommendation accuracy. By leveraging a broad real-world dataset, the proposed method ensures practical applicability and better personalization, ultimately helping students acquire relevant skills for job roles and enhancing their employability in a competitive market.

5. Personalized Career-Path Recommendation Model for Information Technology Students in Indonesia, Authors: Puji Catur Siswipraptini, Harco Leslie Hendric Spits Warnars, Arief Ramadhan, Widodo Budiharto.

This study introduces a Personalized Career-Path Recommendation Model (CPRM) tailored for Information Technology students in Indonesia, aiming to address the lack of structured guidance in career specialization. Using a personalized Naïve Bayes (p-NB) algorithm, the model integrates personality types, subject preferences, and job profiles to generate career recommendations. The system is implemented as a web-based application and evaluated through expert focus groups and student feedback, showing over 83% user satisfaction. By leveraging educational data mining and grounded theory, CPRM emerges as a novel academic advising tool that enhances decision-making for IT career paths among Indonesian students.

6. Predictive Models for Career Guidance, Based on Academic and Behavioral Data with Data Mining and Machine Learning Technique, Authors: Brijesh Kumar Verma, Nidhi Srivastava, Ajay Kumar Bharti.

This research proposes a robust career guidance framework that integrates academic and behavioral data using data mining and machine learning techniques. By analyzing academic scores, personality traits, learning styles, and demographic attributes, the system creates predictive models to suggest career paths tailored to individual student profiles. Algorithms such as K-Means, Random Forest, SVM, and Neural Networks are used in both clustering and classification modes. The hybrid approach enhances precision and personalization, addressing limitations in traditional career counseling. This scalable, data-driven method supports informed and individualized career decisions for students.

7. Skill-based Career Path Modeling and Recommendation, Authors: Aritra Ghosh, Beverly Woolf, Shlomo Zilberstein, Andrew Lan.

This paper introduces a novel, interpretable state-space model to assist users in career planning by analyzing professional profiles and offering personalized recommendations. The model tracks users' skill growth over time using binary-valued latent states and helps identify skill gaps and feasible upskilling paths. Using real-world datasets, the approach outperformed existing models in predicting job titles, skills, and companies. Most importantly, it provides actionable insights for users aiming to reach their career goals through reskilling and lifelong

learning. This work highlights the importance of leveraging big data for guiding modern career development in rapidly evolving job markets.

8. CareEx – An AI Assisted Career Guidance and Eligibility Prediction System, Authors: Soma Prathibha, G. Shamini, Dharshini S, U. Rusitha.

CareEx is an AI/ML-based career guidance platform developed to assist students in identifying suitable career paths and predicting their eligibility for universities. It addresses two common issues: confusion about what to do next and lack of guidance on how to reach specific educational goals. The system provides personalized career recommendations using a dendrogram-based model, taking into account real-world industry demands and public/private sector opportunities. By integrating eligibility prediction with interactive mentorship, CareEx empowers students to understand their strengths and make informed academic and professional decisions.

9. Career Recommendation Systems using Content Based Filtering, Authors: Tanya V. Yadalam, Vaishnavi M. Gowda, Vanditha Shiva Kumar, Disha Girish, Namratha M.

This study explores the development of a career recommendation system utilizing content-based filtering, focusing on personalized job suggestions based on user interests and skillsets. Unlike traditional job portals that overwhelm users with excessive data, this model leverages machine learning to filter relevant job information, addressing challenges like cold start, scalability, and data sparsity in existing systems. The paper critically examines current recommender approaches and proposes improvements for better transparency, security, and accuracy, helping students and job seekers align with careers that match their unique profiles and goals.

10. A Machine Learning-Based Career Recommender System, Authors: Suraj Vasant Gouda, Ms. Bhavani R.

This paper presents a personalized machine learning-based career recommender system aimed at guiding students toward career paths that genuinely match their interests, rather than those influenced by external pressures. Recognizing the challenges students face in navigating the overwhelming amount of information available online, the system helps filter and recommend relevant career options based on individual preferences. By simplifying decision-making and aligning recommendations with students' goals, this system supports more fulfilling and informed career choices.

III. METHODOLOGY

The methodology for developing the student academic and career recommendation system involves several key steps: collecting and preprocessing student data, encoding categorical variables, selecting relevant features, splitting the dataset into training and testing sets, and applying the Random Forest Classifier for model training and prediction. The model is evaluated using standard classification metrics to ensure its accuracy and reliability. Finally, the trained model is integrated into an interactive platform that allows users to input their information and receive personalized academic

and career recommendations, while administrators manage user data and respond to queries.

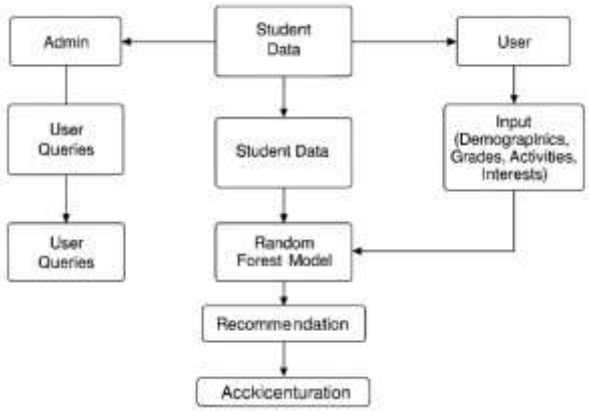

Fig 1. Proposed Methodology

1. Data Collection and Preprocessing:

Student data—including demographics, grades, interests, and extracurricular activities—is gathered and cleaned. Irrelevant or redundant information is removed, and missing values are addressed to ensure data quality.

2. Encoding Categorical Variables:

Categorical attributes such as gender, schooling type, and favorite subjects are converted into numerical values using label encoding. This step is essential for compatibility with machine learning algorithms.

3. Feature Selection:

Relevant features are selected based on their importance to the prediction task. This reduces complexity and improves model performance by focusing on the most impactful student attributes.

4. Data Splitting:

The dataset is divided into training and testing subsets, typically using an 80:20 ratio. This allows the model to learn from one portion of the data and be evaluated on unseen data for generalizability.

5. Model Training with Random Forest Classifier:

The Random Forest Classifier, an ensemble learning method, is trained on the processed data. It builds multiple decision trees and combines their outputs to enhance prediction accuracy and robustness.

6. Model Evaluation:

The trained model is assessed using metrics such as accuracy, precision, recall, and F1-score to ensure it reliably predicts academic and career recommendations.

7. System Integration and User Interaction:

The validated model is deployed within an interactive system. Users can input their details to receive personalized recommendations, while administrators manage user accounts, update course information, and provide additional support.

This structured methodology ensures the recommendation system is accurate, user-friendly, and effective in guiding students toward suitable academic and career paths.

IV. TECHNOLOGIES USED

Programming Language: Python

Python is the primary language for data processing, machine learning model development, and backend logic due to its extensive libraries and community support.

Machine Learning Library: Scikit-learn

The Random Forest Classifier is implemented using the scikit-learn library, which provides robust tools for model training, hyperparameter tuning ,and evaluation. Scikit-learn also offers utilities for data preprocessing, such as label encoding and train-test splitting.

Data Handling: Pandas & NumPy

Pandas is used for data manipulation and cleaning, while NumPy supports efficient numerical computations.

Web Framework: Flask or Django

A lightweight web framework like Flask or a full-stack framework like Django is used to build the interactive user and admin interfaces, manage authentication, and serve model predictions.

Frontend Technologies: HTML, CSS, JavaScript

These standard web technologies are used to create responsive and user-friendly interfaces for both students and administrators.

Database: SQLite / MySQL / PostgreSQL

A relational database stores user profiles, course details, historical data, and recommendation outputs.

Visualization: Matplotlib / Seaborn

Visualization libraries are used for presenting data insights, model performance, and recommendations in an interpretable format.

Deployment: Cloud Platform or Local Server

The complete system can be deployed on a local server for institutional use or on cloud platforms for broader accessibility.

These technologies collectively support the end-to-end development, deployment, and operation of the machine learning-powered recommendation system, ensuring scalability, usability, and reliability for students and administrators.

V. Result

Prediction page

VI. CONCLUSION

In conclusion, the proposed student academic and career recommendation system harnesses the power of machine learning—specifically the Random Forest Classifier—to provide personalized, data-driven guidance for students navigating critical educational and career decisions. By integrating comprehensive student data, robust preprocessing, and an interactive platform for both users and administrators, the system delivers accurate and actionable recommendations that can significantly enhance student outcomes. This approach not only addresses the limitations of traditional counseling methods but also empowers students, parents, and educators with reliable insights, ultimately supporting more informed choices and fostering long-term academic and professional success.

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