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AI-Based Career Path Predictor

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ABSTRACT

Choosing an appropriate career path is becoming more and more complicated due to the rapid expansion of educational opportunities, emerging job roles, and social as well. as economic pressures. Many students make career decisions without adequate awareness of their interests, skills, and long-term opportunities, which may eventually cause dissatisfaction. academic failure, or frequent switching of courses. Artificial Intelligence and Such decisions can be supported in a data-driven manner by Machine Learning. This paper aims to present an AI-based conceptual career path predictor using student data, including academic performance, interests, skills, and background information This will help in recommending apt career paths. Detailed review of existing work on career Among guidance systems, career path prediction, and educational data mining, we propose a framework that couples the supervised learning models with a questionnaire-based data. collection process. The predicted career options are presented as top-ranked paths along with explanations derived from model features. The paper discusses the possible advantages, challenges, and limitations of such a system, including data quality, bias, and ethical considerations. The work draws inspiration from and expands upon ideas already given in existing It includes studies like 'Career Path Prediction Using Machine Learning' by Gavhane et al., 2020. and literature related to the prediction of student performance and career guidance

I. INTRODUCTION

One of the most important decisions in students' lives is selecting an appropriate career. In In practice, many students have difficulties in recognizing their strengths, understanding labor market demands, or consider the long-range effects of what they do. Consequently, they may opt for courses because of peer pressure, social trends, or incomplete information. This can lead to low motivation, poor academic performance, course withdrawals, and dissatisfaction. along with professional life. Traditional career guidance is normally provided by a counsellor or mentor using Psychometric tests, interviews, and manual interpretation to suggest suitable fields. Such methods, although useful, are time-consuming, somewhat subjective, and not readily scalable to large numbers of students. With the increasing availability of educational Using data and developments in Machine Learning, it has become possible to build intelligent systems. that can help in predicting suitable career paths based on patterns learned from historical data. A recent work of Gavhaneet al. (2020) reviewed a variety of techniques used for career path prediction, and highlighted how the classification algorithms can be applied to student and professional datasets for recommending roles like engineer, doctor, pharmacist, lawyer. Financial Advisor, among others. Their work evidences that ML-based models are able to grasp complex relationships between individual attributes and career outcomes. Other studies have applied algorithms such as Naïve Bayes, decision trees, support vector machines, ensemble methods, neural networks, clustering and case-based reasoning to support career guidance and student performance prediction. In this regard, an AI-powered career path predictor may try to offer students: Personalized suggestions of career options based on their academic history, interests; skills, and personality traits. Rather than replacing human counsellors, such a system can serve as an intelligent assistant that offers data-driven suggestions and helps students. Reflect on one's strengths and preferences. In this manner, this paper constructs a research framework for developing such a predictor, informed by the existing literature on career guidance. Educational Data Mining, and Recommender Systems.

II. MATERIALS AND METHODS

A. Data Sources and Attributes The proposed AI-based career path predictor relies on data gathered from students and professionals through structured questionnaires, as well as from institutional records. Following the data collection strategies described in prior work, multiple types of The following attributes are considered: • Academic attributes: marks in key subjects, overall percentage or GPA, and completed courses. • Personal attributes, which include demographic variables like age and education level. • Interest-related attributes: self-reported interests in domains such as technology. medicine, business, arts, research, and entrepreneurship. • Skill-related characteristics include proficiency in programming, communication, problem solving. Creativity and other skills relevant to different career fields. • Historical decisions: current or chosen field of study, internships, and co-curricular activities. In the work of Gavhane et al., various career path datasets were created by Google Forms were distributed among students, teachers, and professionals. Likewise, in the The proposed system suggests using Google Forms or any other equivalent online survey tool to collect Labelled examples indicating input features and actual or intended career path.

B. Preprocessing and Feature Engineering The collected data can have missing values, noise, and inconsistent entries. Standard The preprocessing steps include removal of incomplete records where necessary and imputation. missing values, and encoding categorical variables such as branch, preferred domain and career choice using one-hot or label encoding. Numerical features include marks and scores. are normalised to a common scale. Furthermore, composite features can be created, such as average marks in STEM subjects, count of technical projects, or interest score. for each broad career category.

C. Machine Learning Models According to the literature, several supervised learning algorithms are suitable for career path prediction. Gavhane et al. review works where Naïve Bayes, decision trees, random forests, adaptive boosting, support vector machines, XGBoost, and artificial neural Networks are applied to educational and career datasets. For the proposed system, the Problem is modelled as a multi-class classification task in which each career path y' represents a class label. The following models can be trained and compared: Decision Tree and Random Forest classifiers for interpretable rules and robust performance. Improved performance on tabular data with Gradient Boosting or XGBoost. Support Vector Machine, which uses high-dimensional feature spaces. • Feedforward neural networks to capture nonlinear relationships when enough data are available is available.

D. Training, Validation and Evaluation The dataset is split into training and test sets, and k-fold cross-validation is used to assess model stability. Common metrics include accuracy, precision, recall, F1-score, and confusion matrices for each career class. Top-k accuracy is particularly relevant, as the Thus, some systems may present the top three or top five recommended career paths instead of just one. prediction. Evidence from previous research, such as high accuracies of ensemble and SVM-based models, guide the choice of baseline and advanced models. E. System Architecture and User Interface The prediction module could be integrated into the web-based application that would enable the student to sign up and complete the questionnaire to find recommended career paths. The Architecture usually comprises a data collection layer, a preprocessing and model layer, and a presentation layer. Besides predictions, the system should also show explanations, for instance, specifying that a certain career was recommended because of excellent performance. in certain subjects, relevant interests, or skills. This explainability is important to Trust is built the moment one ensures AI is being used as a supportive tool and not as an unquestioned authority.

III. RESULTS AND DISCUSSION

Various techniques and prior works related to career were discussed in the original study by Gavhane et al. Instead, path prediction algorithms were surveyed rather than implementing a single new one. They reported promising results from different models in the literature, with several studies obtain accuracies ranging between 80–94%, while predicting student performance, course recommendations, or career field suggestions using machine learning. For example, naive Bayes, adaptive boosting, K-means clustering, decision trees, random Forests, Support Vector Machines, and neural networks have seen successful applications in related tasks. such as academic performance prediction, career counselling, and automated major Recommendation. Building on those findings, the proposed AI-based career path predictor is expected to produce competitive performance when trained on a sufficiently large and representative dataset. Decision tree and ensemble methods are likely to perform well due to their ability to model complex interactions among the features, handle mixed numerical and categorical data. At the same time, these models can provide interpretable structures such as feature importance rankings, which can be used to generate explanations for the recommendations. One of the key discussion points is that of quality and variety in data. As stated in the literature, many datasets are collected from limited populations - for instance a single COLLEGE or department) that might limit the generalizability of the models learned. In order to To mitigate this, future implementations should gather data from multiple institutions, branches and demographic groups, and to include both successful and unsuccessful career outcomes. Another challenge is the presence of biases; if certain if careers over or under represent training data, the predictor may systematically favour or ignore particular options. Ethical considerations are also paramount. Recommendations powered by AI should be presented as guidance rather than set judgments. The students should be incentivized to interact with the system as one Input amongst many, coupled with discussions with teachers, counsellors, and family. Transparency in how the model uses the data of users and which features influence the Predictions have to keep people's trust. Privacy-preserving practices, such as All data on students should be anonymized and stored securely. Despite these limitations, an AI career path predictor can still offer a number of benefits: it can scale to large numbers of students, provide quick feedback, highlight overlooked career options, and help students reflect on their strengths. When integrated into Through institutional counselling systems it can release human counsellors from routine analysis. tasks, and let them focus on deeper one-on-one mentoring.

IV. HELPFUL HINTS

This section provides practical hints for students and developers wanting to implement or use an AI-based career path predictor in a real environment:

1. Begin with Good Quality Data:
Gather clear and forthright responses from students. Clearly explain the purpose of the system so they take the questionnaire seriously. Include questions about interests, skills, and
activities, not only marks.
2. Use Simple Models First:
Focus first on simple, easily interpretable models such as decision trees or logistic regression. to understand how different features affect the prediction. Once the basic behavior is clear, you can experiment with more complex models like random forest, XGBoost, or neural networks.
3. Involve teachers and counsellors:
Show the model's outputs to teachers or counsellors and ask them for feedback. Their domain Knowledge can help you to flag unrealistic suggestions or omission of factors you may require.
to add as new features.
4. Always offer choices:
Do not show only one career as the “correct” path. Display the top few recommendations Along with a short reason for each, so the student can compare and decide. This reduces alleviates the pressure and makes the system more supportive.
5 Emphasize Explanations:
Whenever possible, provide explanations such as "This career is suggested because of. ". your strong math scores and interest in programming." Explanations build trust and help The students recognize their strengths.
6. Respect privacy and ethics:
Store data in a secure way, and anonymize it when possible. Inform users on how their data will be utilized. Make it clear that the system is a tool to support decisionmaking, not a final authority.
7 Continuously Improve the System:
Add new data over time, retrain the models, and adjust questions in the form .compare system suggestions with actual outcomes, for instance, students' satisfaction, using the careers they have chosen, and then update the model.
These hints align with the recommendations and observations in the career prediction. and educational data mining literature described by Gavhane et al. and others.

V. CONCLUSION

This paper proposes a research-oriented framework for the AI-based career path predictor. Inspired by the survey and analysis of existing studies on career guidance and educational data mining. The work reviewed indicates that machine learning techniques applied to Carefully collected student data can effectively support the prediction of appropriate career paths and related outcomes. Building on the ideas of Gavhane et al. and other Authors propose a system that brings together data collection and preprocessing using questionnaires. and feature engineering, supervised learning models, and an interpretable web-based user. interface. The contribution of this work lies in outlining how different components-data attributes, algorithms, evaluation metrics, and ethical principles-fit together in designing a Practical AI assistant for career planning. Whereas the focus in this paper is on focused more on the conceptual framework rather than implementing and testing a certain model. It establishes the clear direction for future development. Subsequent work can implement the pipeline, compare multiple algorithms on real datasets, conduct user studies with students and counselors, and refine a system for addressing bias, fairness, and explainability. Eventually, an AI-powered career path predictor has the potential to complement traditional Counselling and empowering students to make more informed and confident decisions about their careers.

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