Stem Career Guidance

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Abstract: The development of AI-based counselling in the domain of the STEM field plays a pivotal role by helping the students to make the right career decisions and also learn appropriate skills required in the industry. This paper highlights the significant benefits of such a system, which includes its ability to faster decision-making and enhance the accuracy of reliable decision making. This report analyses the current processes in detail and addresses different approaches, techniques, methods and challenges in the domain of AI-powered career counselling. While using the ideologies used in various other systems, the paper proposes a comprehensive model based on random forest distribution to accurately predict the career according to the user interests providing key information such as work experience, cognitive skills and relevant credentials and helps them in learning appropriate skills required in the industry and making them job ready.

Index Terms - AI, Career Counselling, Job ready, Skills, STEM, Random Forest Classifier, Machine Learning, Personalised Counselling.

I.INTRODUCTION

The development of AI-based career counselling is a crucial development for catering to students and professionals working in the industry [1]. In STEM fields, especially in engineering, every year technology keeps on evolving, so it is essential to keep up to date with the newest trends and keep learning the new systems and tools [9]. The AI career counselling helps the students to make the right career choices based on their interests and career goals [2][3]. The system bridges the gap between the industry-level skills required and the education being taught in colleges and universities. Our system targets students, teachers, and working professionals to find the right career based on the domain they have the most interest in and the jobs which have the highest scope.

Our system asks the user a set of questions from various fields like biology, mathematics, chemistry, etc. Their qualifications, working experiences and dislike towards certain subjects and job roles – our model takes all these into consideration and predicts the best-suited career for them. The models also suggest taking certain certifications which will help them get their dream job. The models also mention the key skills required for that particular job role and also provide extra information like the minimum experience required for the job role, the average salary range of that particular job, and a detailed description of the job role to make the user have a better understanding of the job role.

The normal traditional system only provides a way to take certain careers but does not tell in detail the specifications and skills required [8][9]. Our system aims to solve these challenges so that users using our system can choose careers, learn the required skills for that job, apply for suitable jobs according to their current skill levels and also keep tabs on the current job trends in the market. Additionally, we also provide an application tracker system so that users can keep track of all the job applications in a systematic manner, and our system also provides notifications to the user whenever a company replies to them in email, saving

them from having to keep checking their emails and allowing them to use time efficiently by learning skills [8]. This bridges the gap between traditional career counselling and modern technological advancements. This system enhances career planning, making it a valuable tool for students, educators, and working professionals [9].

The following sections of this paper will discuss the literature review, system methodology, implementation details, and evaluation results to demonstrate the effectiveness of this approach in career guidance.

Literature Review

Several research papers have thoroughly studied AI based career guidance. The literature indicates agreement on the role of artificial intelligence in career counseling in most fields, especially STEM education. Researchers have examined the use of AI in offering customized career suggestions, stimulating student engagement and closing the gap between industry needs and personal skill building.

TABLE 1   LITERATURE REVIEW

Sr.No	Date & Author Name	Name (Research Paper)	Description
1.	G. Supriyanto, I. Widia, A. G. Abdullah, and Y. R. Yustiana, Dec. 2019	Application Expert System Career Guidance for Students	Explores the use of an expert system for career guidance to assist students in selecting suitable career paths.
2.	JJ. B. Monreal and T. Palaoag, Oct. 2023	Use of Artificial Intelligence in Career Guidance: Perspectives of Secondary Guidance Counselor	Analyzes the role of AI in career guidance from the perspective of secondary school counselors.
3.	W. Holmes, M. Bialik, and C. Fadel, 2019	Artificial Intelligence in Education: Promises and Implications for Teaching and Learning	Discusses how AI is transforming education, including career guidance and learning processes.
4.	G. A. Ansari, Aug. 2017	Career Guidance through Multilevel Expert System Using Data Mining Technique	Introduces a multilevel expert system that utilizes data mining techniques to enhance career guidance.
5.	S. Westman and A. Mononen, Aug. 2021 Artificial Intelligence for C	Artificial Intelligence for Career Guidance – Current Requirements and Prospects for the Future	Examines the current state and future potential of AI in career guidance.
6.	P. Bahalkar, P. Peddi, Dr. S. Jain, Jan. 2025	AI-Driven Career Guidance System: A Predictive Model for Student Subject Recommendations Based on Academic Performance and Aspirations	Proposes an AI model that predicts career paths based on students ' academic performance and interests.
7.	Westman, S., Kauttonen, J., Klemetti, A., Korhonen, N., Manninen, M., Mononen, A., Niittymäki, S., & Paananen, H., 2021	Artificial Intelligence for Career Guidance – Current Requirements and Prospects for the Future	A detailed study on how AI can improve career guidance systems and their implementation.
8.	Prasanna L., & Haritha D., 2019	Smart Career Guidance and Recommendation System	Presents a career guidance system that provides intelligent recommendations for students.

9.	Qamhieh, M., Sammaneh, H., & Demaidi, M. N., 2020	PCRS: Personalized Career-Path Recommender System for Engineering Students	Develops a personalized recommendation system for career guidance specifically for engineering students.

The reviewed research papers collectively highlight the growing role of AI in career guidance, emphasizing its ability to provide personalized recommendations, bridge the gap between industry demands and student skills, and enhance engagement in career decision-making. The above systems explore Artificial Intelligence expert systems, predictive models, and multi-level recommendation techniques to improve career counseling, particularly in STEM. Some research papers only propose theoretical frameworks, while others also analyze practical implementations from the perspectives of students, educators, and industry needs. Overall, the conclusion is that AI-based career guidance systems can bridge the gap between education and industry by delivering accurate, real-time recommendations according to individual skills.

After reviewing the literature there are some features that we have added to our system. As observed in the literature review, they mainly focused on career recommendations and counseling, but our system not only focuses on career counseling it also keeps users updated with real-time job opportunities. It also helps the user to stay updated about industry trends as our project includes real-time job-related trending news. Additionally, we also provide an application tracker system so that users can keep track of all the job applications in a systematic manner, our system also provides notifications to the user whenever a company replies to them in email, saving them from having to keep checking their emails and allowing them to use time efficiently by learning skills.

Motivation of the System:

1. Helping Students with Career Confusion: Many students find it difficult to choose the right career in STEM because they don't have enough information, feel overwhelmed by too many options, or are unsure about their strengths. Our system aims to solve this problem by using AI to provide personalized career suggestions, helping students make clear and informed decisions.

2. Career Guidance Based on Interests: Choosing a career can be tough when there is no proper guidance. Our AI powered system helps students by understanding their interests and recommending careers that match their passions and goals. By asking simple questions about their likes and aspirations, we make sure the suggested career paths are a good fit for them.

3. Bridging the Gap Between Education and Industry: Many students don't know about new and emerging job opportunities in STEM. Our system helps by linking their interests with real job market needs. This way, they can pick the right courses, learn the right skills, and prepare for careers that have strong future demands.

II. PROPOSED SYSTEM

We have developed an AI-powered career guidance platform to offer personalized career recommendations. The system lets user input personal data such as skills, interests, qualifications and work experience. Using the user's given information, system model is trained and tested for personalized career prediction and suggests potential career paths and necessary skills.

1) User Interface: The interface enables users to personalize their experience by entering skills and career preferences. We have designed a form with featured fields to gather user information and interests. It includes fields for profile details (qualifications, interests, work experience, if any, career goals and aspirations), status selection (student or professional) and skill assessment checkboxes. Upon submission of the form, system generates a customized career report providing potential career paths in detail and necessary skills required.

2) Data Processing and Career Prediction: The user's information serves as the database and thus we have stored user inputs in Firebase. This data is crucial for career predictions. The system processes user data and applies machine learning techniques for accurate career recommendations. We have used Random Forest

classifier as system's machine learning model to predict career paths based on user information. The model achieved an accuracy of 60% and was trained using augmented dataset.

3) Methodology:

a) User Registration: User registration is basically user Sign Up which involves entering details like name, email, phone number and password. All of these data are securely stored in Firebase.

b) Profile Details and Preferences: Users complete a form that includes information such as their educational background, professional status (career) and work experience. This information personalizes further questions.

c) Skill Assessment and Interest Evaluation: Then users are asked to complete questionnaire which is based on their STEM-related interests and skills. Questionnaire is a quiz type series of questions which includes text inputs and answer choice type of questions. This is used to determine basis for career predictions.

d) Career Report Generation: The system analyzes user inputs to generates a report with potential career paths suggestions and skills required for each path.

e) Real-Time Job Data and News: The system connects to job listing API and news sources to offer real time job data and news. By this, we aim to provide users with industry updates and relevant job opportunities along with personalized career guidance.

4) Model Structure and Output: Random Forest classifier is used to analyze user data and predict the best career paths for them. The model is prepared to get optimal performance and enhance model's accuracy by applying preprocessing techniques like encoding categorical variables and feature engineering. Then user data is transformed to make it machine learnable through normalization, feature extraction and processing to produce a list of career suggestions. The recommendations include information on career roles description, job opportunities and prediction percentage (probability) of suitability.

III. SYSTEM IMPLEMENTATION

The STEM Career Guidance system is designed to be an intelligent platform that combines advanced machine learning algorithms with a user centric method to provide guided career recommendations. The system combines real time job market trends, skill development pathways and user preferences to deliver actionable insights.

A. System Architecture

The system consists of the following components :

1) Frontend: HTML, CSS, JavaScript and Bootstrap is used to design frontend of our system. The interface collects user inputs and displays optimal career recommendations, industry trends as Tech news, highly demand job roles in a graphical representation and detailed information about each of those job roles.
2) Backend: Node.js is used to develop the backend. Here, user data is processed and integrated to machine learning algorithm for career predictions.
3) Database: Firebase serves as the real-time database for storing user details, preferences and historical interactions.
4) Machine Learning Model: The Random Forest classifier is trained on an augmented dataset and is used for predicting career paths.

B. Implementation Process

The STEM Career Guidance System is implemented by using a structural method in order to ensure high accuracy in predictions and smooth user experience. The system begins with data collection through an interactive user interface where user fills in details like their educational qualifications, work experience, skills and career interests by answering a simple questionnaire. To ensure compatibility with system's machine

learning model this data is preprocessed and normalized into machine-readable formats. We have used is Random Forest classifier as system's machine learning model which is giving an accuracy of 60%. The model is trained to analyze user's inputs and generate personalized career suggestions based on that. The system keeps career predictions, job opening news and Tech news UpToDate by dynamically updating its recommendations based on changing user inputs and evolving industry trends, the system dynamically updates recommendations, so it stays useful and feels more personalized over time. Recommendation includes a career title, job market statistics and prediction confidence percentages. To ensure real-time relevance, external APIs are integrated: a Job Listing API fetches relevant job openings and a News API provides updates on emerging trends in the STEM job market. A Career Report is used to show users the processed results and highlight the practical steps they can take to build new skills and excel in their career. Firebase is used to securely store user data and preferences working as real-time database.
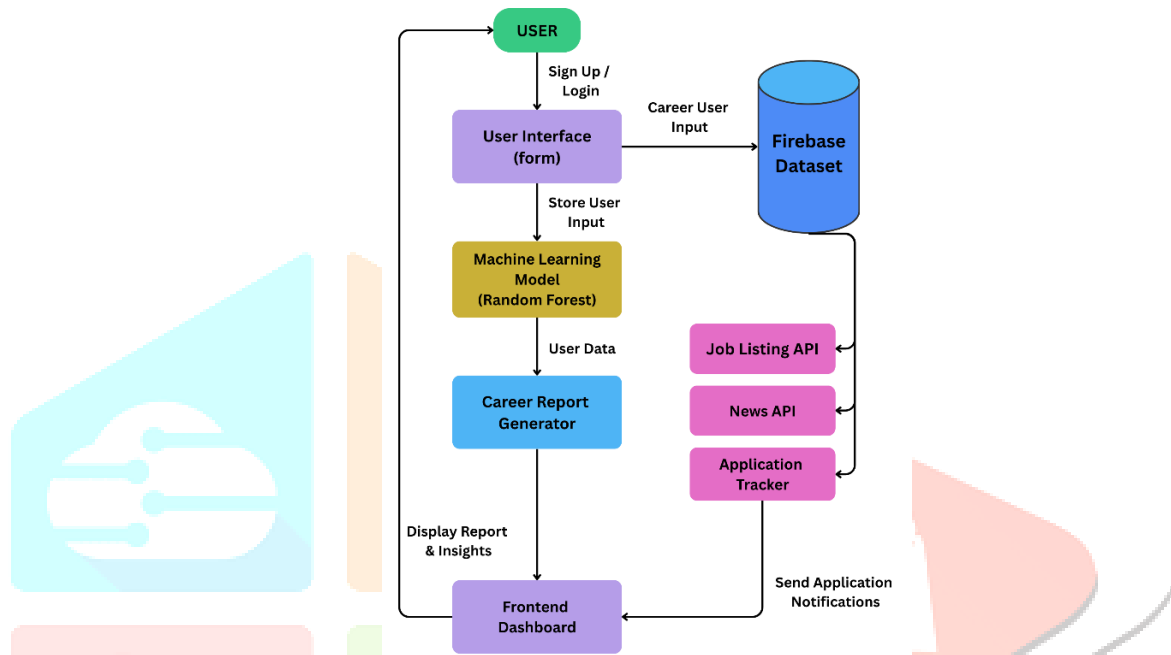

fig 1: architecture of stem career guidance

IV. ANALYSIS AND RESULTS

The system uses the Random Forest classifier was used in the development and testing of the suggested system, which demonstrated its efficacy in career prediction with an accuracy of 60%.
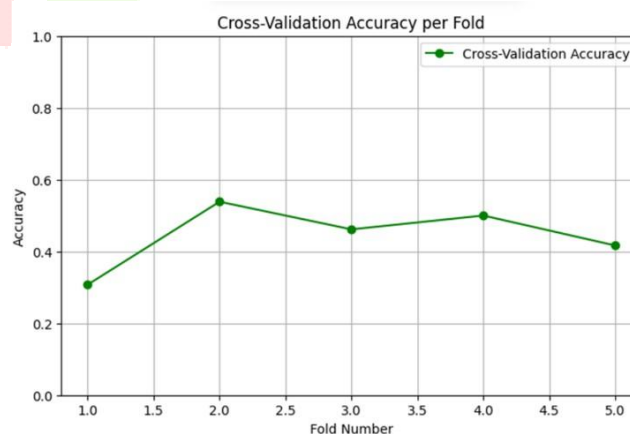

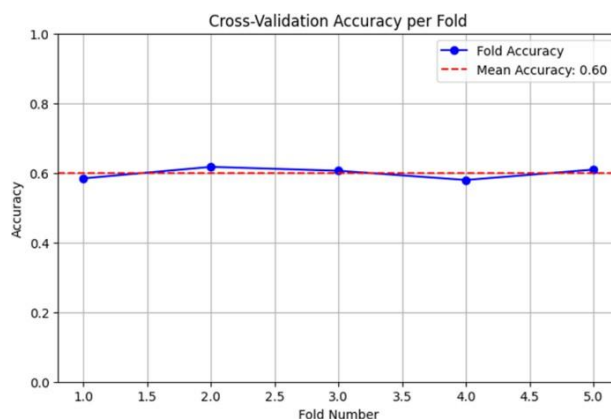fig 2: cross validation accuracy graph of previous model

fig 3: cross validation accuracy graph of current model

To evaluate the robustness and capability of generalization of the proposed model, 5-fold cross-validation was performed and the fold-wise accuracy was analyzed as shown in Figures 2 and 3. Figure 2 shows the fold-wise cross-validation accuracy of Model A. In Model A, accuracy is very inconsistent. It is noticeable that the validation accuracy fluctuates from 0.3 to 0.55. This variability concludes that Model A is inconsistent in generalization across different subsets of the data, indicating high sensitivity to training data distribution.

In Figure 3, cross validation accuracy of Model B. Here, the accuracy remains relatively stable across all folds, ranging from 0.58 to 0.62. A red dotted line indicating the mean accuracy is included for reference. This is indicating a consistent average performance of 0.60. This minimal variance across folds shows the model's ability to generalize, demonstrating greater robustness and reliability in predictive performance. We collected user input and contrasted the system's performance with that of the current career platforms in order to determine how effectively it works in real-time. All things considered, the comments point out areas that need work and offer ideas that can be useful for others looking into different career paths.
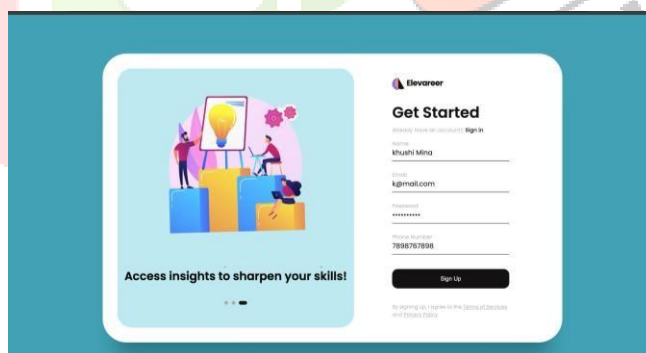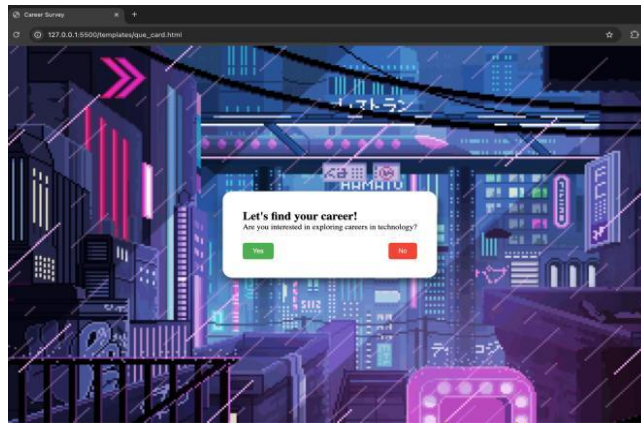

fig 4: sign up page

fig 5: survey form

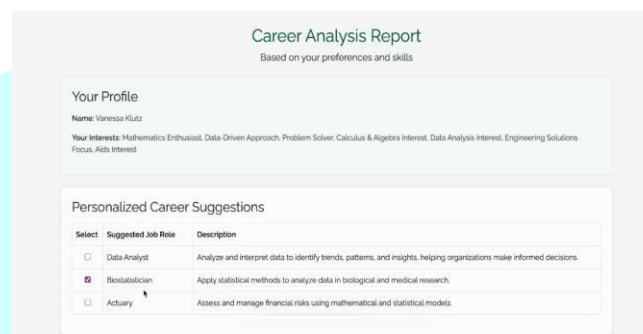fig 6: quiz page for user preferences
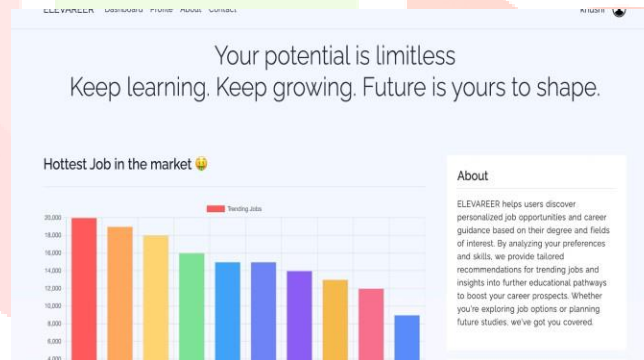

fig 7: career analysis report

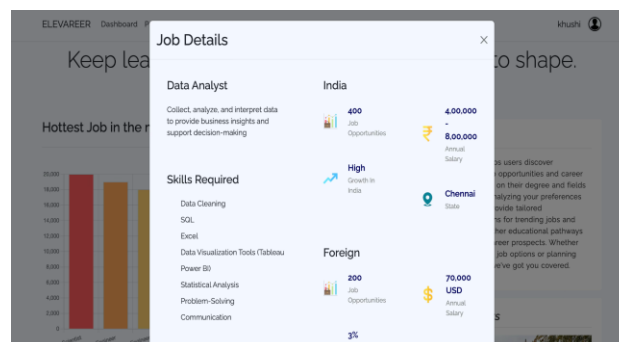fig 8: home page with current job trends
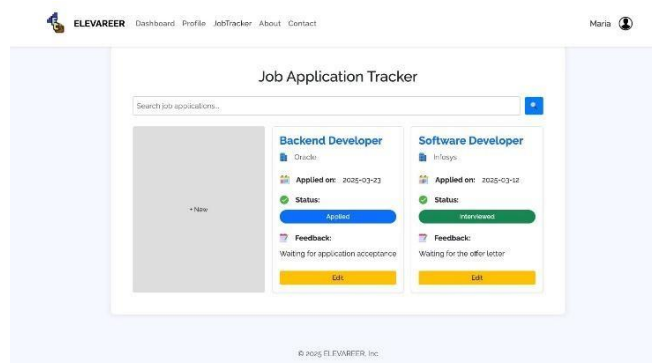

fig 9: trending job details page

fig 10: job tracker page

V. CONCLUSION AND FUTURE WORK

This career forecast project illustrates how machine learning and Data-technology will assist people in making smarter and more personalized decisions. The system has an intelligent career recommendation analysis capable of analyzing user data through Random Forest classifier algorithm. It takes into consideration a user's skills, interests, educational background, as well as current trends and scenarios of the job market. Because of its skill matching capabilities, real time industry updates, and support for non- traditional career paths, the platform has become quite popular and valuable for students, working professionals, and individual who consider switching in career.

While the current system functioning is good, there are still opportunities for improvement particularly in the accuracy and user satisfaction. For example, collecting more detailed user data through expanding the dataset, the system can differentiate among similar career paths also termed as fine-grained recognition. The system is capable for providing complex insights to deeply recommending users. By utilizing advanced NLP methods, it would be able to analyse unstructured data such as user feedback and review as well as reports from the labour market. This system is adaptable and scalable to any industry change in future.

There is an immense amount of exploration which can be conducted, like, implementing deep learning techniques for enhancing the model performance or accuracy. Incorporating practical features like resume builders, personalized course recommendations, interview preparation, and application tracking would greatly enhance the system's performance. In addition to these features, enabling a feedback loop where users can provide scores to the relevance of the assigned jobs will enable the model to improve over time. Another promising direction for the future development is considered to be the integration of the localized career data, which could allow for attracting more users searching for international jobs or those interested in emerging sectors in particular regions.

Overall, this project highlights how crucial it is to build a dynamic, user centric prediction tools that helps to keep ahead in race in today's rapidly evolving global market and workforce. By enabling users to make informed decisions, such platforms create meaningful impact on people's Professional Journey.

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