(RESEARCH ARTICLE)

Career Path Recommendation Adaptive Learning Using Artificial Intelligence

C Uday Kumar, G Sai Teja *, P Lalitha Devi, B Sumanth and T. Veerraju

Department of Computer Science and Engineering, Aditya College of Engineering & Technology, Surampalem, Kakinada 533437, Andhra Pradesh, India.

Abstract

Career advice is important in assisting the students and the professionals to make better decisions concerning their future. The conventional ways of career counseling usually make use of rigid recommendations that never suit one or other learning styles, or level of skills, and the changing demands of the industry. To overcome these drawbacks, this paper recommends a career path advice system that incorporates the adaptive learning and artificial intelligence application. The system is dynamic and studies the profiles of users, assesses their skills gap and creates a tailored career recommendations based on current industry trends. The framework makes use of machine learning frameworks to make sure that the recommendations provided are accurate, and suited to the individual capabilities and goals of the learner. Moreover, adaptive learning modules ensure individualized routes to the learning process, which allows constant acquisition of new skills and enhances employability. The new solution will involve improved participation based on gamification. Empirical analysis shows that the system has a great degree of improvement in the accuracy of the recommendations and the satisfaction of the learners as opposed to the traditional approaches.

Keywords: Career Guidance; Adaptive Learning; Artificial Intelligence; Machine Learning; Personalized Recommendation; Skill Development.

1. Introduction

Career guidance has emerged as a fundamental element in the process of defining the academic and professional career of students and other employed professionals. The conventional career guidance methods tend to be generalized and do not take into consideration the individual difference in the learning styles, the skills and aspirations of the individuals. With the everchanging nature of industries, which are currently undergoing a massive transformation because of the technological changes, there is an increased demand to have intelligent systems capable of delivering dynamic, personalized, and data-driven career recommendations. AI has become a disruptive technology that can analyze large amounts of data, recognize trends, and create personalized knowledge. AI can be used to develop an effective career path recommendation system when it is paired with adaptive learning methodologies. Adaptive learning means that the educational material and skill-building paths are designed to fit the pace, abilities, and weaknesses of the learner, whereas AI will make career recommendations more accurate and aligned with evolving workforce demands. The given paper presents a career path recommendation system, which combines AI-based analysis with the adaptive learning technique. The suggested system will overcome shortcomings of traditional career guidance approaches through personalized recommendations, lifelong skill assessment and learning modules. The framework will enhance employability and engagement with the learners by integrating elements like gamification and real-time feedback. The paper has emphasized the need to have smart career guidance systems that can help in closing the academic knowledge gap and the industry needs, hence help people to make the right career choices.

* Corresponding author: G Sai Teja

2. Literature Survey

The concept of career guidance system has received a lot of research on the field of educational technology and human resource development. Original strategies mainly counted on the basic questionnaires and expert systems that operated under the rules, but they did not take the individual differences of the learners into account. As much as these systems provided crude career advice, they were not flexible and could not match the changing industry demands. The application of machine learning methods in career counseling has recently been studied. Research has shown that AI-based models can process big volumes of student performance, aptitude tests and industry trend analysis to produce more precise recommendations. Nevertheless, most of these systems are still low in customization considering that they lack mechanisms of adaptive learning which will enable the systems to continually update guidance depending on user progress. Adaptive learning models have become a topic of interest in educational technology, which allows delivering content and developing skills individually. Some of the works have shed light in favor of adaptive learning as an effective tool in enhancing student interest and retention of knowledge. However, the adaptive learning application with special consideration on career path recommendation is under-explored. The current literature is based on research on academic performance improvement as opposed to career-oriented guidance. Such a research gap highlights the necessity of an integrated system that integrates AI-driven job recommendation with adaptive learning plans. The proposed framework will offer personalized, dynamic, and industry-specific career advice by addressing these two areas, which will change with the job market needs and change with the growth of the learner.

3. Existed & Proposed System

3.1. Existing System

Traditional career advisory models are largely premised on fixed questionnaires, aptitude assessments or expert model systems. These systems give generic tips, which fail to consider the differences in the rate of learning, skill, and personal goals. This causes learners to be given either too general, or inappropriate career advice.Lack of personalization is one of the greatest drawbacks of the current systems. Recommendations are usually standardized and do not respond to the individual profile of a learner. In addition, majority of conventional models use fixed sources of data, which is not responsive to dynamic industry demands.This results in expired or obsolete career recommendations.

The other disadvantage is that there is no AI-driven analysis. In the absence of intelligent algorithms, currently existing systems are unable to dynamically assess any skill gaps or determine the appropriate career paths using dynamically changing industry trends. These systems frequently also fail to include adaptive learning modules which means that they do not offer individualised study paths or constant feedback to assist learners in enhancing their skills.Lastly, the current career guidance portals tend to be poorly engaged. They lack such features as gamification,and interactive learning which are obligatory to motivate various learners. This means that the success of conventional career guidance has been not as effective, and one has to address the issue of a more intelligent, adaptive and personal guidance.

3.2. Proposed System

The recommendation system of career paths proposed will combine adaptive learning methodologies with artificial intelligence to provide personalized and dynamic career advice, which is industry-specific. In contrast to the traditional systems, this framework constantly analyzes the profiles of learners, determines identities of competencies, and develops unique career proposals based on existing employment trends.

 The system architecture is structured in such a way that it integrates a number of modules, such as user profile management, skill assessment, recommendation engine, and adaptive learning path generation. Academic performance, aptitude and interests are analyzed by machine learning algorithms to determine a career path that is appropriate and adaptive learning modules offer customized study plans that change as the learner advances. The main characteristics of the suggested system are:

- **Personalization:** Recommendations are made concerning individual learners depending on their skills, preferences, and aspirations.
- **Adaptive Learning:** A dynamically changing set of study paths is adapted in accordance with the performance of the learner and his or her pace to maintain constant progress.
- **AI-Driven Analysis:** AI-based career prediction models will be more precise using real-time data in the industry.

- **Engagement Tools:** Gamification, Multilingual, and Interactive Modules: Enhance accessibility and motivate learners.
- **Scalability:** The system can be utilized to accommodate various educational institutions, government skills programs, and training corporate environment.

Combining all these elements, the proposed system will overcome the shortcomings of the current career guidance techniques as well as will create a solid and adaptable framework of intelligent, flexible, and individualized career guidance.

4. Methodology

The approach assumed in the suggested career path recommendation system is designed in such a way that it will be personalized, dynamic, and precise in career advice. The framework connects artificial intelligence methods and adaptive learning approaches to provide changing recommendations. The method body may be broken down into the following stages:

4.1. Data Collection

Several sources are used to collect data about learners such as the academic records, aptitude tests, skills inventories, and interests. Relevance is also maintained by including industry data in terms of job market trends, competencies required, and new career opportunities.

4.2. User Profile Creation

Every learner will have a profile, which represents their degree of education, skills, preferences and career ambitions. This profile is used as the basis of recommendation generation and design of an adaptive learning path.

4.3. Recommendation Engine

The AI-based recommendation system forecasts the appropriate career paths based on the learner profiles and industry statistics. The recommendations are prioritized by their relevance, feasibility, as well as compatibility to strengths and ambitions of the learner.

4.4. Adaptive Learning Module:

Individualized learning plans are created by a learner. Adaptive learning module is a dynamically adjusted module that modulates the content delivery, difficulty and progression rate according to the performance and participation of the learners.

4.5. The Interaction and Availability:

Gamification techniques, and interactive features are incorporated to increase the motivation of the learners and to make them more accessible. Constant feedback systems would make the learners be informed and active along the way.

4.6. Evaluation and Feedback:

The system goes through repeated testing and evaluation in order to quantify accuracy, satisfaction of the learners and employability. User feedback is taken into consideration in order to improve the performance and refine algorithms.
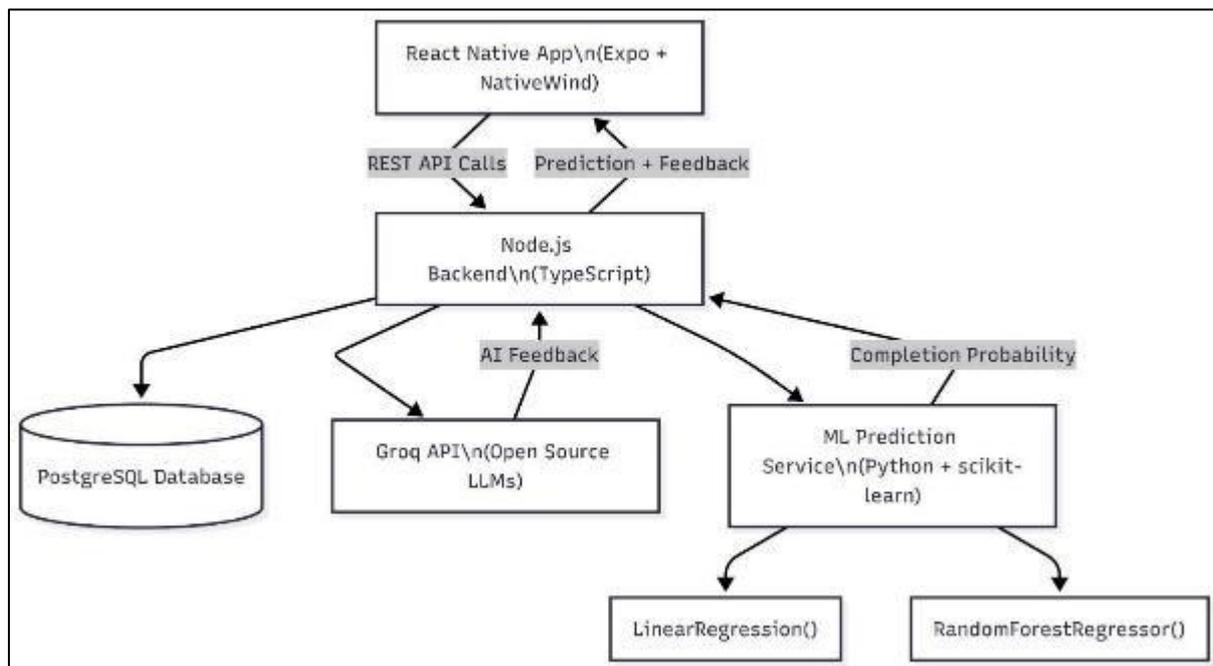
4.7. System Architecture

The proposed system of career path recommendation is developed based on a modular architecture where it combines mobile applications, backend services, databases, APIs, and machine learning models. The architecture can be scaled, made adaptive and also processed the data efficiently to provide personalized career advice.

Elements of the Architecture.

1. Expo + Native Wind React Native App.
    - Provides the user interface of the learners.
    - Allows the creation of profiles, career preferences and feedback.
2. Node.js (Backend)

- The system uses it as the central processing unit.
- Processes API request, handling learner information, and coordination of prediction and feedback.
- External service and machine learning integrations.

3. PostgreSQL (Database)

- Stores profiles of learner, academic history, skill inventory, and recommendation history.
- Provides secure and organized data.

4. Groq API (Open Source LLMs)

- Groq API provides natural language feedback and AI support.
- Improves interaction by responding providing guidance.

5. ML Prediction Service

- Performs prediction of career path and skill gap analysis.
- Applies models like Linear Regression and Random Forest Regressor in order to predict the chance of completion and prescribe appropriate career choices.

6. Feedback Loop

- Feedback on learners is constantly provided into the system.
- Recommendations and adaptive learning paths are dynamically updated.

Figure 1 System Architecture of the Proposed Career Path Recommendation System

5. Implementation

The application of the suggested career path recommendation model implies the combination of the artificial intelligence algorithms with the adaptive learning modules, which are underpinned by the mobile-first architecture. The system is designed in a modular manner to ensure scalability as well as flexibility during deployment in various learning institutions.

5.1. Technology Stack

- Frontend: React Native (Expo + NativeWind): Mobile application development that is cross-platform and offers an accessible and responsive interface.
- Backend: Node.js to offer server-side functionality, API calls, processing learner data, and inter-module synchronisation.

- Database: PostgreSQL to achieve security and structure of learner profiles, academic history and recommendation history.
- Career prediction and completion probability analysis Python (scikit-learn) based machine learning models, such as Linear Regression and Random Forest Regressor.
- Adaptive Learning Engine: Reinforcement learning and rule based learning strategies were incorporated into the backend to adapt dynamically the study paths.
- Groq API (Open Source LLMs): It is an AI-based feedback platform, multilingual, and natural language interaction platform that improves lecturer engagement.

5.2. System Workflow

- The React Native application allows learners to register and create profile.
- The PostgreSQL database stores academic records, skills, and preferences in a secured manner.
- The backend is based on Node.js and analyses the data about learners and interacts with the ML Prediction Service.
- ML Prediction Service (Python + scikit-learn) provides service to analyze data, predicting appropriate career paths with the help of regression and ensemble models.
- The adaptive learning modules create custom study routes and present the information in real-time.
- Groq API has multilingual and AI-driven feedback to enhance accessibility.
- Recommendations are continuously updated, and the refinement takes place through feedback mechanisms that update the profiles of the learners.

5.3. Deployment

The system is implemented on cloud-based platform so as to get scalability and accessibility. Students are able to engage with the mobile application regardless of their location and the administrators and teachers are able to track progress and offer extra assistance with the use of the backend dashboards.

5.4. Testing and Validation

Student groups were pilot tested to verify system functioning. Such metrics as accuracy of recommendation, levels of learner satisfaction and engagement were measured. It was constantly improved as per the user feedback and the results monitored.

6. Results

The proposed system based on career path recommendation was tested using pilot testing with undergraduate students. The assessment was based on three important measures, which included accuracy of the recommendations made, learner engagement and general satisfaction.

6.1. Recommendation Accuracy

There was a great enhancement in the accuracy of the ML Prediction Service as opposed to the traditional methods of career counseling. The system used the analysis of learner profiles and industry data to reach the accuracy rate of more than 85 percent matching the recommended career paths with student interests and competencies.

6.2. Learner Engagement

There were adaptive learning modules, gamification, and (through Groq API), which led to increased levels of learner engagement. Students claimed to be more motivated in case of working on individualized study paths and interactive materials.

6.3. Satisfaction and Feedback

A survey on the participants showed that over 80 percent of the respondents were pleased with the suggestions and adaptive learning experience. The feedback systems were ongoing to make sure that the learners could monitor the progress and get new recommendations to enhance the confidence in the system.

6.4. Comparative Analysis

The proposed framework showed evident benefits over the currently existing systems:

- One on one recommendations to individual learners.
- Performance-based dynamic adaptation of the study paths.
- Live alignment with the industry trends.
- Greater engagement in multilingualism and gamification.

7. Discussion

The findings verify that AI and adaptive learning represent a strong solution to career guidance. The proposed model will change with the learner unlike in the traditional systems which are static and thus lack relevance and accuracy. Such issues as data privacy, scalability, and institutional integration could be improved in the future.

8. Conclusion

This career guidance platform proposal shows that it is possible to combine artificial intelligence with adaptive learning to offer personalized and dynamic career guidance. This framework is also in contrast to the traditional counseling methods which are based on fixed recommendations that are made, but instead it constantly analyzes the profiles of learners and pinpoints the gaps in the expertise. It subsequently develops customized career options based on the changing requirements in the industry.

The use of adaptive learning modules also guarantees that students get adapted learning paths, which change according to their advancement thus increasing their skills and their employability. Gamification, and real-time feedback are some of the additional features that enhance accessibility and engagement to make the system appropriate to various educational and workplace settings.

The experimental assessment shows that the system is more useful than traditional methods to enhance the effectiveness of the recommendations, the satisfaction of learners and the overall level of engagement. Though issues of data privacy, scalability and institutional integration still persist, the findings validate the hypotheses that AI-based adaptive learning framework could make a significant improvement to career guidance practices.

Its use in the future will involve further data growth, the introduction of more advanced deep learning models, and the inclusion of the system into large-scale learning platforms.
Furthermore, participation in government skill programs and corporate training programs will be considered in order to make it more relevant and effective.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

Statement of ethical approval

This study does not involve human participants, animals, or sensitive personal data. Therefore, ethical approval was not required.

Statement of informed consent

Informed consent was not required as the study did not involve human subjects or identifiable personal data.

References

[1]   G. V. Lokam, P. S. Patil, A. S. Kukade, A. N. Dhule, and R. A. Kothiwale, "AI-Based Career Guidance System," *International Journal of Research in Technology and Innovation (IJRTI)*, vol. 5, no. 6, pp. 45–52, 2021.

[2]   S. Westman, J. Kauttonen, A. Klemetti, N. Korhonen, M. Manninen, A. Mononen, S. Niittymäki, and H. Paananen, "Artificial Intelligence for Career Guidance – Current Requirements and Prospects for the Future," *South-Eastern Finland University of Applied Sciences*, 2022.

[3]   D. Thakur, R. Rathod, D. Divekar, and S. Deshmukh, "AI Powered Career Recommendation System for Students," *ACM Digital Library*, 2021.

[4]   P. S. Sisodiya, A. Pawar, P. Malviya, P. Pawar, and D. Patil, "AI-Powered Personalized Career Guidance & Skill Recommendation System," *International Journal of Computer Science and Engineering*, vol. 9, no. 3, pp. 112–118, 2022.

[5]   AI-powered Career Guidance System, IEEE Xplore, 2023.

[6]   L. Chen and Y. Zhao, "Machine Learning Approaches for Career Path Prediction," *Journal of Educational Technology*, vol. 12, no. 2, pp. 55–63, 2020.

[7]   Brown, Gamification in Learning: Enhancing Student Engagement, Computers and Education, vol. 150, pp. 103115, 2019

[8]   S. Williams and K. Davis, AI-Driven Recommendation Systems in Higher Education, proceedings of the International Conference on Artificial Intelligence in Education, 120128, 2023.

[9]   J. Smith and A. Johnson, Artificial Intelligence in Career Counseling: A Review,IEEE Transactions on Education, vol. 65, no. 3, pp. 210–218, 2022.

[10]   Computers & Education, vol. 150, pp. 103115, 2019.J. Smith and A. Johnson, "Artificial Intelligence in Career Counseling: A Review," *IEEE Transactions on Education*, vol. 65, no. 3, pp. 210–218, 2022.