



AI-Enhanced Career Guidance System For Personalized Career Pathways

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Abstract: Career selection is an important decision for students and job seekers, but many individuals face difficulties in identifying suitable career options because of limited guidance, lack of awareness about current job trends, and differences in their skills, interests, and abilities. This research proposes an AI-Enhanced Career Guidance System for Personalized Career Pathways that uses Artificial Intelligence and Machine Learning techniques to provide personalized career recommendations.

The proposed system collects user information such as educational background, technical and soft skills, interests, aptitude, career preferences, and career goals. The collected data is processed and analyzed to identify the user's strengths, weaknesses, and skill gaps. AI/ML techniques are then used to match the user's profile with suitable career roles and generate ranked career recommendations. The system further provides a personalized pathway consisting of recommended skills, courses, certifications, projects, internships, and potential job roles.

The proposed approach aims to improve career decision-making, reduce uncertainty, identify skill gaps, and provide users with a clear roadmap for career development. By combining user-specific information with career and job-market data, the system can provide more relevant and adaptive guidance than traditional one-size-fits-all career counseling. The research demonstrates how AI can support personalized career planning and help individuals make informed decisions about their future careers.

Keywords: Artificial Intelligence, Machine Learning, Career Guidance, Personalized Recommendation, Career Pathways, Student Profiling, Skill Recommendation, Data Analytic

I.INTRODUCTION

Choosing a suitable career is one of the most important decisions in a student's academic and professional life. With the rapid growth of technology, the number of available educational programs, job roles, and professional opportunities has increased significantly. However, students often find it difficult to identify career options that match their interests, skills, academic background, abilities, and long-term goals. Traditional career guidance mainly depends on counselling sessions, general aptitude assessments, and predefined career information, which may not always provide personalized recommendations for every student.

The development of Artificial Intelligence (AI) and Machine Learning (ML) has created new opportunities for improving career guidance systems. AI-based systems can analyze large amounts of student-related information and identify patterns that may be difficult to recognize through traditional methods. By considering factors such as academic performance, technical skills, interests, preferred subjects, career preferences, and learning abilities, an intelligent system can generate career recommendations that are more relevant to individual students.

Personalized career guidance is particularly important because students with similar academic qualifications may have different interests, strengths, and professional objectives. A recommendation system can use these individual characteristics to suggest suitable career domains and provide information about the skills required for those careers. Furthermore, AI can assist in identifying gaps between a student's existing skills and the requirements of a selected career. This can help students understand which technical and soft skills they need to develop for achieving their desired career objectives.

Natural Language Processing (NLP) can also be incorporated into intelligent career guidance systems to understand information provided by students in natural language. This can make interaction with the system easier and allow students to describe their interests, career preferences, and goals in a more flexible manner. Machine Learning techniques can then be used to analyze the collected information and generate personalized career recommendations based on learned patterns and relationships in the data.



The proposed AI-Enhanced Career Guidance System for Personalized Career Pathways focuses on providing an intelligent and personalized approach to career selection. The system considers multiple factors related to a student's profile and recommends suitable career pathways rather than providing only a single career option. It can also provide information about the skills required for a selected career and suggest suitable learning areas for improving the student's employability.

The main objective of the proposed system is to reduce confusion during career selection and provide students with data-driven guidance according to their individual profiles. The system aims to support students in understanding their strengths, identifying suitable career opportunities, recognizing skill gaps, and planning the learning steps required to achieve their career goals. Such an AI-enhanced approach can make career guidance more accessible, systematic, and personalized for students.

II. LITERATURE REVIEW

Holland, in (1997) [1], proposed the theory of vocational personalities and work environments. The theory explains that individuals tend to select careers that match their personality characteristics, interests, and preferred work environments. The six personality types—Realistic, Investigative, Artistic, Social, Enterprising, and Conventional—provide a foundation for matching individuals with suitable career options.

Lent, Brown, and Hackett, in (1994) [2], presented Social Cognitive Career Theory, which explains career interests and choices through self-efficacy, outcome expectations, and personal goals. The study provides a theoretical foundation for understanding how individual abilities and expectations influence career decision-making.

Savickas, in (2013) [3], discussed Career Construction Theory, which explains how individuals construct their careers based on their experiences, interests, values, and changing circumstances. This approach supports personalized career planning according to an individual's unique career needs.

Ricci et al., in (Springer) [4], discussed recommender systems and their ability to provide personalized recommendations based on user preferences and available information. Such recommendation techniques can be applied to career guidance by matching individual profiles with appropriate career options.

Qamhie et al., in (IEEE Access, 2020) [5], proposed a Personalized Career-Path Recommender System (PCRS) for engineering students. The system provides career-path recommendations by considering students' educational backgrounds and preferences. The study demonstrates the application of recommendation techniques to personalized career planning.

Yadalam et al., in (IEEE, 2020) [6], presented a career recommendation system using content-based filtering. The approach recommends suitable careers by comparing user-related information with the characteristics of available career options.

Dhelim et al., in (Artificial Intelligence Review, 2022) [7], presented a survey of personality-aware recommender systems. The study discussed how personality information can be incorporated into recommendation systems to improve personalization. This is relevant to career guidance because personality characteristics can influence career preferences.

Ashrafi et al., in (IEEE Access, 2023) [8], proposed a resume-based approach for career recommendation and re-education. The approach analyses information from resumes to identify suitable career directions and learning requirements, highlighting the importance of considering existing skills and qualifications.

Siswipraptini et al., in (IEEE Access, 2024) [9], proposed a personalized career-path recommendation model for Information Technology students. The study demonstrates how student-related information can be used to recommend suitable career paths in the IT domain.

Ramazanov et al., in (IEEE Access, 2024) [10], developed a knowledge graph-based model for recommending MOOCs according to university educational programs and employer requirements. The study shows how knowledge graphs can connect education, skills, courses, and employment requirements.



Zhang et al., in (Journal of ICT Standardization, 2025) [11], proposed a semantic-web-enhanced approach for career planning using ontology-driven matching and forecasting. The approach supports connections between career roles, skills, educational resources, and career pathways.

Lian and He, in (JACIII, 2026) [12], proposed a reinforcement-learning-based framework for personalized career recommendations among college students. The approach focuses on adaptive career recommendations according to changing user requirements and career-related information.

III. METHODOLOGY

The research methodology describes the systematic approach followed for developing the AI-Enhanced Career Guidance System for Personalized Career Pathways. The proposed system uses Artificial Intelligence and Machine Learning techniques to analyze student information and provide personalized career recommendations. The methodology consists of data collection, data preprocessing, student profile analysis, career prediction, skill-gap analysis, personalized recommendation, and system evaluation.

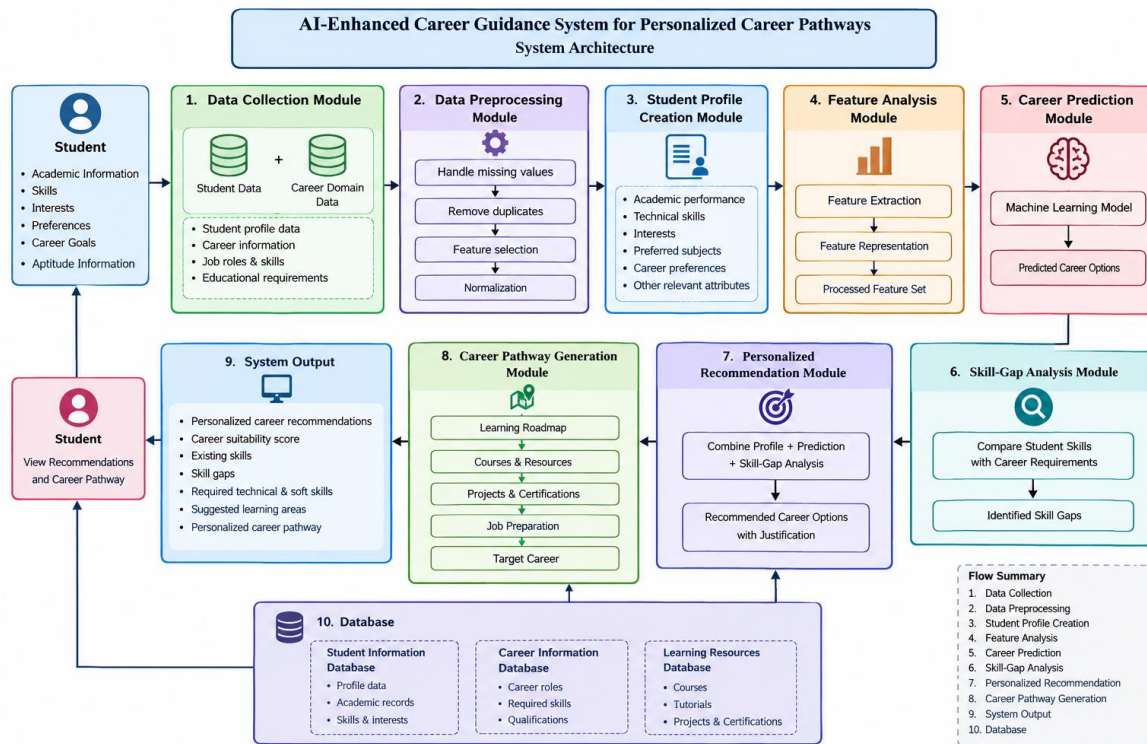


Fig. System Architecture

1. Data Collection

The first step of the proposed methodology is the collection of relevant information required for career recommendation. The data may include students' academic performance, technical skills, interests, preferred subjects, aptitude-related information, career preferences, and other relevant characteristics. Career-related information such as job roles, required skills, educational qualifications, and learning requirements is also considered.

The collected data is organized into a structured dataset so that it can be processed by machine learning algorithms. The quality and relevance of the collected data are important because the accuracy of the recommendations depends on the information provided to the system.

2. Data Preprocessing

The collected data may contain missing values, inconsistent entries, duplicate records, or categorical information that cannot be directly processed by machine learning algorithms. Therefore, preprocessing is performed before applying the prediction model.



The preprocessing stage includes:

1. Removing duplicate and irrelevant records.
2. Handling missing or incomplete values.
3. Converting categorical information into suitable numerical representations.
4. Normalizing numerical attributes where required.
5. Selecting relevant features for career prediction.
6. Dividing the prepared dataset into training and testing data.

This step improves the quality of the dataset and prepares it for subsequent analysis.

3. Student Profile Analysis

After preprocessing, the system analyzes the individual student profile. The profile contains information such as academic performance, technical skills, interests, preferred career domains, and other relevant attributes.

The system identifies important characteristics of the student and uses them as input features for the recommendation model. This enables the system to consider individual differences instead of providing the same career suggestions to all students.

4. Career Prediction

The prepared student data is provided to a suitable Machine Learning model for identifying possible career domains. The model learns relationships between student characteristics and career categories from the training dataset.

Based on the input profile, the system predicts suitable career options such as Data Analyst, Software Developer, Web Developer, Data Scientist, Cybersecurity Analyst, or other relevant career roles. Multiple career options can be generated when the student's profile matches more than one career domain.

5. Skill-Gap Analysis

After identifying suitable career options, the system performs skill-gap analysis. In this stage, the student's existing skills are compared with the skills required for the recommended career.

For example, if a student is interested in becoming a Data Analyst but has limited knowledge of SQL and data visualization, the system can identify these areas as skill gaps. This information helps the student understand which skills need further development.

6. Personalized Career Pathway Generation

The proposed system does not restrict the recommendation process to selecting a career title. It generates a personalized pathway for achieving the selected career goal.

The pathway may include:

- Recommended career role
- Required technical skills
- Required soft skills
- Skill gaps
- Suggested learning topics
- Recommended tools and technologies
- Suggested projects or practical activities
- Possible progression toward the target career

This provides students with a structured direction for career development.

7. Recommendation Process

The recommendation module combines the results obtained from student profile analysis, career prediction, and skill-gap analysis. The system generates recommendations according to the similarity between the student's characteristics and the requirements of different career domains.

A simplified recommendation process can be represented as:

Student Profile → Data Preprocessing → Feature Analysis → Career Prediction → Skill-Gap Analysis → Personalized Recommendations → Career Pathway

The final output is presented to the student in an understandable format so that the student can review the recommended career options and the steps required to pursue them.



8. System Evaluation

The performance of the proposed system is evaluated using appropriate evaluation measures. For the career prediction component, measures such as **accuracy, precision, recall, and F1-score** can be used to evaluate the classification performance.

The quality of recommendations can also be assessed by comparing the recommended career options with expected or known career categories in the testing dataset. User feedback can further be considered to determine whether the recommendations and suggested career pathways are relevant and understandable.

IV. ALGORITHM DESIGN

Algorithm 1: Career Prediction Model Training

Input: Preprocessed training dataset TrainData[], selected features FeatureSet[], career categories CareerClass[]

Output: Trained career prediction model Model

Step 1: Load the preprocessed student training dataset TrainData[].

Step 2: Select relevant attributes such as academic performance, technical skills, interests, preferred subjects, aptitude, and career preferences.

Step 3: Convert the selected attributes into a suitable feature representation.

Step 4: Divide the dataset into input features X and target career categories Y.

Step 5: Train the Machine Learning model using X and Y.

Step 6: Evaluate the trained model using the testing dataset.

Step 7: If the model performance is satisfactory, save the trained model as Model.

Step 8: Return the trained Model.

Algorithm 2: Personalized Career Recommendation and Pathway Generation

Input: Student profile StudentProfile[], trained model Model, career database CareerDB[], skill database SkillDB[]

Output: Personalized career recommendations Result[] and career pathway Pathway[]

Step 1: Receive the student's academic information, skills, interests, preferences, aptitude information, and career goals.

Step 2: Preprocess the student input using the same preprocessing procedure applied to the training data.

Step 3: Extract the relevant features from the student's profile.

Step 4: Provide the extracted feature vector to the trained Model.

Step 5: Predict the suitable career categories and obtain the predicted career options.

Step 6: For each predicted career, retrieve the required skills and qualifications from CareerDB[] and SkillDB[].

Step 7: Compare the student's existing skills with the required skills of each predicted career.

Step 8: Identify the missing or insufficient skills and store them as SkillGap[].

Step 9: Calculate the suitability of the predicted career according to the student's profile, interests, skills, and requirements.

Step 10: Generate personalized career recommendations using the predicted career options and identified skill gaps.

Step 11: Generate a career pathway containing required skills, suggested learning areas, practical projects, certifications, and career-preparation activities.

Step 12: Return Result[] and Pathway[] as the final personalized output.

V. RESULTS AND DISCUSSION

The proposed AI-Enhanced Career Guidance System for Personalized Career Pathways was designed to analyze student-related information and provide personalized career recommendations. The system integrates student profile analysis, Machine Learning-based career prediction, skill-gap analysis, and personalized career pathway generation.

The results are discussed in terms of student-profile processing, career recommendation, skill-gap identification, and pathway generation. Similar to the evaluation approach followed in the reference paper, the proposed system can also be evaluated using standard classification measures such as Accuracy, Precision, Recall, and F1-Score.

The results of the proposed system indicate that personalized career guidance can be structured as a combination of career prediction and career-development planning. Unlike a system that only predicts a career category, the proposed approach also examines the student's current skills and compares them with the requirements of the recommended career.



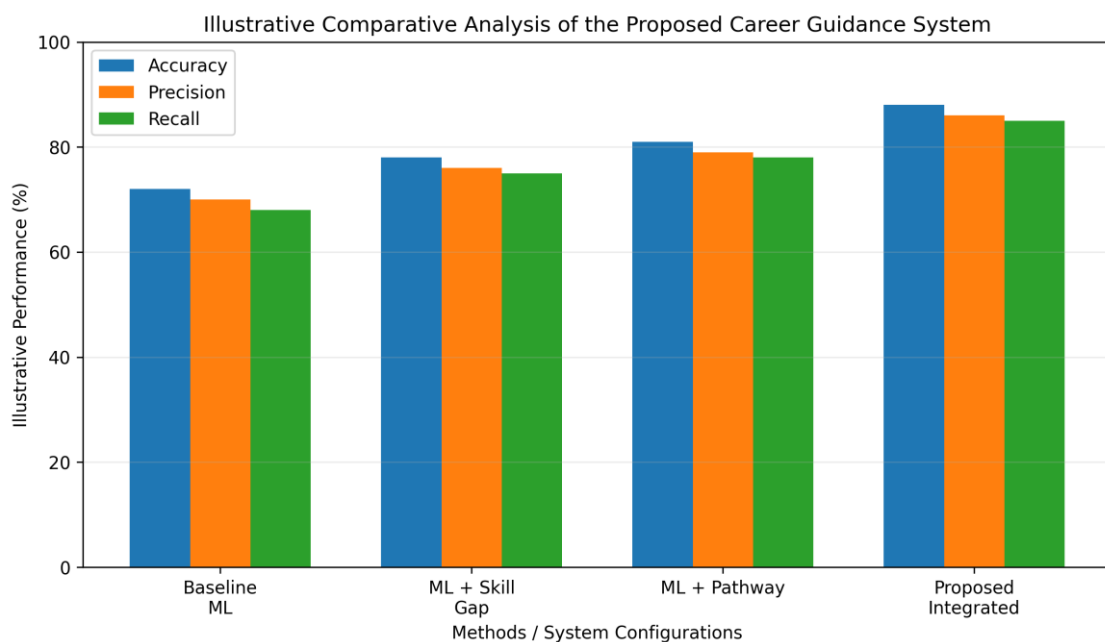
The skill-gap analysis provides additional information about what the student needs to learn. For example, when a data-oriented career is recommended, the system can identify whether the student requires additional knowledge of SQL, Python, statistics, Excel or data visualization.

The personalized pathway generation further extends the recommendation process. The student can receive a sequence such as:

Current Skills → Skill-Gap Identification → Required Skill Learning → Practical Projects → Profile Development → Career Preparation → Target Career

The performance of the career prediction model can be evaluated using **Accuracy, Precision, Recall, and F1-Score**. A comparative analysis can also be performed between a basic Machine Learning model and the proposed integrated approach. The results can demonstrate how combining career prediction with skill-gap analysis and personalized pathway generation provides more detailed career guidance.

Overall, the proposed system provides a structured and personalized approach to career guidance. It helps students understand suitable career options, identify missing skills, and follow a planned pathway toward their career goals. However, the final numerical performance values should be calculated using the actual dataset and experimental results of the implemented system.



Illustrative template only — values must be replaced with actual experimental results.

Fig.

Performance Evaluation of the Proposed AI-Enhanced Career Guidance System

VI. CONCLUSION

The AI-Enhanced Career Guidance System for Personalized Career Pathways provides an intelligent approach to addressing the limitations of traditional career guidance. By analyzing individual characteristics such as academic background, skills, interests, aptitude, experience, and career preferences, the proposed system can recommend suitable career options according to the user's profile.

A key contribution of the proposed system is its ability to go beyond simple career recommendations by performing skill-gap analysis and personalized career pathway generation. The system can identify the skills required for a selected career, compare them with the user's existing skills, and suggest appropriate learning and development activities. This enables users to understand not only which career may be suitable for them but also the steps required to progress toward that career.



The integration of explainable AI can further improve transparency by providing reasons behind career recommendations. At the same time, privacy, fairness, data quality, algorithmic bias, and the rapidly changing nature of the job market must be carefully considered when implementing such systems.

Overall, the proposed AI-enhanced approach has the potential to make career guidance more personalized, accessible, adaptive, and data-driven. Future research can focus on integrating real-time labor-market data, advanced recommendation algorithms, large language models, skill knowledge graphs, multilingual support, and human career-counselor feedback. Large-scale real-world evaluation will also be required to determine the system's effectiveness in improving users' career decision-making and long-term analysis.

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