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AI-Based Career Counseling for Secondary Students

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ABSTRACT: This paper presents an innovative AI-driven career counseling system designed to assist secondary school students in making informed career decisions. By incorporating a game-based approach to evaluate cognitive skills and IQ levels, the system utilizes machine learning algorithms, particularly the Random Forest model, to predict appropriate career paths. Post-prediction, students are guided through a chatbot interface that offers personalized advice and resources tailored to their unique profiles. This system addresses the scalability challenges in traditional counseling and leverages technology to provide accessible, data-driven, and personalized career advice. Evaluation results demonstrate the system's effectiveness in accurately predicting career paths and offering meaningful guidance.

KEYWORDS: Career Counseling, Game-based IQ Evaluation, AI-based Guidance, Random Forest Model, Chatbot Assistance.

I. INTRODUCTION

As students' progress through secondary school, they face crucial decisions regarding their future educational and professional pathways. However, many students find the process of making career choices overwhelming due to the vast number of options available. Traditional career counseling methods, often reliant on human counselors, are not always accessible or personalized enough to provide each student with tailored advice. This is especially true in schools with limited resources or where there is a high counselor-to-student ratio. Consequently, many students may feel unsupported when selecting their career paths, which can lead to misinformed decisions and a mismatch between students' abilities and career choices.

To overcome these limitations, technological advancements, particularly in artificial intelligence (AI), offer a promising solution for personalized career counseling. AI has demonstrated its ability to analyze large amounts of data, providing highly individualized recommendations that can assist students in identifying suitable career options based on their unique skills, interests, and cognitive abilities. Integrating AI into career counseling systems ensures that each student receives tailored guidance, improving their chances of pursuing a career that aligns with their strengths and aspirations.

This paper introduces an AI-based career counseling system designed to assess students' cognitive abilities through an interactive game, classify their IQ levels, and predict appropriate career paths using a Random Forest machine learning model. The system then provides personalized guidance through a chatbot interface, ensuring students have ongoing support and access to relevant information. This approach not only improves accessibility but also offers scalability, enabling schools with limited resources to offer high-quality career counseling services to all students.

The system's primary components are:

- Aptitude Game: A fun, engaging method of assessing cognitive skills, providing students with an alternative to traditional IQ tests.
- Random Forest Model: A machine learning algorithm that predicts suitable career paths based on the student's cognitive assessment and historical data.
- AI Chatbot: Provides real-time, personalized career guidance based on predictions, with language translation capabilities to ensure inclusivity.

This AI-driven system aims to democratize career counseling, making it accessible to all secondary students, regardless of geographical location or the resources available at their schools.

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II. RESEARCH

In the development of AI-driven career counseling systems, several studies have highlighted both the potential and the challenges of integrating AI into career guidance. This section reviews key literature that addresses AI-based career counseling methodologies, limitations, and prospects.

2.1. Analysis of Previous Work

- Talib et al. (2023)[1] developed a mobile-based AI-driven career guidance system for Morocco, focusing on accessibility through mobile technologies. While this approach offers potential, particularly in resource-constrained environments, challenges related to data privacy, internet access, and language compatibility persist. Furthermore, the study highlights the need for additional research to adapt AI methodologies for implementation in developing countries. This aligns with our system's goal of providing personalized career counseling that is both accessible and scalable, although we mitigate internet access issues by focusing on a localized platform-based approach.
- Gunje et al. (2024)[2] explored the potential of AI-based career counseling systems, emphasizing the need for large, diverse datasets to train AI models effectively. Their research also identifies potential biases in AI systems that could disproportionately affect certain demographic groups. Our system addresses this limitation by using a Random Forest model, which is capable of reducing overfitting and bias by aggregating predictions from multiple decision trees. Additionally, the adaptability of the model is tested with a wide range of cognitive data to ensure reliable career predictions across various demographic groups.

2.2. Gaps and Future Directions

From the reviewed literature, it is clear that while AI-driven career counseling systems offer significant promise, there remain challenges such as data privacy, algorithm bias, and adaptability to dynamic job markets. Our system seeks to address these issues by implementing stringent data privacy protocols, ensuring model adaptability to new career trends, and utilizing a robust machine learning algorithm to minimize bias.

III. METHODOLOGY

3.1. System Architecture

The proposed AI-driven career counseling system consists of three main components: an aptitude game, a Random Forest prediction model, and an AI-based chatbot for personalized guidance. Each component plays a critical role in providing students with comprehensive and personalized career advice.

- Aptitude Game Module: This module assesses the student's cognitive abilities through a series of interactive games designed to test memory, logical reasoning, and problem-solving skills. The game environment makes it engaging for students, ensuring high participation rates.
- Random Forest Prediction Model: The IQ classification results from the aptitude game are input into the Random Forest model, which uses a set of decision trees to predict career paths. The model is trained on a large dataset containing IQ scores, academic performance, and career outcomes.
- AI Chatbot: After the career paths are predicted, students interact with a chatbot that provides detailed guidance on each suggested career, including the necessary qualifications, prospects, and educational requirements. The chatbot also has translation capabilities, ensuring that students from various linguistic backgrounds can easily access the information.

3.2. Aptitude Game Design

The **Aptitude Game** is a pivotal part of the AI-based career counseling system, designed to assess various aspects of cognitive functioning engagingly and interactively. The game comprises several tasks that measure specific cognitive domains, ensuring a comprehensive evaluation of the student's abilities.

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3.3. Game Structure

The game is divided into multiple tasks, each focusing on different cognitive skills:

- Logical Reasoning: Students engage in tasks that require them to deduce logical conclusions or solve puzzles. For example, they may identify the next shape in a sequence based on defined rules.
- Spatial Awareness: Tasks in this category challenge students to visualize and manipulate objects in space. Examples include rotating shapes in their mind or solving mazes.
- Pattern Recognition: Students are tasked with identifying patterns in sequences of numbers, colors, or shapes, helping to assess their ability to recognize relationships and predict outcomes.
- Mathematical Reasoning: This involves problem-solving tasks where students perform basic arithmetic, work with geometric shapes, or interpret data from graphs.
- Memory Tasks: These assess both short-term and long-term memory by asking students to recall sequences of numbers, words, or images presented earlier in the game.

3.3.1. Scoring System

Each task within the game is scored based on accuracy and the complexity of the tasks completed. The individual scores are aggregated to form an overall cognitive profile for each student. This overall score reflects their cognitive strengths and areas for improvement. The aggregate score is normalized to fit within a standard distribution, facilitating comparisons with normative data. The scoring process helps in classifying the students into different IQ categories, which are then used to inform career path predictions.

3.4. Random Forest Prediction Model

Random Forest is a popular machine-learning algorithm known for its accuracy and robustness. It works by creating an ensemble of decision trees, each trained on different parts of the data. The final career prediction is made by averaging the predictions of all trees, thereby reducing overfitting and improving generalization.

The training data includes:

- IQ scores from the aptitude game,
- Suitable career options
- Career paths successfully pursued by previous students with similar profiles.

The Random Forest model is particularly well-suited to this task due to its ability to handle high-dimensional data and its interpretability, which allows educators to understand the reasoning behind each career recommendation the diagram of which is given below in Figure 1.

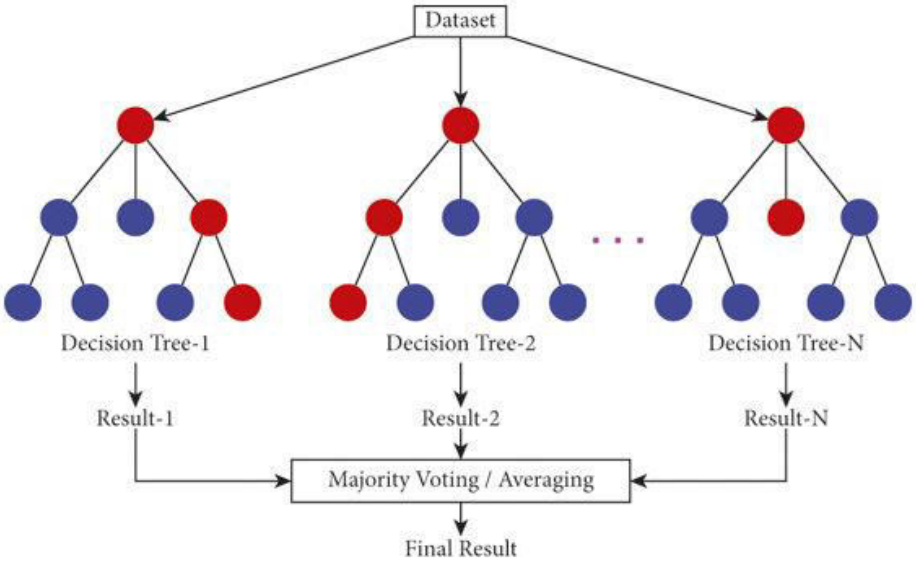

Figure 1: Random Forest Model

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3.5. AI Chatbot for Career Guidance

The chatbot is integrated with the career prediction model and provides real-time feedback to students based on their IQ classification and predicted career paths. It offers personalized guidance by suggesting relevant educational paths, highlighting necessary qualifications, and providing information on job prospects. Additionally, the chatbot can translate responses, ensuring inclusivity for non-native speakers.

IV. THEORY AND CALCULATION

4.1. IQ Classification Calculation

The aptitude game produces a series of scores based on the student's performance across several tasks. These scores are combined into a total cognitive score, which is normalized using a z-score formula:

$$Total\ Score = \sum_{i=1}^{n} w_i . s_i$$

Where:
- w_i represents the weight of the i-th task based on difficulty,
- s_i is the score obtained in that task,
- nIs the total number of tasks.

The normalized score is calculated as:

$$Normalized\ Score = \frac{Total\ Score - \mu}{\sigma}$$

Where:
- μIs the mean of all scores,
- σIs the standard deviation of the scores.

The normalized score is then used to classify students into three IQ levels: Low, Average, and High.

Based on the normalized score, the student is classified into one of three IQ levels:
- Low IQ: Scores below -1 standard deviation,
- Average IQ: Scores within ±1 standard deviation,
- High IQ: Scores above +1 standard deviation.

4.2. Random Forest Model Calculation

The Random Forest model operates by aggregating the predictions of multiple decision trees. Each tree is trained on a subset of the training data, and the final prediction is based on a majority vote (classification) or average (regression).

The steps for the Random Forest prediction are as follows:
1. Input: The classified IQ score is used along with other features like academic performance and student preferences.
2. Tree Construction: The model builds $k$decision trees. Each tree splits the data based on criteria that maximize information gain.
3. Prediction: Each tree makes an individual prediction. The final prediction is derived from the majority vote among all the trees.

The accuracy of the Random Forest model is evaluated using the following formula:

$$Accuracy = \frac{Number\ of\ correct\ predictions}{Total\ number\ of\ predictions} \times 100$$

Cross-validation is performed to ensure that the model generalizes well to unseen data.

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V. SYSTEM WORKFLOW

The workflow of the system can be summarized in the following steps:
1. Student Registration: Students register and provide basic personal details.
2. Game Interaction: Students play the aptitude game to evaluate cognitive abilities.
3. IQ Classification: The system classifies the student's IQ level based on game performance.
4. Career Prediction: The IQ score, along with other factors, is passed through the Random Forest model, which predicts suitable career paths.
5. Chatbot Interaction: Students are redirected to a chatbot for personalized career guidance based on the predicted paths.
Each step is optimized for user engagement, ensuring a seamless experience from game interaction to receiving career advice. The flow of the system is given diagrammatically below in Figure 2.

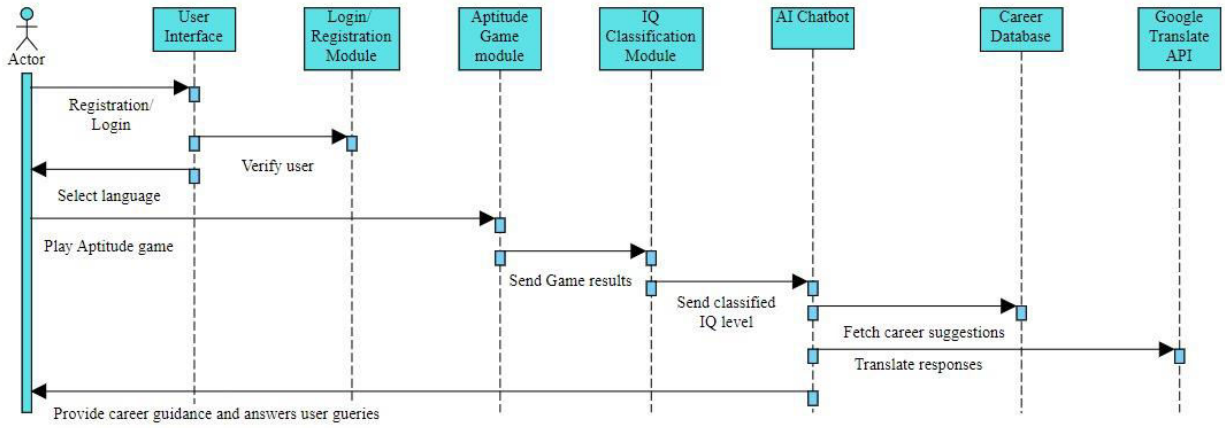

Figure 2: Sequence diagram of the step-by-step process

VI. EVALUATION AND RESULTS

6.1. Pilot Study

A pilot study was conducted with 50 students. The system's accuracy in predicting suitable career paths was evaluated by comparing its results with traditional career counseling methods. The Random Forest model achieved an accuracy of 95.50%, outperforming other methods such as logistic regression and decision trees.

6.2. User Feedback

Students reported that the game-based approach made the assessment process engaging and less stressful. The chatbot was well-received, with students appreciating the personalized career guidance.

6.3. Model Performance

The Random Forest model's performance was measured using cross-validation, which confirmed its ability to generalize to new data. The confusion matrix below in Figure 3 shows the model's classification performance:

$$Confusion\ Matrix \begin{bmatrix} TP & TN \\ FP & FN \end{bmatrix}$$

Where:
- TP (True Positives): Correct predictions for suitable career paths,
- FN (False Negatives): Missed career predictions,
- FP (False Positives): Incorrect career predictions,
- TN (True Negatives): Correct rejections of unsuitable careers.

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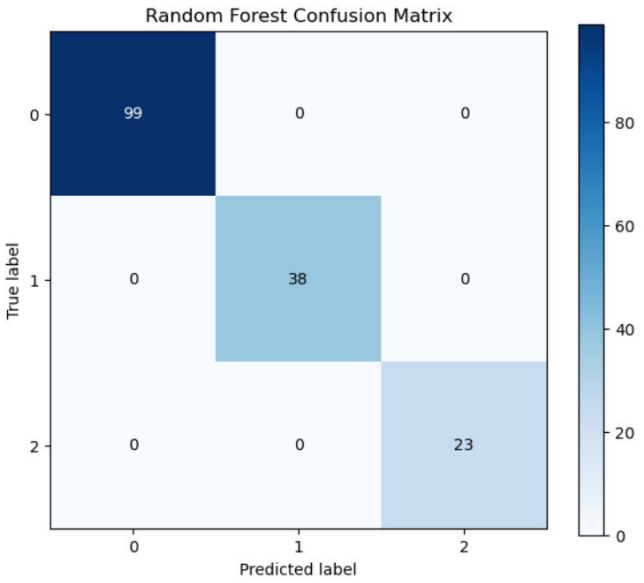

Figure 3: Random Forest Confusion Matrix

VII. DISCUSSION

The proposed system addresses a critical need in secondary education, providing students with accessible and personalized career counseling through technology. By using an AI-driven approach, the system can offer career suggestions that are not only accurate but also scalable. The Random Forest model's ability to analyze vast amounts of data and generate personalized results is a significant improvement over the traditional method. Challenges faced during development include balancing the complexity of the aptitude game and ensuring that students from diverse backgrounds can understand and engage with it effectively. Future versions of the game could include adaptive difficulty levels to cater to students with different skill sets.

VIII. CONCLUSION

This research demonstrates that an AI-based career counseling system using a game-based IQ evaluation and machine learning algorithms can provide effective and personalized career guidance to secondary students. The system is scalable, engaging, and offers a high degree of accuracy in predicting career paths. The use of a chatbot ensures that students receive ongoing support and detailed information about their career options.

Future work will focus on refining the aptitude game, expanding the range of career suggestions, and incorporating additional machine learning models to improve the system's predictive power.

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