

MentorChain: An AI-Powered Career Recommendation and Blockchain-Based Verification Platform

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ABSTRACT

This study presents MentorChain, an AI-powered career recommendation and verification platform designed to assist students in making informed academic and professional decisions. The system integrates psychometric assessment, ensemble machine learning, automated report generation, and blockchain-based verification within a unified framework.

A 29-item psychometric questionnaire captures student interests, aptitude, and personality traits, which are processed through feature engineering to generate predictive inputs. The recommendation engine employs a calibrated soft-voting ensemble of Random Forest and XGBoost classifiers trained on a dataset of 12,000 synthetic student profiles across 13 career domains.

Experimental results demonstrate high performance, achieving an accuracy of 97.71%, an F1-score of 97.71%, and a log-loss of 0.0975. The system generates personalized career recommendations along with confidence-based explanations and automated PDF reports.

To ensure report integrity, cryptographic hashes are stored on a blockchain using smart contracts, enabling tamper-evident verification without exposing sensitive user data. The proposed system combines artificial intelligence and blockchain technology to provide secure, transparent, and personalized career guidance.

General Terms

Machine Learning, Blockchain Technology, Educational Systems, Security, Privacy, Decentralized Systems

Keywords

Artificial Intelligence, Blockchain, Career Guidance, Machine Learning, Educational Technology, Decentralized Systems, Psychometric Assessment

1. INTRODUCTION

Choosing a career is one of the most important decisions in a student's life, as it influences future education, professional growth, and personal satisfaction. However, many students find it difficult to identify a career path that matches their interests, abilities, and personality. Career decisions are often influenced by peer pressure, family expectations, social trends, or limited awareness of available opportunities, which can result in confusion and unsuitable career choices.

Traditional career counselling methods usually depend on manual assessments and expert guidance. While these approaches provide valuable support, they can be time-consuming, subjective, and difficult to scale for a large number of students. In addition, many existing career guidance systems focus primarily on recommendation generation and provide limited support for report authenticity, explainability, and secure verification. and often lack mechanisms to

ensure the authenticity and security of generated reports.

Recent advancements in Artificial Intelligence (AI) have created new opportunities for developing intelligent career guidance systems. Machine learning techniques can analyze multiple factors such as aptitude, interests, personality traits, and behavioural patterns to generate personalized career recommendations. At the same time, blockchain technology offers a secure and transparent method for verifying digital records and protecting them from unauthorized modifications.

To address these challenges, MentorChain was developed as an AI-powered career recommendation and verification platform. The system uses a 29-question psychometric assessment to understand student characteristics and applies ensemble machine learning models, including Random Forest and XGBoost, to predict suitable career paths across thirteen professional domains. The platform further generates detailed PDF reports and secures their authenticity through blockchain-based hash verification.

By combining psychometric analysis, machine learning, automated reporting, and blockchain security within a single platform, MentorChain provides a practical and reliable solution for personalized career guidance. The system aims to assist students in making informed career decisions while ensuring transparency, trust, and accessibility throughout the guidance process.

2. SURVEY OF LITERATURE

2.1 AI-Based Career Assessment Foundation

Artificial Intelligence (AI) has significantly transformed career assessment by enabling the automated analysis of student interests, aptitude, personality traits, and academic performance. Traditional career counselling methods often rely on manual evaluation and expert judgement, which can be subjective and difficult to scale. Machine learning algorithms such as Decision Trees, Random Forest, and Naive Bayes have been widely adopted for career prediction tasks due to their ability to identify patterns within student data and generate personalized recommendations [19], [20]. Recent advancements in Natural Language Processing (NLP) have further enhanced career guidance systems by enabling the analysis of textual information from resumes, academic records, and user profiles [5].

Deep learning techniques have also shown promising results in career recommendation systems. Models based on BERT and Bidirectional Long Short-Term Memory (Bi-LSTM) networks have demonstrated improved performance in understanding contextual relationships within educational and career-related data, resulting in more accurate recommendations [21], [22].

2.2 Blockchain Security in Educational Technology

Blockchain technology has emerged as an effective solution for addressing security, transparency, and trust issues in educational systems. The decentralized and immutable nature of blockchain ensures that records cannot be altered once stored, thereby improving the reliability of academic credentials and digital documents [1], [6]. Smart contracts enable automated verification processes without requiring centralized authorities, reducing the risk of fraud and unauthorized modifications [6], [10].

Several studies have explored blockchain-based storage architectures for educational applications. Saif et al. proposed the integration of Blockchain and IPFS to provide secure and distributed data storage while maintaining accessibility and integrity [1]. Similarly, Saini and Sharma introduced a hierarchical semi-decentralized storage model that improves security and scalability in educational environments [13]. These approaches demonstrate the potential of blockchain for protecting sensitive educational records and assessment reports.

2.3 AI-Based Career Prediction and Assessment

Recent research has shown substantial progress in AI-powered career guidance systems. Lokam et al. developed an AI-based career guidance system that utilized machine learning and natural language processing techniques to provide personalized recommendations based on user profiles and market trends [5]. Their work demonstrated the effectiveness of data-driven career matching using similarity-based approaches.

Aher and Ingole proposed an integrated framework combining personality analysis and sentiment analysis to generate career recommendations based on psychological traits and user interests [18]. Their approach highlighted the importance of considering multiple dimensions of student behavior during career assessment. Suganya et al. compared Decision Tree, Random Forest, and Naive Bayes algorithms for career classification and reported Random Forest as the most effective model among the evaluated classifiers [19]. These studies confirm the growing importance of machine learning techniques in supporting career-related decision making..

2.4 Psychometric Assessment and Emotional Intelligence

Psychometric assessment has become an important component of modern career guidance systems because it helps evaluate an individual's interests, personality, aptitude, and behavioral characteristics. Wang and Ji introduced Psychor, a psychometric-inspired benchmark designed to evaluate the reasoning and intelligence capabilities of AI systems beyond conventional task-oriented assessment methods [7]. Their work emphasizes the value of comprehensive psychological evaluation frameworks.

Researchers have also investigated emotional intelligence as a factor in career recommendation systems. Wang et al. validated machine learning approaches for psychometric analysis and demonstrated the effectiveness of AI models in assessing behavioral traits and cognitive characteristics [17]. These findings indicate that integrating psychometric assessment with machine learning can improve the quality and personalization of career recommendations.

3. COMPARATIVE ANALYSIS

Table 1. Comparative Analysis of AI and Blockchain Approaches

Study	Methodology	Key Outcome	Scalability	Limitations
Lokam et al. [5]	ML + NLP	Personalized career recommendations	Moderate	Limited real-time data
Aher & Ingole [19]	Big Five + Sentiment Analysis	Improved behavioral assessment	Low	Privacy concerns and limited data sources
Suganya et al. [20]	Decision Tree, Random Forest, Naive Bayes	Random Forest achieved highest accuracy	Moderate	Focused mainly on academic attributes
Saif et al. [1]	Blockchain + IPFS	Secure decentralized storage	High	Computational overhead
Wang et al. [6]	Smart contracts + CP-ABE	Secure record verification	High	Complexity
Mentor-Chain (Proposed)	Psychometric Assessment + Ensemble ML + Blockchain Verification	Personalized career prediction with secure report verification	High	Performance depends on dataset quality

4. RESEARCH GAP AND MOTIVATION

4.1 Identified Research Gaps

The literature review reveals several limitations in existing career guidance systems. Most AI-based career recommendation platforms focus primarily on prediction accuracy but provide limited support for report authenticity, security, and verification. On the other hand, blockchain-based educational systems emphasize secure storage and credential validation but lack intelligent career prediction capabilities [1], [6].

Many existing solutions rely on a single machine learning model and do not incorporate psychometric assessment, behavioral analysis, and aptitude evaluation within a unified framework [18], [19]. Furthermore, generated career reports are often stored in centralized systems, making them vulnerable to unauthorized modification and reducing user trust.

Another important limitation is the lack of integrated platforms that support multiple stakeholders such as students, psychologists, and administrators. Most systems provide recommendations but do not offer monitoring, report management, or secure verification mechanisms.

To address these challenges, MentorChain integrates psychometric assessment, ensemble machine learning, automated PDF report generation, psychologist monitoring, and blockchain-based report verification into a single platform. The proposed system aims to provide accurate, secure, and trustworthy career recommendations while maintaining data integrity and transparency.

MENTOR-CHAIN SYSTEM ARCHITECTURE

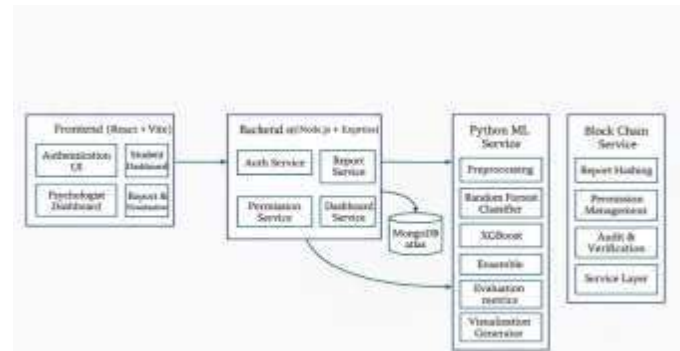
MentorChain is an AI-powered career recommendation and verification platform designed to assist students in making informed academic and professional decisions. The system combines psychometric assessment, ensemble machine learning, explainable artificial intelligence, automated report generation, and blockchain technology to provide personalized and secure career guidance.

The platform begins with a 29-question psychometric assessment that evaluates student interests, aptitude, personality traits, and career preferences. The collected responses are processed through a feature engineering pipeline that transforms 18 raw attributes into 45 informative features, including academic composites, personality indicators, career-orientation metrics, interaction features, and statistical measures. These engineered features are analyzed using a calibrated soft-voting ensemble model consisting of Random Forest and XGBoost classifiers to predict suitable career domains.

Based on the prediction results, the system generates a detailed PDF career report containing recommended career paths, confidence scores, confidence tiers, and personalized guidance. The recommendation engine also provides dynamic sub-role suggestions and feature-based explanations to improve transparency and interpretability. To ensure authenticity and prevent tampering, a cryptographic hash of the generated report is recorded on the blockchain using Solidity smart contracts.

The platform provides dedicated dashboards for students and psychologists, enabling assessment management, report generation, recommendation analysis, and secure verification of career reports. By integrating artificial intelligence, explainable machine learning, and blockchain-based verification, MentorChain delivers personalized, transparent, secure, and trustworthy career guidance while maintaining the integrity of generated assessment reports.

Fig. 1. Proposed Block Diagram of Mentor Chain System



5. METHODOLOGY

The MentorChain platform was developed to provide students with personalized career guidance while ensuring the authenticity and security of generated assessment reports. The overall workflow consists of psychometric assessment, data processing, machine learning-based prediction, report generation, and blockchain verification.

5.1 Psychometric Assessment

The process begins with a psychometric assessment consisting of 29 carefully designed questions. These questions evaluate various aspects of a student's profile, including interests, aptitude, personality traits, strengths, and career preferences. The responses collected from the assessment form the foundation for career analysis and recommendation.

5.2 Data Processing and Feature Engineering

The assessment responses are converted into numerical values representing different student characteristics. Initially, 18 raw attributes are extracted from the questionnaire. To improve prediction quality, these attributes undergo feature engineering, where additional meaningful indicators are derived. This process generates 45 features that capture academic performance, personality characteristics, career orientation, and relationships between multiple traits.

5.3 Career Prediction Using Ensemble Learning

To train the recommendation system, a synthetic dataset containing 12,000 student profiles across 13 career domains was created. The prediction model combines Random Forest and XGBoost algorithms using a calibrated soft-voting ensemble approach. This combination helps leverage the strengths of both algorithms and improves the reliability of career recommendations. Based on the processed student profile, the model predicts the most suitable career domains and assigns confidence scores to each recommendation.

5.4 Recommendation Interpretation

In addition to predicting career domains, the system provides confidence-based explanations to help users understand the recommendation process. Students receive multiple career options along with confidence levels and specialized career paths related to their predicted domain. This approach improves transparency and supports informed decision-making.

5.5 Automated Report Generation

Once the prediction process is completed, the system automatically generates a detailed PDF report. The report includes assessment results, recommended career paths, confidence scores, and personalized guidance. This document can be used by students, educators, and career counsellors for further discussion and planning.

5.6 Blockchain-Based Verification

To ensure that generated reports remain authentic and tamper-proof, a cryptographic hash of each report is stored on the blockchain through a Solidity smart contract. Instead of storing the complete report on-chain, only the hash value is recorded, preserving privacy while allowing future verification of report integrity.

6. PERFORMANCE EVALUATION

The performance of the MentorChain recommendation engine was evaluated using a synthetic dataset containing 12,000 student profiles distributed across 13 career domains. The dataset was divided into training and testing sets, and predictions were generated using a calibrated soft-voting ensemble consisting of Random Forest and XGBoost classifiers.

Feature engineering was applied to transform 18 raw assessment attributes into 45 engineered features, including career-orientation indicators, interaction features, and statistical measures. These engineered features improved the model's ability to capture complex relationships between student interests, aptitude, personality traits, and career preferences.

Experimental results demonstrated strong predictive performance. The Random Forest model achieved an accuracy of 97.00%, while the XGBoost classifier achieved an accuracy of 97.75%. The proposed ensemble model obtained an overall classification accuracy of 97.71%, a weighted F1-score of 97.71%, and a log-loss value of 0.0975. These results indicate that the ensemble model provides reliable and well-calibrated career recommendations across multiple career categories.

The generated recommendations are further enhanced through confidence-based ranking and dynamic sub-role suggestions, enabling students to explore specialized career paths aligned with their strengths and interests.

Table 2. Performance Table

Model	Accuracy (%)	Weighted F1-Score (%)	Log Loss
Random Forest	97.00	97.00	0.1614
XGBoost	97.75	97.75	0.1248
Proposed Ensemble	97.71	97.71	0.0975

7. RESULTS AND DISCUSSION

Figure 4.1: Psychometric Assessment Interface



Fig. 4.1. Psychometric assessment interface used for collecting student interests, aptitude, and personality traits.

Figure 4.2: Career Recommendation Results



Fig. 4.2. Career recommendation dashboard displaying predicted career domains and confidence scores.

Figure 4.3: Generated PDF Report



Fig. 4.2. Generated pdf report

Figure 4.4: Blockchain Verification



Fig. 4.4. Blockchain-based report verification mechanism ensuring report authenticity and integrity.

The MentorChain platform was successfully developed and evaluated as an AI-powered career recommendation and verification system. The platform integrates psychometric assessment, feature engineering, ensemble machine learning, automated report generation, and blockchain-based verification within a unified framework.

The psychometric assessment module consists of 29 questions designed to evaluate student interests, aptitude, personality traits, and career preferences. Responses collected from users are processed through a feature engineering pipeline that transforms 18 raw attributes into 45 engineered features, including career-orientation indicators, interaction features, and statistical measures. These features provide a comprehensive representation of student characteristics and improve prediction quality.

The recommendation engine employs a calibrated soft-voting ensemble of Random Forest and XGBoost classifiers. A synthetic dataset containing 12,000 student profiles distributed across 13 career domains was used for model training and evaluation. Experimental results demonstrated strong predictive performance. The Random Forest classifier achieved an accuracy of 97.00%, while the XGBoost classifier achieved an accuracy of 97.75%. The proposed ensemble model achieved an overall accuracy of 97.71%, a weighted F1-score of

97.71%, and a log-loss value of 0.0975.

The system generates personalized career recommendations along with confidence scores and specialized sub-role suggestions. Examples of recommended career domains include Software Engineering, Data Science, Civil Engineering, Business Analysis, Medicine, Psychology, Graphic Design, Teaching, and Entrepreneurship. Confidence-based ranking improves recommendation transparency and helps users understand the suitability of different career paths.

A detailed PDF report is automatically generated after assessment completion. The report contains career recommendations, confidence levels, key strengths, and personalized guidance. To ensure authenticity and prevent tampering, a SHA-256 cryptographic hash of each generated report is recorded on the blockchain using Solidity smart contracts. This mechanism enables secure verification without storing sensitive user information directly on-chain.

The experimental results indicate that combining feature engineering, ensemble machine learning, automated reporting, and blockchain verification creates a reliable and trustworthy career guidance platform. The proposed system demonstrates the practical applicability of integrating Artificial Intelligence and Blockchain technologies for secure and personalized educational decision support.

8. CONCLUSION

This paper presented MentorChain, an AI-powered career recommendation and verification platform that combines psychometric assessment, ensemble machine learning, automated report generation, and blockchain-based verification to support informed career decision-making. The platform utilizes a 29-question psychometric assessment to evaluate student interests, aptitude, personality traits, and career preferences.

A feature engineering pipeline was employed to transform 18 raw assessment attributes into 45 engineered features, enabling a richer representation of student profiles. The recommendation engine integrates Random Forest and XGBoost classifiers through a calibrated soft-voting ensemble approach to generate personalized career recommendations across thirteen professional domains.

Experimental evaluation demonstrated strong predictive performance, achieving an overall classification accuracy of 97.71%, a weighted F1-score of 97.71%, and a log-loss value of 0.0975. The system further enhances transparency through confidence-based recommendations and specialized role suggestions aligned with individual strengths and interests.

To ensure report authenticity and integrity, cryptographic hashes of generated PDF reports are securely recorded on the blockchain using Solidity smart contracts. This approach enables tamper-evident verification while preserving user privacy.

The proposed platform demonstrates that the integration of Artificial Intelligence and Blockchain technologies can provide secure, explainable, and personalized career guidance. MentorChain offers a practical solution for educational institutions and students seeking trustworthy career recommendation systems while contributing to the advancement of intelligent educational technology.

9. FUTURE SCOPE

Future enhancements to MentorChain may include the integration of real-world student datasets from educational institutions to further improve model generalization and recommendation quality. Additional explainable AI techniques such as SHAP and LIME can be incorporated to provide deeper insights into prediction outcomes and improve user trust.

The platform can also be extended to incorporate real-time labor market information, skill-demand analysis, internship

recommendations, and academic pathway planning. Privacy-preserving machine learning approaches such as federated learning may further strengthen data security while enabling collaborative model improvement across institutions.

Future versions may additionally support multilingual assessments, adaptive testing mechanisms, and advanced blockchain interoperability features to improve accessibility, scalability, and adoption in diverse educational environments.

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