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An Analytical Review of AI and Machine Learning Techniques for Financial Fraud Detection

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Abstract - The rapid growth of digital financial services and online transaction platforms has significantly increased the risk of financial fraud. Traditional rule-based fraud detection systems are no longer sufficient to detect complex and evolving fraudulent patterns. This paper presents an analytical review of Artificial Intelligence and Machine Learning techniques applied to financial fraud detection. Supervised, unsupervised, ensemble, and deep learning models such as Logistic Regression, Support Vector Machines, Random Forest, XGBoost, Autoencoders, and Long Short-Term Memory networks are analyzed using performance metrics including accuracy, precision, recall, and F1-score. The study highlights the strengths and limitations of these techniques and emphasizes the need for explainable and adaptive AI models to ensure transparency, scalability, and regulatory compliance.

Keywords - Financial Fraud Detection, Machine Learning, Artificial Intelligence, Ensemble Models, Deep Learning, Explainable AI

I. INTRODUCTION

The digital transformation of the financial sector has enabled faster and more convenient transaction services through online banking, e-commerce platforms, and mobile payment systems. However, this rapid digitization has also led to a significant rise in financial fraud, including identity theft, phishing, and unauthorized transactions. Detecting fraudulent activities in real time has become a critical challenge for financial institutions.

Artificial Intelligence and Machine Learning techniques offer effective solutions for automating fraud detection by analyzing large volumes of transactional data and identifying hidden patterns. These models adapt to evolving fraud strategies, making them more efficient than traditional rule-based systems.

II. RELATED WORK

Early fraud detection approaches relied on statistical models such as Logistic Regression and Decision Trees. While interpretable, these models struggled with non-linear relationships and imbalanced datasets. Ensemble techniques such as Random Forest and Gradient Boosting improved detection accuracy by capturing complex feature interactions. Deep learning models including Autoencoders and LSTM networks further enhanced fraud detection by learning temporal and anomalous patterns, though they introduced challenges related to interpretability.

III. METHODOLOGY

Financial transaction data from publicly available and simulated datasets was used in this study. Preprocessing steps included data cleaning, normalization, and encoding of categorical variables. Class imbalance was addressed using oversampling techniques. Multiple machine learning and deep learning models were trained and evaluated using accuracy, precision, recall, and F1-score metrics.

IV. RESULTS AND DISCUSSION

The results indicate that ensemble models such as Random Forest and XGBoost achieve higher accuracy and robustness compared to traditional models. Deep learning techniques demonstrate strong detection capabilities but require higher computational resources. The findings suggest that a balance between accuracy and interpretability is essential for real-world deployment.

V. CONCLUSION

This paper reviewed various AI and ML techniques used in financial fraud detection and compared their performance. Ensemble and deep learning models outperform traditional statistical approaches, though challenges such as data imbalance and interpretability remain. Future research should focus on integrating Explainable AI and adaptive learning mechanisms.

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