A Hybrid Approach for Fraudulent Transaction Detection: SMOTE-Autoencoder Framework

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***Abstract*—Fraudulent transactions represent a formidable challenge across diverse industries, with particularly profound implications within finance industry, where they can yield significant financial losses and precipitate reputational harm. Traditional rule-based approaches to fraud detection exhibit notable deficiencies in adapting to the dynamic nature of fraudulent behaviors, resulting in elevated rates of false positives. This paper introduces a pioneering methodology for detecting fraudulent transactions, leveraging the integration of the Synthetic Minority Over-sampling Technique (SMOTE) and autoencoder-based anomaly detection. Given the prevalent class imbalance inherent in real-world transaction datasets, SMOTE plays a pivotal role in rectifying this imbalance, notably mitigating false negatives. The deployment of autoencoder architecture facilitates the discernment of latent patterns and the identification of anomalies indicative of fraudulent conduct. The efficacy of the proposed framework is rigorously evaluated by employing a principal component analysis (PCA) transformed dataset, meticulously crafted to emulate authentic transactional environments. The empirical assessment unequivocally substantiates the framework's proficiency in accurately identifying fraudulent transactions while concurrently minimizing false positives. The ensuing experimental findings underscore profound enhancements in detection performance when contrasted with conventional methodologies, thereby underscoring the transformative potential of the proposed approach in fortifying fraud detection systems. This research engenders substantive contributions to the evolutionary trajectory of fraud detection methodologies, engendering invaluable insights conducive to mitigating fraudulent activities pervading financial transactions.**

***Index Terms*—Fraudulent transactions, Fraud detection, Synthetic Minority Over-sampling Technique (SMOTE), Autoencoder-based anomaly detection, Class imbalance, Principal Component Analysis (PCA), False positives, False negatives, Machine learning, Anomaly detection, Data imbalance, Dynamic fraud behaviors**

I. Introduction

Fraudulent transactions pose a pervasive and intricate challenge across various industries, with the finance sector bearing particularly profound implications. These deceitful activities encompass a range of fraudulent behaviors, including but not limited to unauthorized purchases, identity theft, and money laundering. Such nefarious acts not only inflict significant financial losses but also precipitate detrimental repercussions on the reputation and trustworthiness of the institutions involved. Within the realm of financial transactions, fraudulent activities manifest in diverse forms. One prevalent type is credit card fraud, wherein perpetrators exploit stolen or compromised credit card information to make unauthorized purchases or cash withdrawals. Another common form is account takeover fraud, wherein fraudsters gain unauthorized access to individuals' accounts through various means, including phishing attacks or malware. While once considered practical, traditional rule-based approaches to fraud detection exhibit notable inadequacies in adapting to the dynamic and evolving nature of fraudulent behaviors. These approaches rely on predefined rules and thresholds to identify suspicious transactions, often resulting in elevated rates of false positives and false negatives. False positives refer to legitimate transactions erroneously flagged as fraudulent, while false negatives denote fraudulent transactions that go undetected.

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An excellent style manual for science writers is [7].

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TABLE I
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	Table column subhead	***Subhead***	***Subhead***
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ACKNOWLEDGMENT

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