

Fraud Detection: A Graph Theoretical Approach Using GNN-GAN Model

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Abstract

This study presents an advanced approach to financial fraud detection by combining Graph Neural Networks (GNN) and Generative Adversarial Networks (GAN) in a unified framework called GNN-GAN. Traditional machine learning methods primarily focus on individual transaction data, often overlooking the underlying network of interconnections that reveal fraud patterns. Our approach addresses this limitation by converting transaction data into graph structures, where nodes represent transactions and edges indicate relationships between them. This graph-based transformation enables the model to capture complex interactions that signal potential fraudulent behavior. The model incorporates three key modules: a Neighborhood Noise Purifier, which uses Multi-Layer Perceptrons (MLPs) to filter irrelevant data; a Graph Neural Network (GNN) layer, which enhances relational insights among transaction nodes; and a Generative Adversarial Network (GAN) component that generates synthetic fraud patterns to train and improve model robustness. Testing on financial datasets, such as Kaggle's credit card transaction dataset, demonstrates the model's effectiveness in improving accuracy, recall, and computational efficiency. By leveraging the GNN-GAN model, this study achieves higher detection precision, offering a scalable and innovative solution to address evolving financial fraud challenges. This research marks a significant step towards more resilient, adaptive fraud detection systems that better safeguard financial institutions.

Keywords

Fraud detection, MLP, GAN-GNN, Graph Theory

Biographies

Ferdous Sarwar is a distinguished Professor in the Department of Industrial and Production Engineering (IPE) at Bangladesh University of Engineering and Technology (BUET). He holds a Ph.D. in Industrial and Manufacturing Engineering from North Dakota State University, USA, along with B.Sc. and M.Sc. degrees from BUET. Dr. Sarwar's research areas include advanced manufacturing, operations management, decision analysis, and supply chain optimization. He is a prolific contributor to esteemed international journals and is actively involved in consultancy, leveraging his expertise to enhance operational efficiencies and manufacturing practices within Bangladesh's industrial landscape.

Aheer Sravon is a student with a strong background in industrial engineering, data science, and machine learning. Currently studying at Bangladesh University of Engineering and Technology, Aheer Sravon has developed expertise in machine learning, financial fraud detection, and data-driven problem-solving. With a focus on using advanced techniques like Graph Neural Networks (GNN) and Generative Adversarial Networks (GAN), Aheer Sravon is passionate about improving accuracy and efficiency in detecting complex fraud patterns. They have actively contributed to projects on financial security, exploring innovative approaches to enhance industry practices.