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A Cost-Sensitive Deep Learning-Based Approach for Network Traffic Classification

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Abstract: *Network Traffic Classification (NTC) is a critical task in intrusion detection, network optimization, and cybersecurity. But class imbalance of network traffic data is a natural challenge to baseline machine learning approaches, leading to biased classification and poor detection of minority traffic classes. To compensate for this, in this paper we propose a cost-sensitive deep learning approach that combines new data balancing techniques such as SMOTE (Synthetic Minority Over-sampling Technique) with new deep architectures such as Feed- Forward Neural Networks (FFN), Convolutional Neural Networks (CNN), and Stacked Autoencoders (SAE). We also propose cost-sensitive models such as COSTSAE, CostCNN,DeepPacket+CostCNN,DeeperPacket+CostSAE, DFR+CostSAE and DFR+CostCNN that add class-specific penalties to maximize classification performance over low-frequency traffic classes. Our approach is evaluated on the ISCX VPN-nonVPN dataset, which has varied network traffic types such as chat, file transfer, streaming, video, audio, and email protocols. We evaluate model performance in terms of loss analysis metrics, confusion matrices, accuracy, recall, precision, categorical accuracy, and training history. Experimental findings indicate that our cost-sensitive deep learning models enhance classification performance, particularly for minority classes, by a large margin in comparison with traditional deep learning approaches..*

Keywords: Network traffic classification, class imbalance, deep learning, cost-sensitive learning

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