Graph Attention and Convolutional Networks for Detecting Inter-class Cardiac Disorders from Multi-lead ECGs

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Introduction: Automatic detection and classification of cardiac disorders play a critical role in the analysis of clinical electrocardiogram (ECG). Deep learning methods are effective for automated feature extraction and have shown promising results in ECG classification. Most of these methods, however, assume that multiple cardiac disorders are mutually exclusive. In this work, we have created and trained a novel deep learning architecture that considers inter-class relationships for addressing the multi-label classification in different multi-lead ECG configurations.

Methods: A novel deep learning architecture has been trained for addressing the multi-label classification of 2, 3, 6 and 12 lead ECGs. The architecture combines a Convolution Neural Network (CNN) module for extracting ECG feature representations and a Graph Attention Network (GAN) module for modelling label dependencies. Specifically, the proposed GAN introduces the attention mechanism into a Graph Convolution Network (GNN) that addresses the computationally inefficiency found in previous GNNs. The attention mechanism enables our deep learning architecture to focus on the most important and useful parts of the input to make predictions.

Results: In the unofficial stage of PhysioNet/Computing in Cardiology Challenge 2021, our deep learning architecture (Team 'Leicester-Fox') achieved 5-fold cross-validation scores of 0.627/0.558/0.573/0.557 and F1 scores of 0.603/0.572/0.581/0.549 respectively for 12/6/3/2 ECG-lead configurations.

Conclusions: Novel deep learning architectures integrating CNNs and GANs improves the handling of inter-class relationships and therefore enhances the performance in automated ECG clinical diagnosis of multiple cardiac disorders. Our novel deep learning architecture is efficient and readily applicable to many practical applications.