Implementation of Convolutional Neural Network for ECG-Based Arrhythmia Classification

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Abstract
Electrocardiogram (ECG) signals are vital for detecting arrhythmias, abnormal heart rhythms that can lead to serious health complications. Traditional ECG classification methods often rely on extensive feature engineering and expert input. This study used the MIT-BIH Arrhythmia dataset to assess the performance of Convolutional Neural Network for automated arrhythmia classification. To boost generalization, CNN's design includes a few layers of complexity, and dropout. To address class imbalance, data balancing techniques are applied. Time Warping and Magnitude Warping augmentation is introduced to simulate signal variability and further improve robustness. A comprehensive hyperparameter tuning framework evaluates five CNN configurations, with the optimal setup using three convolutional layers (128-256-128 filters), batch normalization, dropout (0.15–0.4), and two dense layers (256-128 units). Achieving an accuracy and F1-score of 97.41% from the baseline, highlighting its potential for real-world automated ECG analysis. This work extends deep learning approaches for biological signal processing, promoting more efficient and accurate arrhythmia detection.

Keywords*: Convolutional Neural Network, ECG Classification, Arrhythmia Detection, Deep Learning, MIT-BIH*