A Novel Deep Learning and Machine Learning Framework for Multi-Label Classification of Cardiovascular Diseases from ECG Images

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In a world where access to advanced medical technologies is often limited in the Global South, a simple paper ECG (Electrocardiogram) holds the key to unlocking improved cardiovascular health for millions affected by the high prevalence of cardiovascular diseases (CVDs) in resource-limited settings. We develop and evaluate a fusion of deep learning and machine learning techniques for multi-label classification of CVDs from ECG images. Focusing on PhysioNet Challenge's classification task, we develop a robust multi-label model for cardiovascular disease diagnosis.

Our approach utilizes state-of-the-art (SoTA) deep learning architecture VGG-19 to extract informative features from a dataset of approximately 21,000 generated ECG images from time-series data and header files, incorporating realistic distortions to mimic real-world scenarios. These extracted features are used for training a Random Forest classifier known for its robustness to class imbalance. To address the multi-label nature of CVD diagnosis (where a patient may have multiple conditions), a one-vs-rest classification strategy is utilized training a separate binary classifier for each CVD label. Each classifier learns to distinguish between multiple conditions, allowing the model to predict multiple labels for a given ECG image.

Performance evaluation is conducted using 10-fold cross-validation and F-measure for the classification task. During the training phase, our baseline model achieved a mean classification F-measure of 0.20 (Team Name: Deakin_Squad). While initial submissions based on this deep learning and machine learning approach did not achieve a leaderboard score in the unofficial phase (Entry IDs: 1110, 1130, 1207), ongoing efforts focus on further refinement to enhance performance.

During the official phase, our approach will leverage SOTA deep learning architectures like Resnet-151v2, Alexnet for feature extraction, and more advanced classifiers like XGBoost and RUSBoost to further improve model classification performance leading to improved patient outcomes. These advancements will be submitted in the official phase of the challenge.