Swarm decomposition enhances the discrimination of cardiac arrhythmias in varied-lead ECG using ResNet-BiLSTM network activations

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Introduction: There have been many attempts to develop accurate models for cardiac arrhythmias identification. However, there is still a lack in the knowledge about the impact of ECG leads reduction on the performance of these models. ***Methods:*** Here, we investigate the ability of residual neural networks (ResNet) and Bi-directional long short-term memory (BiLSTM) units in discriminating between 24 types of cardiac arrhythmias through 12-lead, 6-lead, 3-lead, and 2-lead ECG signals. Furthermore, we highlight the use of a novel non-stationary signal decomposition algorithm, namely swarm decomposition (SwD), in analyzing the oscillatory components (OC) contaminated within ECG signals under different arrhythmia conditions. Initially, only 4 leads were selected in this work, namely lead I, II, aVR, and V5. All signals go through a pre-processing stage (denoising, smoothing, and baseline filtering) to enhance their quality. Then, using lead II, the best 10-second location in the recording was selected through analysis of the root mean square error (RMSE). Next, three SwD OCs were extracted from lead II signals representing high, mid, and low frequency modes. Furthermore, the corresponding sample entropy, fractal dimensions, kurtosis, and skewness of the OCs were calculated as additional SwD features. Next, ResNet-BiLSTM combined network was initially trained and used to extract deep features from the available lead scenarios alongside the SwD OCs. Then, network activations for every scenario were extracted and concatenated with age, gender, additional SwD features, and heart rate variability (HRV) features. Finally, the leads were utilized as judges (total of 8 judges) and the final predictions were obtained by analysis of judges' scores. ***Results:*** Our team, Care4MyHeart, achieved a challenge metric score of 0.313, 0.282, 0.298, and 0.298 on 12-lead, 6-lead, 3-lead, 2-lead validation datasets, respectively, during the unofficial phase. ***Conclusions:*** This study suggests SwD as a promising approach to enhance arrhythmia detection in varied-lead ECG.