Abstract

Accurate arrhythmia classification is crucial for effective heart diagnosis and treatment. Recently, many studies have focused on arrhythmia diagnosis; however, their accuracy remains suboptimal, and they lack model interpretability, which could assist experts. This study presents several accurate models for arrhythmia classification by utilizing a 1D Convolutional Neural Network (CNN1D) combined with Attention mechanisms and Gated Recurrent Units (GRU), a 1D Convolutional Neural Network (CNN1D) combined with Gated Recurrent Units (GRU), and a 1D Convolutional Neural Network (CNN1D) combined with Long-Short Term Memory (LSTM). To reduce noise in ECG signals, we employed a denoising method known as the Butterworth filter, ensuring more accurate feature extraction from electrocardiogram (ECG) data. These models are designed to classify ten types of arrhythmias, including Paced Beat, Atrial Premature Contraction, Fusion of Ventricular and Normal Beat, Left Bundle Branch Block Beat, Normal Beat, Right Bundle Branch Block Beat, Premature Ventricular Contraction, Nodal (Junctional) Escape Beat, Non-conducted P-wave (Blocked APB), and Isolated QRS-like Artifact. Furthermore, to provide transparency and interpretability to the model's predictions, we applied Explainable Artificial Intelligence (XAI) techniques using Layer-wise Relevance Propagation (LRP). Experimental results demonstrate that our proposed models achieve high accuracy in arrhythmia classification, with an overall accuracy of 96.8%, precision of 96.8%, sensitivity of 96.8%, and an F1 score of 96.8%. The integration of LRP not only helps validate the model's performance but also offers actionable insights for clinicians, potentially improving patient outcomes.

Keywords: *ECG*, *Arrhythmia*, *XAI*, *LRP*, *Hybrid model.*