BioWaveNet: A Novel Multi-Scale Convolutional Neural Network for Generalized Bio-Signal Applications

Thuwajit, Punnawish (School: Suankularb Wittayalai School)
Mateepithaktham, Thee (School: Suankularb Wittayalai School)

Bio-signals are widely used in healthcare assessment and treatment. However, clinicians must exert immense effort and hold extensive expertise for their analysis, leading to a heavy workload for clinical personnel. This has led to attempts to automate bio-signal analysis via machine learning. Here, feature engineering plays an important role in extracting useful features and boosting the machine learning models' performance. However, feature engineering is often too rigid for practical use and requires in-depth knowledge for its development. In an effort to generalize the abilities of traditional feature engineering, we propose BioWaveNet, our novel multi-scale convolutional neural network architecture. BioWaveNet utilizes different scales to view bio-signals from various perspectives, akin to learnable feature engineering. We showcase the effectiveness of two custom-made BioWaveNet models developed for two prevalent medical disorders: EEGWaveNet for seizure detection by Electroencephalography (EEG), and PPGWaveNet for respiratory rate estimation via Photoplethysmography (PPG). Tested on benchmark datasets and outperforming other baseline methods, both models demonstrate their robustness with consistently high, subject-independent performances on all datasets: over 98% accuracy in seizure prediction, and an error rate of just 2 breaths per minute in respiratory rate estimation. Via transfer learning, both models improved their performances. Their small size would allow for remote deployment, contributing towards the development of wearable devices to aid clinicians. BioWaveNet can potentially be a benchmark for other bio-signal applications, fulfilling our goal to generalize the development of such machine learning algorithms.