Employing Adversarial Machine Learning and Computer Audition for Smartphone-Based Real-Time Arrhythmia Classification in Heart Sounds

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We propose a novel approach to detect arrhythmias in Phonocardiograms (PCGs). Typically, many arrhythmia conditions are unknown until a patient is suggested an ECG/EKG test. This method, despite being accurate, limits the use case to hospitals and clinics with specialized equipment; thus, limiting the portability of diagnosing. Implementation of Adversarial Machine Learning (ML) and Computer Audition (CA) in combination with heart sounds provide ease of access to everyone who has a device capable of recording audio. Ideally, allowing medical professionals to treat arrhythmias in the developmental stages. The new design is comprised of two subsystems; one is based on the relationship between Electrocardiograms (ECGs) and PCGs, and the other between PCGs and arrhythmias. The first subsystem uses a Generative Adversarial Networks (GAN), in which both generated and real PCG signals are fed into the discriminator for classification. In subsystem two, ECG spectrograms are dimensionally reduced, then constructed into PCG spectrograms using a transGAN. These constructed PCG spectrograms, when converted back into time series, should be identical to the ground truth. This novel approach allows for an increase in the number of cardiovascular pathologies classified in heart sounds. After testing, the GAN model (subsystem one) achieved an accuracy of 94.98%, a specificity of 90.30%, and a sensitivity of 99.52% on the testing set. Furthermore, the transGAN showed extremely promising results, in that the transGAN discriminator was able to construct the PCG spectrogram accurately. The proposed method's ease of use allows for simple integration in mobile devices, such as smartphones, making it feasible in medical and consumer applications.

Awards Won:

American Statistical Association: First Award of $1,500