Contribution ID: **34** Type: **"Classic" talk**

Time Series Classification: From Astronomical Transients to Human Heart Sounds

Thursday, 27 May 2021 10:10 (20 minutes)

Background and objectives: Cardiovascular disease (CVD) is still the leading cause of mortality. Early diagnosis of heart disease is crucial in preventing mortality. On the other hand, according to the World Health Organization, approximately 80% of deaths due to cardiovascular disease occur in low and middle-income countries. There is a lack of medical specialists in remote areas to diagnose these diseases. Artificial intelligence-based decision support systems and automated diagnostic tools can help with heart disease diagnosis.
An automated classification method using LightGBM and deep learning is investigated in this study to classify four types of heart sounds including artifact, extra heart sound, murmur, and normal. The classification algorithm for this purpose is inherited from the previously used algorithm for the classification of LSST astronomical time series known as the PLAsTiCC dataset.
Methods: The classification model is developed using a total of 542 PhonoCardioGram(PCG) samples collected by electronic stethoscopes or mobile devices. We use both deep and feature-based approaches for classification. After pre-processing and denoising of PCG signals, features have been extracted from the raw data. Extracted features fed to LightGBM. We also used a deep learning approach, feeding raw signals to a convolutional neural network (CNN).To improve accuracy in a noisy environment and robust model, the proposed method uses data augmentation techniques for training data sets.
Results: The accuracy of the LGBM on the test set is 0.82 for the classification of heart sounds. It also had achieved good results in our previous review related to astronomical time series classification. Precision, recall, and F1 score of multi-class classification are 0.84, 0.84, and 0.82 respectively. If we consider all abnormal cases as a unique class and normal cases as another, LGBM shows 0.87 accuracies for binary classification of normal and abnormal classes. Using the CNN approach obtains 79% accuracy in PCG multi-class classification.

Conclusions: Machine-learning techniques provide high precision results in cardiac diagnosis and screening. The proposed model can be transferred to any computing device. This non-invasive method is efficient and suitable for real-time applications and can provide a diagnostic tool in primary health care centers.

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Session Classification: Morning 1

Track Classification: Surveys