Two-Stage Multitask-Lerner for PCG Murmur Location Detection

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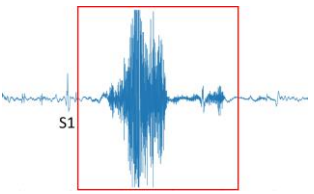
Pre-screening for heart conditions is particularly challenging in developing countries due to the lack of expensive equipment and a shortage in medically trained professionals. As heart sounds can be captured easily by smartphones or similar devices, their automated analysis may provide a cost-efficient alleviation of this problem.

In this study, we present an approach for detecting heart murmurs that utilizes a Pooling-based Artificial Neural Network (PANN) structure for extracting features from audio waveforms of arbitrary lengths and classifying single recordings based on recording location and the extracted features in an end-to-end manner.



Segment with low signal quality is removed.

The recordings are pre-processed independent of location by removing segments with low signal quality and applying bandpass filtering (10 to 800Hz). Only during training, a fixed signal length of 8.2 s is used to increase efficiency.

The PANN employs a standard convolutional block with batch norm and dropout. The intuition of the convolution block is that it gets activated by murmurs in the respective parts in each segment. The approach then takes advantage of the periodicity of murmurs by employing average and max pooling layers that collect and summarize the information about murmur appearance from all segments of the signal, rendering the output feature dimensions independent of the input length. The output features of the pooling layer are then combined in a fully connected layer with (1) information from statistical features from classical audio processing, (2) the one-hot encoded recording location, and (3) demographic features.

By processing each recording location separately and combining the detection results based on simple decision rules we enable the user to verify the suspected murmur postion.

We performed a 5-fold stratified cross-validation and report the calculated evaluation measures as average (standard deviation): AUROC 0.742 (0.022), AUPRC 0.560 (0.026), Accuracy 0.7346 (0.022), F-measure 0.504 (0.019), Challenge-Metric 1021 (18). The official validation score was 994.