Explainable deep learning for non-invasive pulmonary artery hypertension detection from heart sounds

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Aims: Late diagnoses of patients affected by pulmonary hypertension (PH) have a poor outcome. This observation has led to a call for earlier, non-invasive PH detection. Cardiac auscultation can represent a non-invasive, cost-effective alternative to both right heart catheterization and doppler analysis to measure the pulmonary artery pressure (PAP), due to the physiological relations that links changes in the PAP with the morphology of heart sounds.
Methods: We propose the use of deep neural network applied to digital heart sound recordings to detect hypertensive patients. Post-hoc explanations are used to identify which features of the heart sounds are mostly informative of the presence of PH.
Results: The proposed approach was tested over a dataset of 42 subjects (29 with PH and 13 without PH), with reference PAP measurements obtained via right heart catheterization. The proposed approach achieves .95 ROC AUC, compared with .78 of an adaptation of the Gaussian mixture model (GMM) method proposed in (Kaddoura *et al.* 2016). Classification outputs are shown to be fundamentally based on specific regions of the heart sounds.
Conclusions: The results obtained with the proposed method show that deep learning approaches applied to heart sound achieve the state-of-the-art.