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Improved COVID-19 classification of cough audio

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We report progress in our research aiming to detect COVID-19 from smartphone audio recordings. In our previous work we reported that it is possible to discriminate between recordings of COVID-19 positive coughs and coughs by COVID-19 negative or healthy individuals using machine learning algorithms. Since the available datasets of COVID-19 coughs are small, the classifiers exhibited a fairly high variance. In subsequent work we have investigated the effectiveness of transfer learning and bottleneck feature extraction for audio COVID-19 classification, in this case performing experiments for three sound classes: cough, breath and speech. For pre-training, we use datasets that contain recordings of coughing, sneezing, speech and other noises, but do not contain COVID-19 labels. Convolutional neural network (CNN), long short term memory (LSTM) and Resnet50 architectures were considered. The pre-trained networks are subsequently either fine-tuned using smaller datasets of coughing with COVID-19 labels in the process of transfer learning, or are used as bottleneck feature extractors. Results show that a Resnet50 classifier trained by this transfer learning process delivers optimal or near-optimal performance across all datasets achieving areas under the receiver operating characteristic (ROC AUC) of 0.98, 0.94 and 0.92 respectively for the three sound classes (coughs, breaths and speech). This indicates that coughs carry the strongest COVID-19 signature, followed by breath and speech. Our results also show that applying transfer learning to capitalise on the larger datasets without COVID-19 labels leads not only to improved performance, but also strongly reduces the standard deviation of the classifier AUCs measured on the test sets during cross-validation, indicating better generalisation. We conclude that transfer learning and bottleneck feature extraction can improve COVID-19 cough, breath and speech audio classification, yielding automatic classifiers with higher accuracy. Since audio classification is non-contact, does not require specialist medical expertise or laboratory facilities and can be deployed on inexpensive consumer hardware, it represents an attractive method of screening.

Student?

No

Supervisor name

Supervisor email

Primary author: Prof. NIESLER, Thomas (University of Stellenbosch)

Presenter: Prof. NIESLER, Thomas (University of Stellenbosch)

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