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Developing a multivariate prediction model for the detection of COVID-19 from crowd-sourced respiratory voice data.

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Introduction: COVID-19 has affected more than 223 countries worldwide. There is a pressing need for non-invasive, low-costs and highly scalable solutions to detect COVID-19, especially in low-resource countries. Our aim was to develop a deep-learning model for identifying COVID-19 using voice data provided by the general population via personal devices.

Methods: We used the Cambridge University dataset consisting of 893 audio samples, crowd-sourced from 366 participants via the COVID-19 Sounds app (covid-19-sounds.org). Voice features were extracted using a Mel-spectrogram analysis. Using the voice data, we developed deep learning classification models to detect positive COVID-19 cases. These models included Long-Short Term Memory (LSTM) and Convolutional Neural Network (CNN). We compared their predictive power to baseline models (Logistic Regression and Support Vector Machine).

Results: Fig. 1 shows model parameters and results. The LSTM model achieves the highest accuracy (**84%**), beating state of the art sound based models (72.1%).

Model	Parameters	Accuracy	Sensitivity	Specificity
Logistic regression	Input = patient's medical history, gender, smoking status, age, symptoms, hospitalized	75%	75%	76%
SVM	Input = patient's medical history, gender, smoking status, age, symptoms, hospitalized, kernel= rbf, C=1,gamma= auto	75%	74%	77%
CNN	Type = ResNet50, input = Mel-spectrogram images ,input shape=(150, 150,3), Trainable parameters ≈ 23M, non-trainable parameters ≈ 53K , loss= binary crossentropy, optimizer= adam, activation = softmax	81%	81%	81%
LSTM	Input= MFCC features, total parameters ≈ 849K ,loss= binary crossentropy, optimizer= adam, activation = softmax	84%	84%	83%

Conclusions: Deep-learning can detect subtle changes in the voice of COVID-19 patients. The sensitivity of our

model shows a significant improvements compared to the antigen test (**84%** vs. 56.2%), yet with a lower specificity (**83%** vs. 99.5%). As an addition to other testing techniques, with a simple voice analysis this model may aid to fast diagnosise COVID-19 cases.
