Indian Institute of Science (IISc) Open Day, 4th March, 2023

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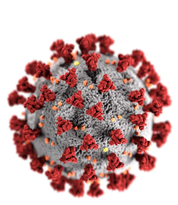
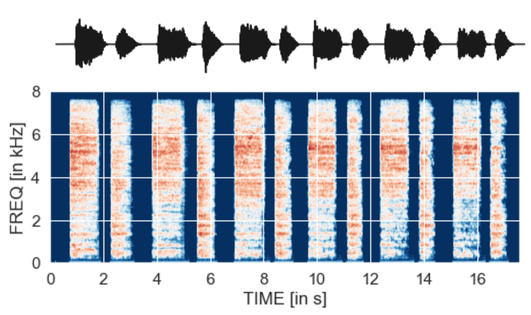
Sound Based COVID-19 Diagnosis

COVID-19 diagnosis methods:

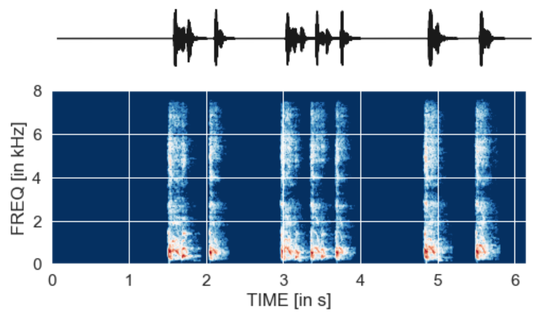
- RT-PCR testing
- RAT testing
- Point-of-care testing (POCT)



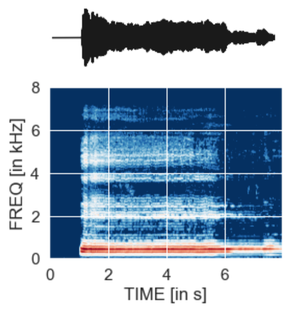
Dataset



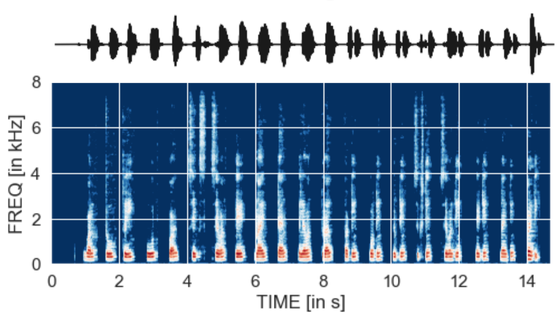
Breathing



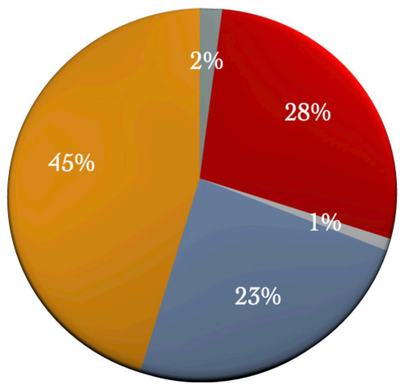
Cough

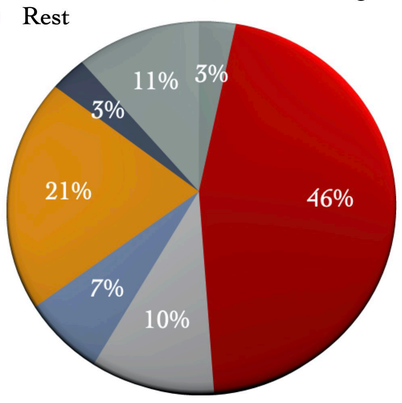


Vowel-a

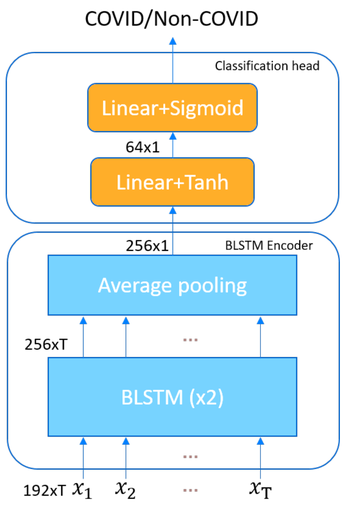


Speech





BiLSTM Classifier



- Two bi-directional long-short term memory (BiLSTM) layers and a fully connected layer
- Trained on segments of utterances
- Inference based on average probability scores over segments

Performance

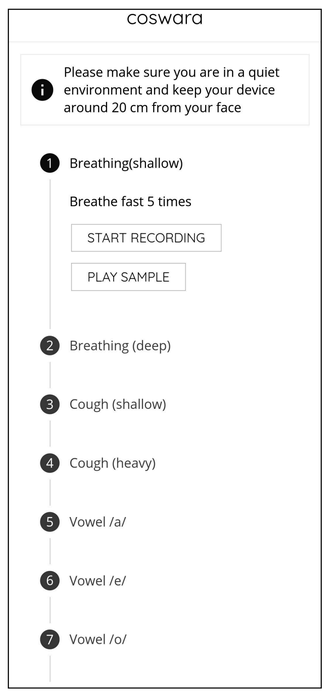
Sample name	Sample description	Classifier performance on test set (AUC %)				
		LR	RF	MLP	BLSTM	Transformer
Breathing	breathing-shallow	69.9(64.9-74.5)	76.6(71.7-80.9)	78.6(74.2-82.8)	77.9(73.5-81.9)	78.1(73.8-82.1)
	breathing-deep	68.7(63.6-73.7)	74.0(68.5-78.5)	74.5(69.4-78.8)	75.7(71.0-80.2)	76.7(71.9-81.2)
Cough	cough-shallow	73.6(68.6-77.9)	77.1(72.4-81.2)	76.8(72.0-81.1)	76.6(71.7-80.8)	75.5(70.8-79.7)
	cough-heavy	74.3(69.5-78.5)	79.3(74.9-83.2)	78.6(74.3-82.5)	79.8(75.3-83.9)	79.4(75.1-83.3)
Vowel phonation	vowel-[u]	70.0(65.1-74.5)	75.7(71.3-80.0)	73.2(68.5-77.5)	73.6(68.4-78.6)	74.9(69.9-79.6)
	vowel-[i]	69.4(64.5-74.1)	74.3(69.2-79.0)	69.6(64.0-74.3)	77.3(73.1-81.9)	77.5(73.3-81.9)
	vowel-[ae]	71.1(66.4-75.6)	77.3(72.9-81.4)	70.5(65.4-75.0)	79.3(74.5-83.4)	78.6(74.0-82.6)
Speech	Counting normal	69.4(64.5-73.9)	76.0(71.1-80.2)	75.7(71.1-80.0)	80.8(76.6-84.7)	80.1(75.7-83.8)
	Counting fast	71.7(67.3-76.2)	75.7(71.4-79.9)	73.7(68.5-78.3)	79.4(74.5-83.6)	79.3(74.5-83.6)
Sound fusion	Joint inferencing using all sound categories	73.9(69.1-78.2)	78.9(74.4-82.6)	76.2(71.4-80.6)	84.1(80.1-87.8)	84.1(80.2-87.7)
Sound plus symptom fusion	Joint inferencing using sound fusion plus symptom	89.2(85.8-92.1)	91.2(88.2-93.8)	90.1(86.9-93.0)	92.1(89.3-94.4)	92.0(89.2-94.1)

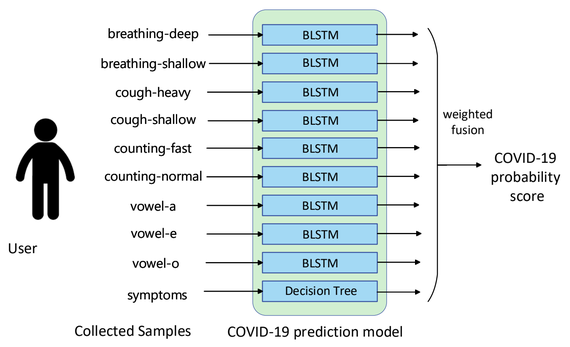
Table 5
Description of binary classification performance for various classifier models (logistic regression (LR), random forest (RF), multi-layer perceptron (MLP), bi-directional long short-term memory (BLSTM) and transformer) on the different types of audio sample categories. A decision tree model is also trained for symptom based COVID classification with test set performance of 84.9%(81.0%-88.5%). The sound plus symptom fusion results are obtained by fusing sound fusion model scores with symptom based scores.

Bias Analysis

Subset from test set	Count COVID/ Non-COVID	AUC (%)	p value
Gender			
Male	54/218	93.0 (90.0-95.5)	0.870
Female	46/82	91.2 (86.6-95.3)	0.745
Age			
15-30	40/145	91.0 (87.1-94.7)	0.260
30-45	22/93	89.9 (82.2-95.8)	0.387
45-60	22/35	96.1 (92.2-99.4)	0.579
60-95	8/6	86.0 (65.0-100.0)	0.152
Vaccination			
With	67/58	86.9 (81.7-91.7)	p<0.050
Without	33/242	90.1 (84.7-94.5)	0.260
Mask			
With	47/36	83.3 (75.9-90.1)	p<0.050
Without	53/94	87.1 (81.9, 91.9)	0.397
English Proficiency			
With	91/289	92.0 (89.2-94.6)	0.904
Without	9/11	88.8 (73.7-100.0)	0.471
Date of collection			
Before Dec. 21	50/150	91.9 (87.7-95.2)	0.110
After Dec. 21	50/150	92.9 (89.3-95.9)	0.110
Collection Province			
Karnataka	52/99	95.5 (92.3-98.3)	0.402
Others	48/201	92.0 (89.3-94.4)	0.509
Prevalence			
20%	70/280	92.0 (90.7-93.3)	0.781
10%	30/270	91.7 (87.5-95.9)	0.357
5%	15/285	91.4 (85.0-97.8)	0.523
2.5%	7/273	92.2 (81.8-100.0)	0.588

Web-application





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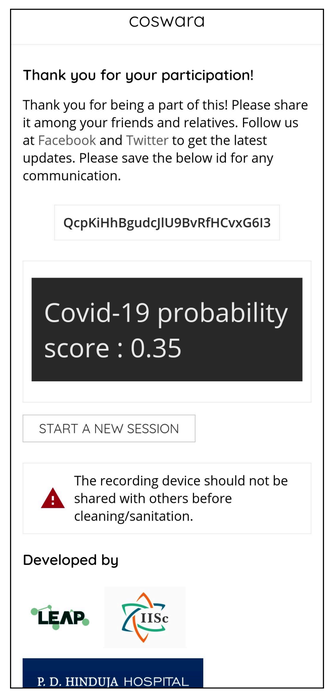
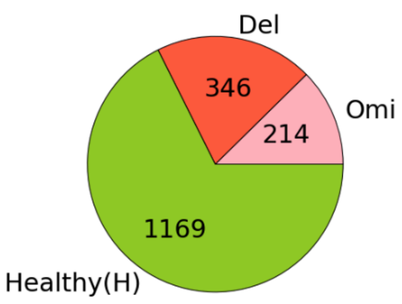
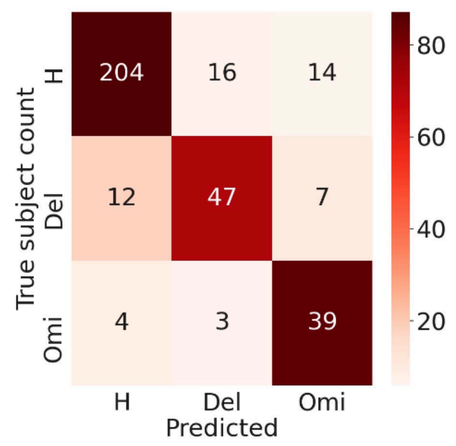


Strain Analysis





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