International Journal of Current Research and Review
DOI: http://dx.doi.org/10.31782/IJCRR.2021.SP192

Research Article

IJCRR
Section: Healthcare
ISI Impact Factor (2019-20): 1.628
IC Value (2019): 90.81
SJIF (2020) = 7.893

COVID-19 Pandemic: Role of Machine Learning & Deep Learning Methods in Diagnosis

Naresh Kumar Trivedi, Sarita Simaiya, Umesh Kumar Lilhore*, Sanjeev Kumar Sharma

Chitkara University Institute of Engineering and Technology, Chitkara University, Punjab, India.

ABSTRACT

Introduction: COVID-19 has become a global pandemic that even the World Health Organization declared in February 2020. Artificial Intelligence (AI) based techniques such as Machine learning (ML) and Deep Learning (DL) techniques may play an essential role in determining patient populations who have COVID-19. The machine learning technique allows the users to imitate artificial intellect as well as to absorb massive amounts of data to detect trends and observations quickly. Deep learning constructs networks across layers that build an artificial neural network intelligent enough to understand and making rational decisions concerning COVID-19 diagnosis.

Objective: The main objective of the research is to accurately detect as well as diagnose the covid-19 patients based on chest images.Covid-19 pandemic is spreading rapidly and the testing kits, labs, hospitals, health workers as well as diagnosis are limited.

Methods: The DL and ML approach helps in explaining the COVID-19 pandemic and resolving it. This research mainly utilizes the chest X-ray data set (collected from the USA) for the prediction of Covid-19 patients (confirm, recover, death).

Results: The experimental results are showing the accuracy result of CNN method 92.4 % and Random forest method 87.9 %.

Conclusion: Based on the experimental results we can say the CNN (deep learning) method performs outstanding over Random forest (machine learning) in terms of detection rate % and accuracy %.

Key Words: COVID-19, Machine learning, Pandemic, Deep learning, Medical diagnosis

INTRODUCTION

A central problem of the COVID-19 disease outbreak is already increasingly affecting the universe. This novel Coronavirus epidemic COVID-19 seems to be a global epidemic although, as per the 'World Health Organization (WHO), over 12.3 million have also been affected and therefore more than 650 thousand have dropped dead globally before July 9th, 2020. This COVID-19 disease outbreak has already become a significant danger not just for the fellow human-being of huge numbers of people, but also to global environment survival but also aspects of society.[1,2] Depending on different indicators and measurements, several predictive approaches rely on possible developments. Countrywide "Gross Domestic Product Rate (GDP Percent)" has fallen dramatically.[3,4]

Some person has indeed been highly contaminated with COVID-19 when being quarantined much as separated of others, or to provide adequate care but treatment.[5,6] The entire paper has been divided into several types including implementation of Covid-19 and AI technologies, concerning DL, ML, and subsequent including relevant work, problems, and function of ML and DL, late covering patient evaluation using DL, ML as well as ending future work including thesis conclusions.[7,8]

MATERIALS AND METHODS

Research on the pandemic COVID-19 seems to be a key area of research. Throughout this portion, we're discussing plenty of the distinct researchers' strong research efforts to dealing with this COVID-19 pandemic. The entire universe has been suffering some of the crucial issues related to the COVID-19 disease outbreak, which requires urgent attention.[9,10] In DL,

Corresponding Author:

Umesh Kumar Lilhore, Department of CSE, Chitkara University, Punjab, India.
Email: umesh.lilhore@chitkara.edu.in

ISSN: 2231-2196 (Print) **ISSN:** 0975-5241 (Online)

Received: 17.08.2020 **Revised:** 12.10.2020 **Accepted:** 07.12.2020 **Published:** 30.03.2021

a CNN subset of DNN, mainly utilized to exploring visualization.[4] They are often identified as shift invariant ANN based on the shared design as well as interpretation invariance qualities. The Random Forest is just a classifier technique specifically created for the research community. The whole method is currently being recognized in various image classification as well as to the generation of persistent farm data points, like percentage trees and biomass.[11,12]

Below Table 1 is showing the certain important research contribution & practical solutions towards this global pandemic using ML and DL.

Table 1: Comparison of the various ML & DL method throughout the research of COVID-19

Model	Dataset	Number of Patients	Validation Framework	Data set Description	Outcomes
Convolutional Neural Network	Clinical scientific COVID-19 data	5000 COVID patient data	Validation using Holdout	COVID-19 clinical CT images including the patient with infectious as well as unusual disease	Precision and Specificity more than 90%[13,14]
Machine Learning based SVM Classification	Clinical scientific COVID-19 data	800 COVID patient data	Validation using Holdout	COVID infected patients, including critical & non-serious cases. Also includes data for patients diabetics and coronary	Precision and Specificity more than 75 %, with training & testing set[15,16]
CNN based COVID Net model	Clinical scientific COVID-19 data	650 Patient data	Rotation estimation based Cross-validation	Different x-ray images of COVID patients Male, Female	Precision more than 90% for Binary classes and Multi-classes achieves 88%[17,18]
Random forest Machine learning method	Clinical scientific COVID-19 data	2500 COVID patient data	Rotation estimation based Cross-validation	different BLOOD sample of COVID patients collected from various source	Accuracy and Specificity more than 93%[19,20]

The following are among some of the issues about COVID 19 as well as the function of strategies based on artificial intelligence (DL and ML).[21,22] Challenges in COVID-19 and the Role of ML and DL are as follows-

1. The identification of more risky objects through COVID-19 data sets

The following risks required additional focus throughout the assessment of the COVID-19 disease outbreak.[23,24]

- The risk for infection: what is the probability that somehow a particular person, as well as community, can further infected with COVID-19?
- Risk of severity: What is the potential for serious COVID 19 effects including symptoms which would require medical attention as well as critical care against a patient-based and community?
- Effect risk: what is the probability, as well as how probable seems to be specific treatments to fail, of ineffectiveness for such particular person or entity?

2. The risk and cause of the COVID-19- In the initial phases now there is risk research further into a global pandemic. By using the properties such as age, behavioural norms, position including present conditions a COVID-19 patient can analyses. Whenever an individual or group has gotten affected, researchers had to anticipate their risk of infection including emergency hospital attention over this identifiable group.[25,26]

3. Anticipating COVID-19 patient treatment options-An addition of the intensity estimation tends to forecast every outcome throughout the procedure, which is also simply about forecasting life or death. Precisely, considering specific symptoms that would be important to know how probable a person will be to stay alive.[27,28]

4. Forecasting the propagation of COVID-19 transmission through social media network -The Deep Learning and Machine Learning system predicts the percentage of unique virus transmission through evaluating the nature of personal social media communications.[29,30]

5. Patient examination and COVID-19 diagnosis-Large-scale testing becomes challenging, as well as experiments have become critical in this regard, particularly at the start.[31]

RESULT

Covid-19 pandemic is one of the most disastrous issues of the world. It is spreading rapidly and the whole world is facing a shortage of test laborites, testing kits, and also a diagnosis of covid-19 patients. In this research work, we are using chest images of various persons to identify covid-19 positive or negative, as well as to diagnosis the covid-19 patients.

Data Set

The data set has been collected from Kaggle online Covid-19 X-ray data set that contains a total of 5600 x-ray images.[32] The table-2 is showing the description of Covid-19 image datasets.[33,34] The data set can be divide into two categories one is normal and another is covid-19 patient data. The normal data set contains 600 X-ray images, 250 images are using for training and 350 images for testing and in the covid-19 patient dataset 2000 images for training and 3000 images for testing purposes.[35]

Table 2: Covid-19 data Set description

Category	Normal images	Covid-19 Patient	Total Images
Training dataset	250	2000	2250
Testing dataset	350	3000	3500
All images	600	5000	5600

Simulation And Results

The Simulation was performed using python programming on a 5600, X-ray dataset. Figure-1 is showing X-ray images of the Covid-19 dataset, in which the first row is showing normal images and the second row is showing Covid-19 patient images. Based on the training and testing dataset various experimental parameters were calculated. These parameters contain true positive, true negative, false positive, false negative, and finally calculated accuracy, detection rate, and f-measure.[36,37]

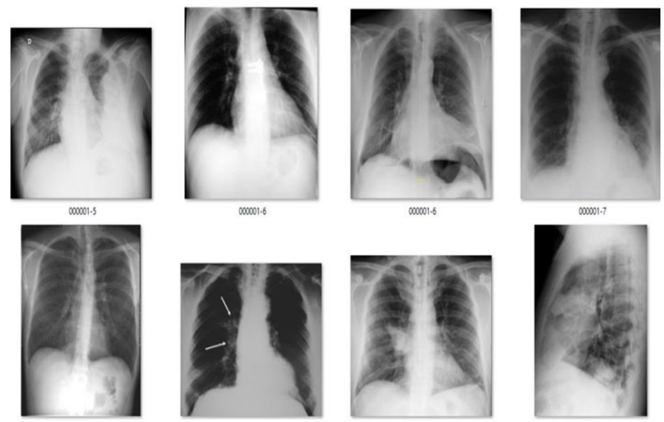

Figure 1: Covid-19 Patients Chest X-ray images.

The simulation process follows various phases which include data pre-processing, filtering, training, testing, and finally resulting phase. The experimental analyses were performed using CNN (Deep learning) and the Random forest (Machine learning) method, using python programming. Table 3 is showing a summary of the results. A total of two simulations were performed.

Simulation 1: In the first scenario total of 5600 X-ray images were used, 2250 images for training purposes, and 3500 for testing purposes.

Simulation 2: In the first scenario total of 1125 X-ray images were used, 1750 images for training purposes, and 3500 for testing purposes.

Table 3: Performance of CNN & Random Forest

Scenario	X-Ray image Dataset		Method	Accuracy	Specificity	Sensitivity
Scenario-1	Training	Testing	Random Forest [2]	87.9	91.2	90.9
	2250	3500	CNN [1]	92.4	98.8	98.3
Scenario-2	Training	Testing	Random Forest [2]	86.5	93.5	91.7
	1125	1750	CNN [1]	91.74	96.28	95.13

Figures 2 to 4 are mainly showing the experimental results of the CNN and Random forest method on the X-ray dataset (Table 3). In Figure 2, a graph is plotted between numbers of Covid-19 cases Vs X-ray images. The detection rate of the CNN method is higher than the Random forest method for various image sets.

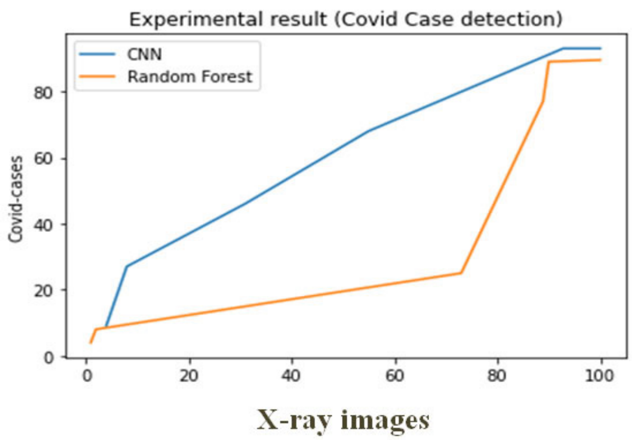

Figure 2: Covid-19 cases detection by CNN and Random Forest.

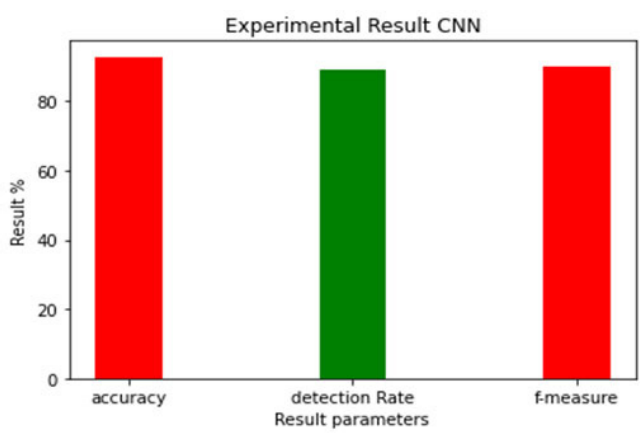

Figure 3: Experimental Result for CNN (Deep learning method) with Covid-19 X-ray Data set.

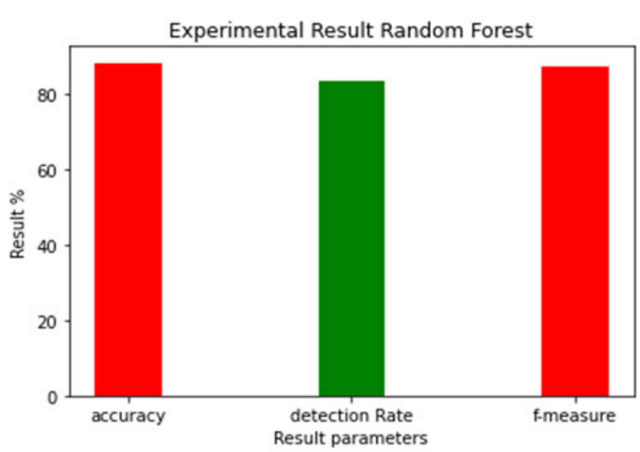

Figure 4: Experimental Result for Random Forest (Machine learning method) with Covid-19 X-ray Data set.

DISCUSSION

We employed the simulation on the Kaggle Covid-19 dataset for machine learning and deep learning methods.[1,3] The experiment mainly finds out the various features include texture, morphological, and image quality to distinguish Covid-19 infected patients and normal person based on lung infections. The main finding of the research was able to detect the Covid-19 infected patients among two popular Machine learning (Random forest) and Deep learning (CNN) methods.

In the previous research[3,4] machine learning methods and research paper[1,2] deep learning methods were used. It is crucial to formulate a deep neural network system like COVID-Net with transparency and accountability in view, because of the mission-critical nature of biomedical studies such as COVID-19 identification that really can affect patients' wellness and well-being. This research work evaluated the performance of machine learning-based random forest and deep learning-based CNN method. In the existing research[2-4] researchers are mainly utilizing the machine learning method, which performs better when the data size is limited. The precision of the experiment, together with the complexity of the design, the number of parameters, and the complexity of data processing are shown in Tables 2 and 3. This can be noticed that just by accomplishing more than 90 % test accuracy of CNN achieves better accuracy, consequently illustrating the effectiveness of exploiting participatory management framework strategies to build fully personalized deep neural network system in an increased way made to fit assignment, statistics, and strategic goals.

The various experimental parameters include detection rate, accuracy, and F-measure were calculated for CNN (Deep learning) and Random Forest (Machine learning method). The leading multi-class characteristic was the boundary. This same boundary seems to be the total pixel quantity at the edge of a picture. The fastest-growing functionalities from COVID-19 Vs viral infection were skewness, randomness, compact size, and thin proportion. The experimental results The CNN model outperforms over Random forest method, it shows an accuracy of 92.4 % (Figures 2-5) by considering the 40 % of training data and 60 % of testing data for the Covid-19 X-ray data set. Together, these results indicate that the boundary is a key differentiated characteristic, coherent with a closely examining which lung infection with COVID-19 appears to become more extraneous and lateral along the lung borders.

To determine a better understanding of the overlap between all the decision-making procedure of deep neural networks besides potential treatments as well as the policy procedure of healthcare professionals throughout chest radiographs, these observations are therefore informative. All performance indicators fell substantially although expected mostly with multi-class classification. Even so, the Classifier and accuracy coupled remained high. These research results are enabling and recommend that COVID-19 lung infection can indeed be distinguished from many other comparable lung infections by the multi-class categorization.

The purpose of this research was to enhance forecasting power by retrieving texture as well as morphological characteristics from X-ray images. The process of machine-learning is a hard process to retrieve the investigators' most suitable and important characteristics. Findings demonstrate that the most suitable and important hidden details provided in the COVID-19 lung infection, which also enhanced the multiple as well as inter classification, is available throughout the segmented images utilizing the CNN approach. These characteristics are most often used as feedback to the CNN process. The findings acquired outperformed these earlier conventional techniques.

CONCLUSION

The outbreaks of COVID-19 is not even the first pandemic, as well as doubtful to be last. However, over the first time, modern communities get the resources that provide a structured, evidence-based, equitable, as well as international solution towards human health. If we try to analyze these images manually it takes lots of time as well as some possibility of inaccuracy. Due to the rapid growth of the Covid-19 pandemic and limited resources (detection kits, lab, health workers, and medicines), the need for an automatic and accurate detection system is always an interesting hot topic for researchers. By using the effectiveness of the whole solution increasing depends partially on ML and DL methods. This research mainly utilizes various chest images (X-ray) of covid-19 patients. The experimental results influence that the CNN method shows a 92.4 % accuracy result over the machine learning method. We could also save numerous human lives now and in the future, unless we begin taking the whole chance to acquire data, pool our expertise as well as incorporate our skill and knowledge. Throughout future work, we will build a methodology premised on artificial intelligence and machine learning to battle in monitoring and mitigation with pandemic COVID-19.

ACKNOWLEDGEMENT

The authors acknowledge the immense help received from the scholars whose articles are cited and included in references to this manuscript. The authors are also grateful to authors/ editors/publishers of all those articles, journals, and books from where the literature for this article has been reviewed and discussed.

Sources of funding: Nil

Conflicts of interest: Nil

REFERENCES

1. Randhawa GS, Soltysiak MP, El Roz H, de Souza CP, Hill KA, Kari L. Machine learning using intrinsic genomic signatures for rapid classification of novel pathogens: a COVID-19 case study. PLoS One 2020;15(4):232-239.
2. Ahmad A, Aryal S, Manandhar I, Munroe PB, Joe B, Cheng X. Artificial intelligence and machine learning to fight COVID-19. Physiol Genom 2020;11(3):200-202.
3. Ardabili SF, Mosavi A, Ghamisi P, Ferdinand F, Varkonyi-Koczy AR, Reuter U, et al. COVID-19 outbreak prediction with machine learning. IEEE Transaction 2020;24(12):491-502.
4. Tuli S, Tuli S, Tuli R, Gill SS. Predicting the Growth and Trend of COVID-19 Pandemic using Machine Learning and Cloud Computing. Internet Things 2020;31(11):327-333.
5. Gergo P, Felde I, Mosavi A, Ghamisi P, Gloaguen R. COVID-19 Pandemic Prediction for Hungary; a Hybrid Machine Learning Approach. Mathematics 2020;8(6):890-899.
6. Kavadi MDP, Patan R, Ramachandran M, Gandomi AH. Partial Derivative Nonlinear Global Pandemic Machine Learning Prediction of COVID 19. Chaos Sol Fractals 2020;11(2):491-507.
7. Pandey R, Gautam V, Bhagat K, Sethi T. A machine learning application for raising wash awareness in the times of covid-19 pandemic. NLP Healthcare 2020;16(3):221-239.
8. Apostolopoulos ID, Mpesiana TA. COVID-19: automatic detection from x-ray images utilizing transfer learning with Convolutional neural networks. Physic Engi Sci Med 2020;14(6):777-786.
9. Ndiaye BM, Tendeng L, Seck D. Analysis of the COVID-19 pandemic by SIR model and machine learning techniques for forecasting. arXiv 2020;21(4):111-121.
10. Magdon-Ismail M. Machine learning the phenomenology of COVID-19 from early infection dynamics. arXiv 2020;17(5):199-209.
11. Kassani SH, Kassasni PH, Wesolowski MJ, Schneider KA, Deters R. Automatic Detection of Coronavirus Disease (COVID-19) in X-ray and CT Images: A Machine Learning-Based Approach. arXiv 2020;7(12):778-788.
12. Apostolopoulos ID, Pesiana M. COVID-19: automatic detection from x-ray images utilizing transfer learning with Convolutional neural networks Physic Engi Sci Med 2020:11(7):111-121.
13. COVID-19 patient pre-condition dataset. Kaggle.com. 2020 [cited 16 September 2020]. Available from: https://www. kaggle.com/tanmoyx/covid19-patient-precondition-dataset.
14. Punn NS, Sonbhadra SK, Agarwal S. COVID-19 Epidemic Analysis using Machine Learning and Deep Learning Algorithms. medRxiv 2020;12(8):147-155.
15. Zhang J, Xie Y, Li Y, Shen C, Xia Y. COVID-19 screening on chest x-ray images using deep learning-based anomaly detection. arXiv 2020;14(5):554-564.
16. Gozes O, Frid-Adar M, Greenspan H, Browning PD, Zhang H, Ji W, et al. Rapid AI development cycle for the Corona-virus (COVID-19) pandemic: Initial results for automated detection & patient monitoring using deep learning ct image analysis. arXiv 2020;24 (6):1144-1152.
17. Patil V, Lilhore U. A survey on different data mining & machine learning methods for credit card fraud detection. Int J Sci Res Comp Sci Engi Infor Tech 2018;3(5):320-325.

18. Khan NS, Lilhore U. Review of various intrusion detection methods for training data sets. Int J Modern Trends Engi Res 2016;11(3):445-452.
19. Li L, Qin L, Xu Z, Yin Y, Wang X, Kong B, et al., Artificial intelligence distinguishes COVID-19 from community-acquired pneumonia on chest CT. Radiology 2020;17(4):200-212.
20. Wang S, Bo K, Ma J, Zeng X, Xiao M, Guo J, et al. A deep learning algorithm using CT images to screen for Corona Virus Disease (COVID-19). MedRxiv 2020;17(5):1232-1239.
21. Pawar N, Lilhore U, Agrawal N. A Hybrid ACHBDF Load Balancing Method for Optimum Resource Utilization in Cloud Computing. IJMTER 2017;15(3):2889-2897.
22. Butt C, Gill J, Chun D, Babu BA. Deep learning system to screen corona-virus disease 2019 pneumonia. Appl Intellig 2020;18(11):178-189.
23. Hemdan EED, Shouman MA, Karar ME. Covidx-net: A framework of deep learning classifiers to diagnose COVID-19 in x-ray images. arXiv 2020;11(7):147-158.
24. Ghoshal B, Tucker A. Estimating uncertainty and interpretability in deep learning for coronavirus (COVID-19) detection. arXiv preprint 2020;23(11):1147-1158.
25. Ardakani AA, Kanafi AR, Acharya RU, Khadem N, Mohammadi A. Application of deep learning technique to manage COVID-19 in routine clinical practice using CT images: Results of 10 Convolutional neural networks. Comp Biol Med 2020;11(3):103-117.
26. Sarma P, Kaur H, Kumar H, Mahendru D, Avti P, Bhattacharyya A, et al. Virological and clinical cure in COVID-19 patients treated with hydroxychloroquine: a systematic review and meta-analysis. J Med Virol 2020;22(8):2214-2228.
27. Deshpande G, Schuller B. An Overview on Audio, Signal, Speech, & Language Processing for COVID-19. arXiv preprint arXiv 2020; 14(3):147-158.
28. Liu D, Wu YL, Xi L, Qi L. Medi-Care AI: Predicting medications from billing codes via robust recurrent neural networks. Neural Netw 2020;12(4):109-116.
29. Ross J, Foley M, Benepal T, Chow J, Marshall C. The challenges of complex molecular testing pathways and the benefits of in-house testing. Lung Cancer 2020;13(9): 338-349.
30. Ben G, Goertzel T, Goertzel Z. The global brain and the emerging economy of abundance: Mutualism, open collaboration, exchange networks, and automated commons. Technol Forecast Soc Change 2020;11(4):65-73.
31. Reeves JJ, Hollandsworth HM, Torriani FJ, Taplitz R, Abeles S, Ming TS, et al. Rapid response to COVID-19: health informatics support for outbreak management in an academic health system. J Am Med Infor Assoc 2020;27(6):853-859.
32. Li W. GeoAI: Where machine learning and big data converge in GIScience. J Spatial Infor Sci 2020;24(4):1147-1158.
33. Kalil AC. Treating COVID-19off-label drug use, compassionate use, and randomized clinical trials during pandemics. JAMA 2020;23(19):1897-1898.
34. Majid A, Muallem N, Brown KT, Moskowitz CS, Hsu M, Zenobi CL, et al. Autologous blood patch injection versus hydrogel plug-in CT-guided lung biopsy: a prospective randomized trial. Radiology 2019;290(2):547-554.
35. Chawla S, Mittal M, Chawla M, Goyal LM. Corona Virus-SARS-CoV-2: An Insight to Another way of Natural Disaster. EAI Endorsed Transact Pervasive Health Tech 2020;6(22):1-9.
36. Anker SD, Butler J, Khan MS, Abraham WT, Bauersachs J, Bocchi E, et al. et al. Conducting clinical trials in heart failure during (and after) the COVID-19 pandemic: an Expert Consensus Position Paper from the Heart Failure Association (HFA) of the European Society of Cardiology (ESC). Eur Heart J 2020;41(22):2109-2117.
37. Giorgio Q, Radin JM, Gadaleta M, Baca-Motes K, Ariniello L, Ramos E, et al. Passive Monitoring of Physiological Data and Self-reported Symptoms to Detect Clusters of People with COVID-19. medRxiv 2020;7(11):227-235.