COVID-19 detection using GAN generated chest X-rays with Deep Transfer models, and Explainable AI

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Abstract

Coronavirus (COVID-19) is one of the deadliest viruses caused by Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which has become a part of today's world. It was declared a pandemic by WHO on 11 March 2020. Among its enormous effects, healthcare systems around the world are having to face unparalleled and escalating stress. However, early discovery of this sort of virus may aid in quick recovery and relieve the load on healthcare systems. To detect this deadly virus, chest X-rays (CXRs) are a comparatively cheaper and faster diagnosis process. In this paper, we aimed to detect COVID-19 positive cases using patients' chest X-rays with CNN and explainable AI. Before applying any CNN model, we used GAN to augment our dataset for better performance, since there are only 307 images available with four classes: COVID-19, normal, pneumonia bacterial, and pneumonia virus. Here the GAN architecture we have applied, significantly enhances the number of chest X-ray images during the training and validation phase, compared to the original dataset. For classification purposes, we have used Alexnet, Googlenet, Resnet50, and Shufflenet deep transfer models, as their architectures have a limited number of layers. This impacts positively on the models' performance as it helps to minimize the complexity, CPU usage, and also execution time. We evaluated our models' performance with and without GAN generated image dataset and it showed significant improvement after using GAN generated images. Finally, to make the prediction explainable, we have used LIME and SHAP as XAI which helps the pathologists to understand the detection and build trust in the AI system. In summary, the whole combination of GAN, CNN models, and explainable AI, helped us to build a robust and accurate COVID-19 detection model using chest X-rays.

Reference

Cohen, J. P.; Morrison, P.; Dao, L.; Roth, K.; Duong, T. Q.; and Ghassemi, M. 2020. COVID-19 Image Data Collection: Prospective Predictions Are the Future.

Khalifa, N. E. M.; Taha, M. H. N.; Hassanien, A. E.; and Elghamrawy, S. 2020. *Detection of Coronavirus (COVID-19) Associated Pneumonia based on Generative Adversarial Networks and a Fine-Tuned Deep Transfer Learning Model using Chest X-ray Dataset.*

Loey, M.; Smarandache, F.; and Khalifa, N. E. M. 2020. *Within the Lack of Chest COVID-19 X-ray Dataset: A Novel Detection Model Based on GAN and Deep Transfer Learning. Symmetry 12: 2073-8994.*

Waheed;Abdul;Goyal;Muskan;Gupta;Deepak;Khanna;Ashish;Al-Turjman;Fadi;Pinheiro;Plácido Rogerio. *Covidgan: data augmentation using auxiliary classifier gan for improved covid-19 detection,Ieee Access,8:91916-91923,2020.*

Rehman; Amjad; Saba; Tanzila; Tariq; Usman; Ayesha; Noor. *Deep learning-based COVID-19 detection using CT and X-ray images: Current analytics and comparisons. IT Professional 23(3): 63-68, 2021*

Ahsan; Manjurul, M.; Gupta; Datta, K.; Islam; Maminur, M.; Sen; Sajib; Rahman; Md; Hossain, Shakhawat M. *Study of different deep learning approach with explainable ai for screening patients with COVID-19 symptoms: Using ct scan and chest x-ray image dataset, arXiv preprint arXiv:2007.12525, 2020*

Ahsan; Manjurul, M.; Gupta; Datta, K.; Islam; Maminur, M.; Sen; Sajib; Rahman; Md; Hossain, Shakhawat M. *Covid-19 symptoms detection based on nasnetmobile with explainable ai using various imaging modalities, Machine Learning and Knowledge Extraction, 2(4): 490-504, 2020*

Sousa,P.d.;Iam; Vellasco;Marley MBR;Silva, C.d.;Eduardo. *Explainable Artificial Intelligence for Bias Detection in COVID CT-Scan Classifiers, Sensors, 21(16): 5657, 2021*

Teixeira;Lucas,O.;Pereira,Rodolfo,M.;Bertolini,Diego;Oliveira,Luiz S.;Nanni;Loris;Cavalcanti;George,DC.;Costa;Yandre, MG.;Impact of lung segmentation on the diagnosis and*

explanation of COVID-19 in chest X-ray images, arXiv preprint arXiv:2009.09780,2020

Karim;Md;Döhmen;Till;Rebholz-Schuhmann;Dietrich and Decker;Stefan;Cochez;Michael;Beyan;Oya.DeepCOVIDExplainer: Explainable COVID-19 diagnosis based on chest X-ray images, arXiv preprint arXiv:2004.04582,2020