3D deep features for Covid-19 screening in CT scans

#deeplearning #artificialintelligence #medicalimaging

Hugo Morvan, Undergraduate student, undergraduate research scholar, University of South Dakota
KC Santosh Ph.D., Chair of the Department of Computer Science, faculty mentor, University of South Dakota

Motivation

- As of 26 August 2022, there have been more than 596 millions confirmed cases of COVID-19, including 6,459,684 deaths, and still hundreds of thousands of new cases daily [1].
- Considering the possible future epidemics of the COVID-19, it is important to develop appropriated AI-driven tools [2].
- Artificial intelligence (AI) has promoted countless contributions in the field of medical imaging. Healthcare tools have advanced the quality of screening procedures in the COVID-19 era [3].
- COVID-19 abnormalities such as Ground-Glass Opacity (GGO) can be observed using chest CT scans. CT scans are widely used to identify unusual patterns in confirmed cases of COVID-19 [4].
- A clinical study in Wuhan, China, discovered that chest CT-scan analysis might have a sensitivity of 0.97 for detecting COVID-19 [5,6].

Methods

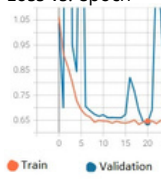
- Deep learning is the most efficient technique that can be used in medical science. It is fast and efficient method for the diagnosis and prognosis of various illness with a good accuracy rate [7].
- A Visual Geometry Group (VGG) Convolutional Neural Network (CNN) was use for this project as COVID-19 manifestations can be visualized in CT-scans [7], and thus recognized by the CNN.
- The dataset for this research comes from the STOIC21 project which consists of 2000 publicly available chest CT-scans. The dataset contains binary labels for COVID-19 presence, based on RT-PCR test results [8].
- The preprocessed dataset was used to train a 3D CNN inspired by the VGG network architecture. Training was performed on a GPU node of the Lawrence consisting of a dual 12-core SkyLake 5000 series CPU, an NVIDIA Tesla V100 32GB GPU and 192GB of RAM.

Results

- After training for 20 epochs, the accuracy reached a maximum of 63% on the validation set and 65.4% on the training set while the loss reached its lowest at 0.644 for the validation set and 0.642 for the training set.

Accuracy vs. epoch

Loss vs. epoch

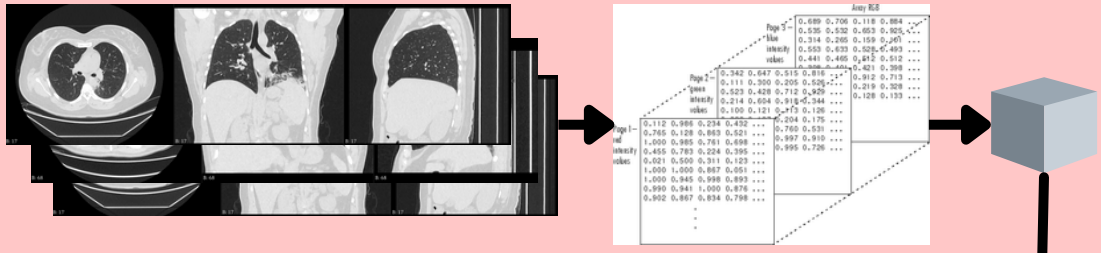


Sources

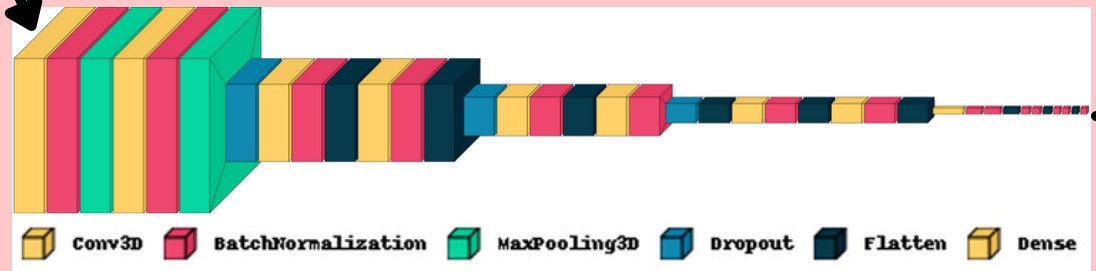
- [1] https://covid19.who.int/ , accessed 29 August 2022.
- [2]KC Santosh. AI-Driven Tools for Coronavirus Outbreak: Need of Active Learning and Cross-Population Train/Test Models on Multitudinal/Multimodal Data. J Med Syst 44, 93 (2020).
- [3]KC Santosh, S Ghosh. Covid-19 Imaging Tools: How Big Data is Big?. J Med Syst 45, 71 (2021).
- [4] H Mukherjee, S Ghosh, A Dhar, Sk Md Obaidullah, KC Santosh, and K Roy. Deep neural network to detect COVID-19: one architecture for both CT Scans and Chest X-rays. Appl Intell 51, 2777– 2789 (2021).
- [5] A. Heidari et al., A privacy-aware method for COVID-19 detection in chest CT images using lightweight deep convoliutional neural network and blockchain, Computer in Biology and Medicine 145 (2022) 105461.
- [6]Q. Dou, et al., Federated Deep Learning for detecting COVID-19 lung abnormalities in CT: a privacy-preserving multinational validation study, NPJ Digit med. 4 (1) (2021) 1-11.
- [7]V. Shah et al., Diagnosis of COVID-19 using CT scan images and deep learning techniques. Emergency Radiology (2021) 28:497-505.
- [8] Revel et al., Study of Thoracic CT in COVID-19: The STOIC Project, Radiology Vol. 301, No 1, 2021.

Detecting **COVID-19** using **Artificial Intelligence :**

Preprocessing



Convolutional Neural network*



*z-dimension scaling modified

Results :

Covid19-positive / Covid19-negative

Scan the code for **contact information**, link to **source code** and **full paper download**

Thank you to Kevin OKelley, the UDiscover program and my mentor Dr. KC Santosh for giving me the opportunity to perform this research. Computations supporting this project were performed on High Performance Computing systems at the University of South Dakota, funded by NSF Award OAC-1626516. USD Research Computing staff Bill Cone provided valuable technical expertise to this project.