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Covid-19 Classification and Segmentation using Transfer Learning, Wavelet Transforms, and UNet

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Introduction

1. The SARS-CoV2 virus impacts the lungs directly and damages alveoli which may cause further complications such as pneumonia and respiratory syndromes

2. Medical imaging comprises detection of objects and their segmentation and classification. Advancements in AI and DL provide solutions in computer-aided healthcare for early detection and diagnosis of patients

Objective

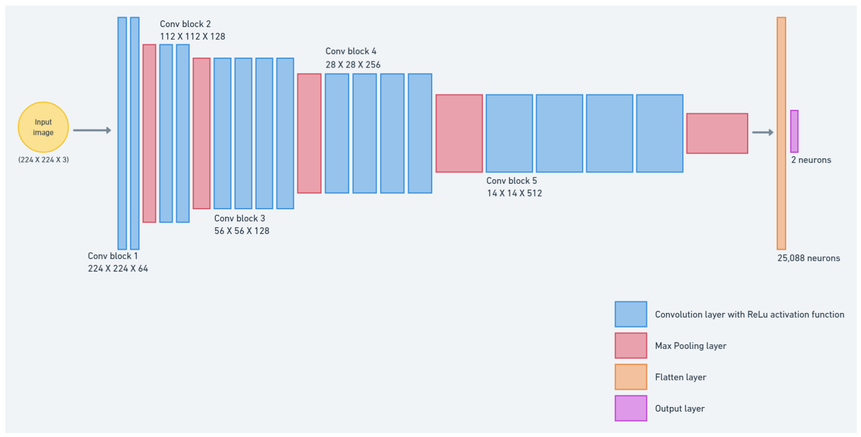
We apply three different algorithms to classify and segment human chest scans:
1. Transfer Learning with VGG-19
2. Transfer Learning with Discrete Wavelet Transformation
3. Segmentation with the UNet architecture.

The first two algorithms are used to classify the lung scans into positive and negative classes, whereas the third algorithm is used to segment the positive scans to obtain the aberrations caused due to infection.

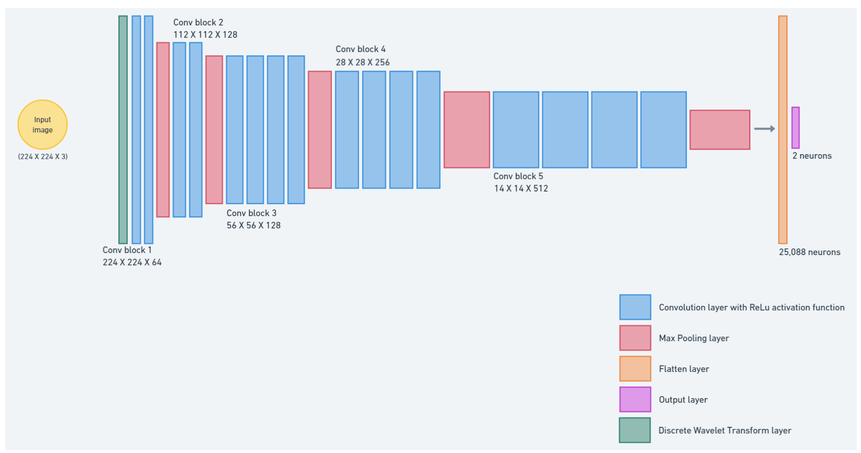
Methods

Dataset

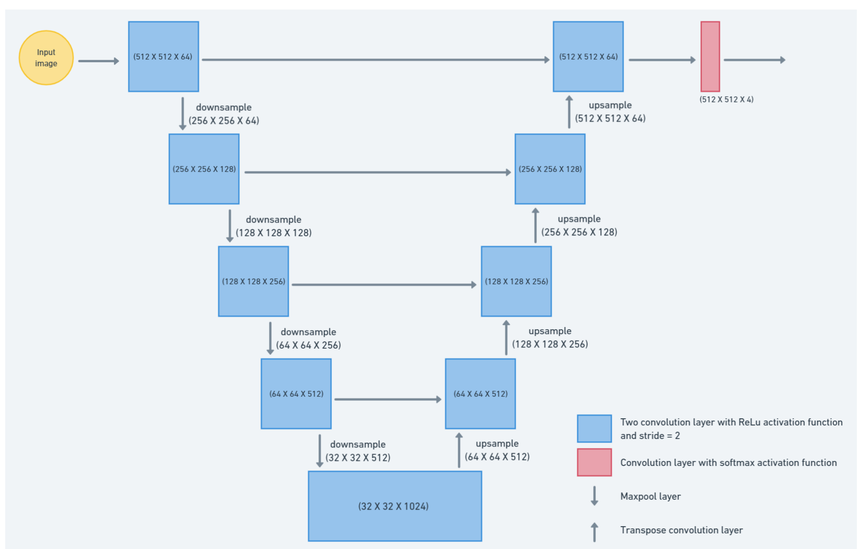
The COVID-CX3 dataset was used: a set of 30,882 CXR images (16,490 COVID-19 positive images) sourced from more than 17,026 patients from multiple countries.



Transfer learning with custom VGG-19 architecture



Custom VGG-19 architecture with DWT layer

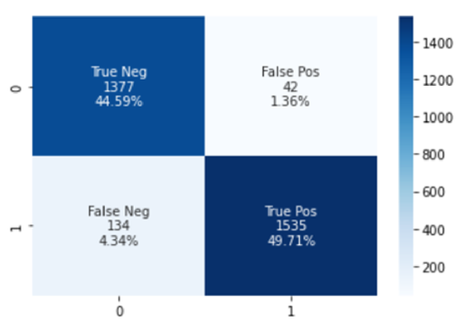


Custom UNet architecture

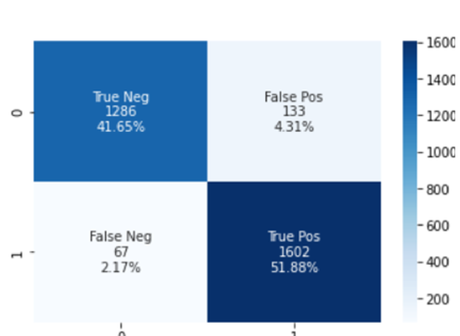
Results

Metric/ Model	VGG-19	VGG-19 with DWT
Sensitivity	0.9197	0.9598
Specificity	0.9707	0.9062
Precision	0.9733	0.9233
Recall	0.9197	0.9598
F1 Score	0.9457	0.9411

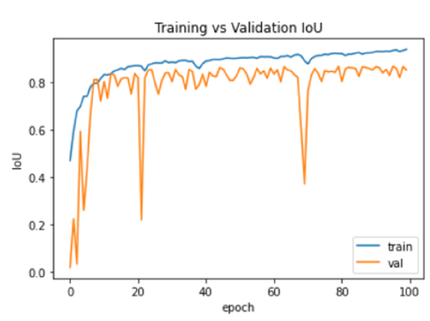
Metric/model	UNet
IoU	0.9381



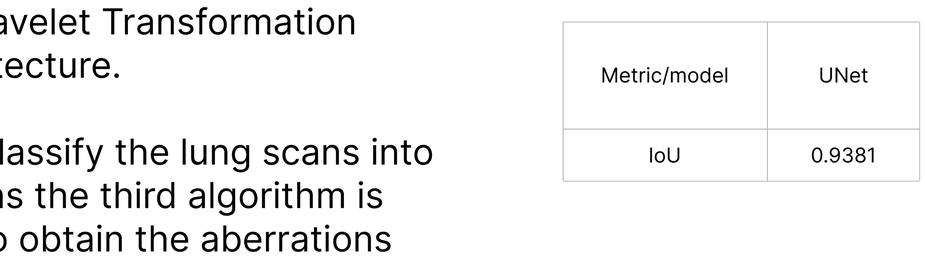
Transfer learning with custom VGG-19



Transfer learning with custom VGG-19 and DWT layer



Segmentation with UNet



Conclusions

We used 3 different algorithms or Deep Learning Models to
1. Predict if a given person has COVID-19
2. Detect the aberrations in the lung CT scans of COVID-19 positive patients.

For classification purposes, two different algorithms were used:
1. Transfer learning using VGG-19
2. Transfer learning with discrete wavelet transformation

The DWT model performed better than the plain Transfer Learning model with respect to some metrics and vice-versa; hence, we cannot specifically choose which model is better for classifying Covid-19 chest X-rays.

The UNet model performed extremely well on the dataset and achieved 97% accuracy on the training data.

Future work

1. Work can be conducted on diverse feature extraction techniques with the help of countourlet transforms and more
2. More advanced computer vision models
3. Improving the accuracy on the dataset

References

1. Pavlova, Maya, et al. “COVID-Net CXR-2: An Enhanced Deep Convolutional Neural Network Design for Detection of COVID-19 Cases from Chest X-Ray Images.” ArXiv:2105.06640 [Cs, Eess], 14 May 2021, arxiv.org/abs/2105.06640. Accessed 27 Apr. 2022.
2. Wu, Yu-Huan, et al. “JCS: An Explainable COVID-19 Diagnosis System by Joint Classification and Segmentation.” IEEE Transactions on Image Processing, vol. 30, 2021, pp. 3113–3126, ieeexplore.ieee.org/abstract/document/9357961, 10.1109/TIP.2021.3058783. Accessed 21 July 2021.