Detection of COVID-19 using Convolutional Neural Networks

Dhruv Sanchety, Cody Swain

***Abstract*—Rapid detection of the COVID-19 infection in patients is essential in order to make better informed decisions and save lives. In this paper we design, implement, and evaluate a multi-class convolutional neural network (CNN) architecture for identification of COVID-19 in patients. Analysis of pre-labelled X-Ray scans and CT scans are utilized in the evaluation of this proposed technique.**

***Index Terms*—Deep Learning, Convolutional Neural Networks (CNN), Coronavirus (COVID-19), Analysis of Variance (ANOVA), Chest X-Rays, Radiology**

I. Introduction

THE disease COVID-19 caused by the severe acute repiratory syndrome corona virus 2 (SARS-CoV-2) has been labelled as a pandemic by the World Health Organization and has altered the global landscape since it's first presentation in Wuhan, China in December[1][2]. A high reproduction rate and a high mortality rate has resulted in government sanctioned border closures, deserted streets, panic-induced stockpiles, and a global recession.

Because the number of infected people grows as an exponential function, it is critical to contain and trace the virus through extensive testing. However, a scarcity and a mediocre true positive rate in standard tests - real-time reverse transcription polymerase chain reaction (rRT-PCR) from a nasopharyngeal swab - indicates the importance of alternate methods to diagnose the infection.

This paper explores the feasibility of a diagnosis of the infection through X-Ray imaging analysis of a patient's lungs. The lungs are analyzed because the virus attacks epithelial cells in the respiratory tract. The analysis is done with Convolutional Neural Networks, a class of deep neural networks that are a regularized variety of multilayered perceptrons often used to analyze visual imagery. The architecture of multilayered perceptrons is similar to the neurons in the human brain and each neuron in a layer is connected to all neurons in the previous layer. However, the aforementioned characteristic of the multilayered perceptrons can result in an overfitted model. To combat the problem, Convolutional Neural Networks exploit the hierarchical nature of data to manage complexity with simpler structures. A convolutional neural network is used in the study because of its ability to extract features.

The performance of the convolutional neural network is evaluated with an independent dataset that is not involved in the development of the network to prevent bias. Furthermore, X-Ray images of patients with pneumonia not induced by COVID-19 are included to evaluate the robustness of the model. ANOVA tests and chi-squared tests are used to compare differences that exist in different groups. The result of the study is considered to be statistically significant if there is a probability of no more than 5% that random chance can produce a similar or more extreme result if the null hypothesis is correct. The performance of the model is measured with the area under the receiver operating characteristic curve (AUROC) and the analysis is performed with Python libraries (Keras, TensorFlow).

Before the convolutional neural network is modeled, it is critical to realize that sensitivity, the measure of the proportion of positives that are correctly identified, is more important than specificity - the measure of the proportion of negatives that are correctly identified. While the consequences of a false positive aren't that dangerous, the consequences of a false negative can result in fatalities and increased infections.

Multiple research teams have designed various convolutional neural network architectures to tackle this issue, but most of the results are hidden and thus may not have their accuracy easily assessed[3]. The leading model is called COVID-NET and is being developed by three researchers at the University of Waterloo in conjunction with a Canadian AI company called DarwinAI[4]. They've chosen to make both their research and datasets open-source and available to the public with the goal of accelerating the pace of development of practical solutions.

The architecture of COVID-NET is highly dependent a design pattern known as projection-expansion-projectionextension (PEPX), which is able to have good computational efficiency while maintaining somewhat high representation capabilities.

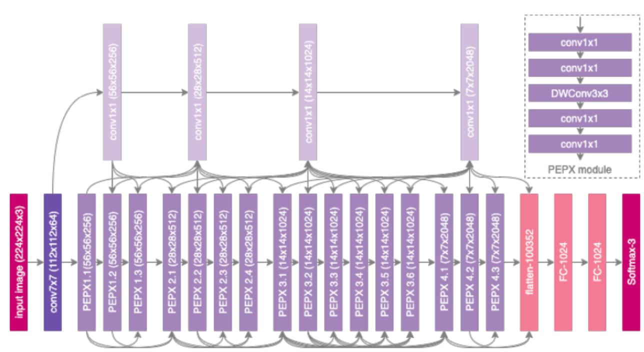

Fig. 1. COVID-Net Architecture

COVID-NET is trained on what has been named the COVIDx dataset, which consists of 13,800 chest X-Ray (CXR)

Revised May 4, 2020

images, created from three public datasets. One noted problem here is a lack of COVID-19 case data. There are only 121 patients in the dataset with COVID-19, and only 183 COVID-19 CXR images in total. These are available for download at https://github.com/lindawangg/COVID-Net.

In this paper we design a slight variant on the COVID-Net architecture, and incorporate a larger dataset, including data from Dr. Joseph Paul Cohen, a fellow at Université de Montréal. His dataset is publicly available at https://github.com/ieee8023/covid-chestxray-dataset, and includes an additional 244 COVID-19 samples.

A. Subsection Heading Here

Subsection text here.

1) Subsubsection Heading Here: Subsubsection text here.

II. Conclusion

The conclusion goes here.

Appendix A
Proof of the First Zonklar Equation

Appendix one text goes here.

Appendix B

Appendix two text goes here.

Acknowledgment

The authors would like to thank...

References

[1] These will be properly cited in the future
[2] ex 2
[3] https://www.technologyreview.com/2020/03/12/905352/ai-could-help-with-the-next-pandemicbut-not-with-this-one/
[4] https://arxiv.org/pdf/2003.09871.pdf

PLACE PHOTO HERE

Michael Shell Biography text here.

John Doe Biography text here.

Jane Doe Biography text here.