

Dissection of Covid-19 Prediction Models

General Info

Project Title: Dissection of Covid-19 Prediction Models

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Project Abstract

In order to establish trust in the clinical routine for the use of neural network models for screening Covid-19, it is vital to know how the models reach their predictions. In this project we are going to put the networks under the microscope and investigate what features and patterns in the data the network uses for prediction. I.e. is there a specific type of texture that model looks for when detecting a pathology or is it a totally irrelevant feature. This give us a qualitative understanding of the prediction process of the model. We will be using the methodology proposed by Zhou et al¹. The prediction models are first pretrained on the CheXpert data set², later finetuned on public Covid-19 X-ray dataset³. The result can help us validate the models, and may also provide new insights about Covid19 by showing discriminative features that the networks may have discovered.

Background

There are couple of papers which present methods for automatic detection of COVID-19 disease⁴⁵ or quantifying the COVID-19 severity score⁶ from X-ray images.

A line of research within neural networks' interpretability investigates the learned features of the models. This can be achieved either by searching over the dataset for the parts of the images that maximally activate a certain neuron¹ or by generating an input image that maximizes that neuron⁷. Previously a methodology similar Zhou et al. is used for understanding mammography classification models⁸.

Technical Prerequisites

- Basic understanding of convolution neural networks
- Very good skills in Python
- Good skills in PyTorch

¹ Bau, David, et al. "Network dissection: Quantifying interpretability of deep visual representations." Proceedings of the IEEE conference on computer vision and pattern recognition. 2017.

² Irvin, Jeremy, et al. "Chexpert: A large chest radiograph dataset with uncertainty labels and expert comparison." Proceedings of the AAAI Conference on Artificial Intelligence. Vol. 33. 2019.

³ <https://brixia.github.io/#get-the-data>

⁴ Oh, Yujin, Sangjoon Park, and Jong Chul Ye. "Deep learning covid-19 features on cxr using limited training data sets." IEEE Transactions on Medical Imaging (2020).

⁵ Ozturk, Tulin, et al. "Automated detection of COVID-19 cases using deep neural networks with X-ray images." Computers in Biology and Medicine (2020): 103792.

⁶ Signoroni, Alberto, et al. "End-to-end learning for semiquantitative rating of COVID-19 severity on Chest X-rays." *arXiv preprint arXiv:2006.04603* (2020).

⁷ Olah, et al., "Feature Visualization", Distill, 2017.

⁸ Wu, Jimmy, et al. "Deepminer: Discovering interpretable representations for mammogram classification and explanation." *arXiv preprint arXiv:1805.12323* (2018).

Benefits:

- Working on a Covid19 related project!
- Possible publication (based on the results)

Work-packages and Time-plan:

	Description	#Students	From	To
WP1	Familiarize with the literature. (ChestX ray classification, and Neural network interpretation) and the datasets	all	01.11	
WP2	Familiarize with PyTorch. Come up with a detailed time-plan (Gantt)	all		
WP3	Train a model on CheXpert dataset	Group1		
WP4	Fine-tune model on Covid Dataset	Group1		
WP5	Setup Network Dissection (E.g. on ImageNet validation set)	Group2		
M1	Intermediate Presentation II	all	17.12.2020	
WP6	Run Network Dissection on Covid19 dataset	all		
WP7	Share results with clinical partners and interpret the features	all		
WP+	(Optional)Run the framework on private CT dataset	all		
WP8	Documentation	all		
M2	Final Presentation	all	26.02.2021	

