C-30

Multi-Centre Optimization and Validation of an Open Deep Learning Model for Covid-19 Detection on Chest Radiographs

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Introduction

The radiographic appearance of Covid-19 infection is fairly unique – characterized by bilateral symmetrical ground-glass consolidation without pleural effusion – and has been reported on both chest CT and chest radiographs (CXRs).

Based on the hypothesis that this uniqueness can be used to reliably diagnose Covid-19 on CXRs, we performed a study to assess and optimize the ability of COVID-Net, an open-source deep learning model published by the University of Waterloo, to detect Covid-19 on local CXRs.

Objective

To optimize and validate COVID-Net for the prediction of Covid-19 in CXRs of Malaysian patients

Methodology

Data Collection:

Hospital Sungai Buloh | Sarawak General Hospital | Hospital Raja Permaisuri Bainun | Hospital Taiping | University of Malaya Medical Centre

Convenient sampling from each hospital:
Cases: up to 100-150 Covid PCR+ CXRs
Controls: up to 150-200 CXRs from October 2019

Training Set: 318 Cases & 368 Controls

Test Set: 318 Cases & 367 Controls

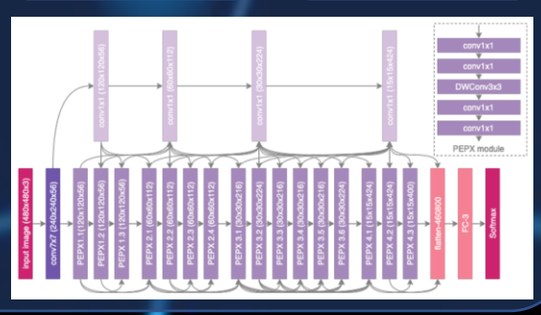
Optimization:

TensorFlow on RTX 2060

Parameters (train_tf.py):
- Image augmentation
- Batch size: 4
- Optimizer: ADAM
- Variable learning rate: 0.0001 to 0.00003
- Epochs at each learning rate: 40+

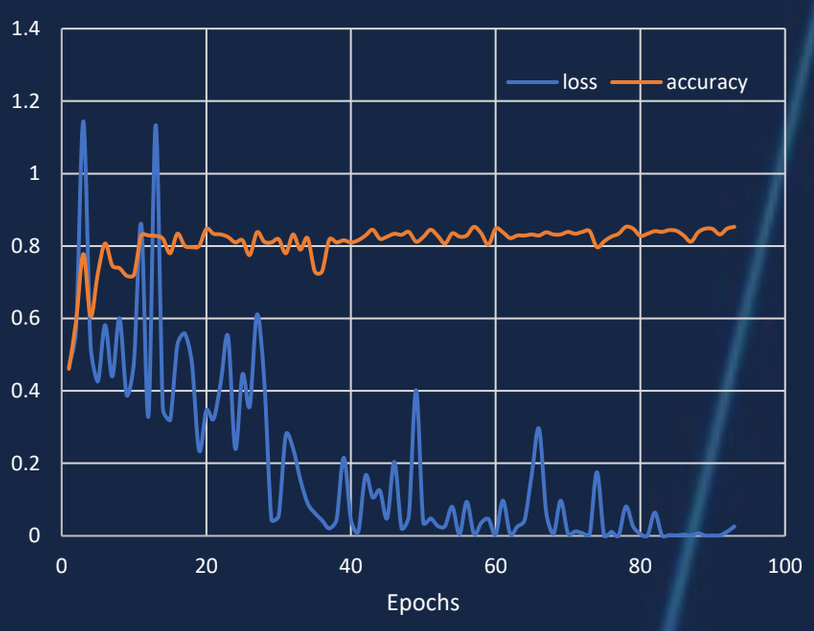
Validation:

Optimized COVID-Net Model vs Published COVID-Net Model (Unoptimized)



Results

Optimization:



Validation:

Published (Unoptimized) COVID-Net Model

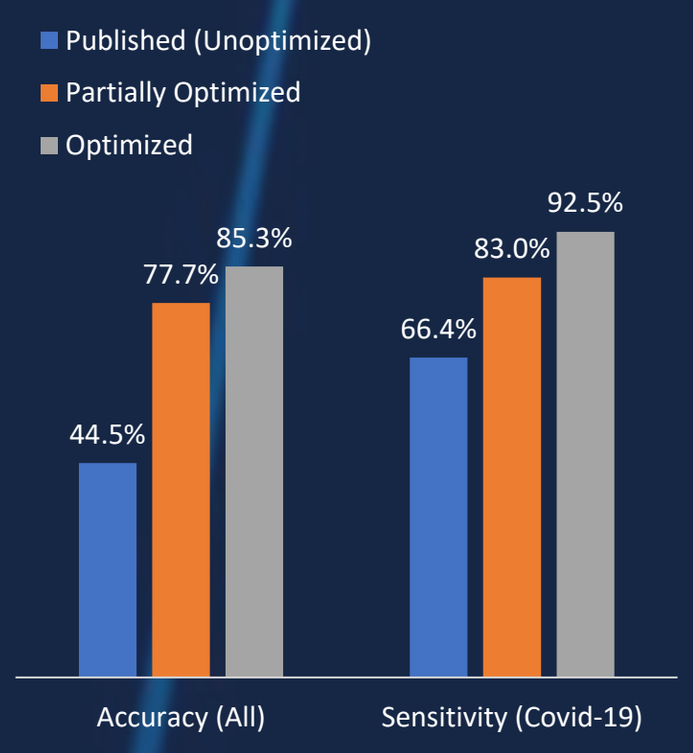
Unoptimized (4A)		Prediction: Normal	Pneumonia	Covid
Ground Truth	Normal	78	3	235
	Pneumonia	1	16	34
	Covid	96	11	211

Partially Optimized COVID-Net Model

20+ Epochs LR: 0.0001		Prediction: Normal	Pneumonia	Covid
Ground Truth	Normal	251	7	58
	Pneumonia	13	17	21
	Covid	45	9	264

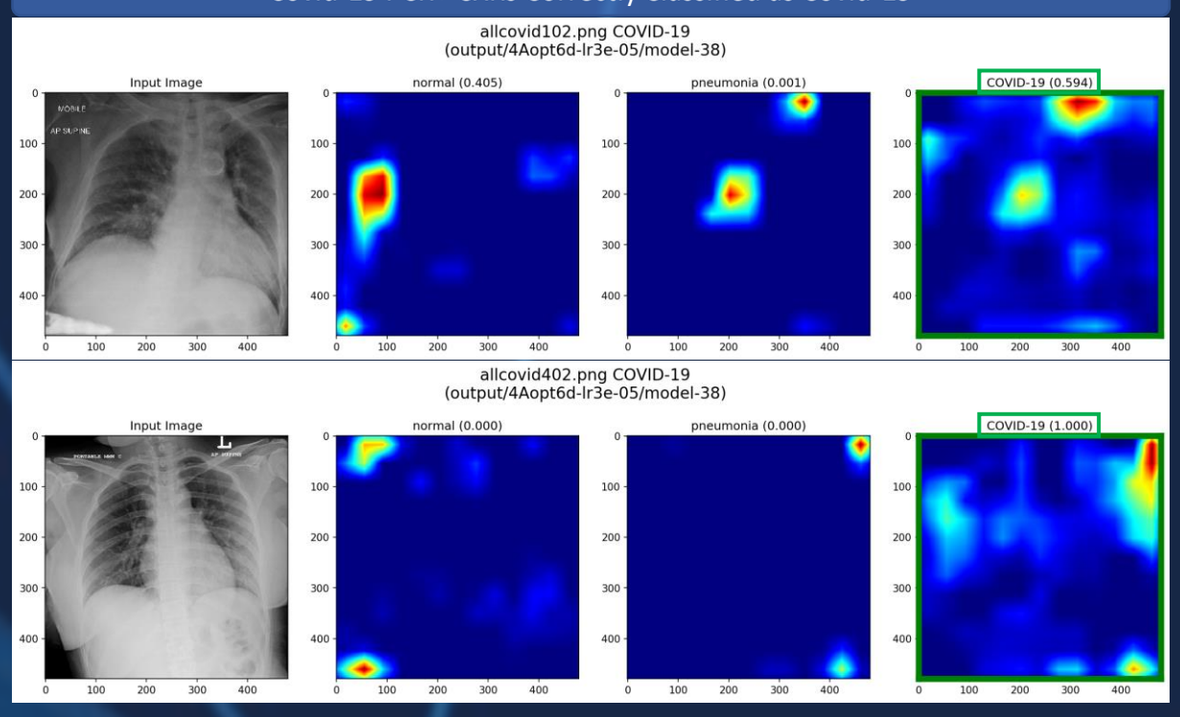
Optimized COVID-Net Model

90+ Epochs LR: 0.0001 → 0.00003		Prediction: Normal	Pneumonia	Covid
Ground Truth	Normal	269	6	41
	Pneumonia	12	21	18
	Covid	19	5	294

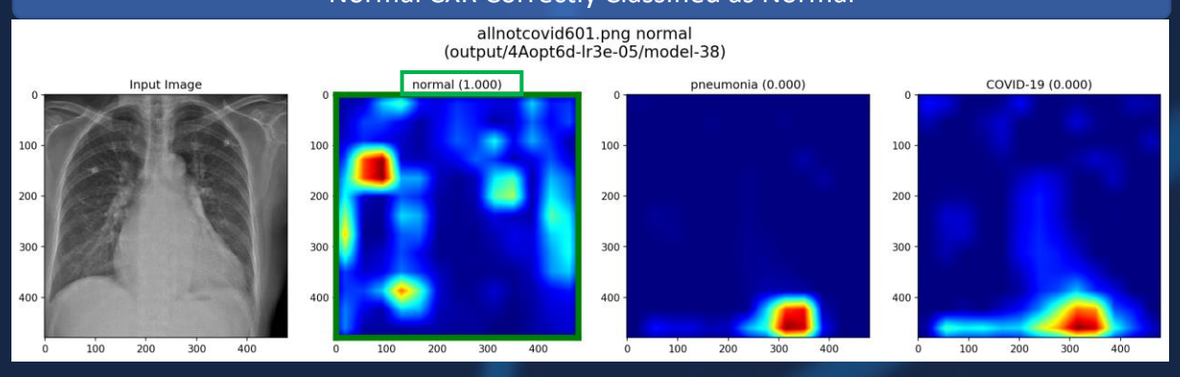


Sample Predictions with Class Activation Maps

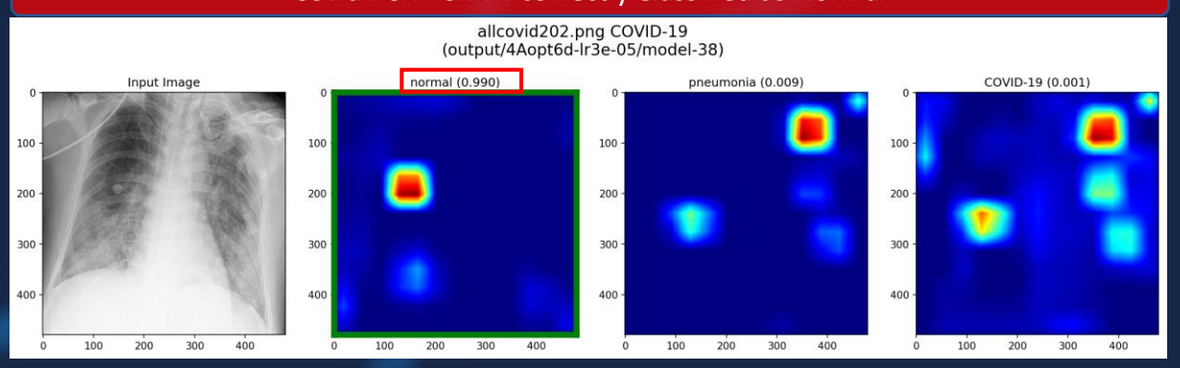
Covid-19 PCR+ CXRs Correctly Classified as Covid-19



Normal CXR Correctly Classified as Normal



Covid PCR+ CXR Incorrectly Classified as Normal



Conclusions

The published (unoptimized) COVID-Net model has mediocre performance which improved tremendously after optimization. This suggests the model is robust but requires optimization with local CXRs before consideration for clinical use.

Class activation maps do not reflect disease distribution. Further work is required for model explainability.

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