

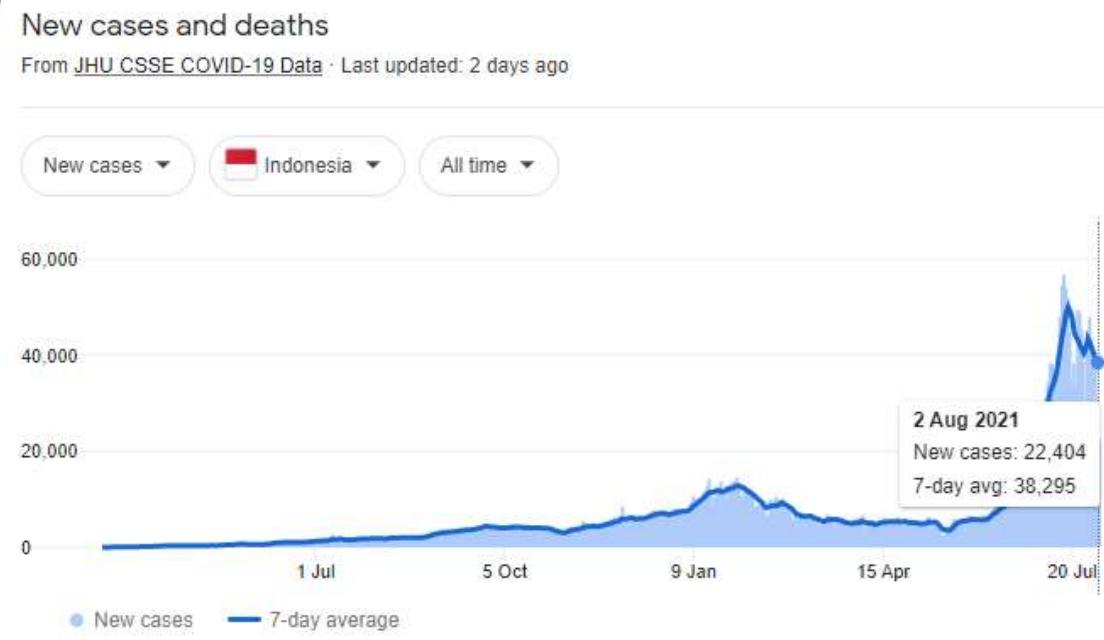
Developing an Early
Warning Tool to detect
COVID-19 Pneumonia

By Angeline Chandraatmadja

(C)

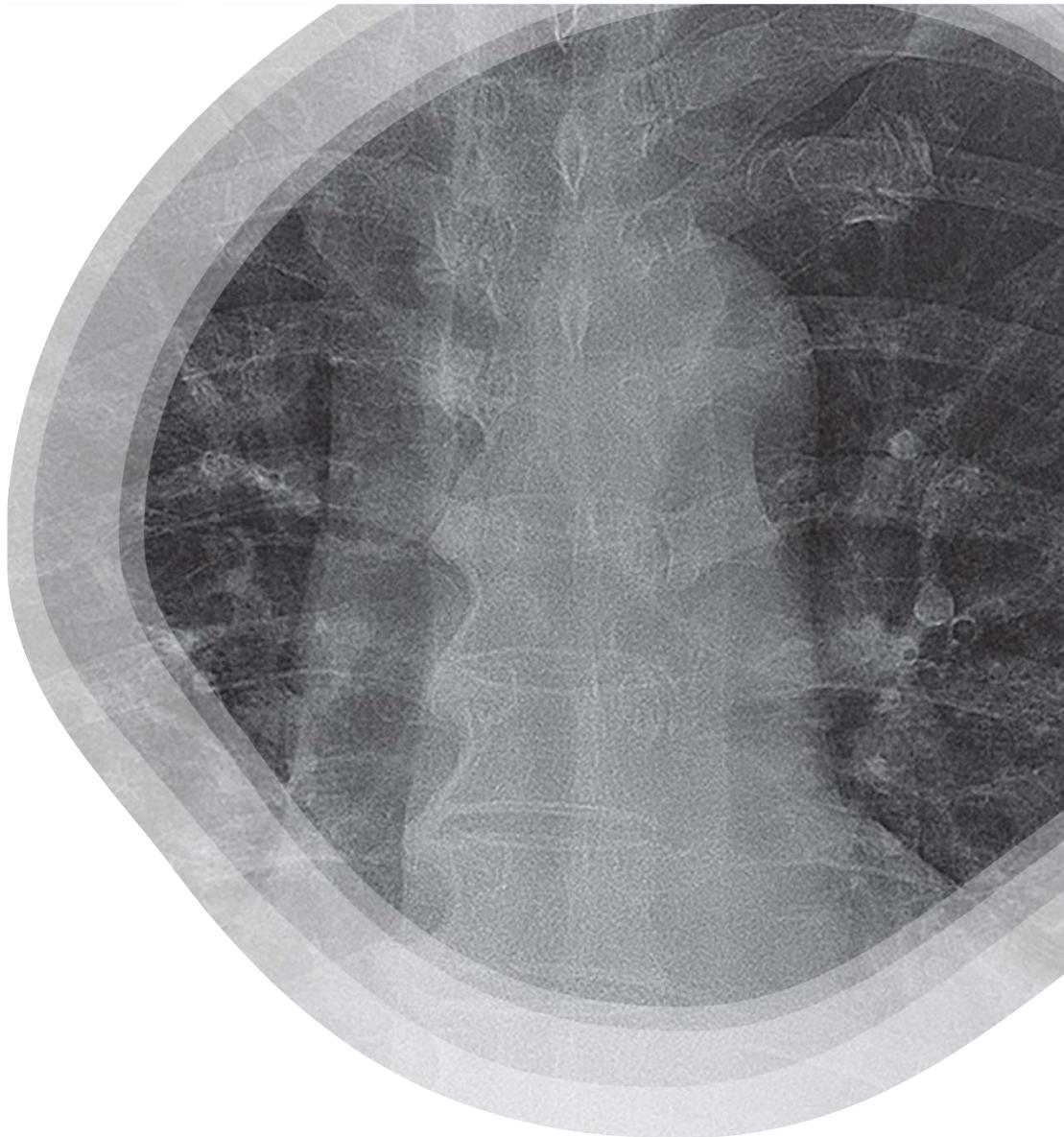
Chest Radiographs in COVID-19 management

- Evaluating severity of illness
 - used for prioritization of patients
 - prescriptions
- Monitoring
 - post COVID-19 chronic lung abnormalities



Machine Learning as an early warning tool for covid-19 pneumonia

- Diagnosing COVID-19 Pneumonia is difficult:
Average sensitivity of 80.4% amongst radiologists
- Evaluation Metrics: F1 Score
- Baseline Accuracy: 53%



Dataset

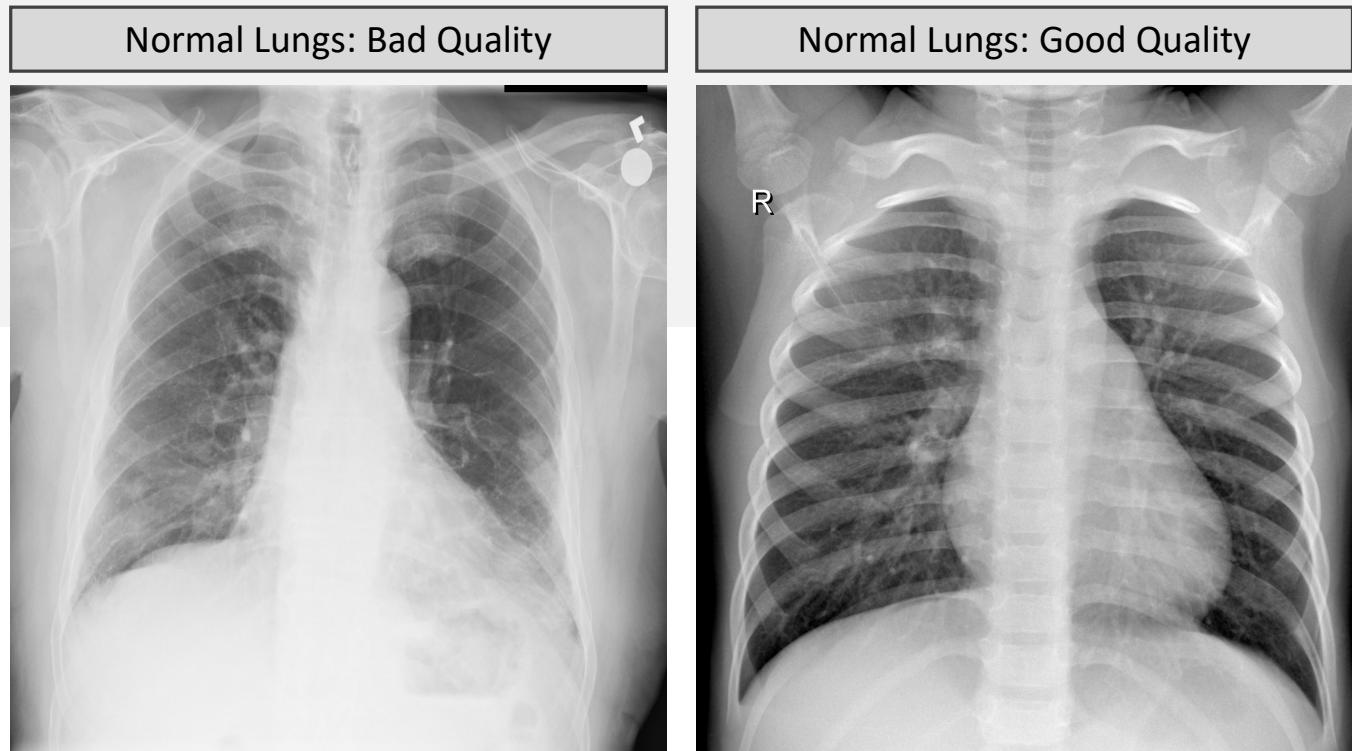
- Format: JPEG, PNG, JPG
- Size: 5 GB
- Dimensions: Varying sizes (1148 x 908 , 2144x 2129, 1845 x 1761, etc)
- Classes:
 - COVID: 363 Images, 6.5%
 - NOFINDING: 1,408 Images, 25.6%
 - THORAXDISEASE: 3,763 Images, 67.9%





BENCHMARK: X-RAYS (RIPE)

- Rotation
- Inspiration
- Projection
- Exposure



Spine is relatively centred in the picture, inspiration effort is poor resulting in an enlarged cardiac shadow, poor visibility of the vertebrae

Spine is relatively centred in the picture, inspiration is deep showing a clear view of the mediastinum, exposure is clear

normal



normal



normal



normal



normal



normal



Image transformation

50% of the trained image is flipped horizontally

- Increase variability

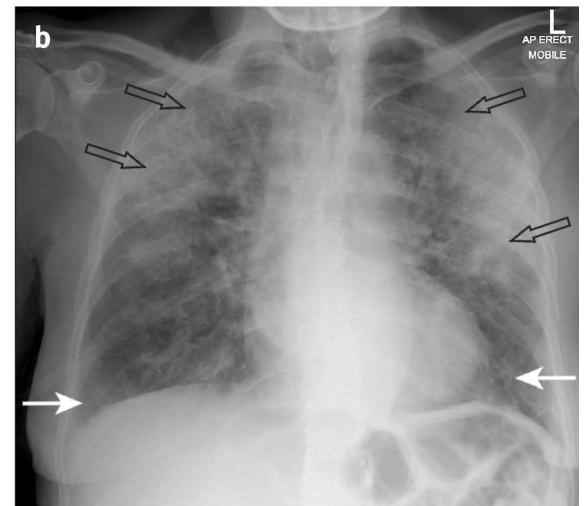
CLASS CHARACTERISTICS

NO FINDING

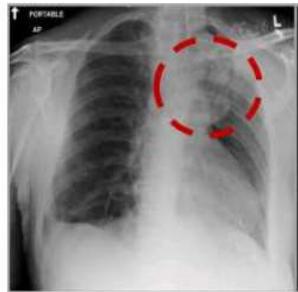


- Central mediastinum and heart appear normal
- Lungs predominantly contain air
- Lung markings are present representing blood vessels

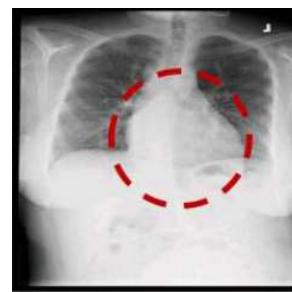
COVID-19 Pneumonia



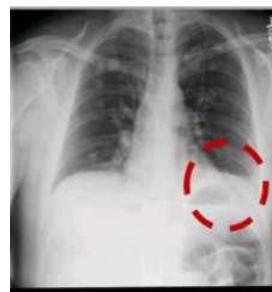
- Ground glass opacity
- Consolidation
- Findings are predominantly in the middle lower zone



Atelectasis
Partial lung collapse



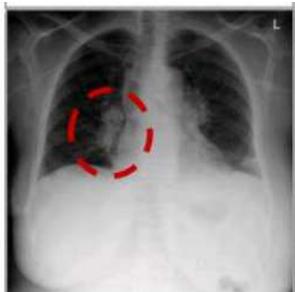
Cardiomegaly
Heart enlargement



Effusion
Water between the lung
and the sac



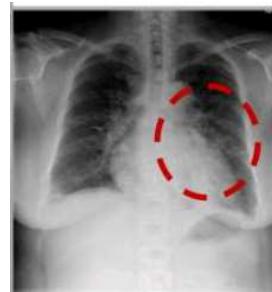
Infiltration
Water inside the lungs



Mass
Cancer/Tumour
Bigger than nodule



Nodule
Cancer/Tumour



Pneumonia
Water in lungs due
to pathogen



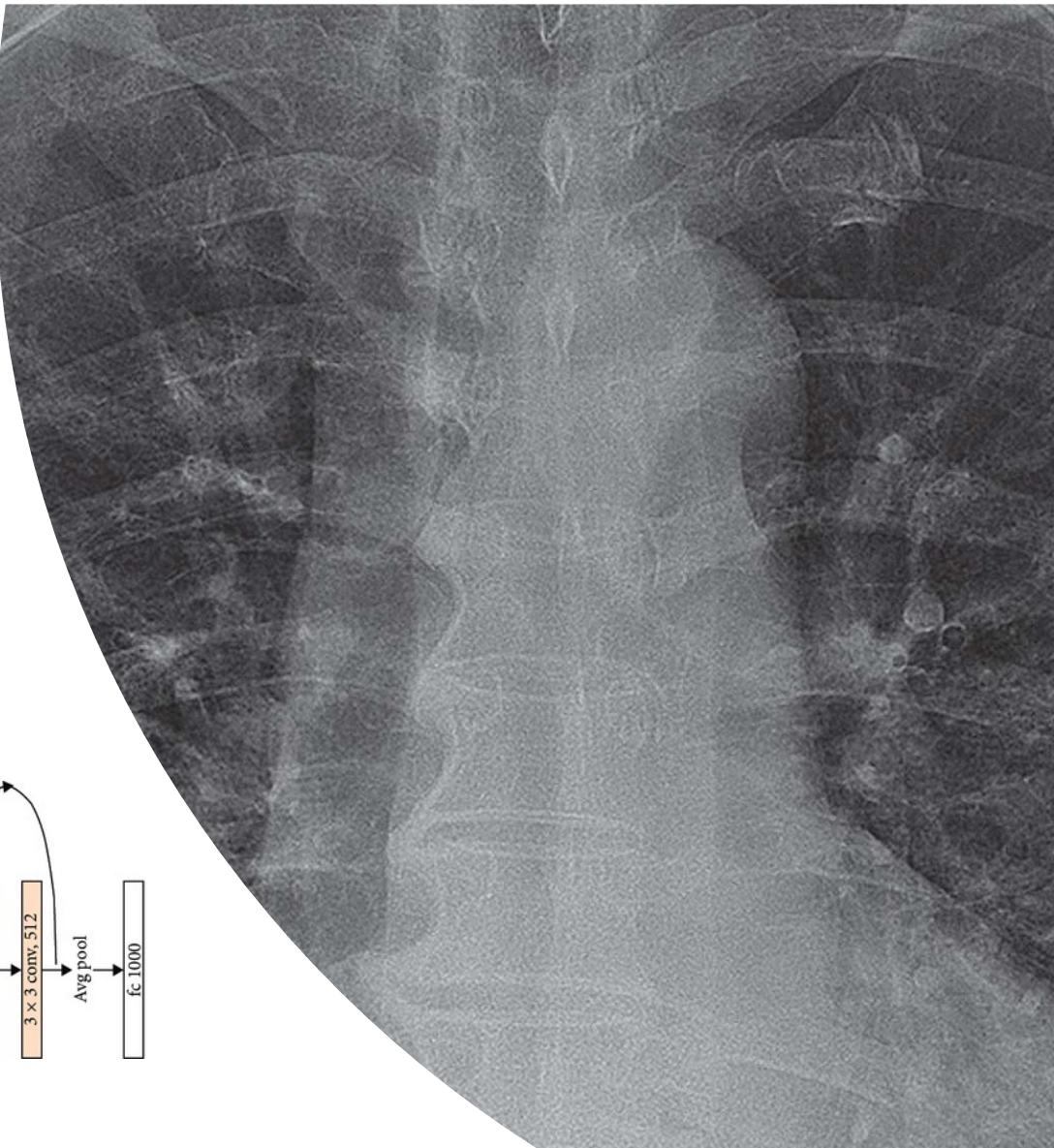
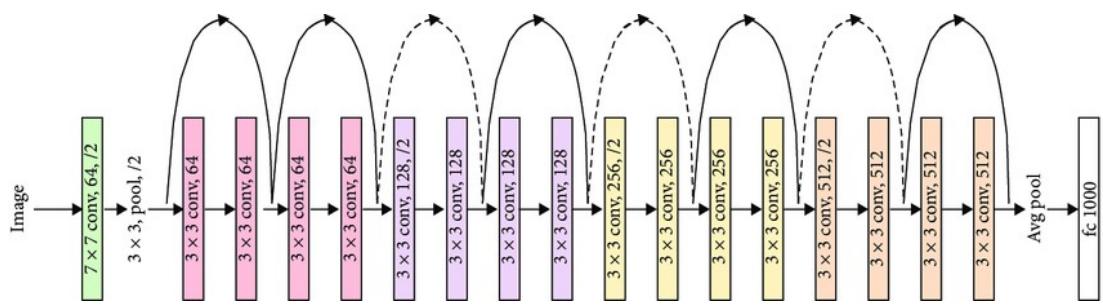
Pneumothorax
total lung collapse

Class Characteristics: Thorax Disease

Eight common thoracic
diseases observed in our
dataset

RESNET18 Model

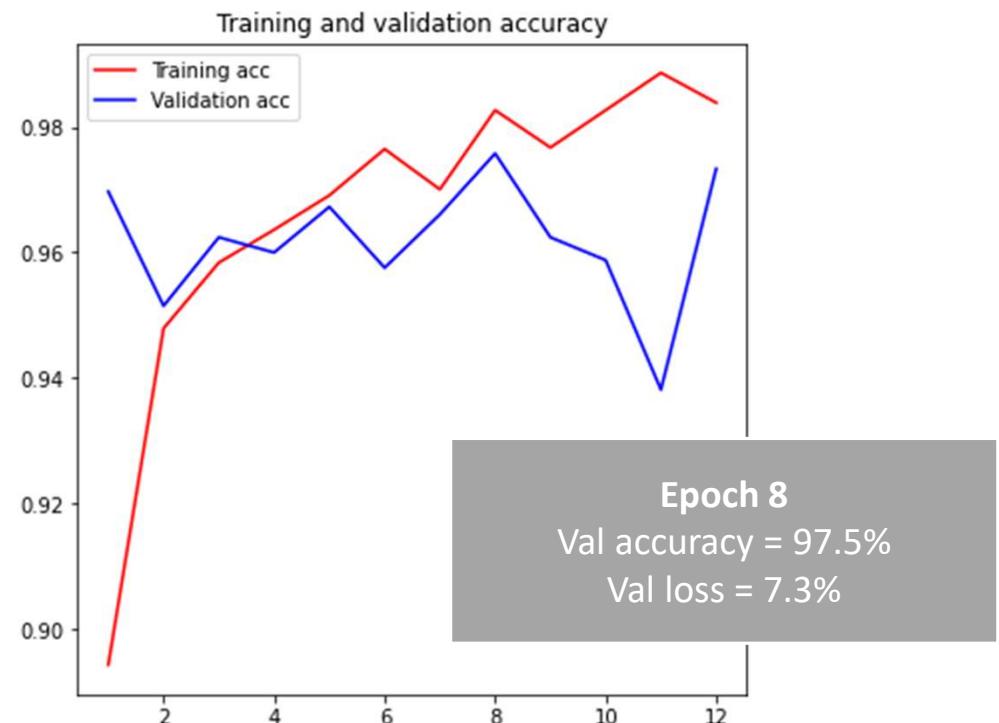
- Dataset: Image net (1million images) → Custom Data
- Input Size: 224 x 224 ← various sizes
- Normalization: normalized ← none
- Classes: 1000 Classes → 3 Classes
- Layers: 18





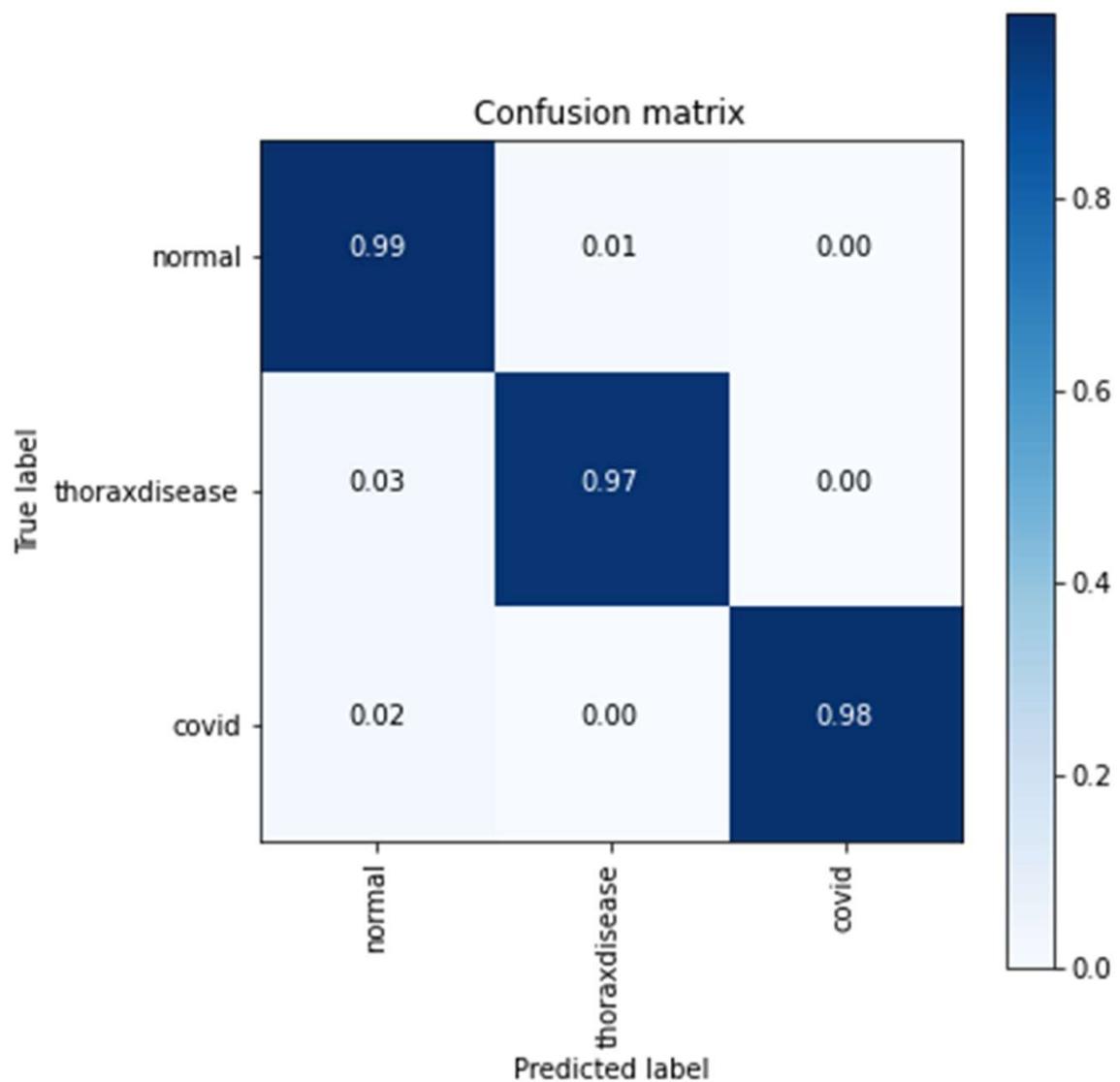
Final Model

- Frozen layers
- Initial LR = $3e-4$
- Reduce LR on Plateau by a factor of 0.1 with patience 3
- Training time: 201.908 minutes
(Paid Google Collab)



Evaluation

- **Accuracy**
Normal: 99%
Thorax Disease: 97%
Covid: 98%
- **COVID-19 Sensitivity: 0.98%**
- **Industry Sensitivity: 84%**
- **Best Kaggle Score:**
- Test F1 : 97%
- Kaggle F1: 90.4%

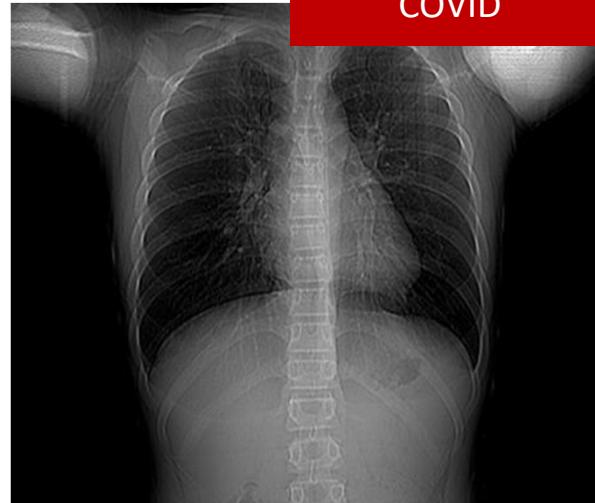


Misclassification Analysis

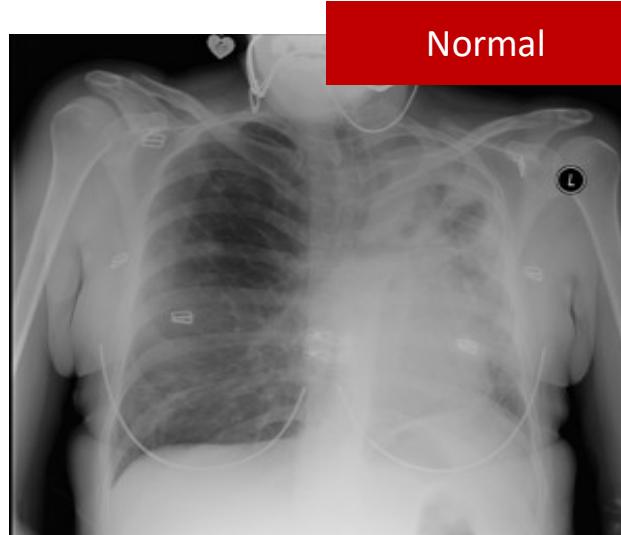
1. Generalize high contrast images → Normal
2. Poorly taken X-Rays
bad inspiration, bad exposure → Thorax/Covid
3. Actual misclassifications of image
4. Very subtle findings



Examples of misclassifications



COVID



Normal



Thorax Disease

normal	51.8%
thorax	42.7%
covid	5.5%

Doctor review: Normal
Actual misclassification?

normal	0.4%
thorax	97.7%
covid	0.02%

Doctor review: Abnormal
Actual misclassification?

normal	16.3%
thorax	31.5%
covid	52.2%

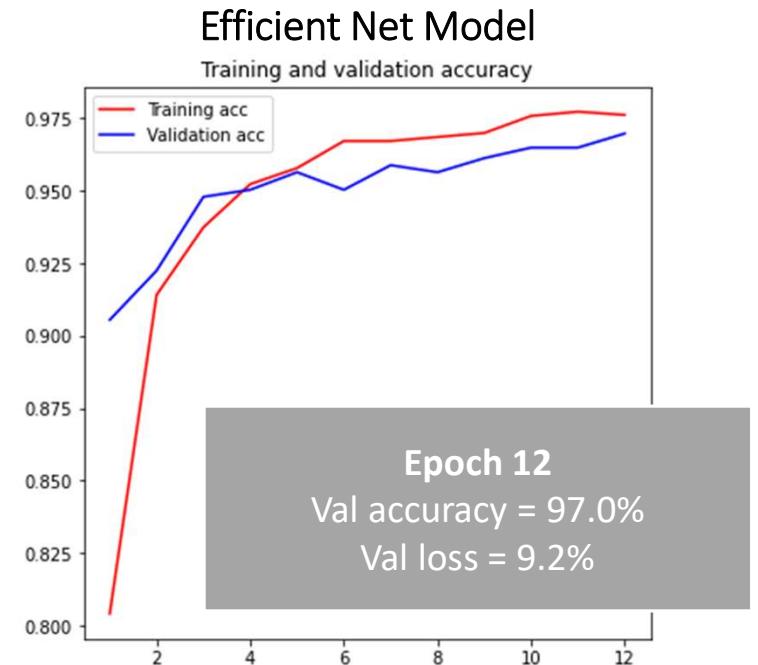
Doctor review: Poor quality, not RIPE

Conclusion

- The model can better detect COVID-19 than the average radiologist
- It cannot tell bad X-Ray from abnormalities like a radiologist can

& Future Works

- Expose model to more classes of lung abnormalities
- Create a model to determine good quality vs bad quality CXR
- Use other models



Thank you

