COVID-19 Detection from Chest Radiography Images

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COVID-19 Detection from Chest Radiography Images

Outline

1. Introduction
2. Related Work
3. Datasets
4. Methods and Results
5. Future Work

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Outline

Introduction

Motivation

- Cut off virus transmission routes by **effective** and **fast testing**
- Visual indicator in Chest X-Ray (CXR) images: **Ground glass opacity**
- Need for **supportive** CXR classification systems
- Need for **visualisation** of COVID anomalies

COVID-19 Detection from Chest Radiography Images

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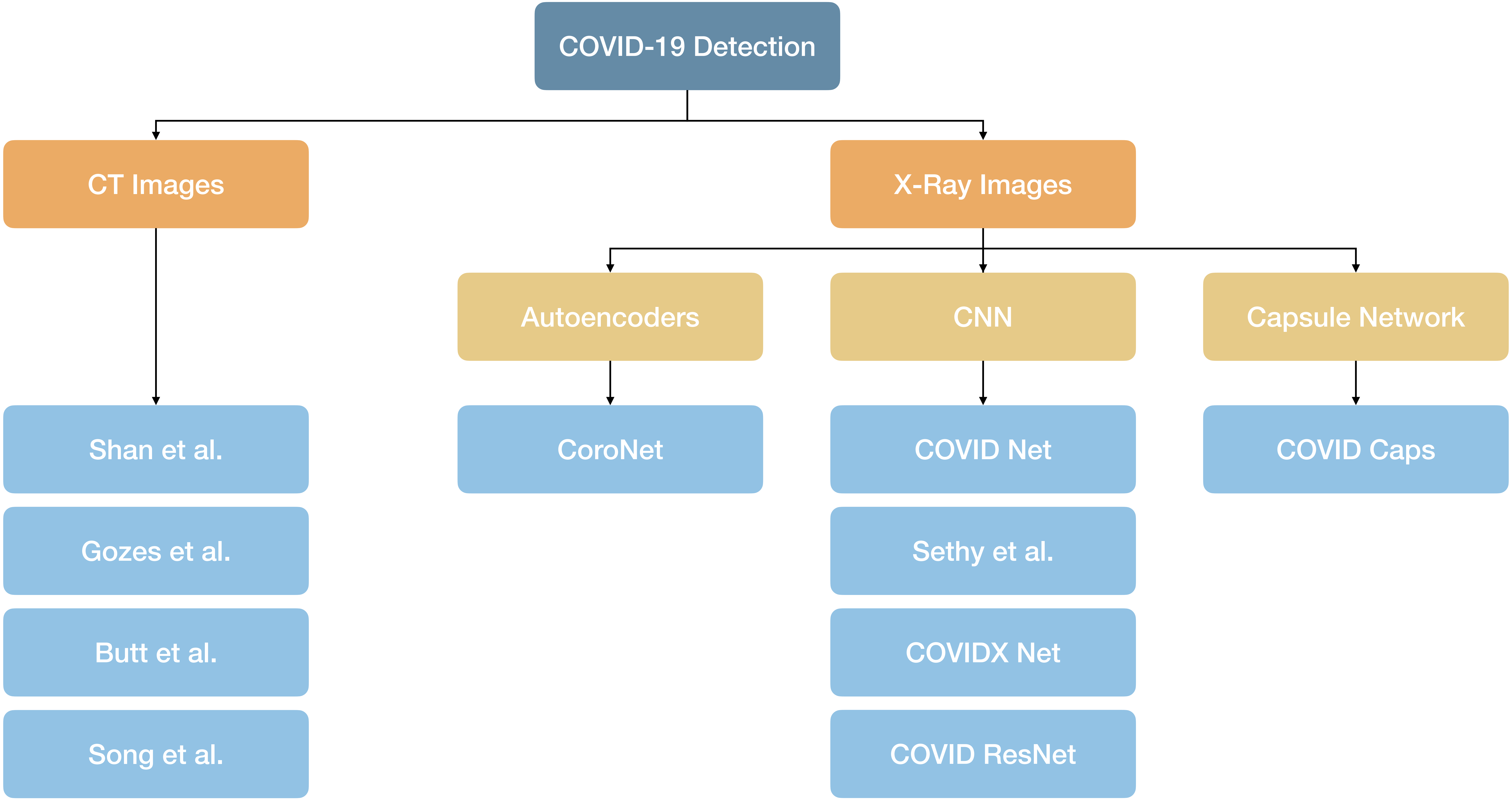
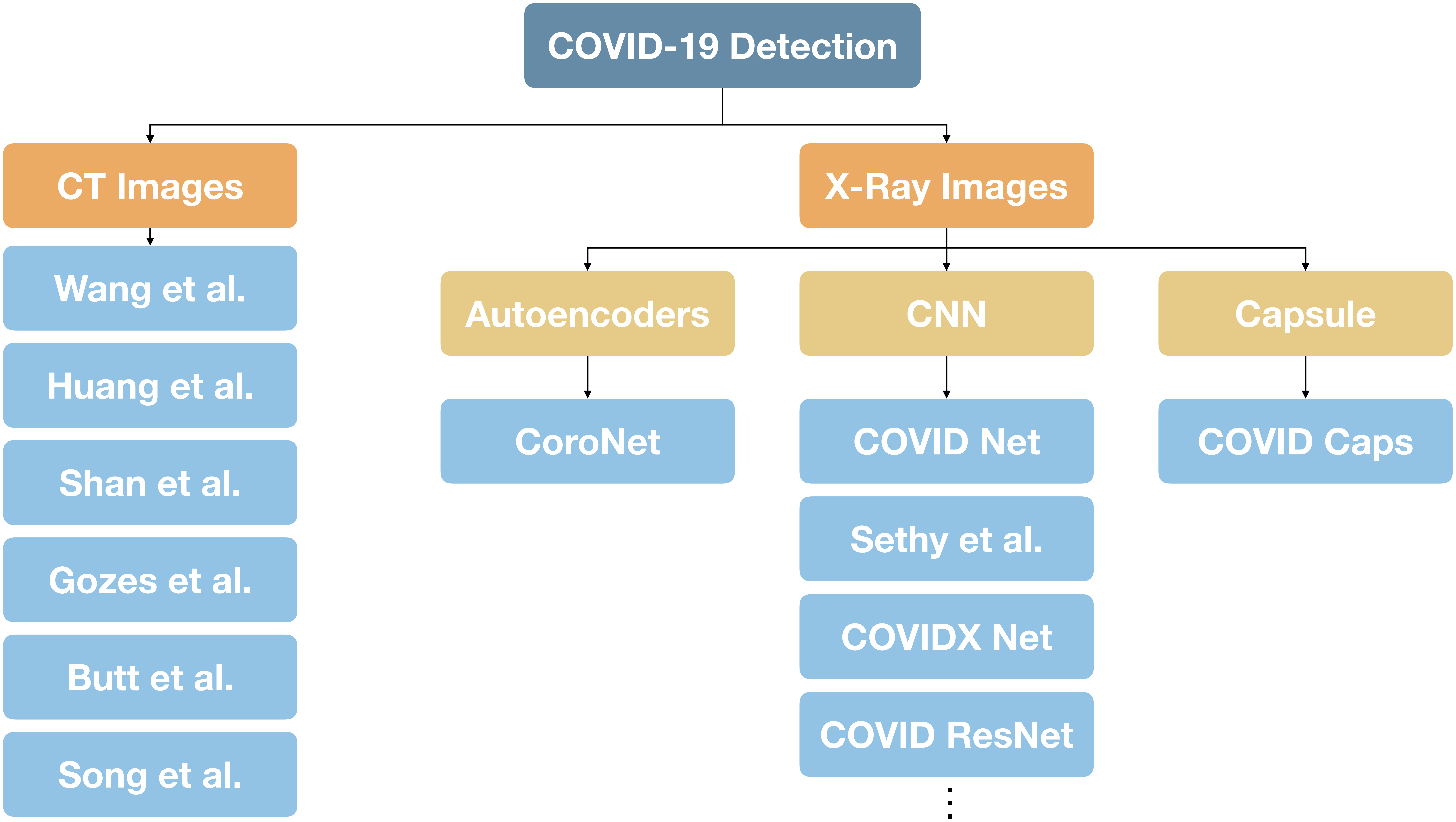

COVID-19 Detection
CT Images
X-Ray Images
Autoencoders
CNN
Capsule Network
Shan et al.
Gozes et al.
Butt et al.
Song et al.
CoroNet
COVID Net
Sethy et al.
COVIDX Net
COVID ResNet
COVID Caps


COVID-19 Detection
CT Images
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Wang et al.
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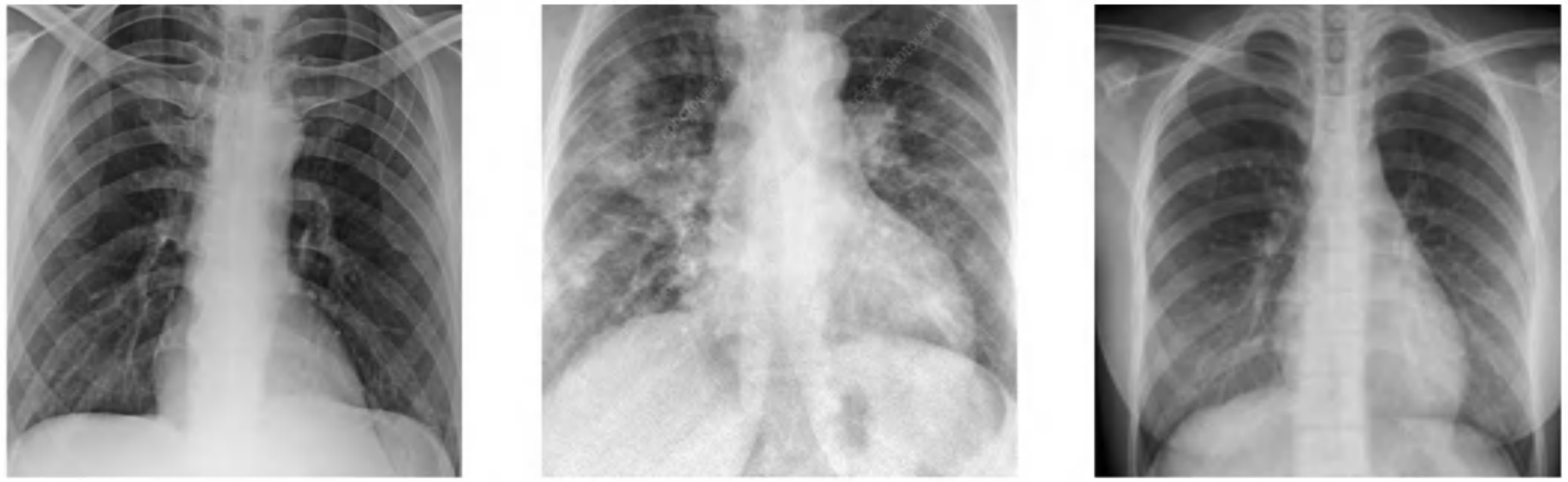
Dataset

- Weighted Loss Function
- Data Augmentation
- K-Fold Cross Validation



Normal | non-COVID-19 Pneumonia | COVID-19 Pneumonia

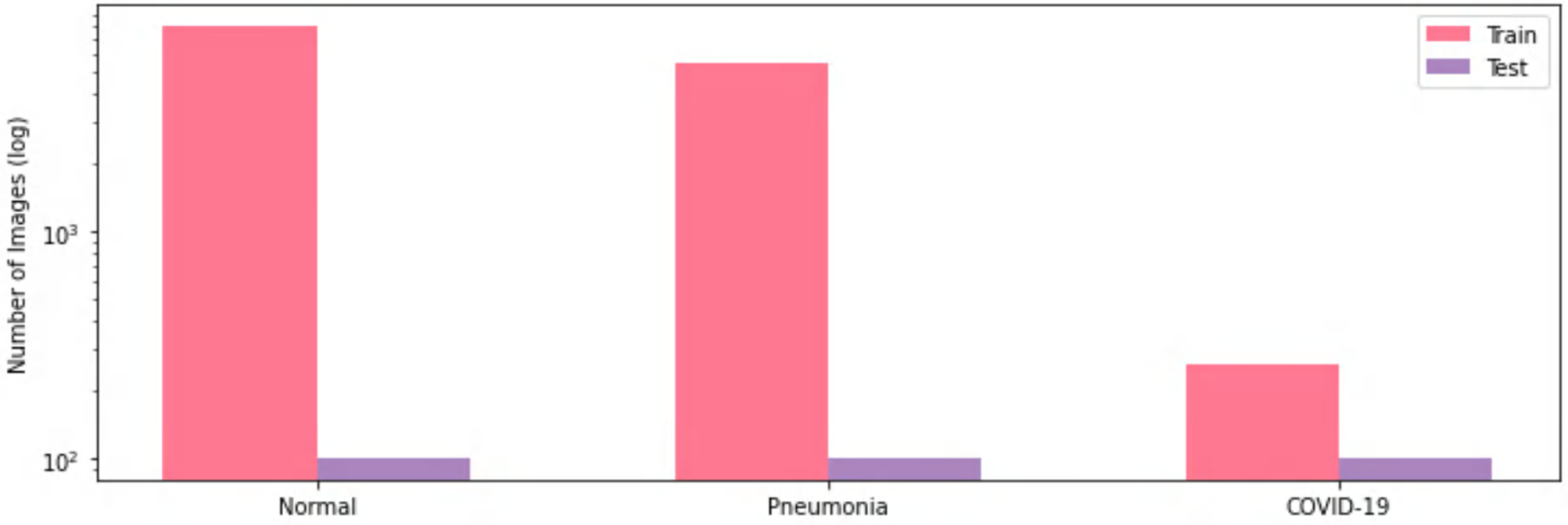


Figure: COVIDXv3 Data Distribution [Wang et al.]

	Train	**Test**
Normal	7966	100
Pneumonia	5451	100
COVID	253	100
Total	13670	300

Why no validation data? #66

Open axkoenig opened this issue on 19 May · 2 comments

axkoenig commented on 19 May • edited

Hello,
I have a general question regarding the COVIDx dataset. You define which images to use as train and test data in the files `train_COVIDx3.txt` and `test_COVIDx3.txt`. However, why don't you also define and use a validation set?
In your paper you describe that the architecture was determined using "Generative Synthesis" - a machine-driven design exploration. On which dataset exactly did you compare the performance of different architectures and hyper-paramaters that the Generative Synthesis approach produced? It is good practice to do this on a validation set, right?
Looking forward to any comments and implementation details on this :)
Alex

👍 2

sergevanhaag commented on 6 Jun

I agree. I am not able to recreate the results if I use a training, validation, and test-set. I am afraid that COVID-NET indirectly overfits on the test-set. I'd suggest using the test-set only once.

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Methods

Approach 1

ResNet-50 Baseline Classifier

Approach 2

Anomaly Detection with U-Net

Approach 3

Multitask Learning

Methods

Approach 1

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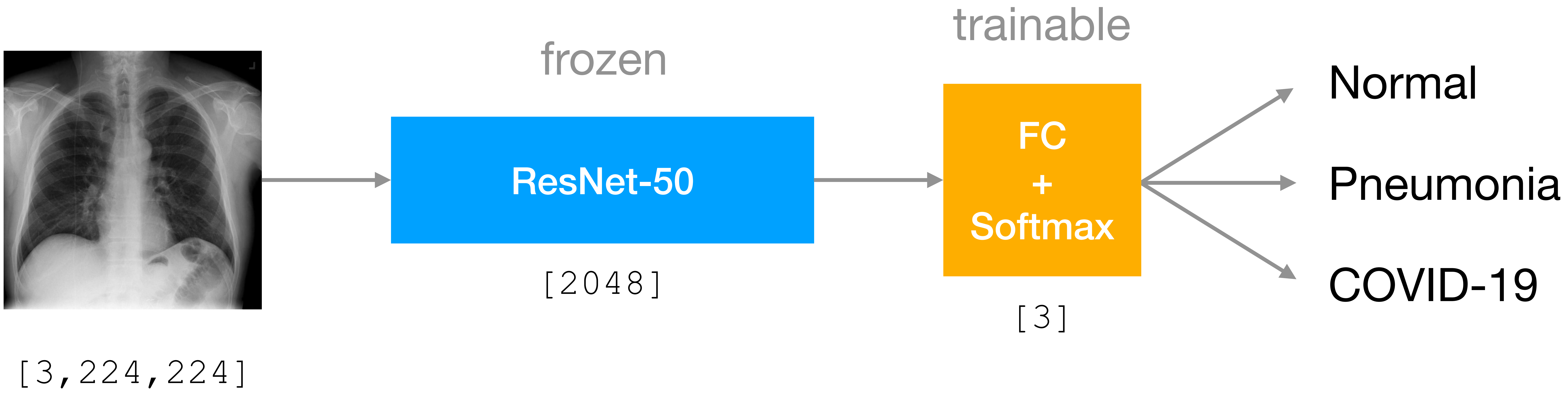
Approach 3

Multitask Learning

ResNet-50 Baseline Classifier

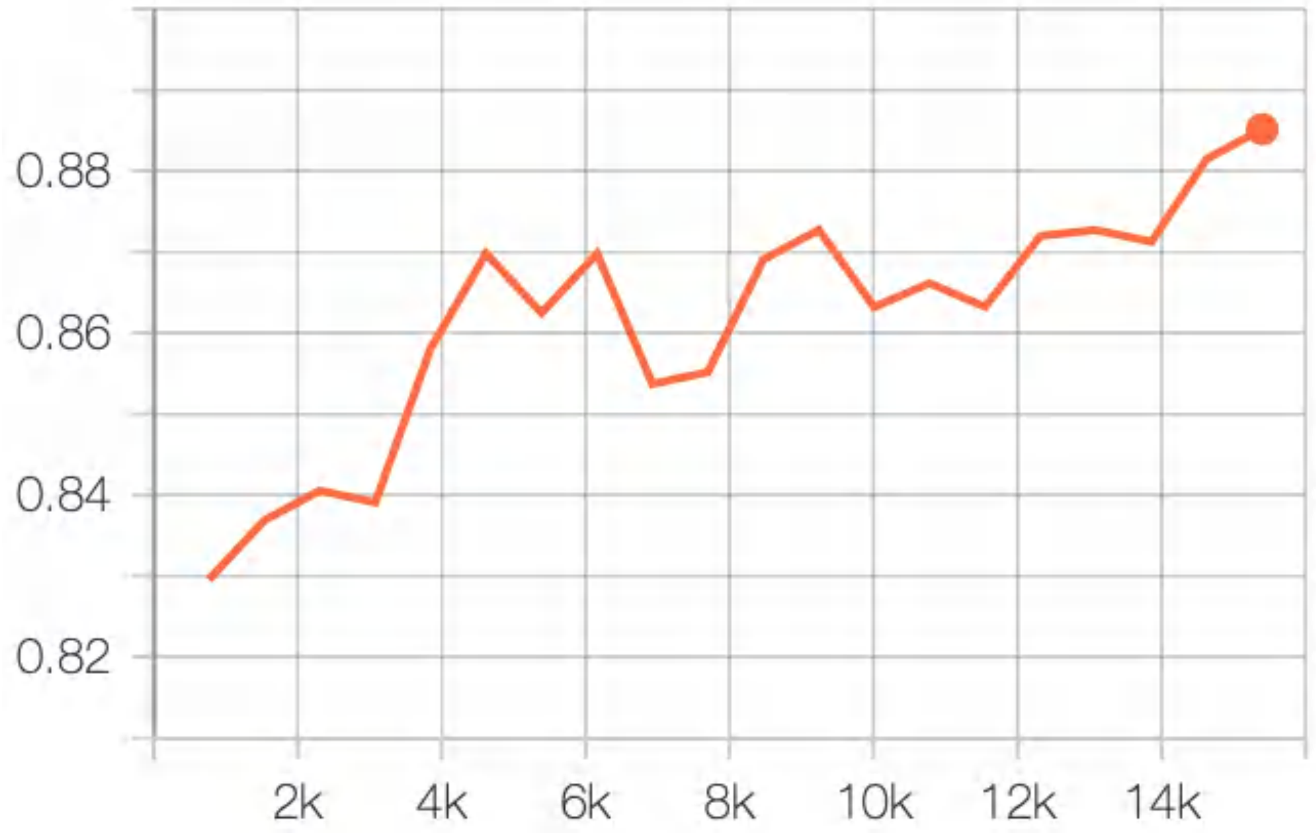
- Transfer Learning on pre-trained model
- Replace last FC layer of ResNet-50



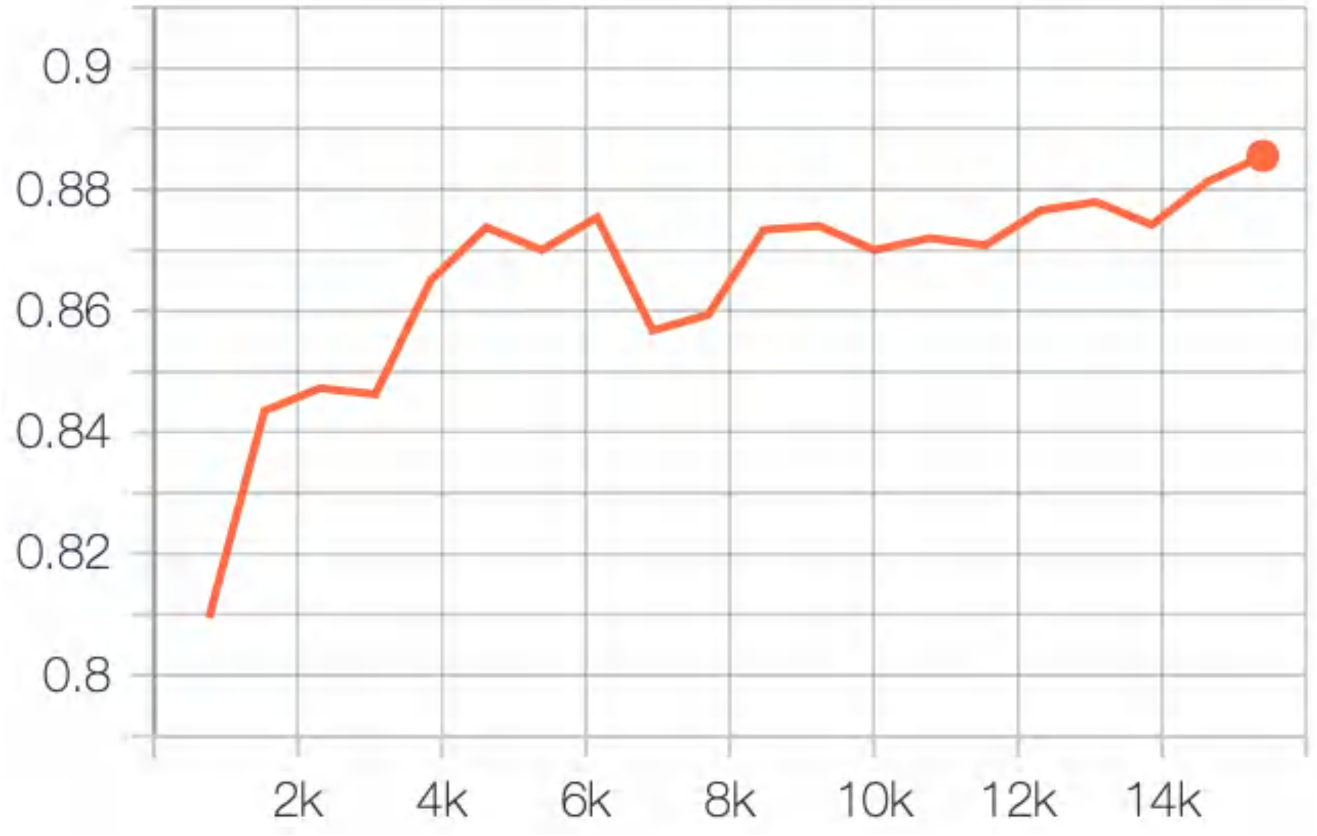
ResNet-50 Baseline — Test Results

Pred. / True	Normal	Pneumonia	COVID
Normal	**88**	12	0
Pneumonia	11	**88**	1
COVID	18	40	**42**

In %	Normal	Pneumonia	COVID	Average
Sensitivity	88.0	88.0	42.0	**72.7**
Precision	75.2	62.9	97.7	**78.6**



Avg. Validation Sensitivity



Avg. Validation Precision

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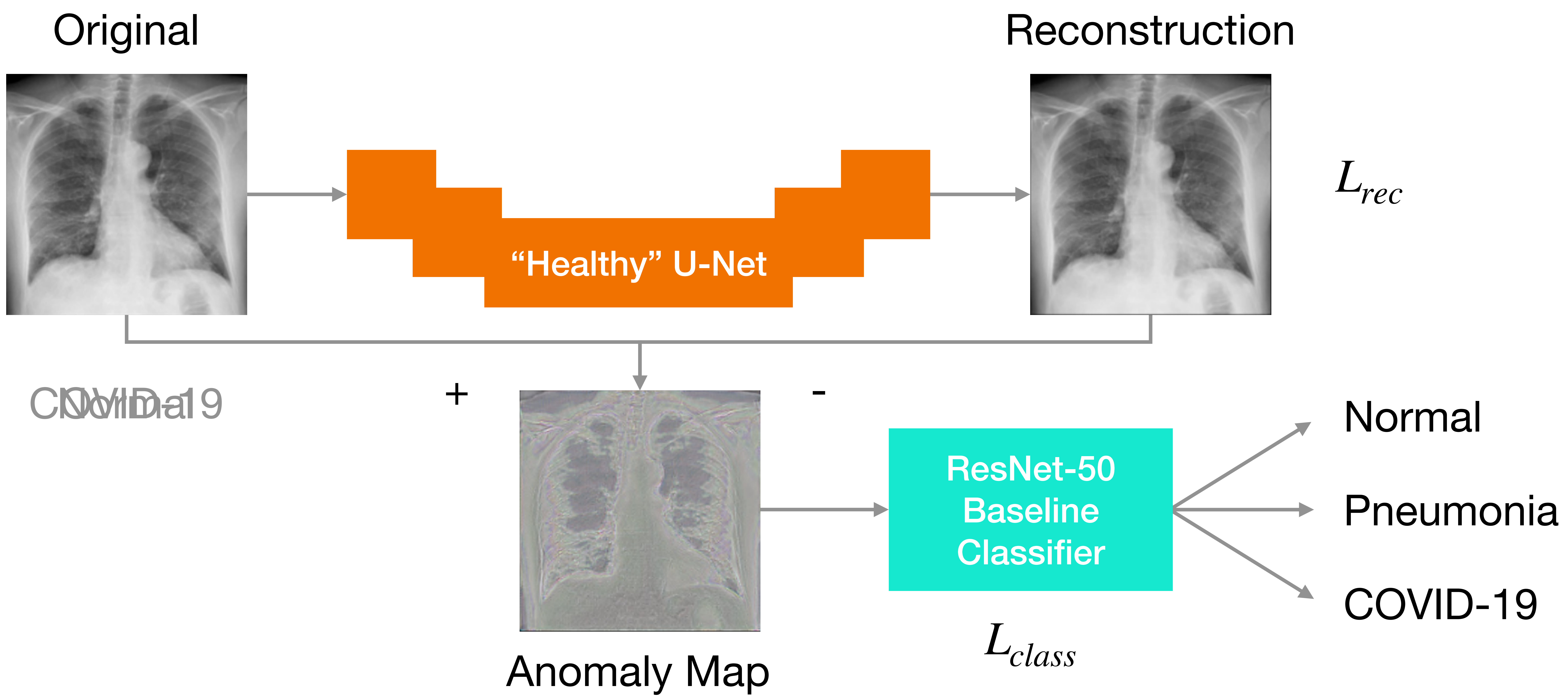
Anomaly Detection with U-Net

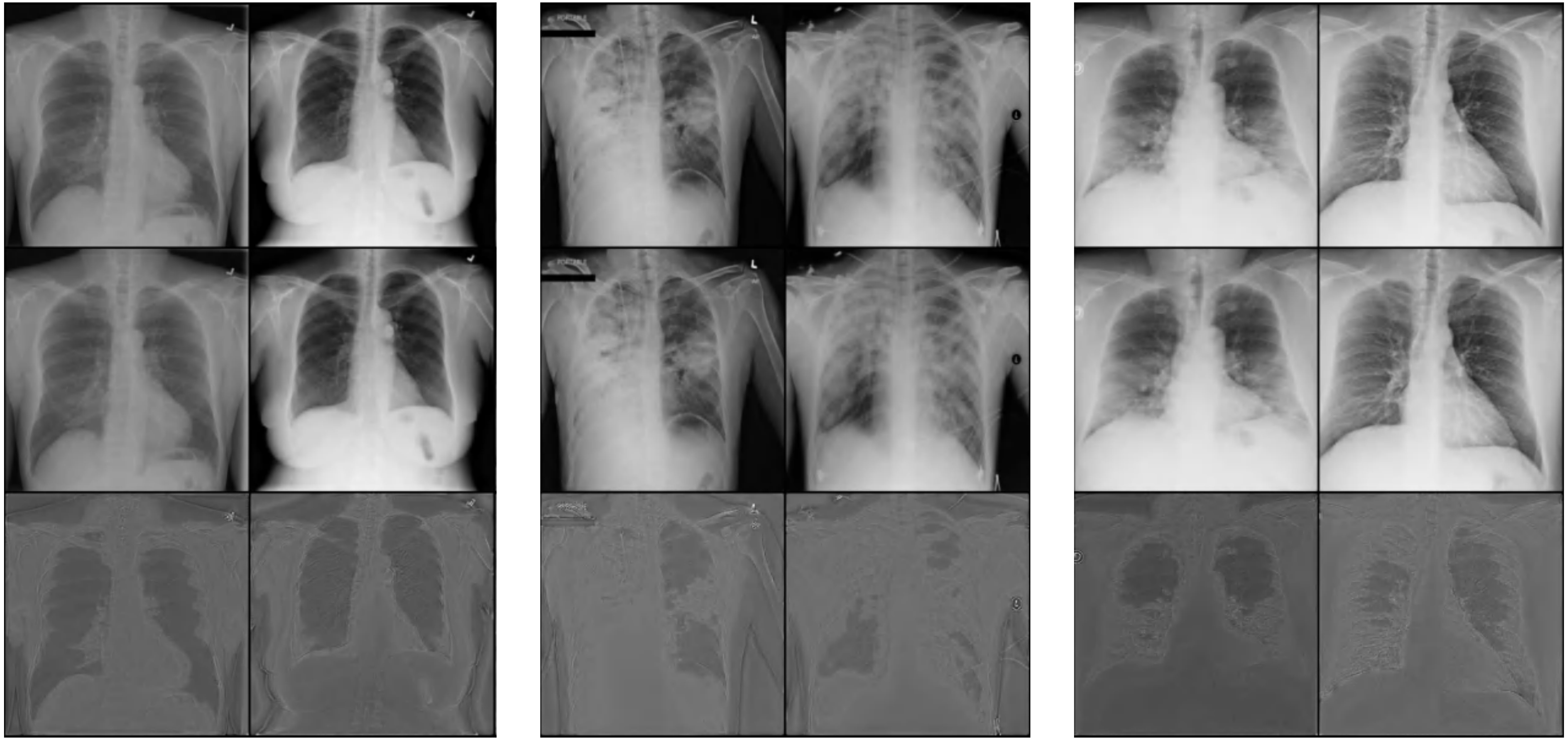


Anomaly Maps

Original

Recon-
struction

Anomaly
Map



Normal

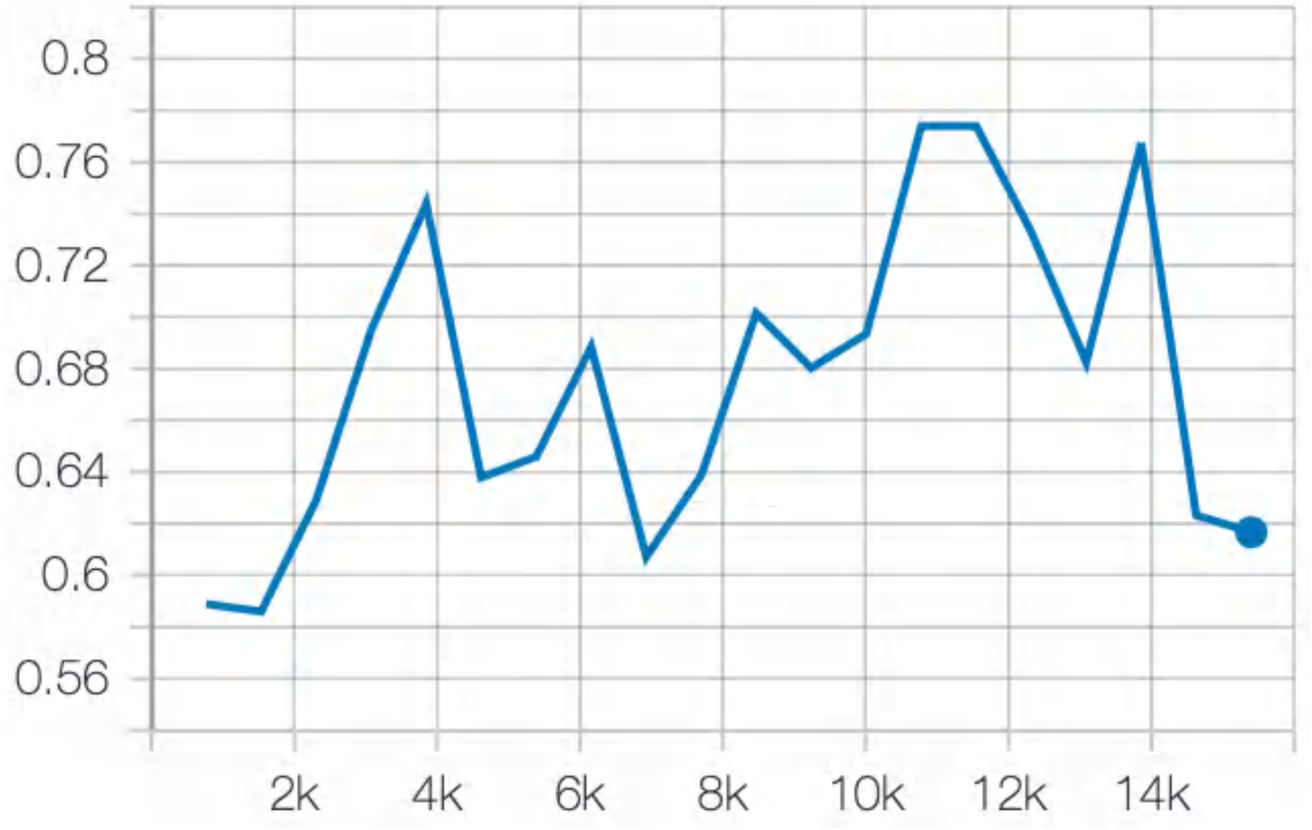
Pneumonia

COVID

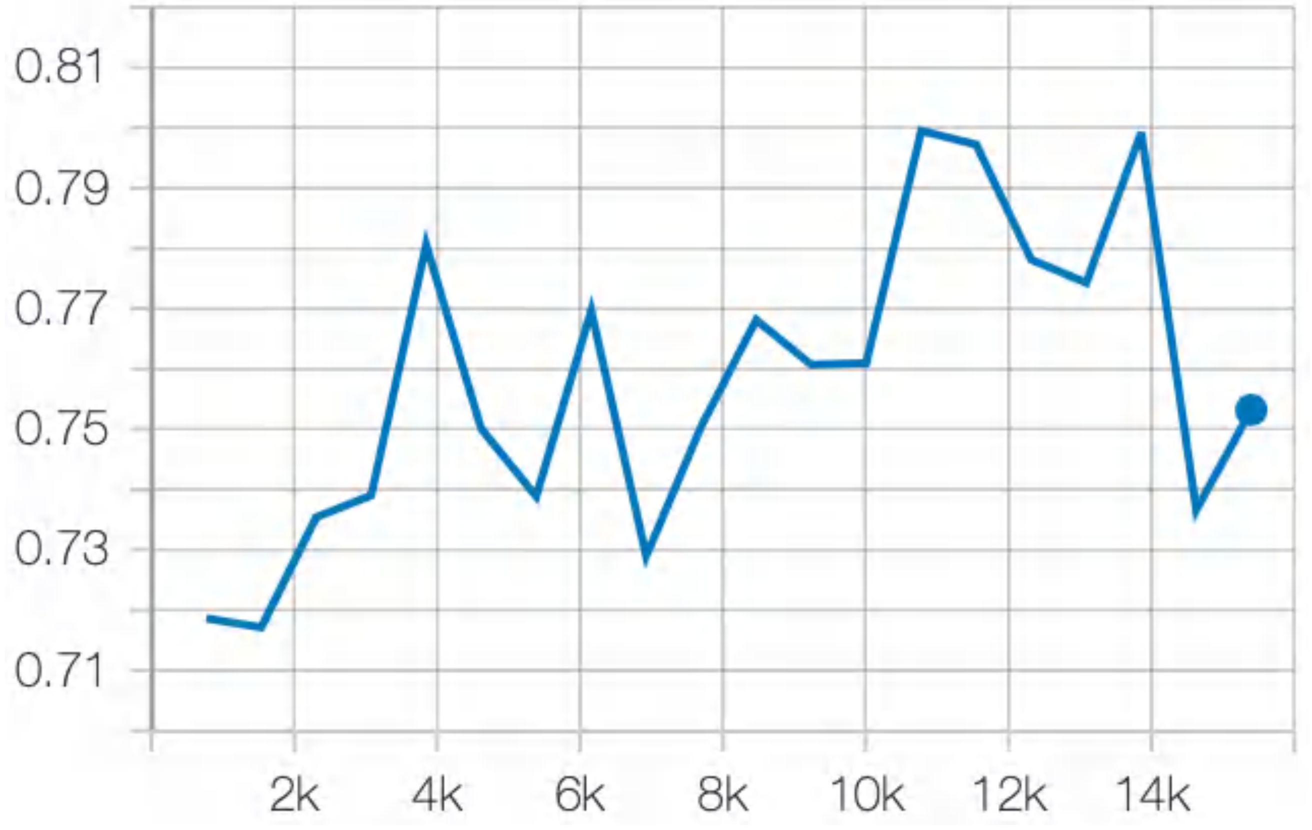
Anomaly Detection — Test Results

Pred. / True	Normal	Pneumonia	COVID
Normal	**46**	47	7
Pneumonia	3	**89**	8
COVID	7	35	**58**

In %	Normal	Pneumonia	COVID	Average
Sensitivity	46.0	89.0	58.0	**64.3**
Precision	82.1	52.0	79.5	**71.2**



Avg. Validation Sensitivity



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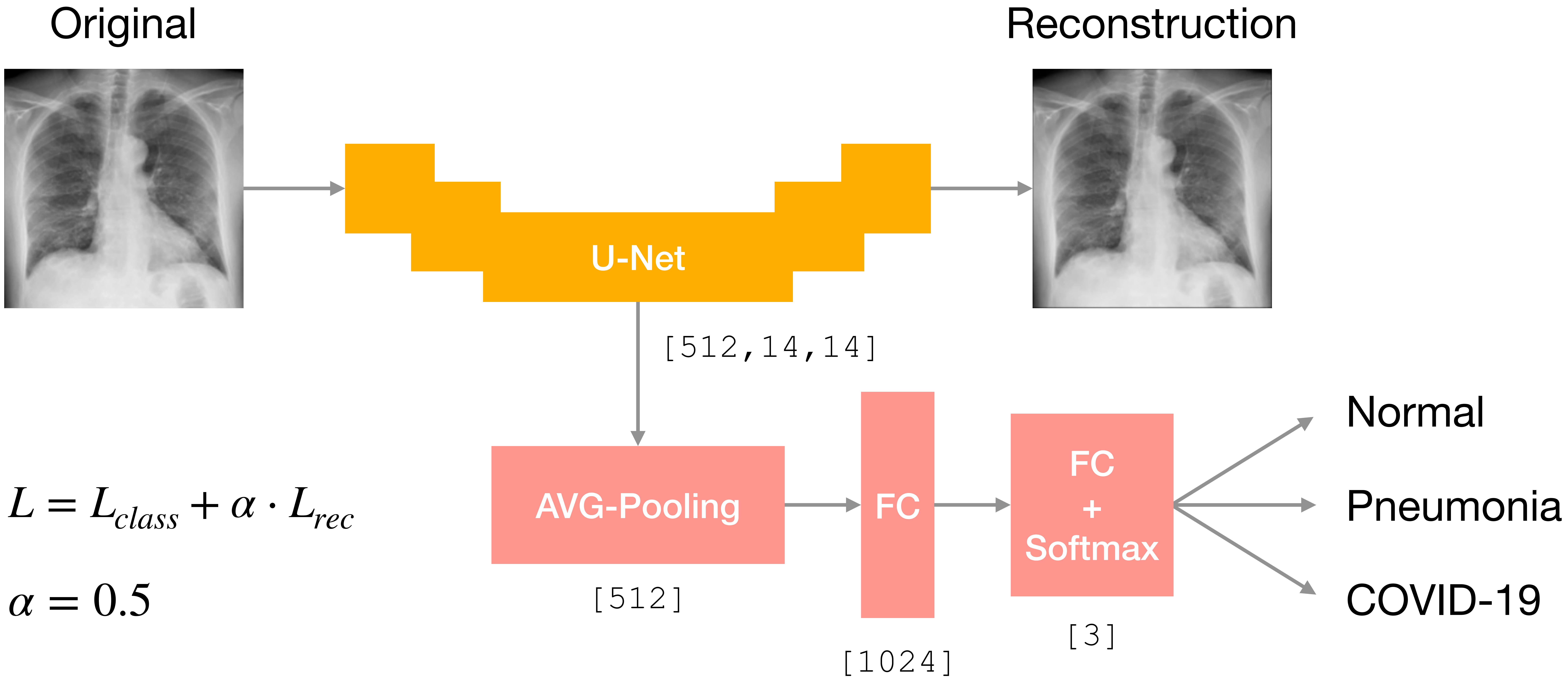
Multitask Learning



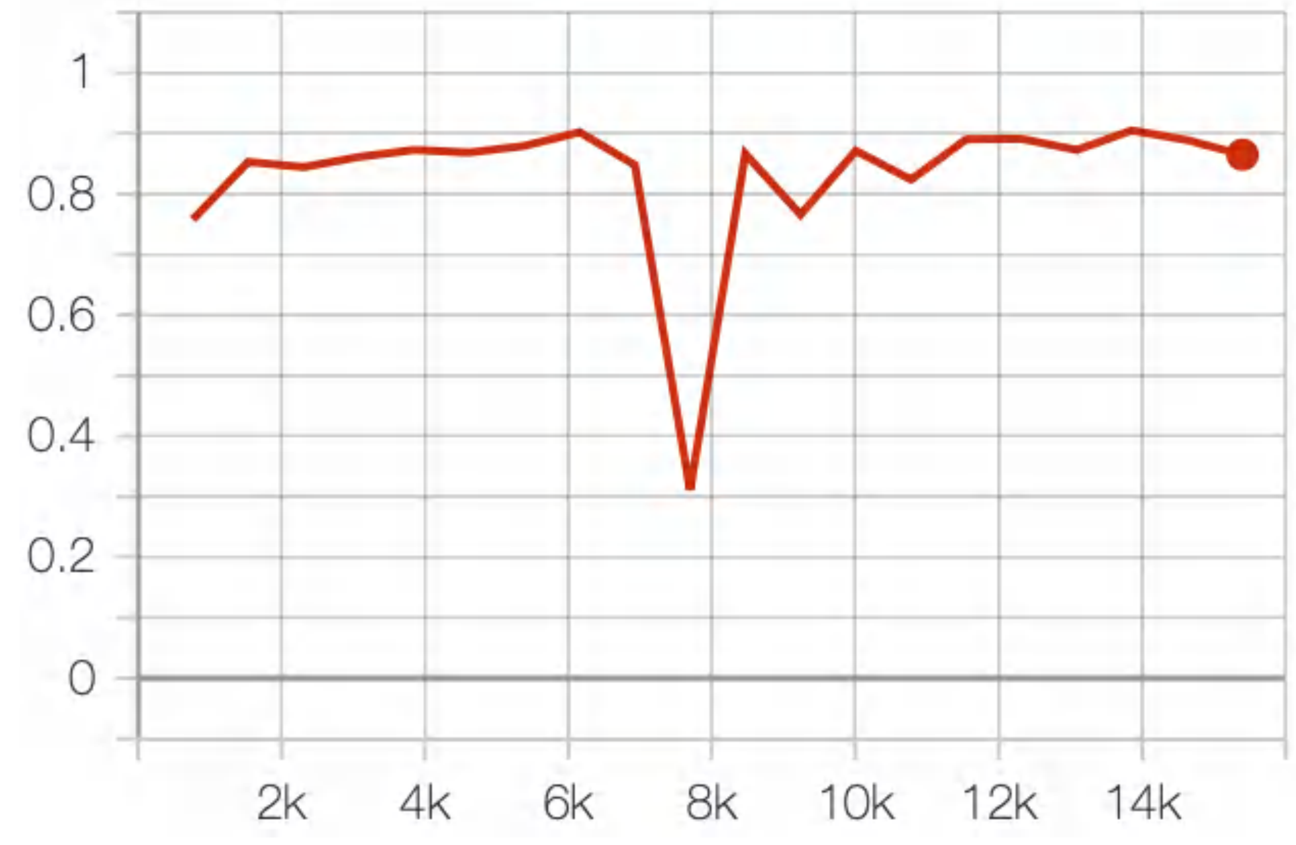
$$L = L_{class} + \alpha \cdot L_{rec}$$

$$\alpha = 0.5$$

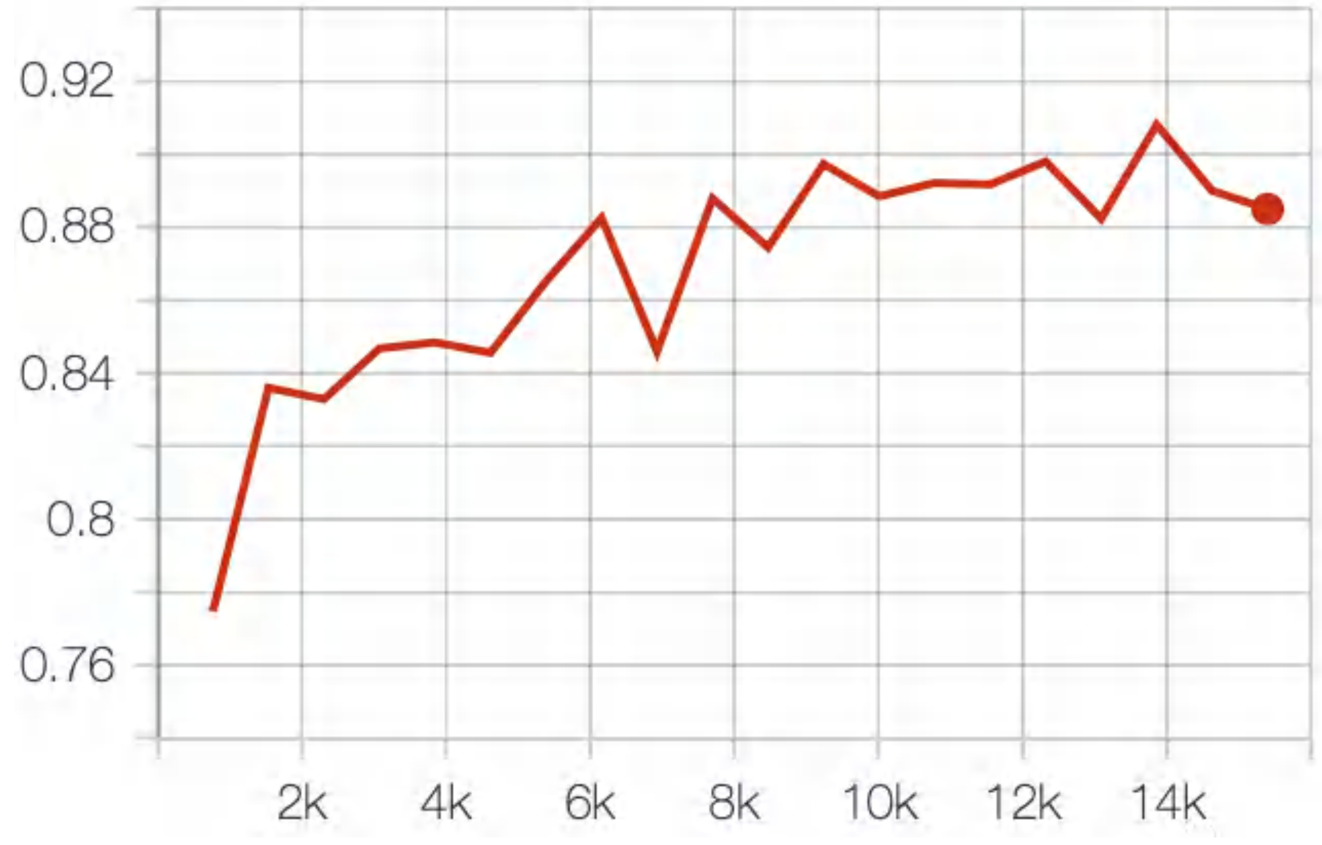
Multitask Learning — Test Results

True \ Pred.	Normal	Pneumonia	COVID
Normal	**87**	11	2
Pneumonia	4	**88**	8
COVID	7	28	**65**

In %	Normal	Pneumonia	COVID	Average
Sensitivity	87.0	88.0	65.0	**80.0**
Precision	88.8	69.3	86.7	**81.6**



Avg. Validation Sensitivity



Avg. Validation Precision

Comparison — Test Results

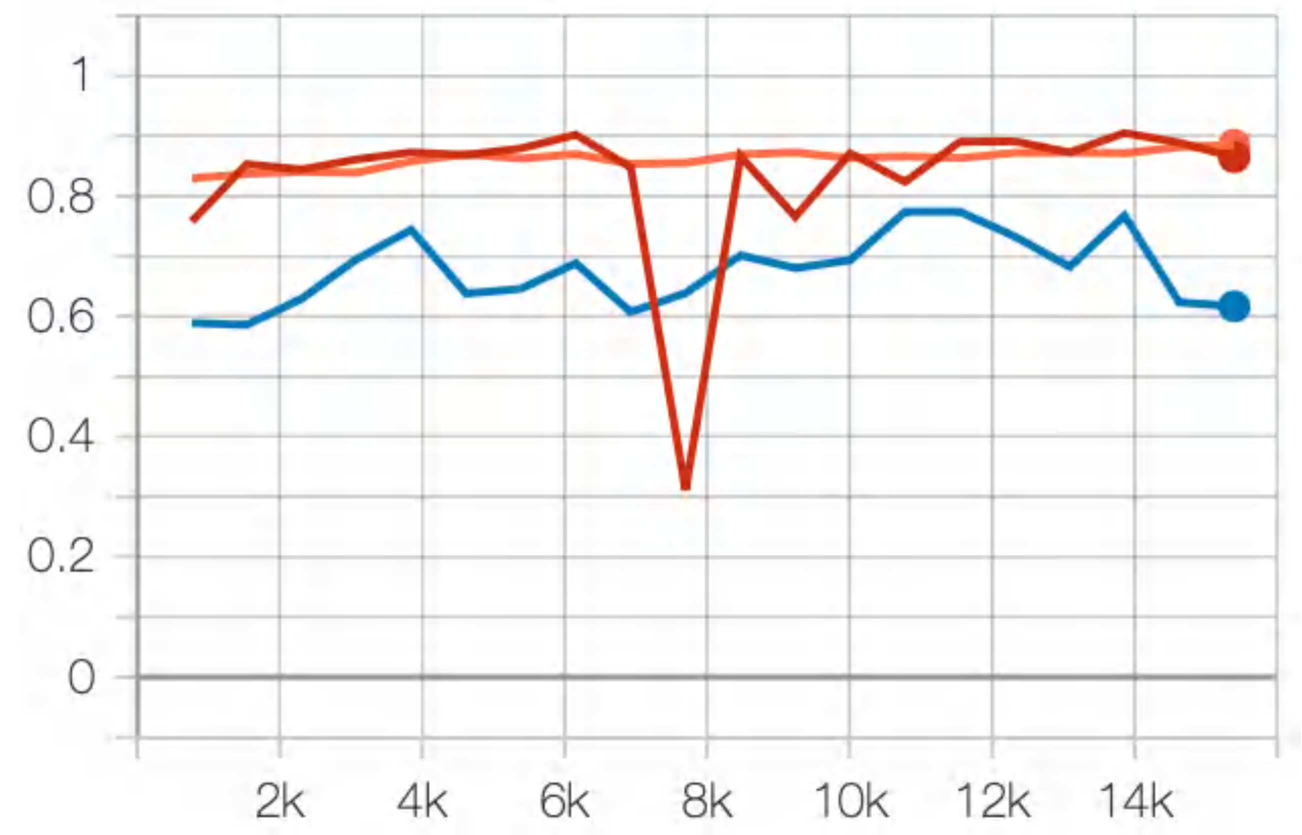
In %	Normal	Pneumonia	COVID	Average
ResNet-50	**88.0**	88.0	42.0	72.7
Anomaly	46.0	**89.0**	58.0	64.3
Multitask	87.0	88.0	**65.0**	**80.0**

Sensitivity

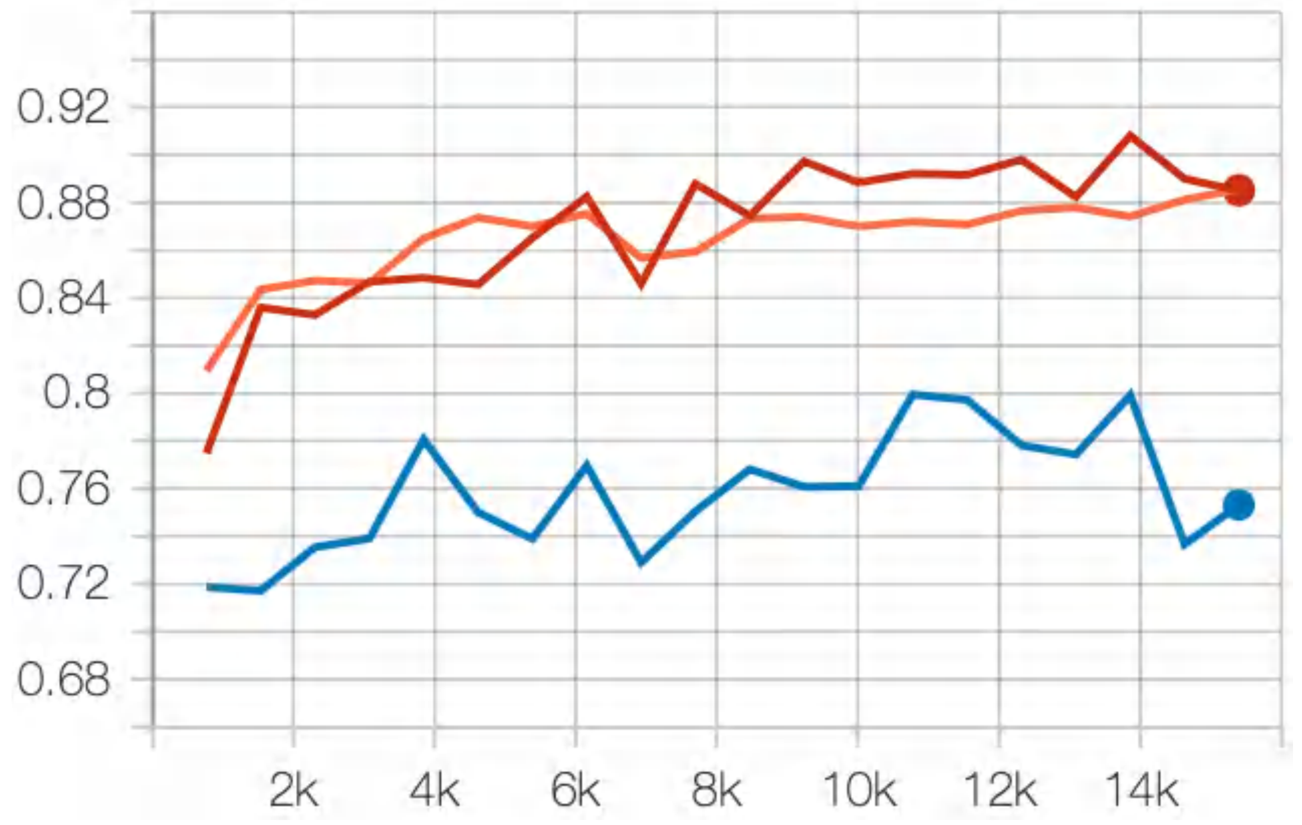
In %	Normal	Pneumonia	COVID	Average
ResNet-50	75.2	62.9	**97.7**	78.6
Anomaly	82.1	52.0	79.5	71.2
Multitask	**88.8**	**69.3**	86.7	**81.6**

Precision

ResNet-50 Anomaly Multitask



Avg. Validation Sensitivity



Avg. Validation Precision

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Future Work

- Improvements
  - Train classifiers for more than 20 epochs
  - Different loss function, e.g. **cosine loss** by Barz et al.
  - Combine loss function weighting with **oversampling**
- Extensions
  - Use bigger **COVIDXv4** Dataset
  - Which approach is worth refining?

References

- Song, Ying, et al. "Deep learning enables accurate diagnosis of novel coronavirus (COVID-19) with CT images." medRxiv (2020).
- Shan, Fei, et al. "Lung infection quantification of covid-19 in ct images with deep learning." arXiv preprint arXiv:2003.04655 (2020).
- Gozes, Ophir, et al. "Rapid ai development cycle for the coronavirus (covid-19) pandemic: Initial results for automated detection & patient monitoring using deep learning ct image analysis." arXiv preprint arXiv:2003.05037 (2020).
- Butt, Charmaine, et al. "Deep learning system to screen coronavirus disease 2019 pneumonia." Applied Intelligence (2020): 1.

References

- Afshar, Parnian, et al. "Covid-caps: A capsule network-based framework for identification of covid-19 cases from x-ray images." arXiv preprint arXiv:2004.02696 (2020).
- Khobahi, Shahin, Chirag Agarwal, and Mojtaba Soltanalian. "CoroNet: A Deep Network Architecture for Semi-Supervised Task-Based Identification of COVID-19 from Chest X-ray Images." medRxiv (2020).
- Sethy, Prabira Kumar, and Santi Kumari Behera. "Detection of coronavirus disease (covid-19) based on deep features." Preprints 2020030300 (2020): 2020.
- Wang, Linda, and Alexander Wong. "COVID-Net: A Tailored Deep Convolutional Neural Network Design for Detection of COVID-19 Cases from Chest X-Ray Images." arXiv preprint arXiv:2003.09871 (2020).

References

- Hemdan, Ezz El-Din, Marwa A. Shouman, and Mohamed Esmail Karar. "Covidx-net: A framework of deep learning classifiers to diagnose covid-19 in x-ray images." arXiv preprint arXiv:2003.11055 (2020).
- Farooq, Muhammad, and Abdul Hafeez. "Covid-resnet: A deep learning framework for screening of covid19 from radiographs." arXiv preprint arXiv:2003.14395 (2020).
- Barz, Bjorn, and Joachim Denzler. "Deep learning on small datasets without pre-training using cosine loss." The IEEE Winter Conference on Applications of Computer Vision. 2020.