

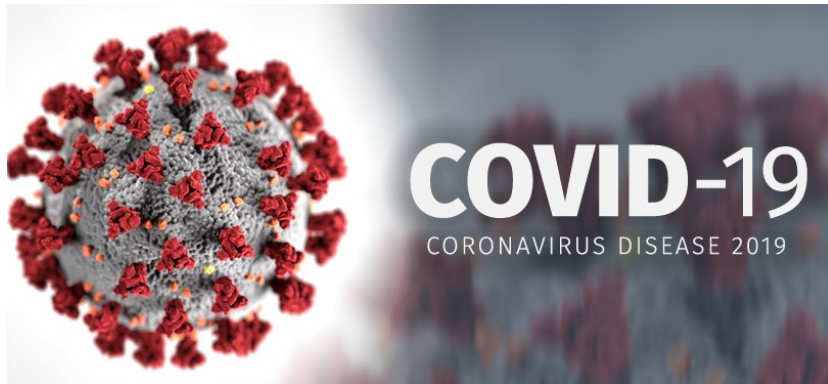
Classification of COVID-19 from chest X-ray images using Deep Neural Networks

Presenter: DAO THI TRUC LOAN

JULY 26, 2022

Introduction

COVID-19 was first reported in late 2019 in Wuhan, China, and has since spread throughout China and around the world, poses a serious threat to global public health.

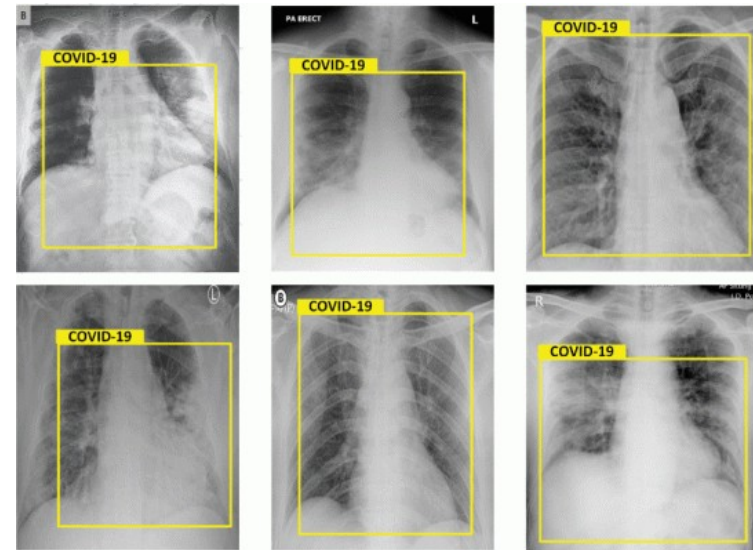


Introduction

- COVID-19 is a respiratory disease, one that especially reaches into your respiratory tract, which includes your lungs.
- Doctors can see signs of respiratory inflammation on a chest X-ray or CT scan. X-ray imaging is a low-cost, easily accessible, and fast method that can be an excellent alternative for conventional diagnostic methods such as RT-PCR and CT scans.



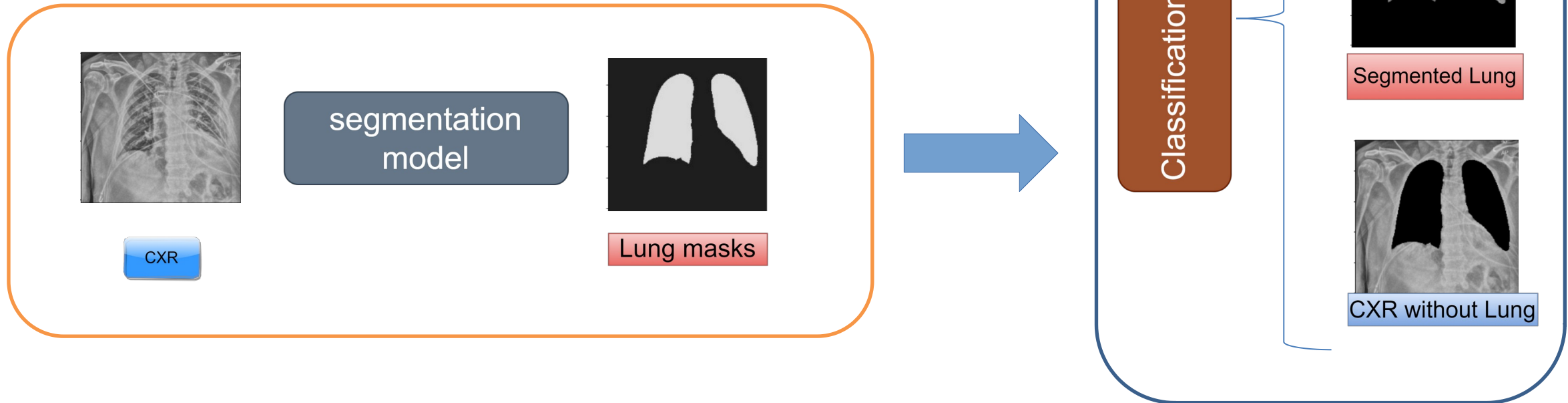
<https://www.webmd.com/lung/ss/slideshow-signs-had-covid>



Results of chest X-Rays, detected as Covid-19. Images courtesy of IEEE

Introduction

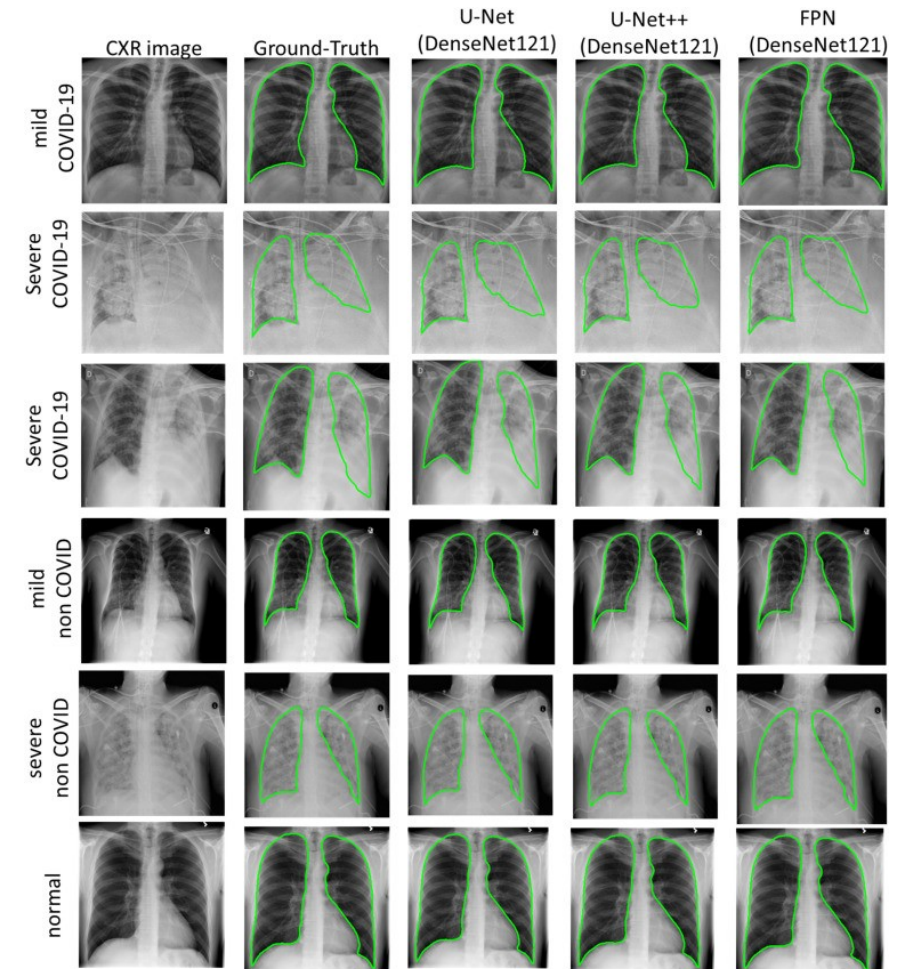
- The first is the task of **classifying covid-19**
- The second is the task of **classifying covid-19 combine lung segmentation**



Related works

Segmentation

The Qatar university research team have constructed the large benchmark dataset with 33,920 CXR images, including 11,956 COVID-19 samples, where the annotation of ground-truth lung segmentation masks is performed on CXRs by an elegant human-machine collaborative approach.



Related works

Classification

Experiment diagram:

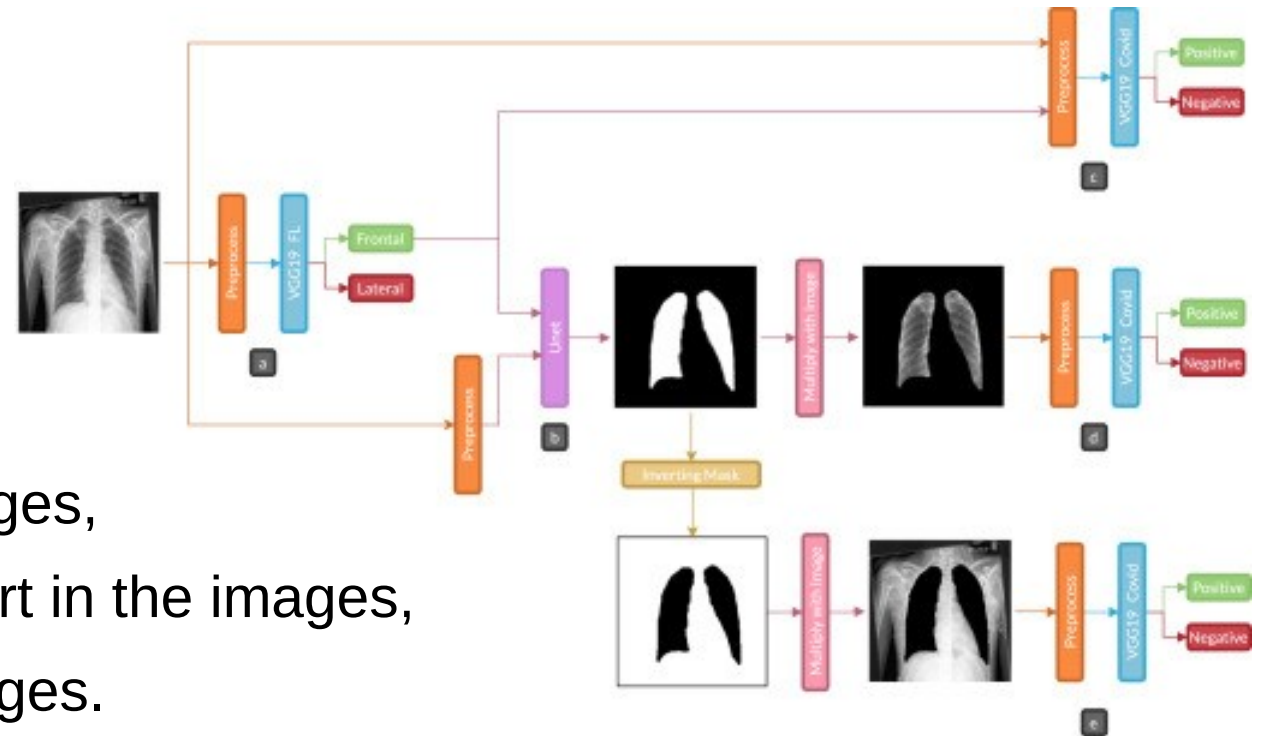
a is the first classification task,

b is the lung segmentation task,

c is a covid prediction with standard images,

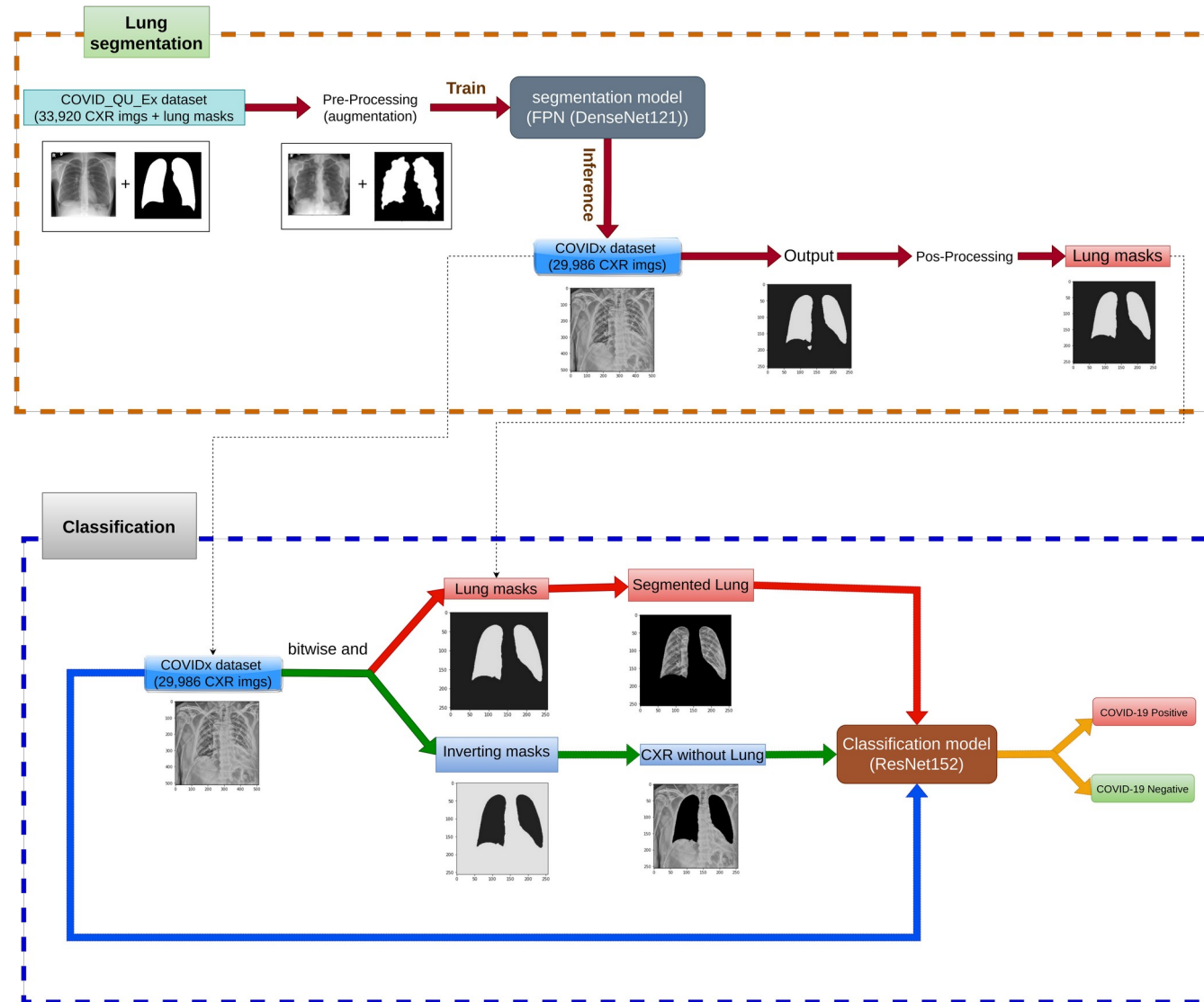
d is a covid prediction with only lungs part in the images,

e is covid prediction without lungs in images.



Part	Accuracy	Sensitivity	Specificity	F1 Score
c	0.939	0.972	0.883	0.965
d	0.933	0.968	0.871	0.961
e	0.956	0.967	0.917	0.969

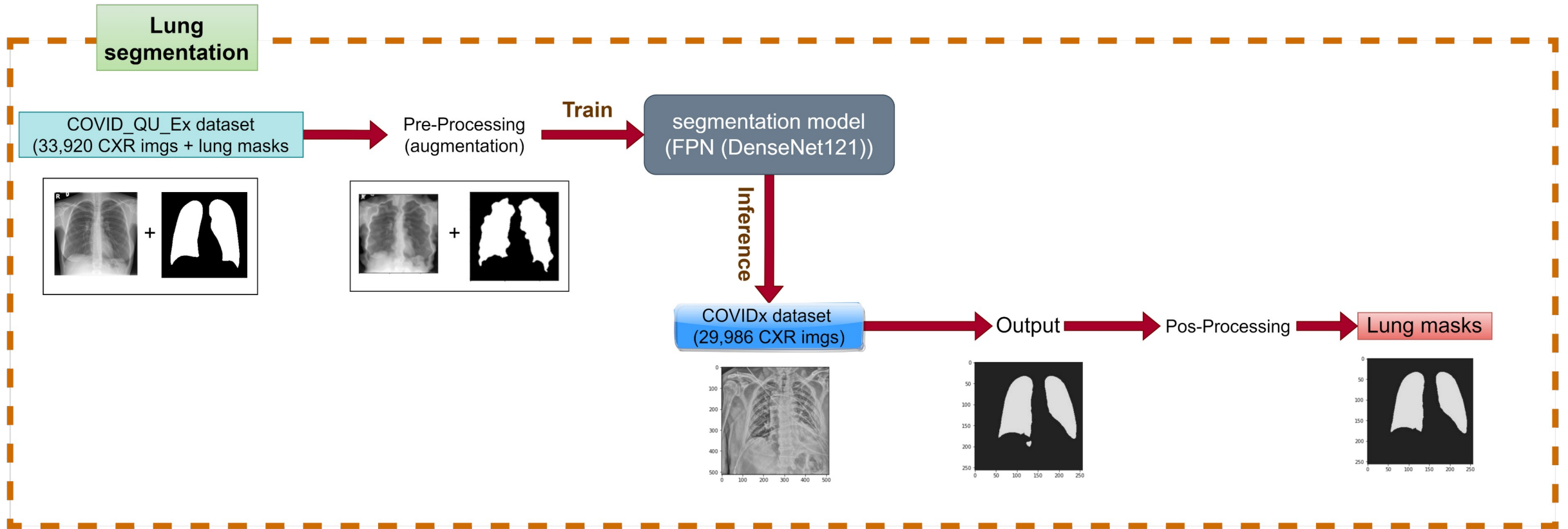
Methods



Schematic representation of the pipeline of the proposed system

Methods

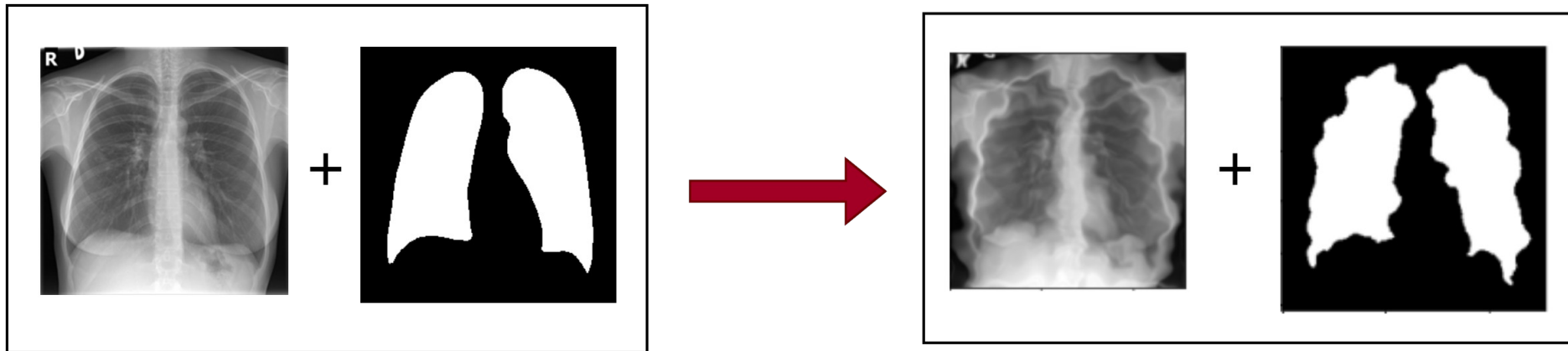
Phase 1: Lung segmentation



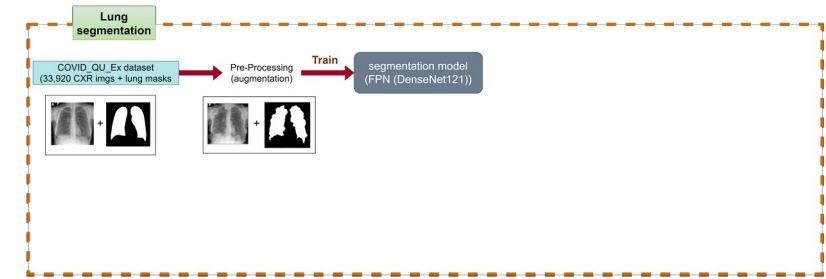
Methods

Phase 1: Lung segmentation

1. Image Preprocessing and Augmentation: resize all images to 256x256 pixels, compute mean and std, Horizontal Flip, Elastic Transform, Rotate, Normalize, ..



Methods



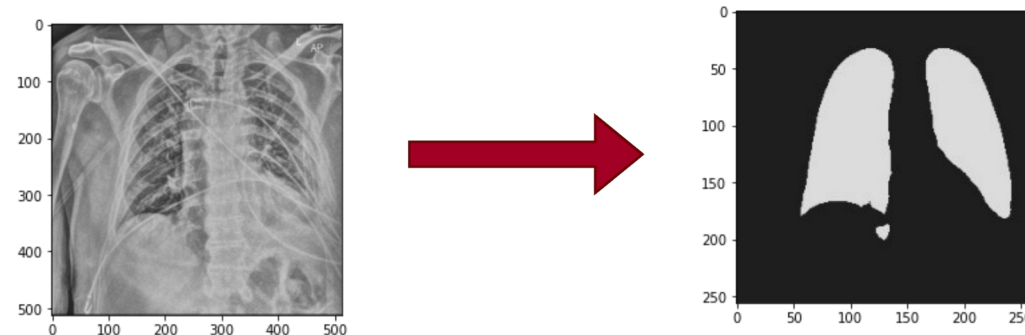
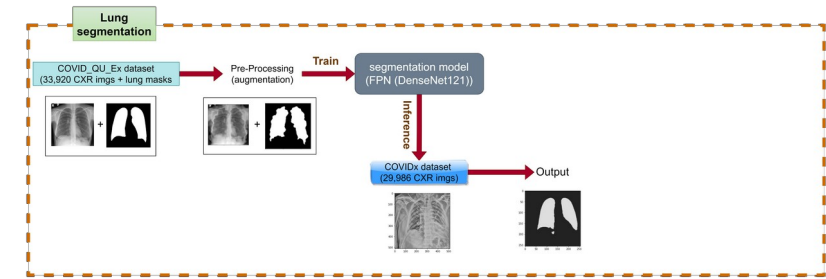
Phase 1: Lung segmentation

- 1. *Image Preprocessing and Augmentation:*** resize all images to 256x256 pixels, compute mean and std, Horizontal Flip, Elastic Transform, Rotate, Normalize, ..
- 2. *Train:*** using segmentation_model_pytorch (FPN (DenseNet121) pretrained on ImageNet. Use comboloss (Dice + BCE + Focal) to compare the output and ground truth

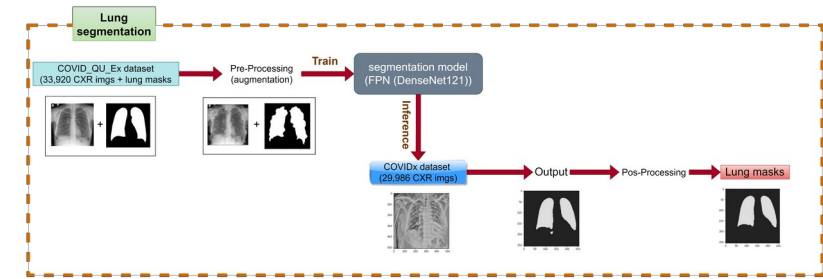
Methods

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- 3. Inference:** using FPN (DenseNet121) pretrained on COVID_QU_Ex dataset to create lung mask for COVIDx dataset

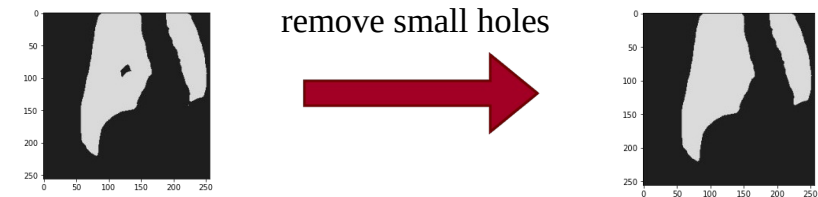
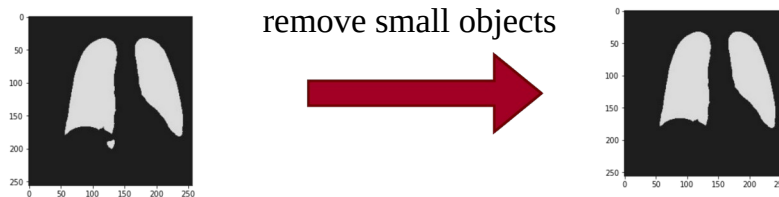


Methods



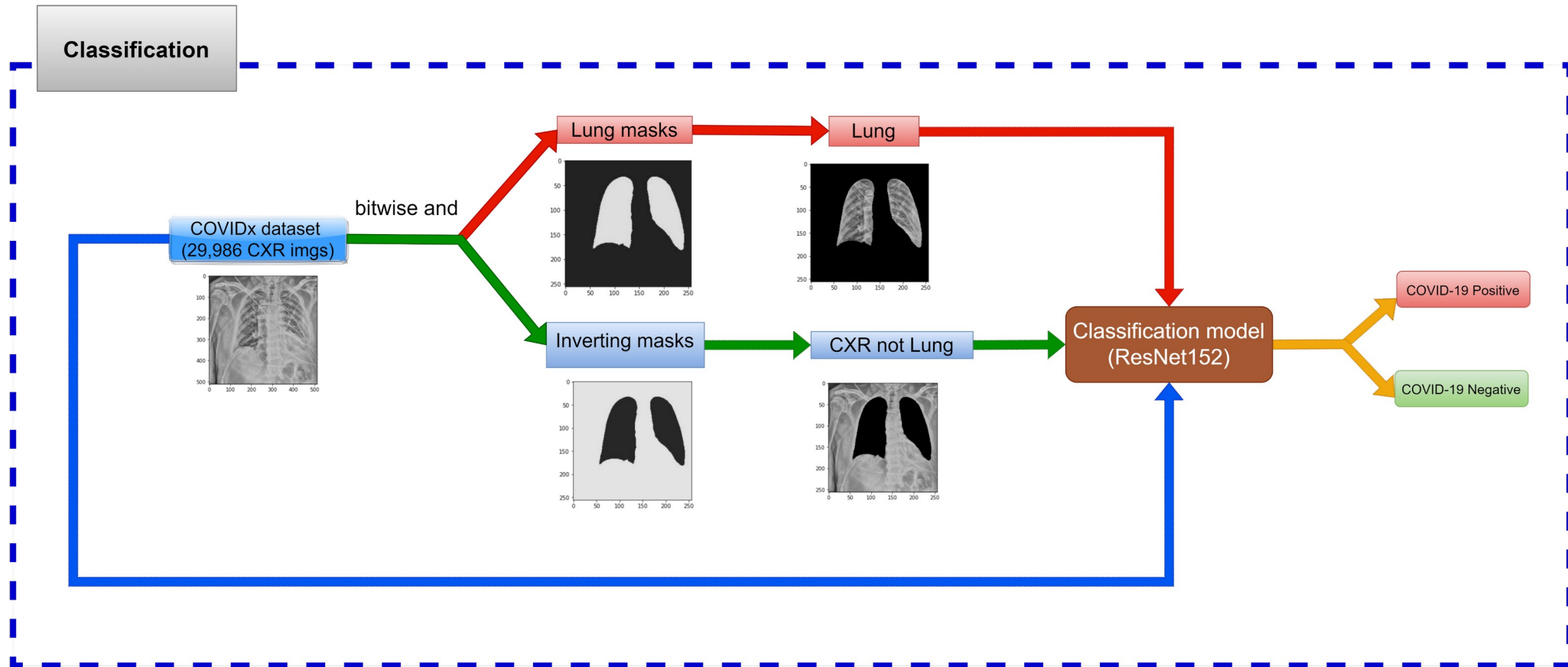
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- 4. PosProcessing:** remove small objects and remove small holes



Methods

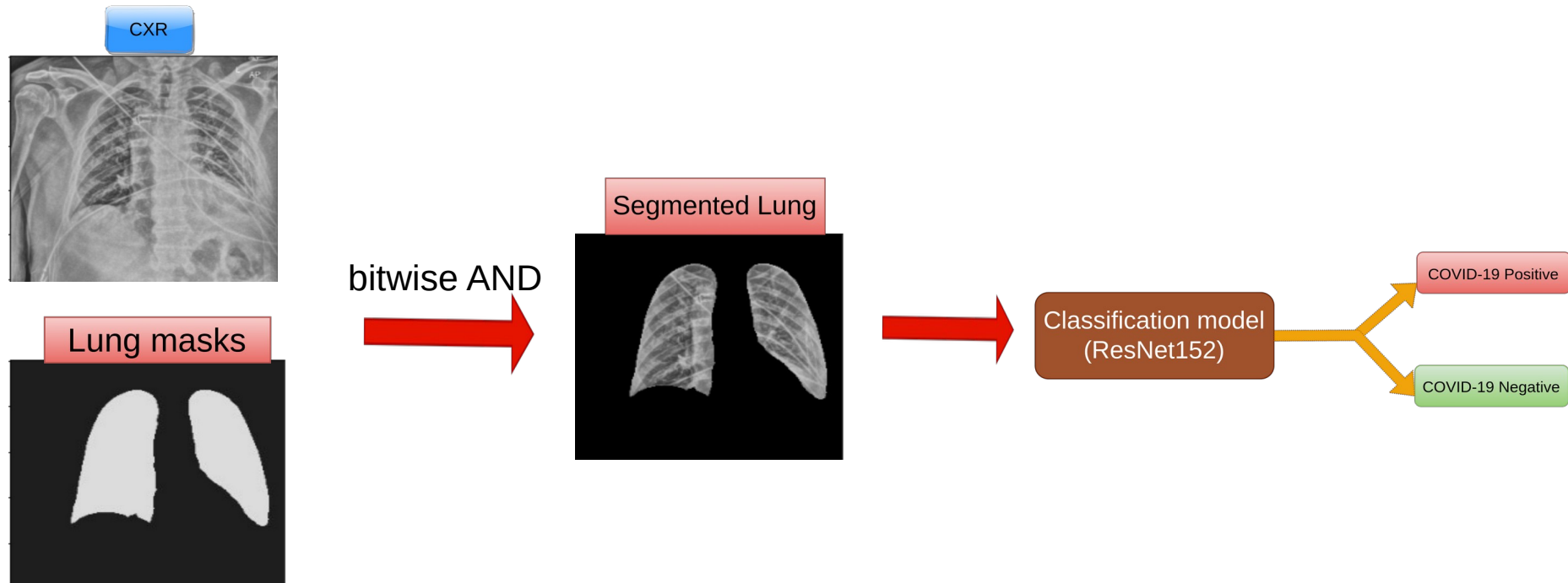
Phase 2: Covid-19 Classification



Methods

Phase 2: Covid-19 Classification

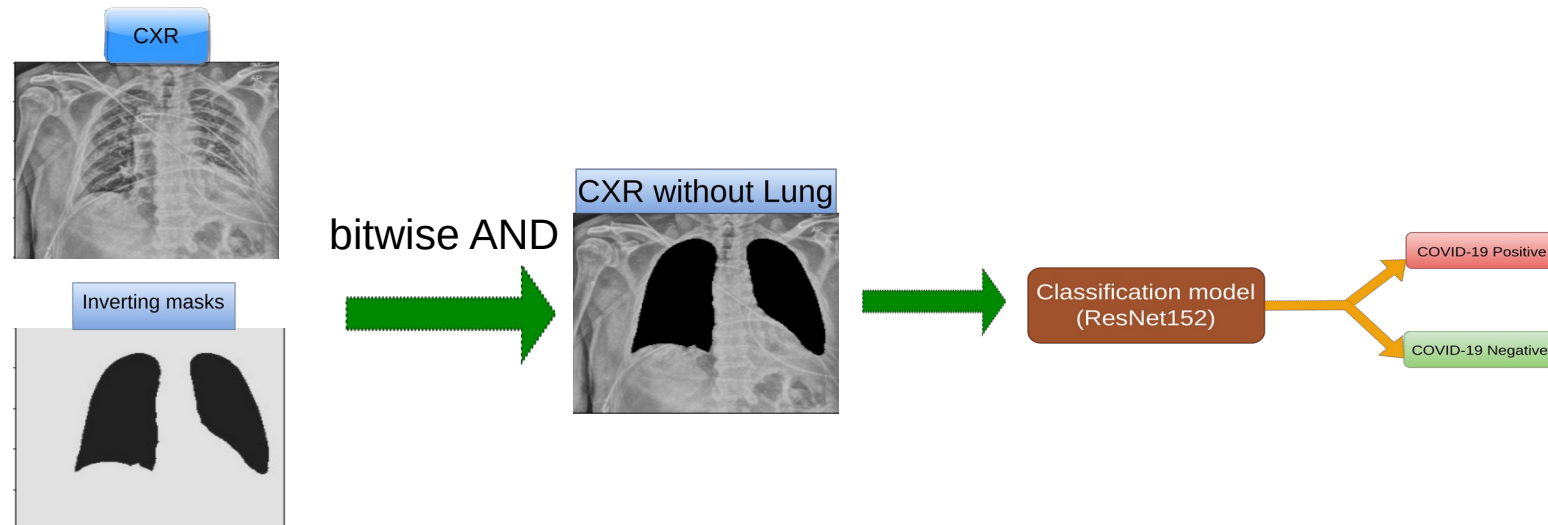
- 1. Segmented Lungs:** First apply **bitwise AND** to the **original CXR** and **lung mask** images to **extract only the lung part** in the original CXR image. Then classify covid-19 on this **segmented lungs**.



Methods

Phase 2: Covid-19 Classification

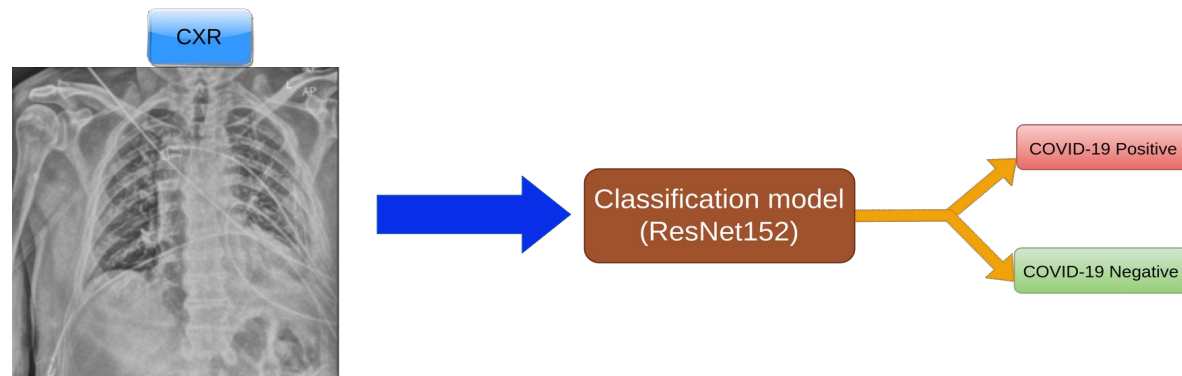
- 1. *Segmented Lungs:*** First apply **bitwise AND** to the **original CXR** and **lung mask** images to **extract only the lung part** in the original CXR image. Then classify covid-19 on this **segmented lung**.
- 2. *CXR without Lungs:*** First apply **bitwise AND** to the **original CXR** and **inverting mask** images to produce a **CXR without Lungs**. Then classification covid-19 on this output.



Methods

Phase 2: Covid-19 Classification

1. **Segmented Lungs:** First apply **bitwise AND** to the **original CXR** and **lung mask** images to **extract only the lung part** in the original CXR image. Then classify covid-19 on this **segmented lung**.
2. **CXR without Lungs:** First apply **bitwise AND** to the **original CXR** and **inverting mask** images to produce a **CXR without Lungs**. Then classification covid-19 on this output.
3. **CXR original:** Covid-19 classification



Datasets

- TRAIN LUNG SEGMENTATION:

- [COVID_QU_Ex](#) consists of 33,920 chest X-ray (CXR) images including:
 - 11,956 COVID-19
 - 11,263 Non-COVID infections (Viral or Bacterial Pneumonia)
 - 10,701 Normal

Ground-truth lung segmentation masks are provided for the entire dataset.

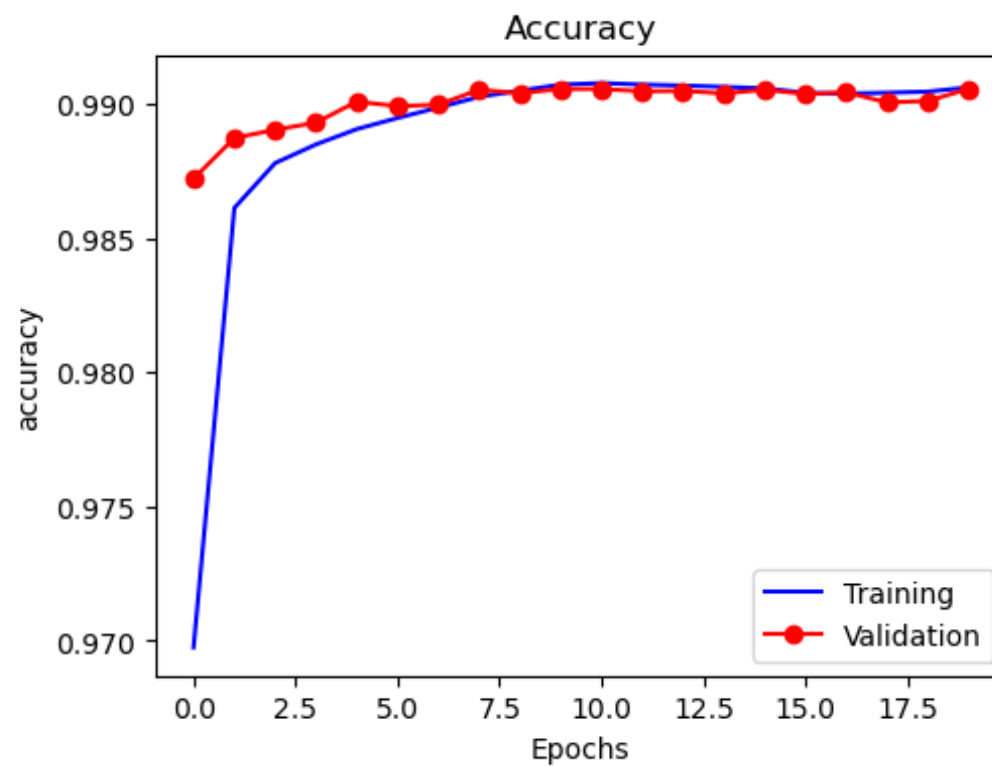
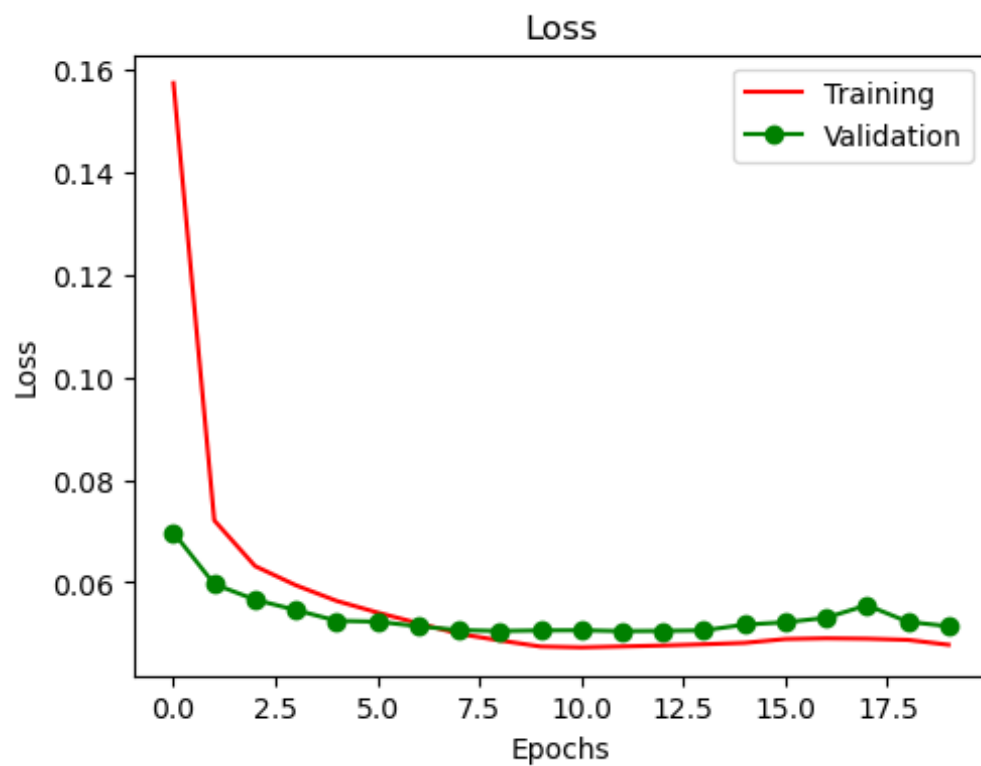
- INFERENCE LUNG SEGMENTATION and CLASSIFICATION COVID-19:

- [COVIDx CXR-3 Dataset](#) (update 06/02/2022) contains 29,986 CXR images

Type	COVID-19 Negative	COVID-19 Positive	Total
Train	13992	15994	29986
Test	200	200	400

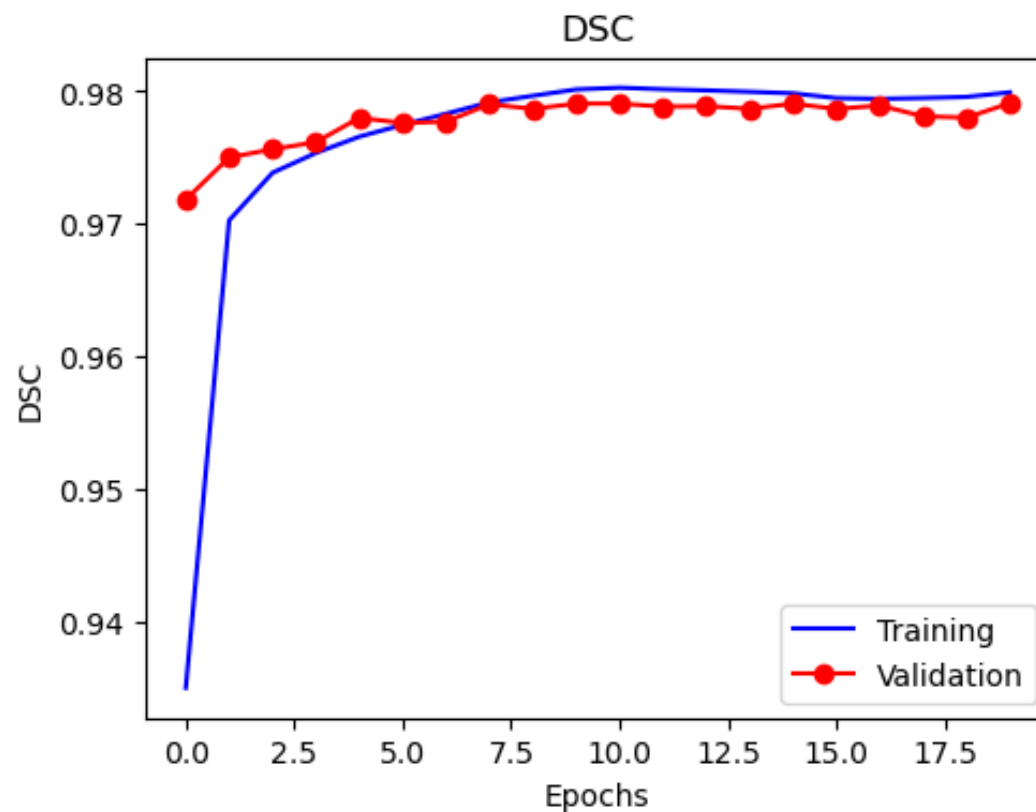
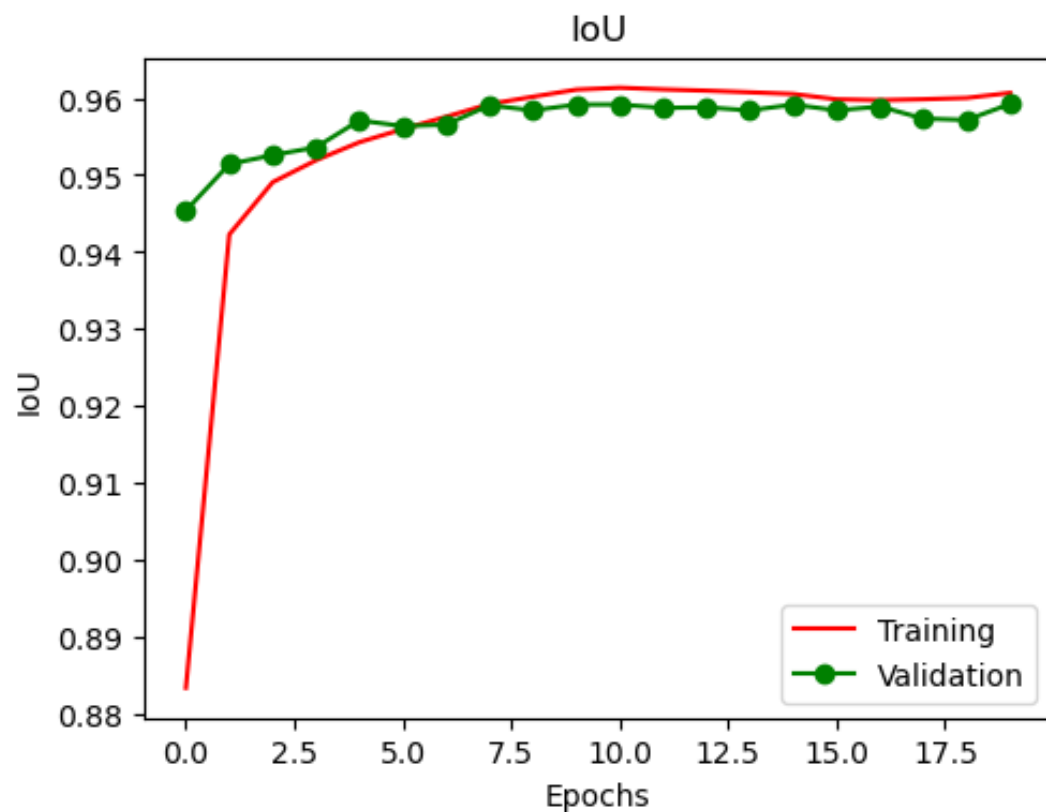
Experimental results

1. Lung Segmentation



Experimental results

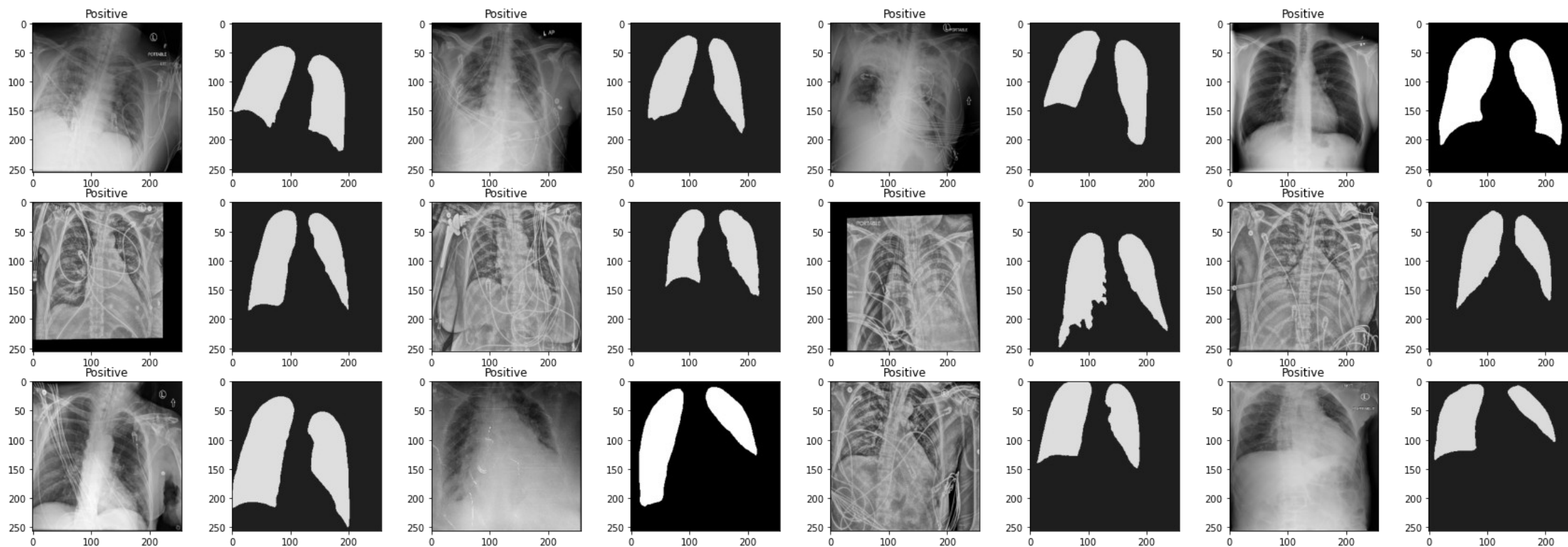
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Experimental results

1. Lung Segmentation

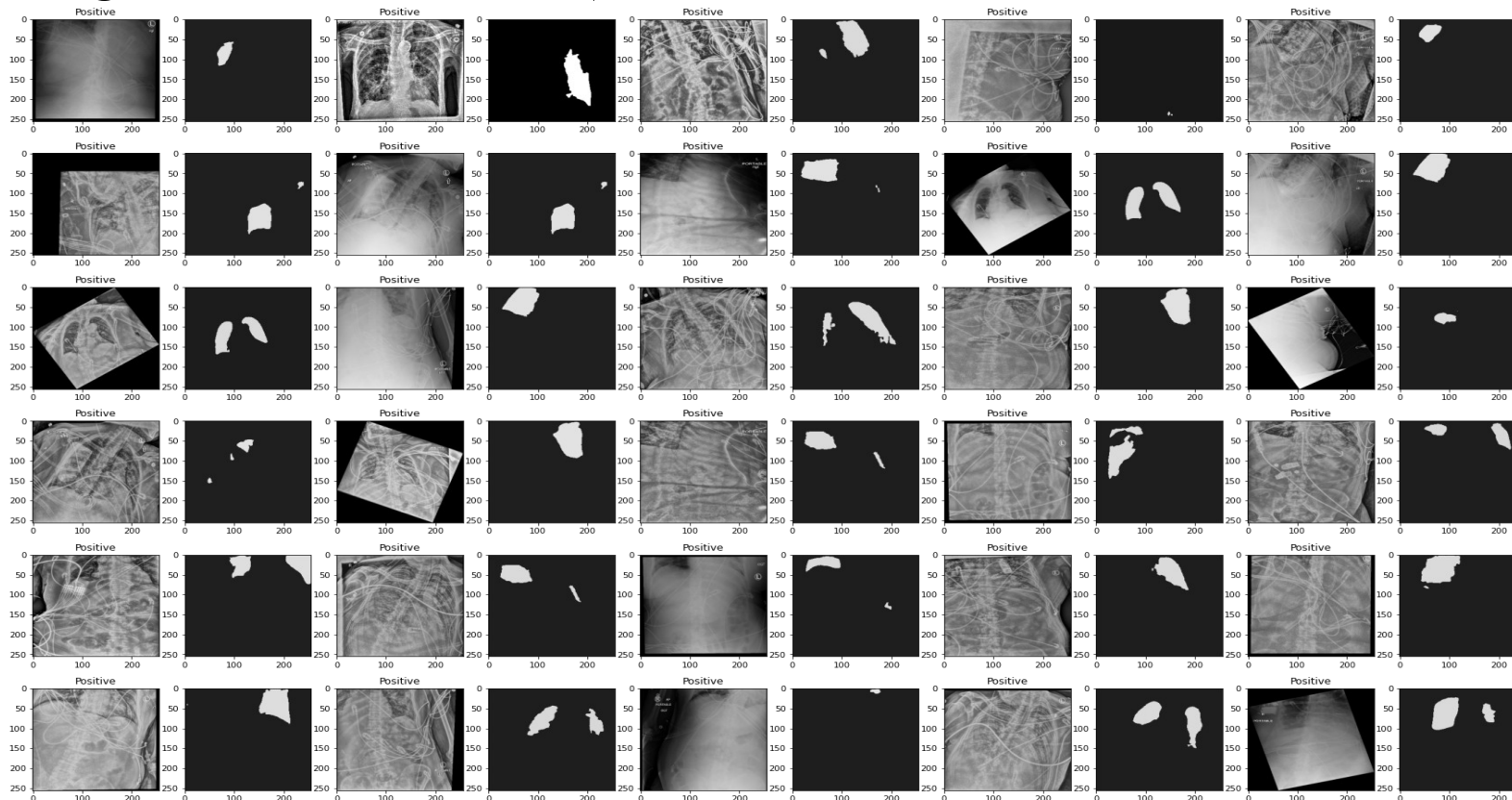
Inference on COVIDx CXR3 dataset



Experimental results

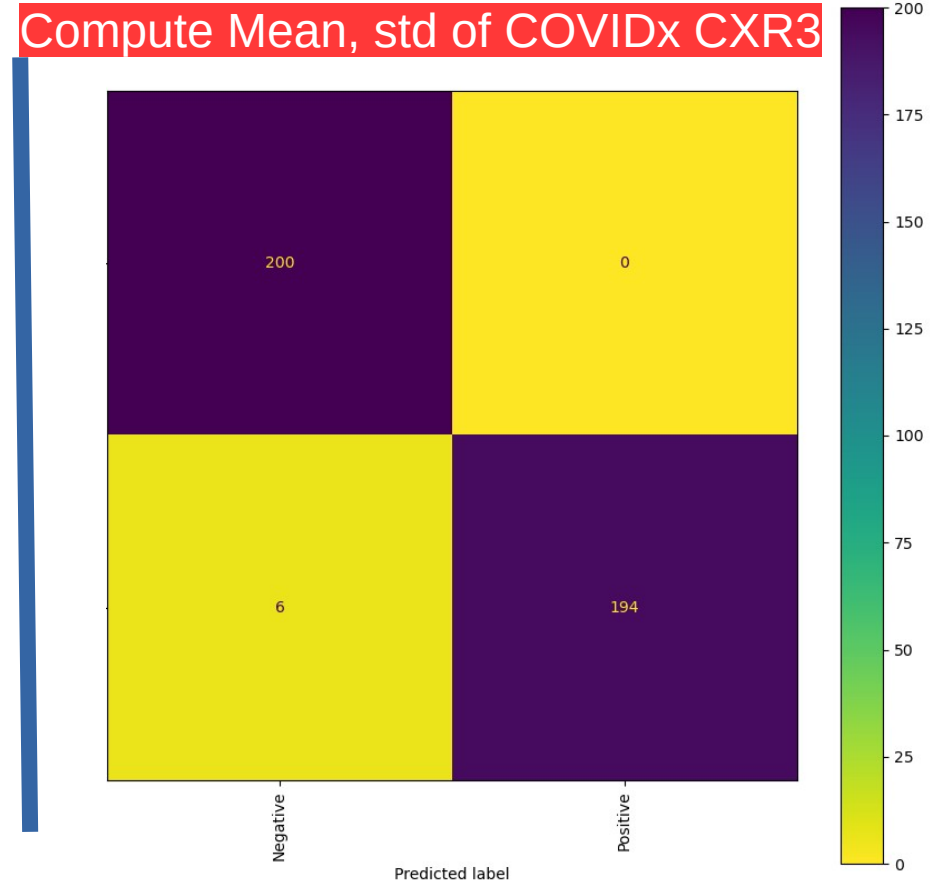
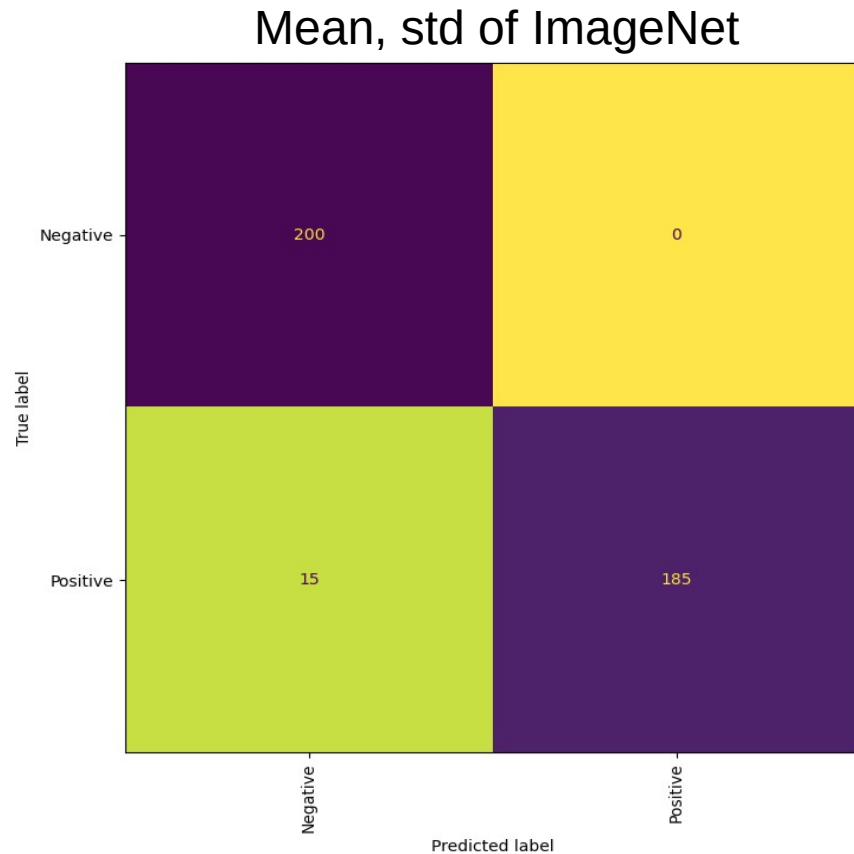
1. Lung Segmentation

Inference: filter out images whose segmented area is less than 15% area of the whole image (*30 images Covid-19 Positive*)



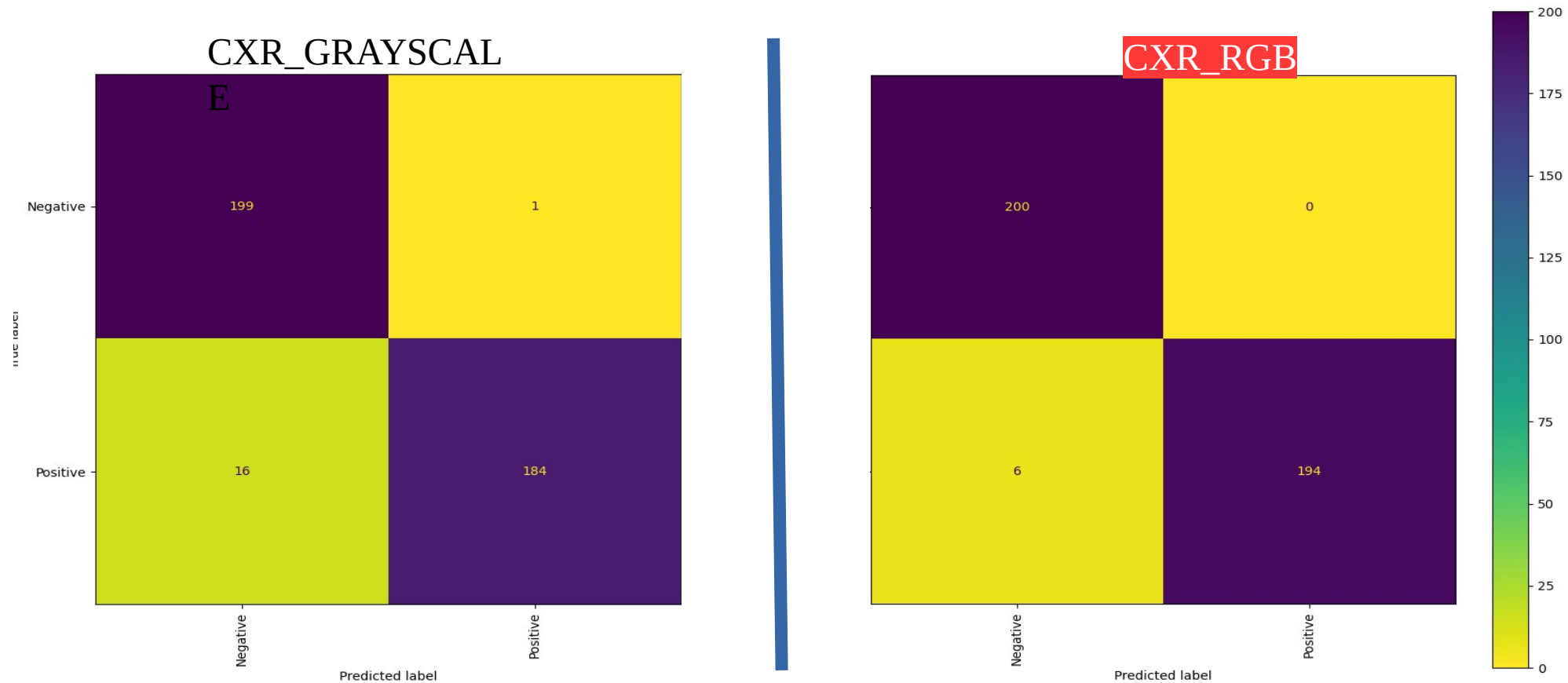
Experimental results

2. Covid-19 Classification: normalize with different mean and std



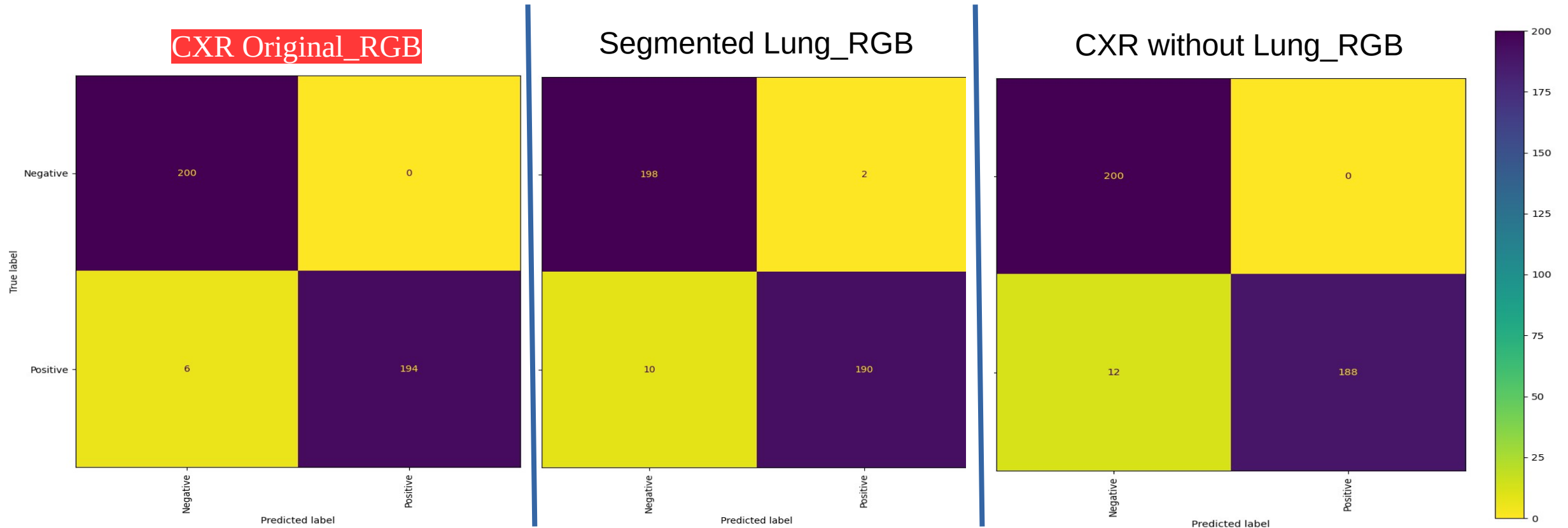
Experimental results

2. Covid-19 Classification: Classification on Grayscale / RGB images



Experimental results

2. Covid-19 Classification: Classification on CXR Original / Segmented Lung / CXR without Lung images



Conclusions

- Generate lung segmentation for COVIDx CXR3 dataset with high confidence
- Perform 3 covid-19 classification experiments on the COVIDx CXR3 dataset with the best results with normalize using mean and std of COVIDx CXR3 dataset, CXR_RGB images, as follows: **precision 0.97, recall: 0.96, f1-score 0.96, accuracy 0.96**

Thank You

