

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

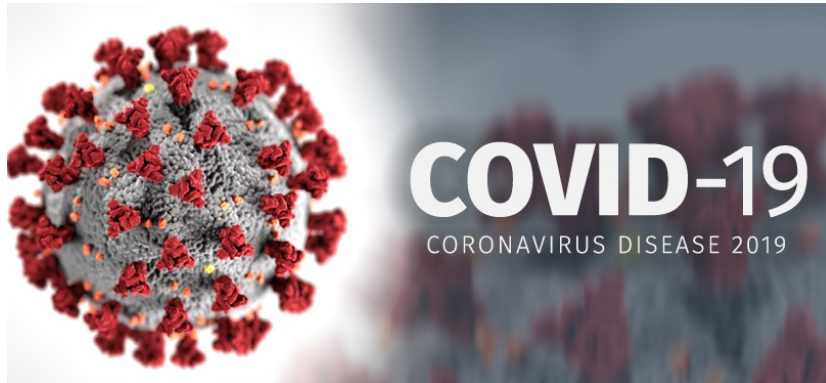
Presenter: DAO THI TRUC LOAN

JULY 26, 2022

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Introduction

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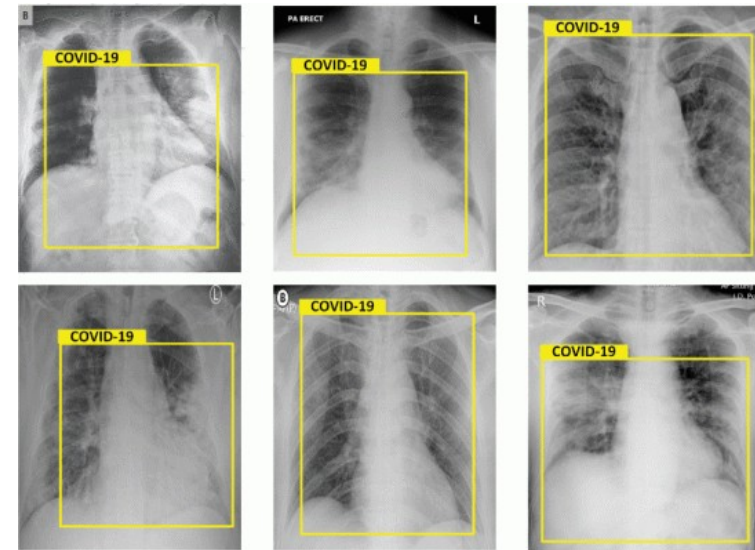
Introduction

COVID-19 is a respiratory disease that especially reaches your respiratory tract, including 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 to conventional diagnostic methods such as RT-PCR and CT scans.

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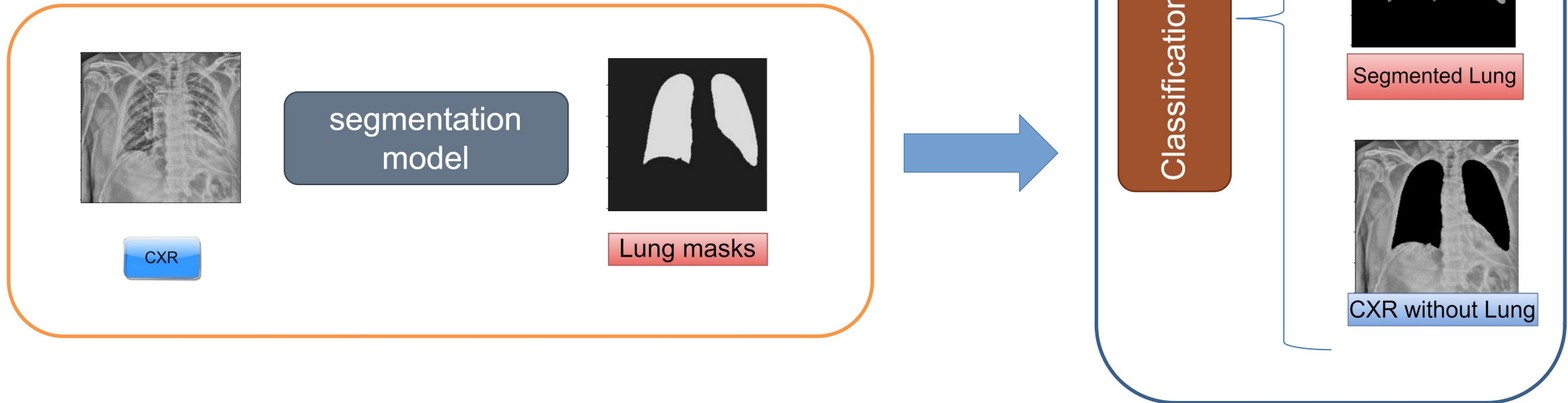
<https://www.webmd.com/lung/ss/slideshow-signs-had-covid>



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**

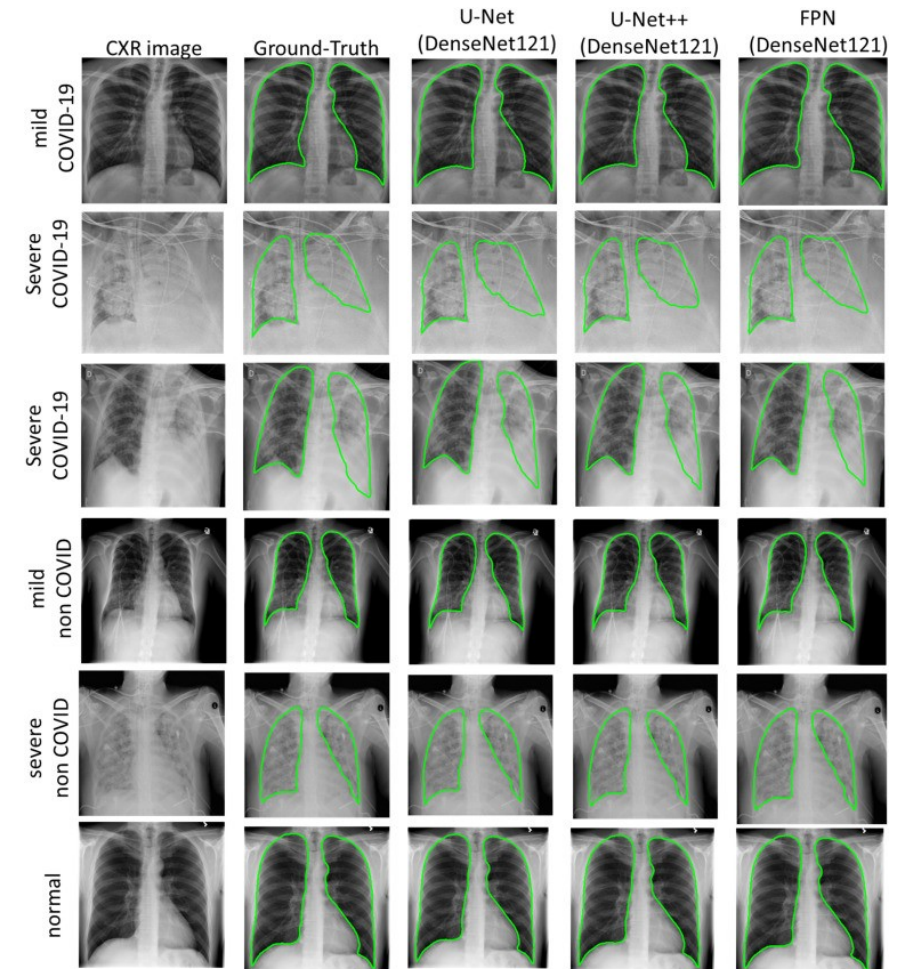


Related works

The Qatar university research team has constructed a 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.

Segmentation

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Related works

Classification

the lungs

Experiment diagram:

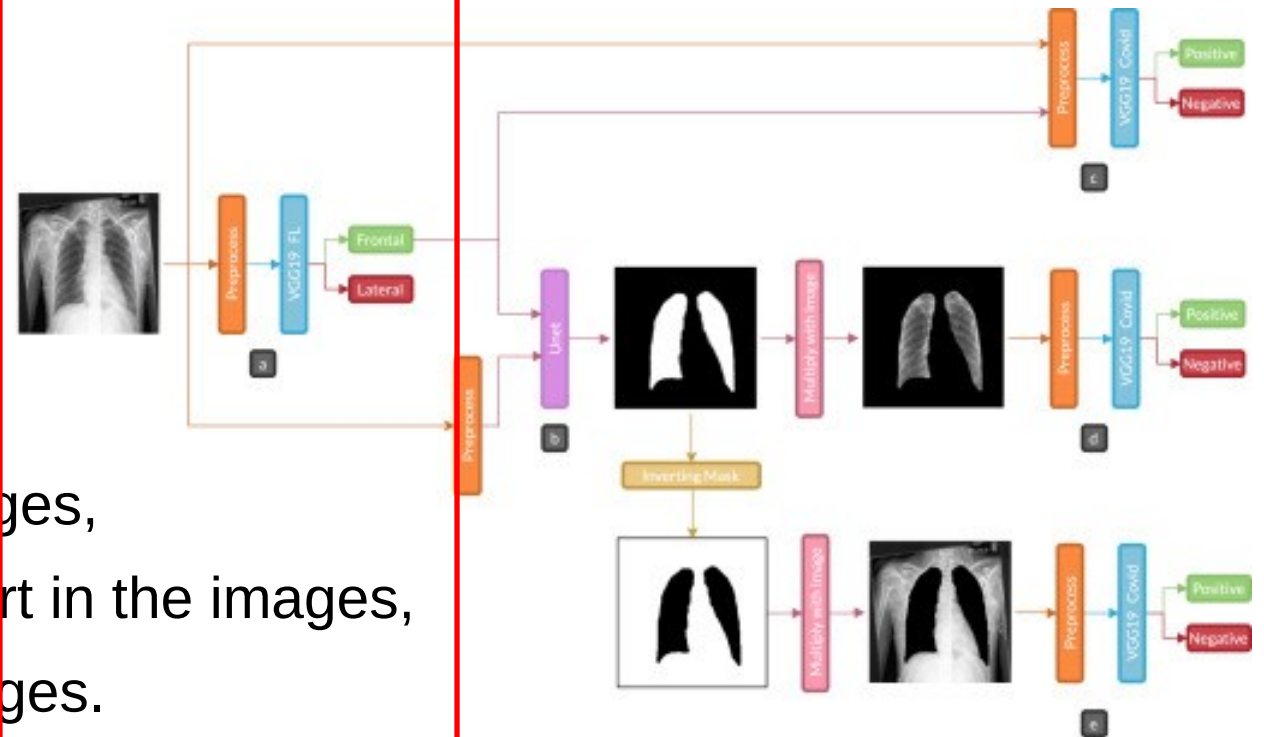
a is the first classification task,

b is the lung segmentation task,

c is a covid prediction with standard images,

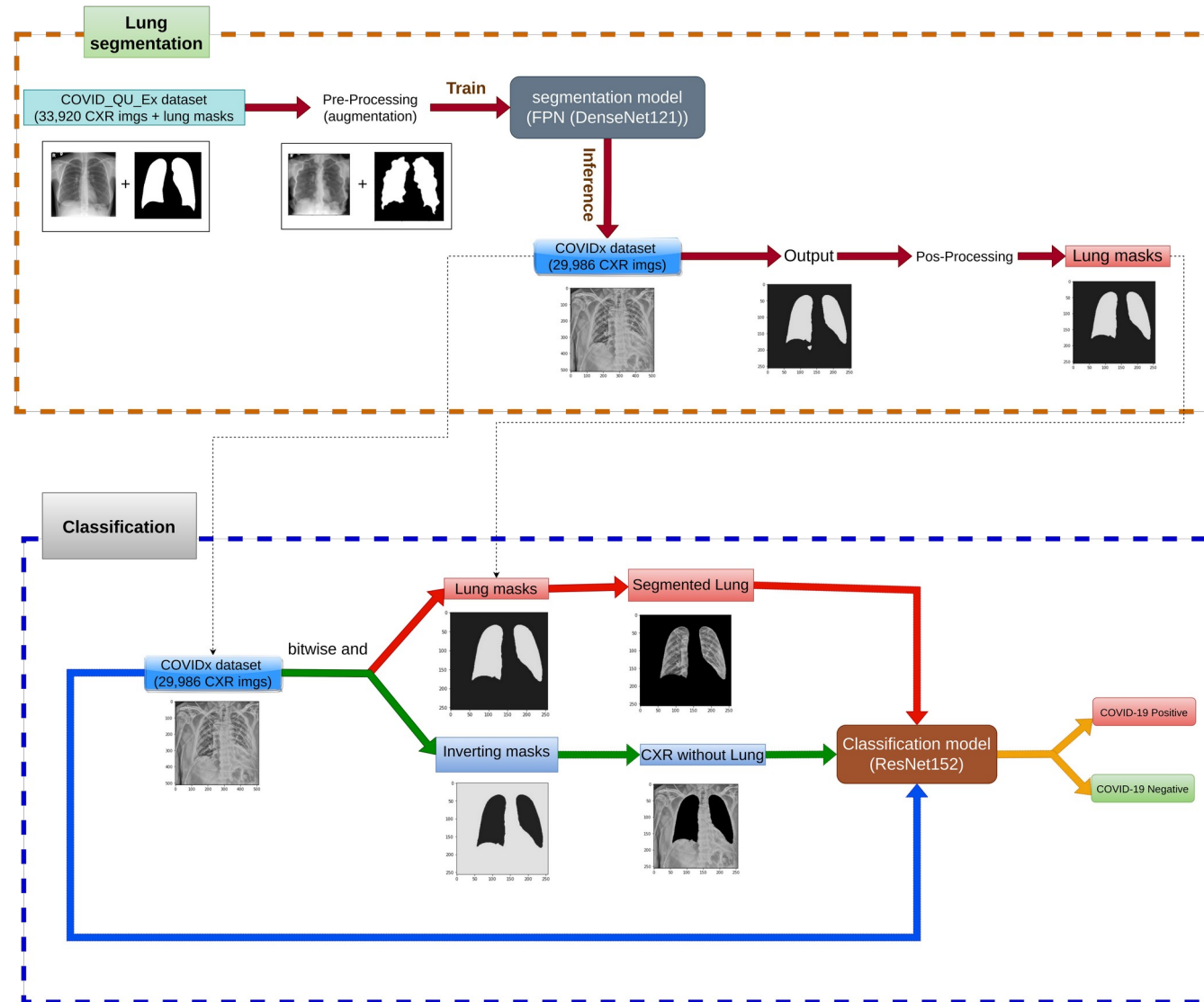
d is a covid prediction with only lungs part in the images,

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

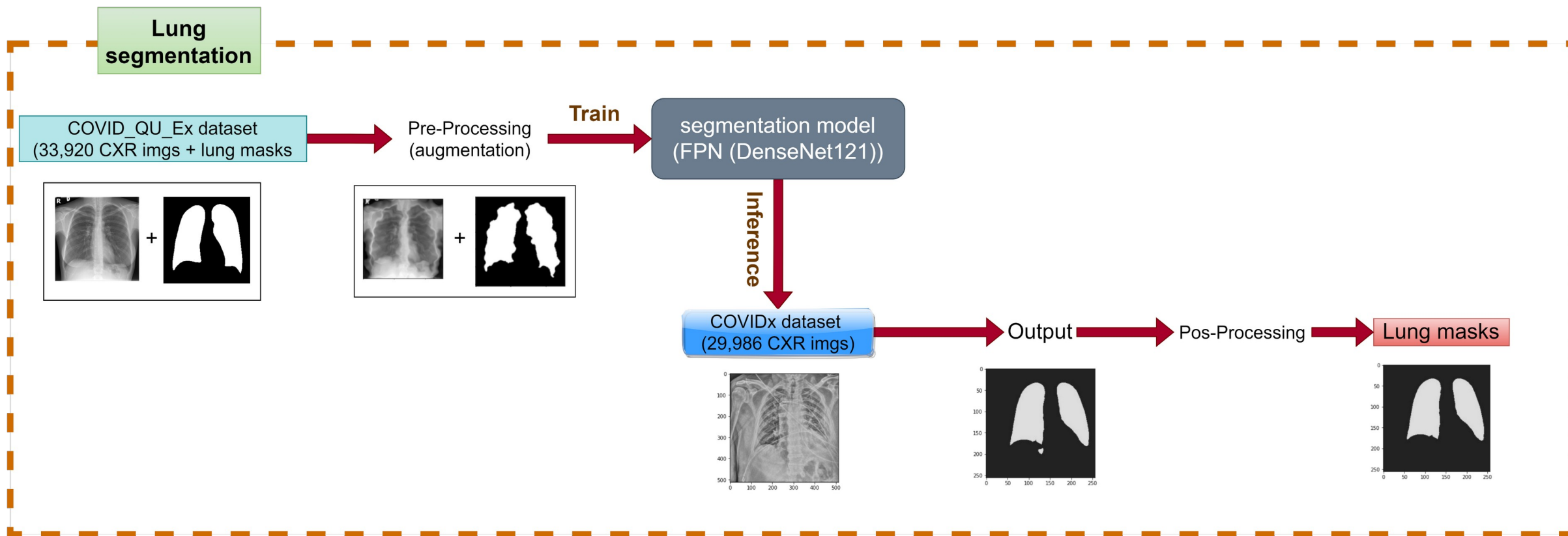


~~Schematic representation of the pipeline of the proposed system~~

Methods

Phase 1:
Classification on
CovidX

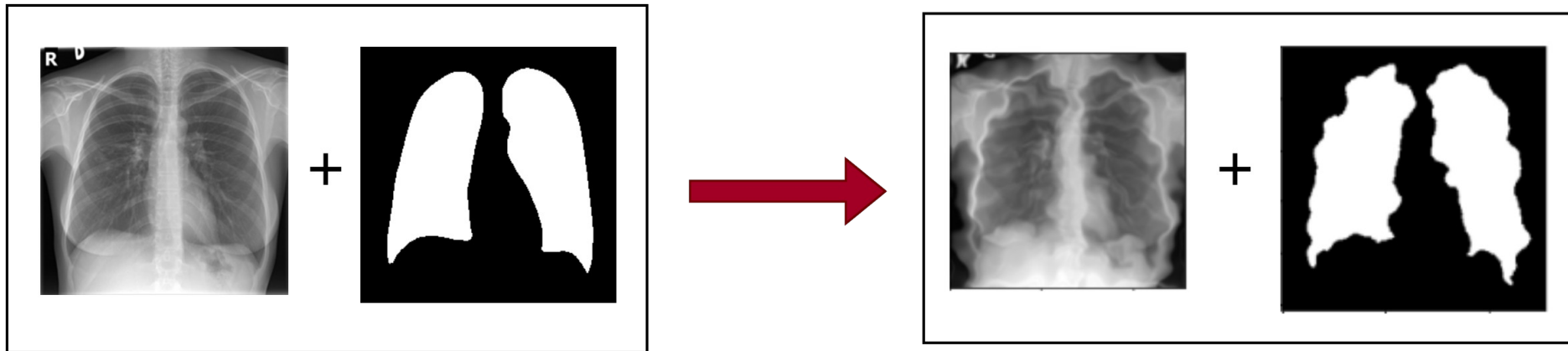
Phase 1: Lung segmentation



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

what's it?
Package, Lib or
API. And
reference?



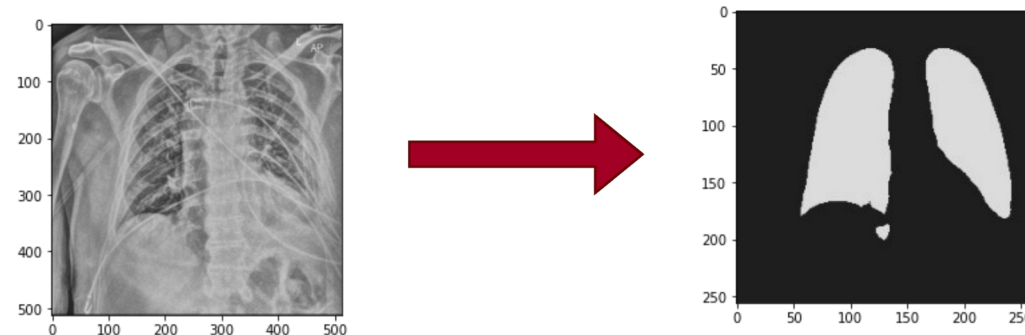
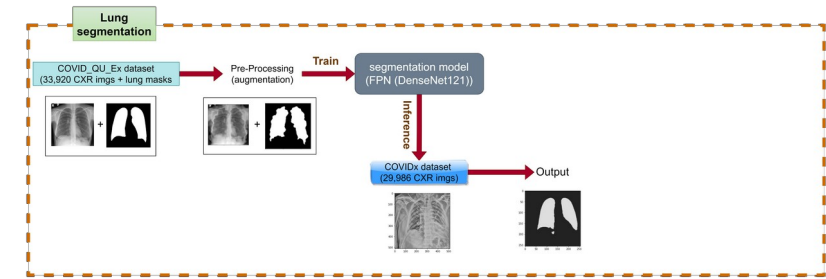
Phase 1: Lung segmentation

- 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

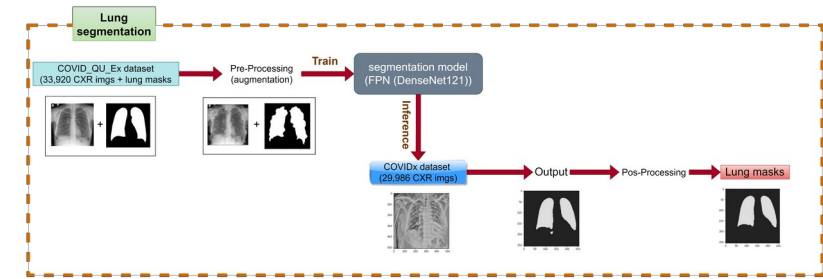
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- 3. Inference:** using FPN (DenseNet121) pretrained on COVID_QU_Ex dataset to create lung mask for COVIDx dataset

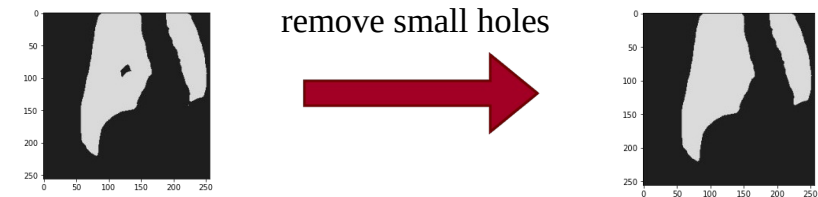
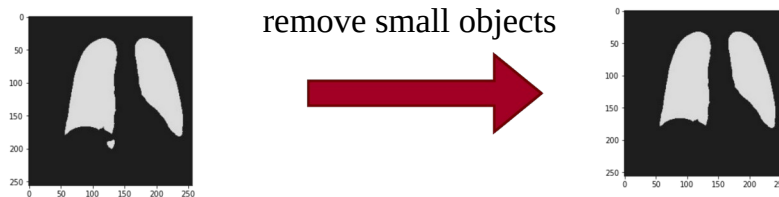


Methods



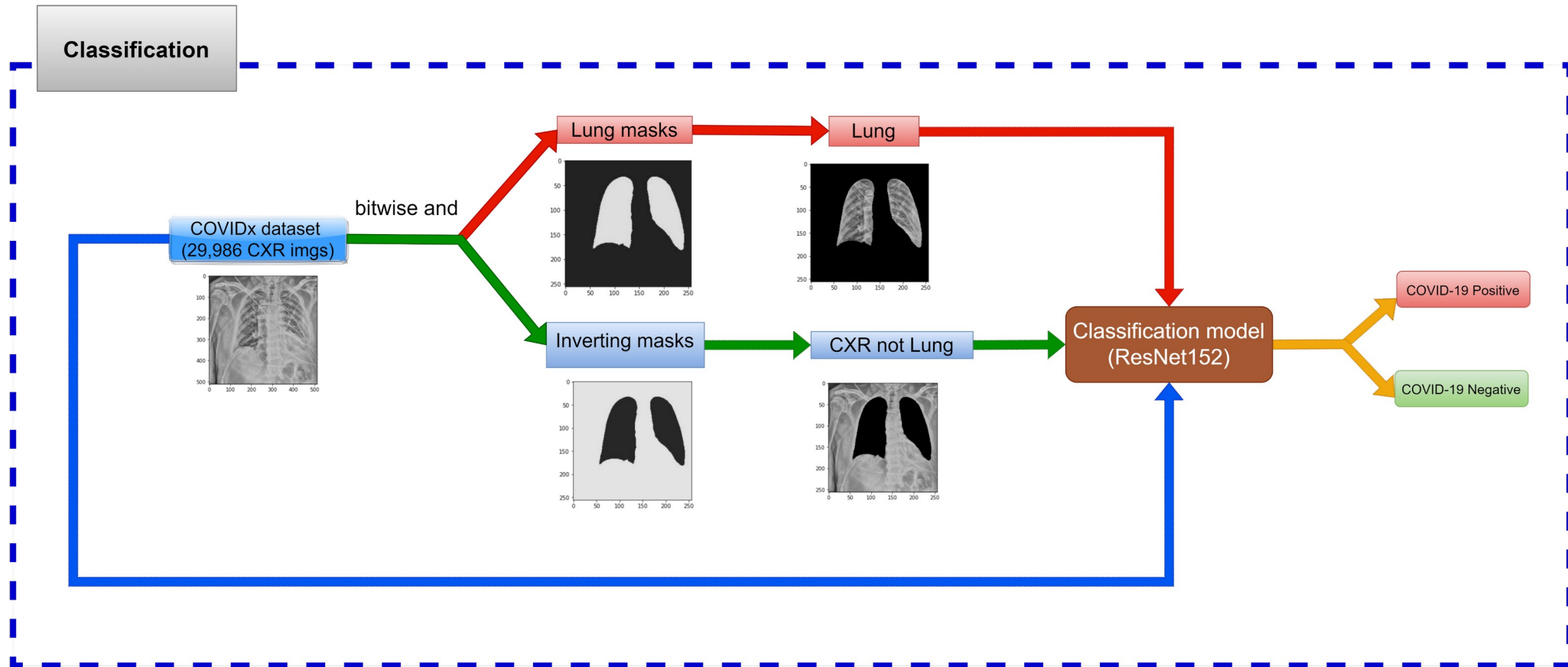
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- 4. PosProcessing:** remove small objects and remove small holes



Methods

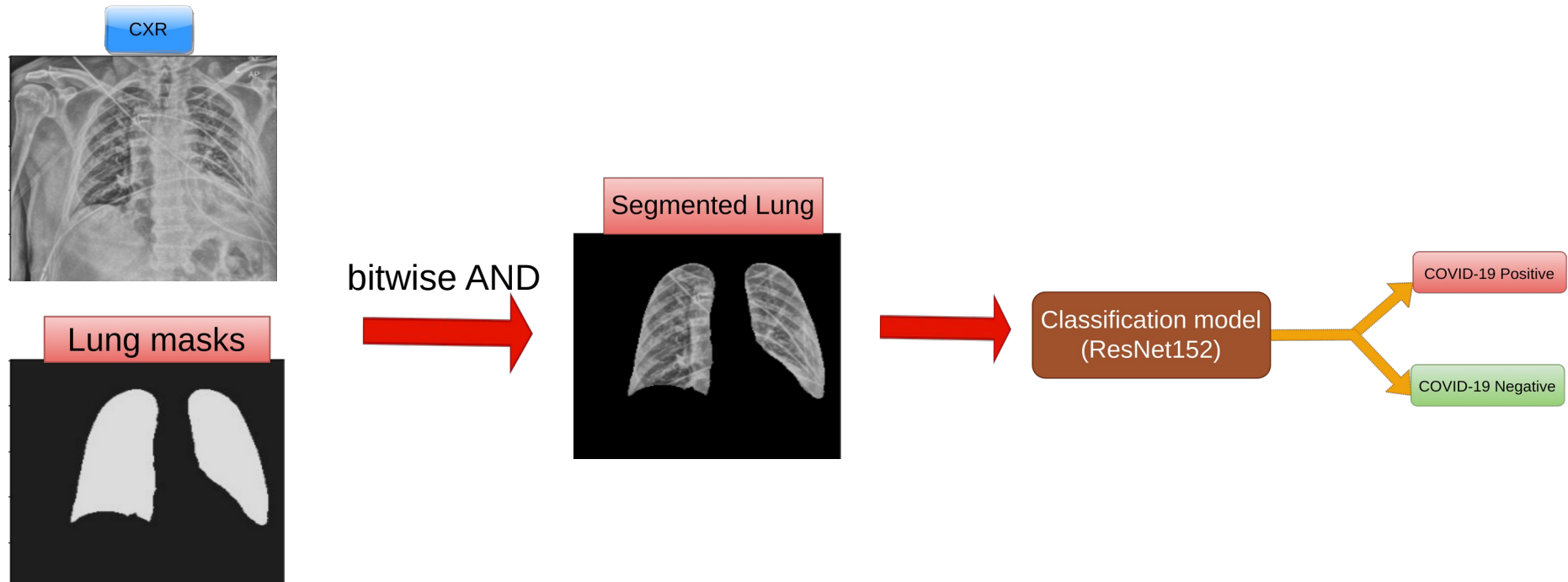
Phase 2: Covid-19 Classification



Methods

Phase 2: Covid-19 Classification

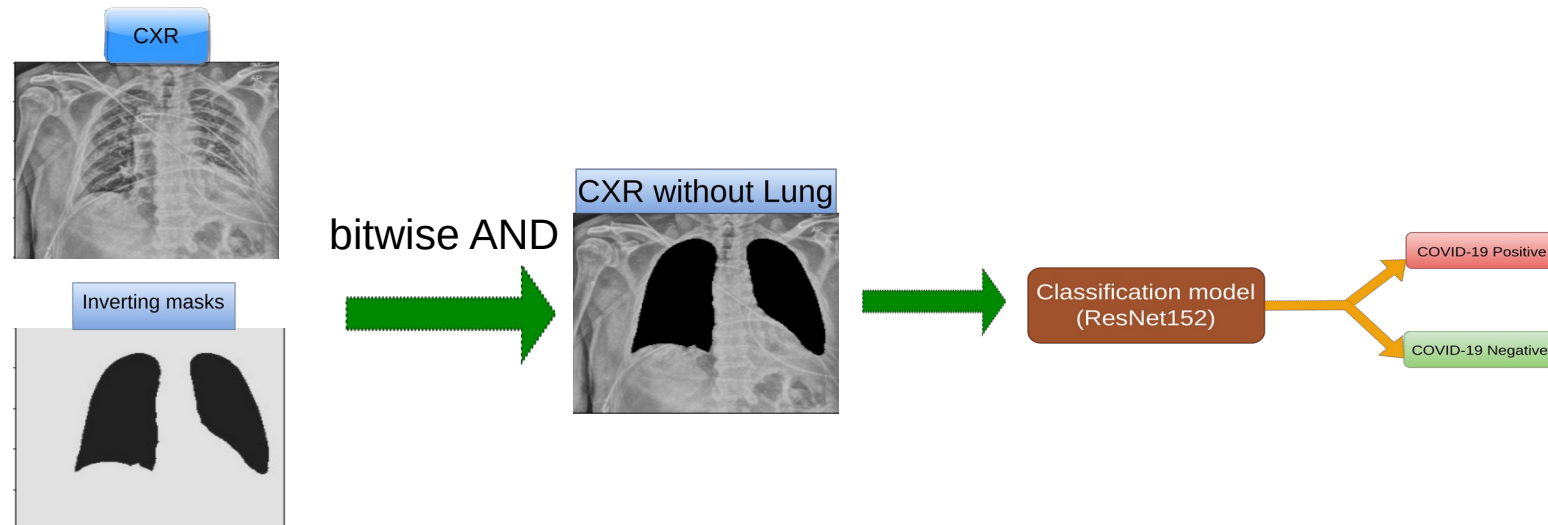
- 1. Segmented Lungs:** First apply **bitwise AND** to the **original CXR** and **lung mask** images to **extract only the lung part** in the original CXR image. Then classify covid-19 on this **segmented lungs**.



Methods

Phase 2: Covid-19 Classification

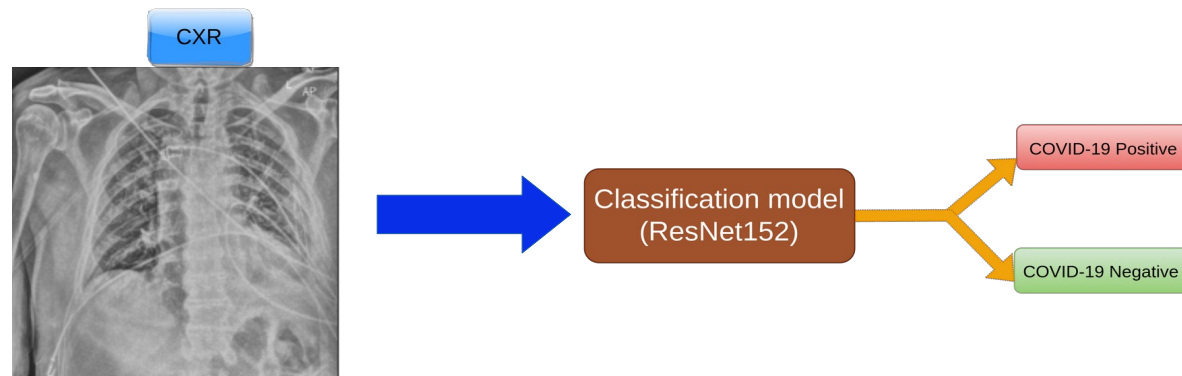
- 1. *Segmented Lungs:*** First apply **bitwise AND** to the **original CXR** and **lung mask** images to **extract only the lung part** in the original CXR image. Then classify covid-19 on this **segmented lung**.
- 2. *CXR without Lungs:*** First apply **bitwise AND** to the **original CXR** and **inverting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

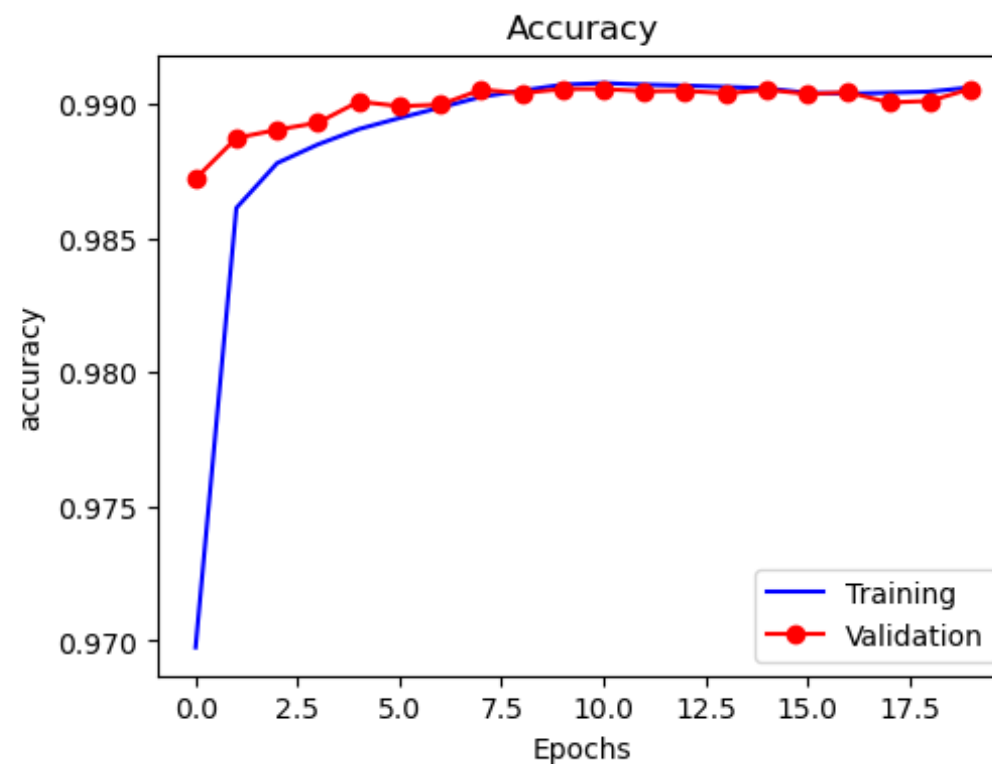
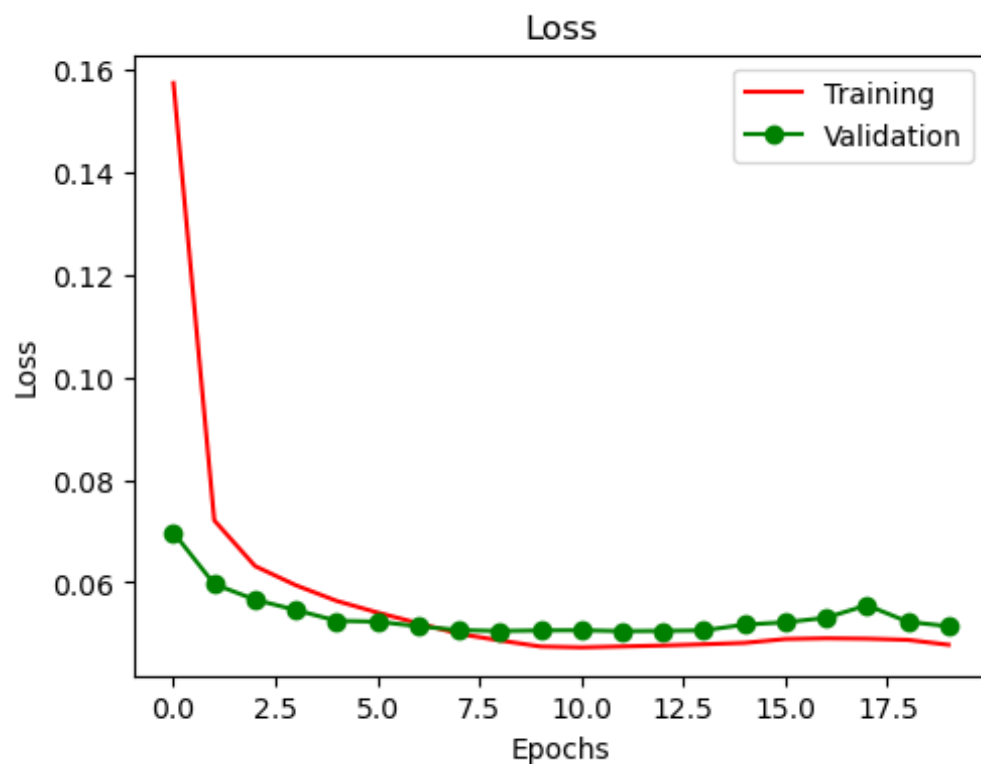
- INFERENCE LUNG SEGMENTATION and CLASSIFICATION COVID-19:

- [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

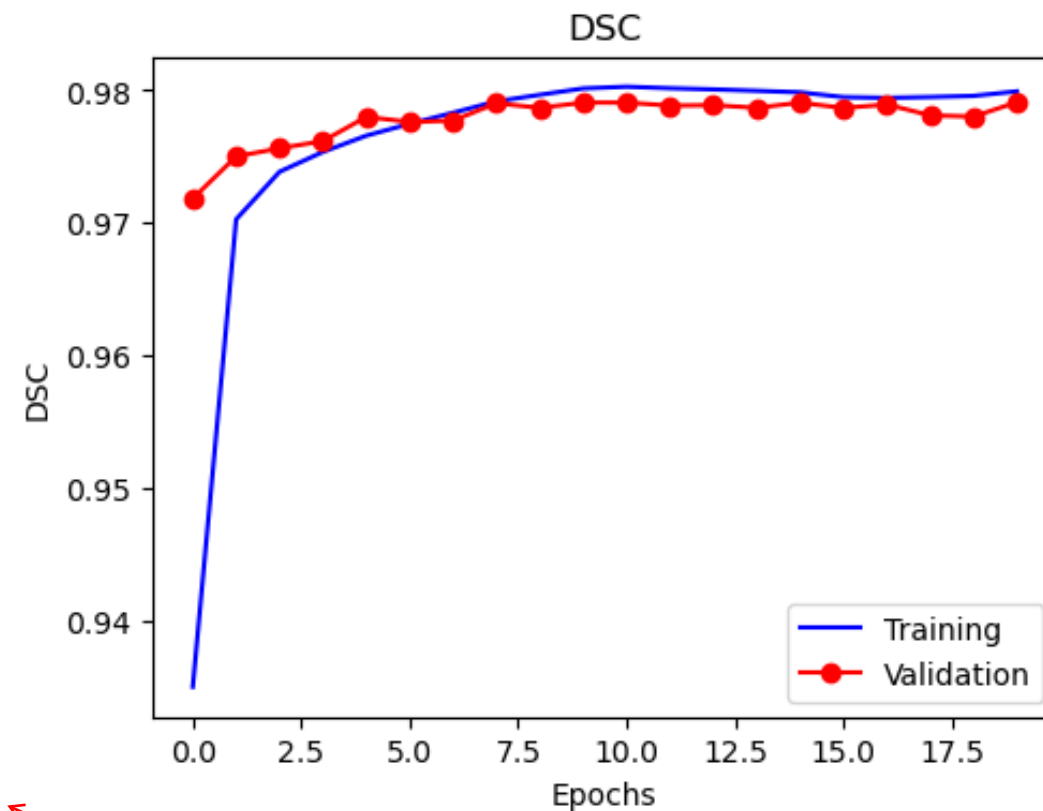
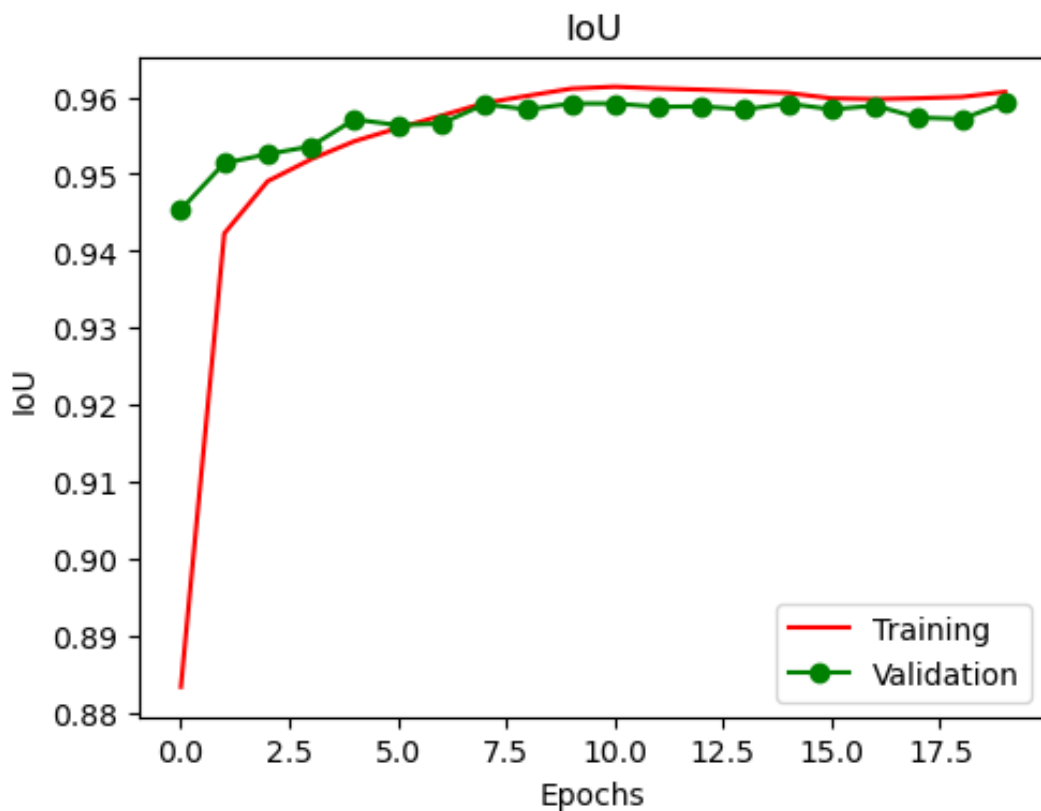
Experimental results

1. Lung Segmentation



Experimental results

1. Lung Segmentation

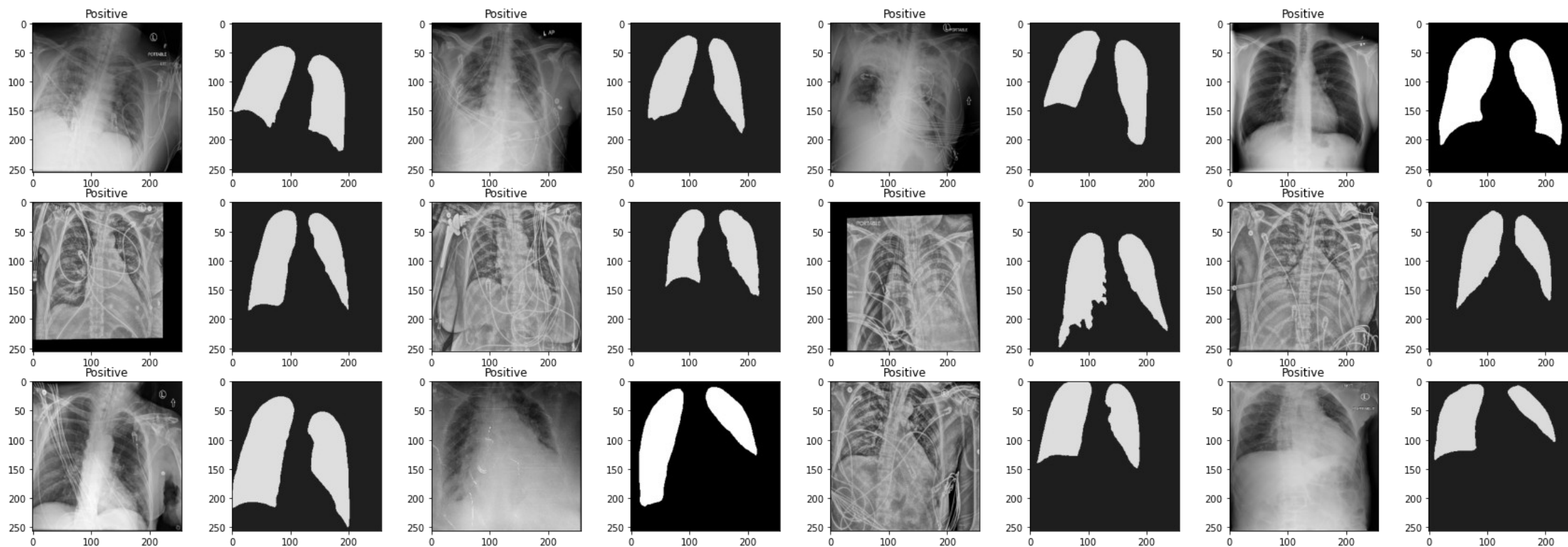


What's curves
name?

Experimental results

1. Lung Segmentation

Inference on COVIDx CXR3 dataset

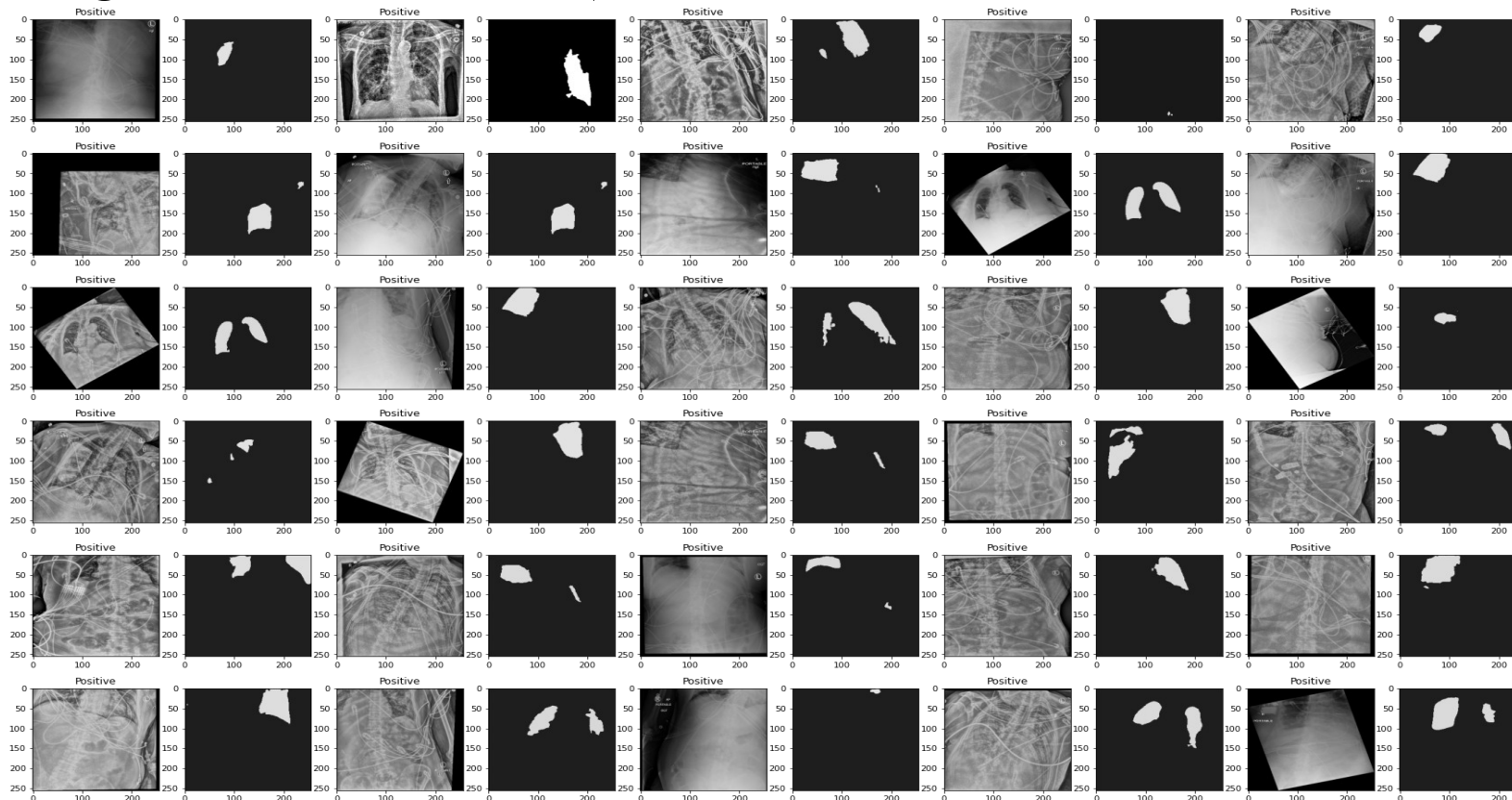


name?

Experimental results

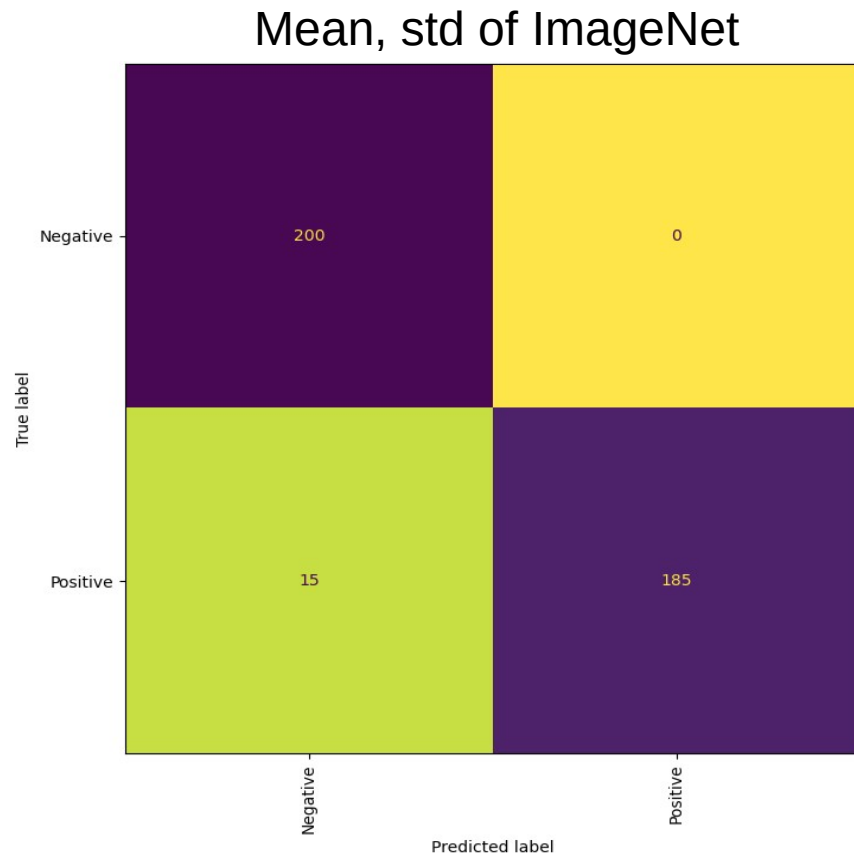
1. Lung Segmentation

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



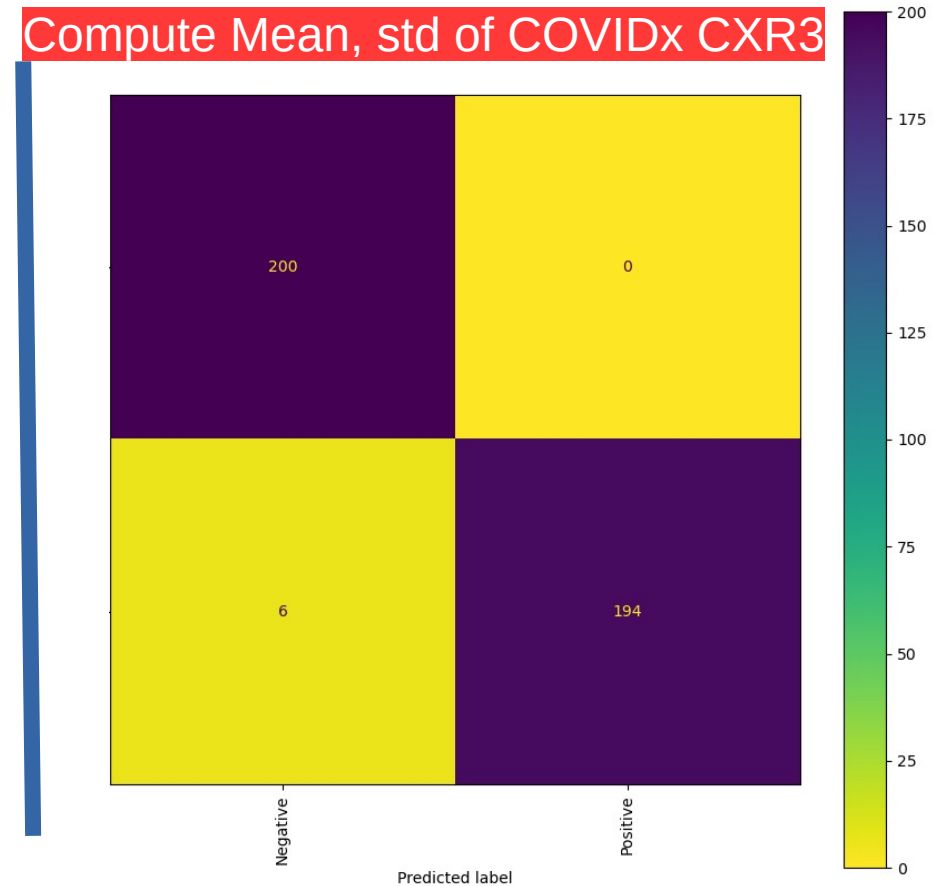
Experimental results

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



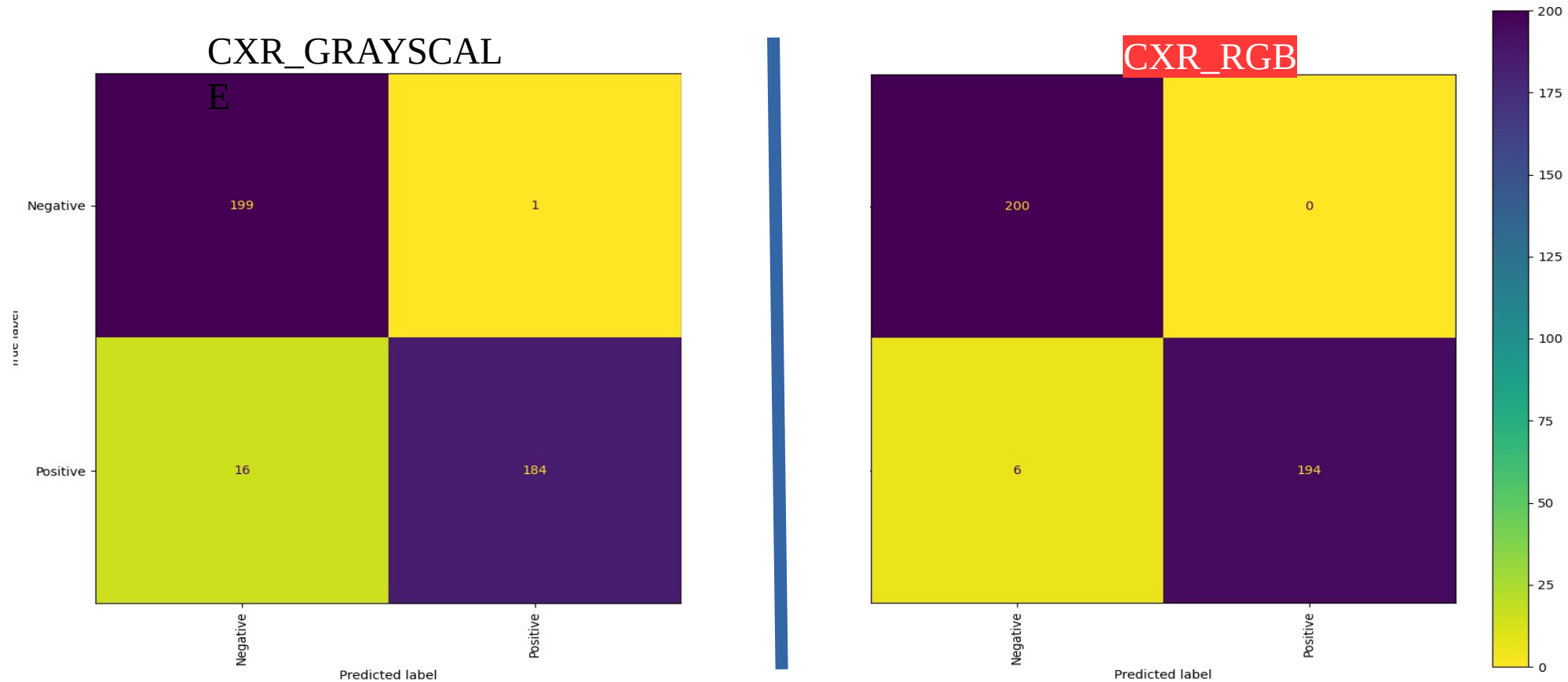
name

Compute Mean, std of COVIDx CXR3



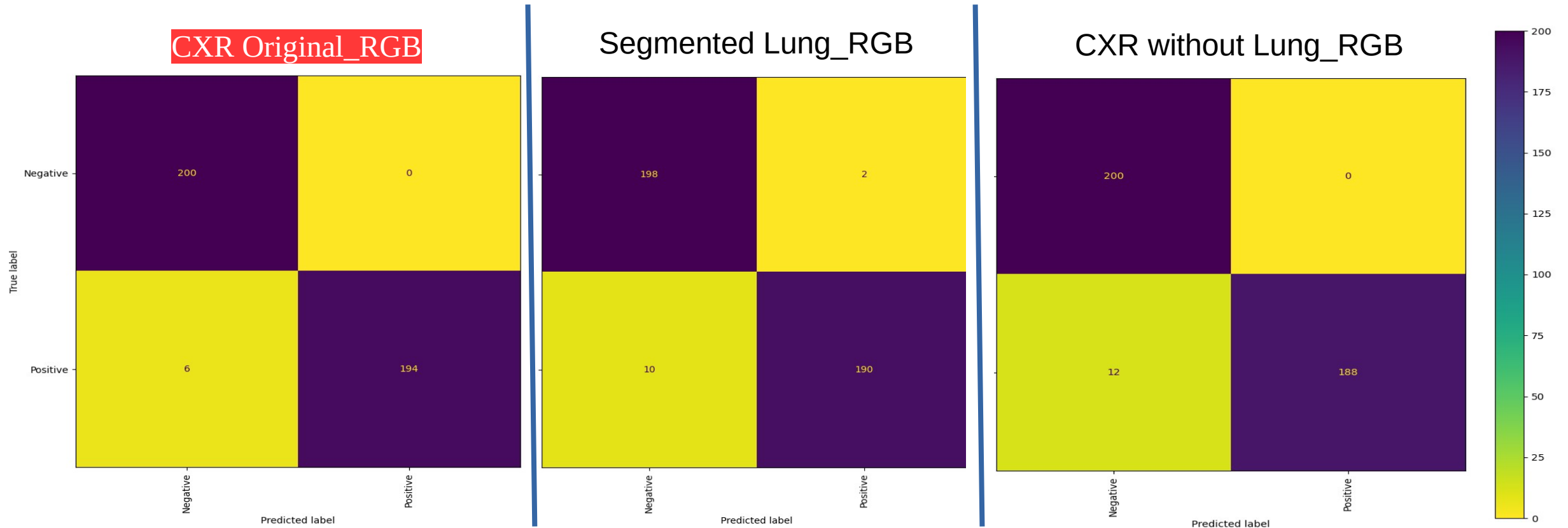
Experimental results

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**

Should be use Sensitivity and Specificity



Thank You

