

EXPLAINABLE DEEP LEARNING FOR COVID-19 DETECTION FROM CHEST X-RAYS

30 April, 2025

■ AGENDA OVERVIEW

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PROBLEM STATEMENT

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PROBLEM

- The COVID-19 pandemic highlighted the urgent need for fast and reliable diagnostic tools. Chest X-rays (CXR) became a preferred method due to their accessibility, speed, and cost effectiveness.
- Deep learning models showed high accuracy in classifying COVID-19 from X-rays but faced trust issues because of their "black-box" nature, making them difficult for doctors to rely on without clear explanations.

APPROACH

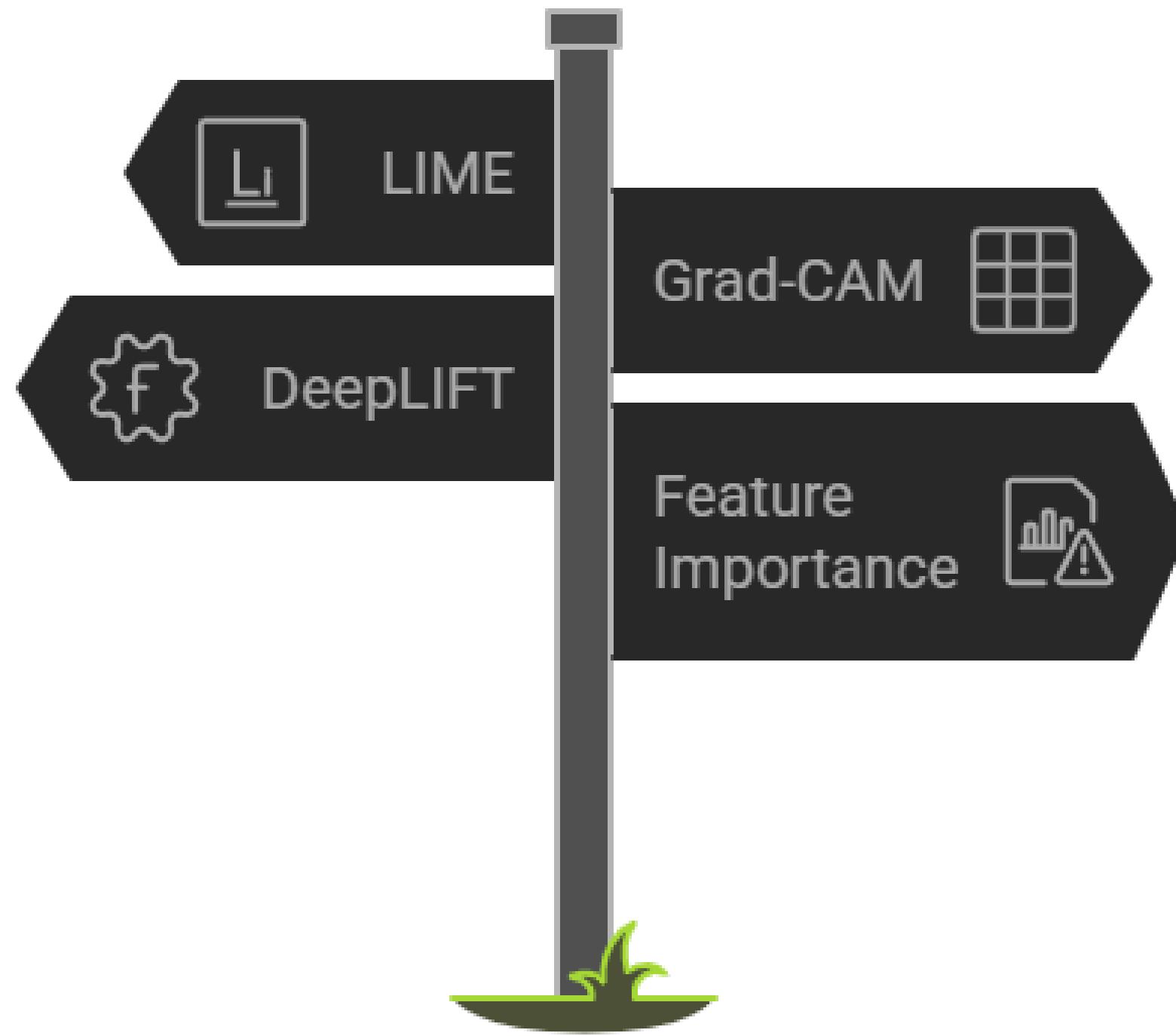
To solve this, Explainable AI (XAI) techniques like Grad-CAM, LIME, Permutation importance, and DeepLIFT were used to make model decisions transparent and understandable.

This research focuses on:

1. Implementing AI models that classifies COVID-19, Pneumonia, and Normal accurately.
2. Explaining its predictions, helping bridge the gap between AI technology and real world clinical use.

EXPLAINABILITY STAGE

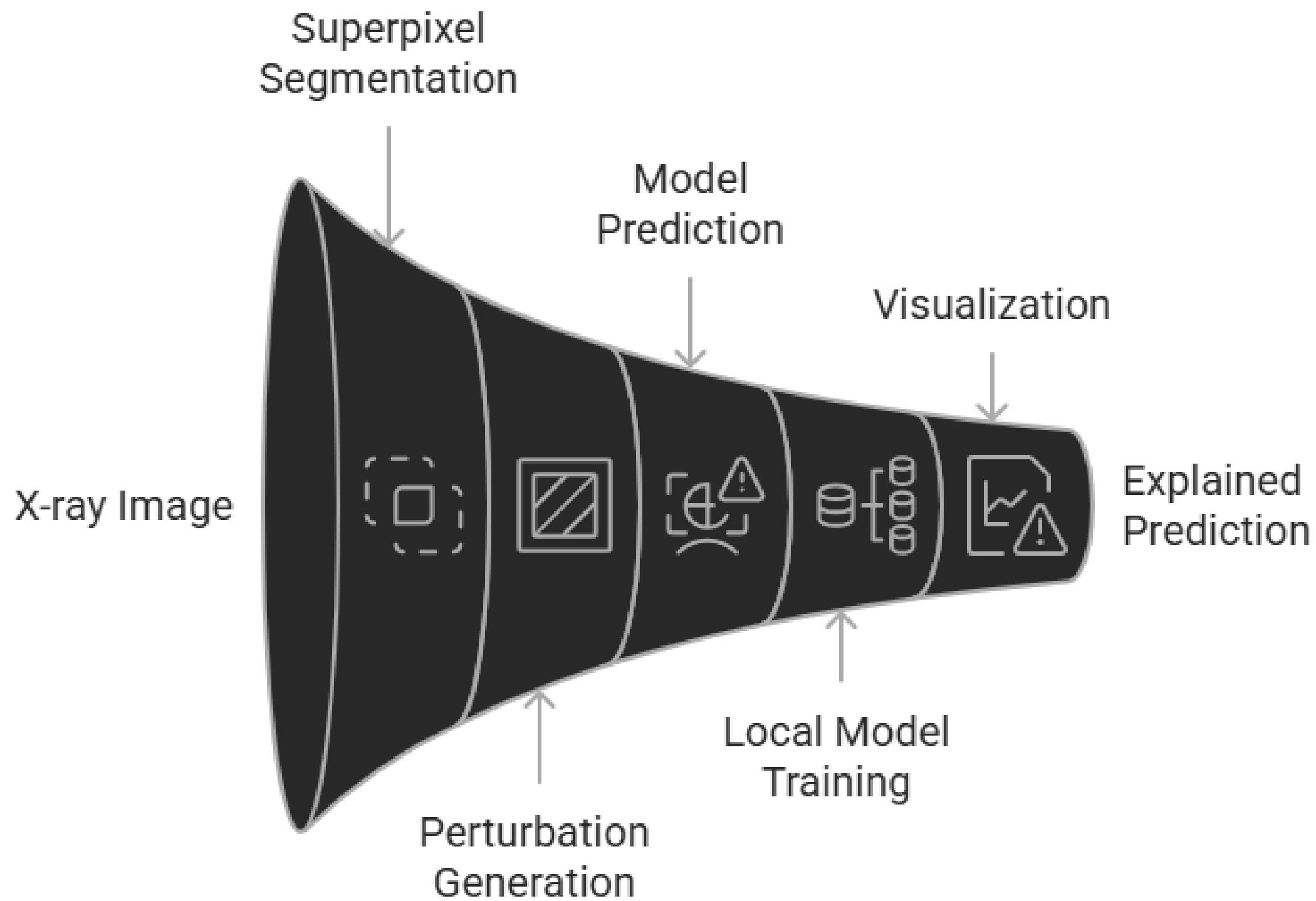
XAI TECHNIQUES



- LIME and Grad-CAM provide localized explanations, highlighting key pixels and image regions.
- Feature Importance and DeepLIFT evaluate feature relevance via performance drops and neuron activation comparisons.

LIME

- Locally explains chest X-ray predictions by segmenting images into superpixels and perturbing them to train a simple model.
- Highlights key lung abnormality regions driving the diagnosis, with results varying by segmentation and perturbation quality.



GRADCAM

- Uses gradients of the final layer and weighted feature maps with ReLU to create a heatmap for chest X-ray predictions.
- Highlights key lung regions with red for strongest influence, then orange, yellow, green, and blue, but coarse resolution may limit detail.

Green and Blue Zones

Minimal or no contribution



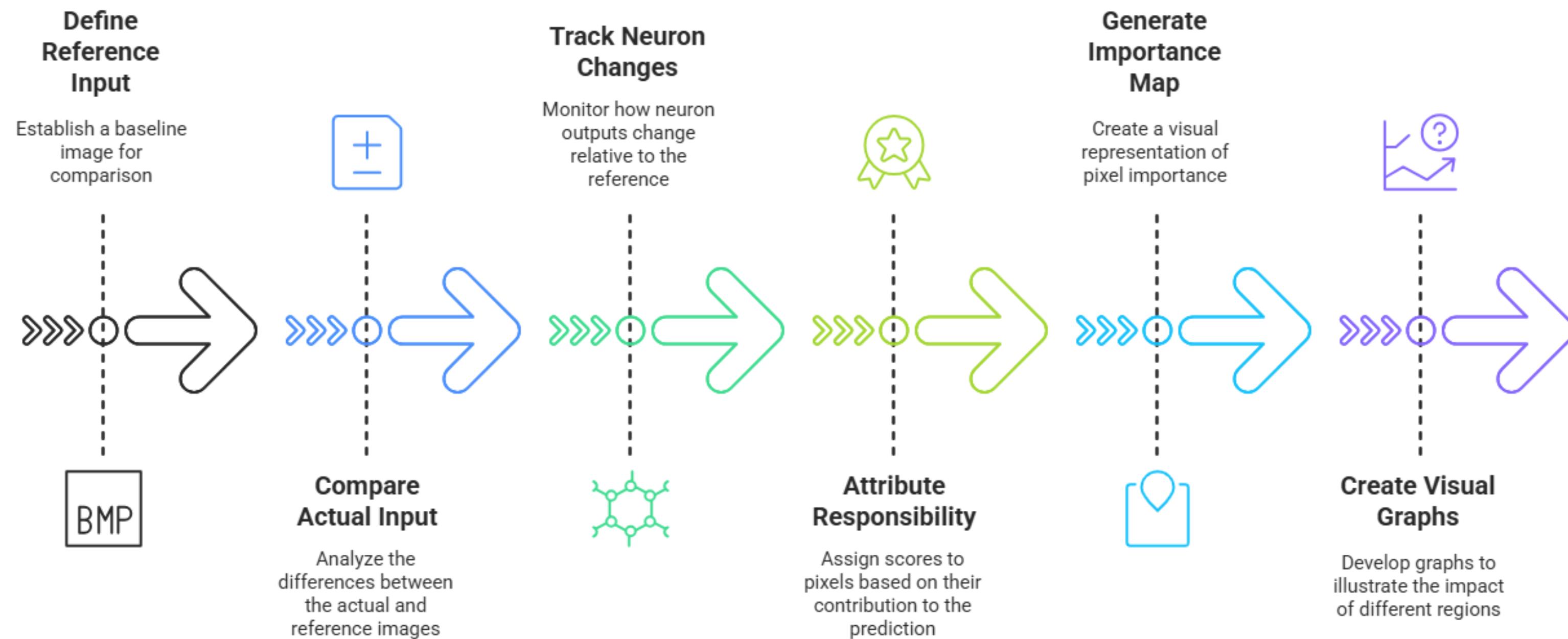
Red Zones

Critical areas driving the model's diagnosis

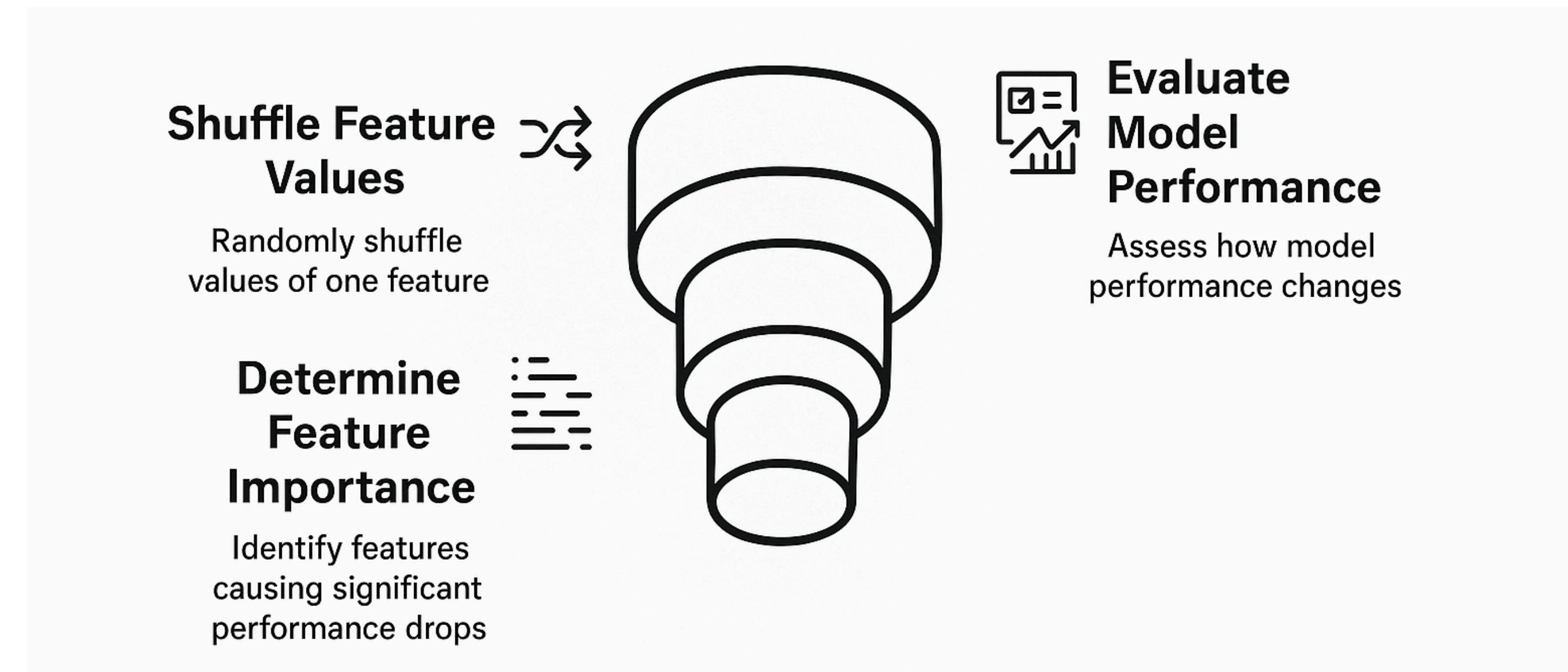
Orange and Yellow Zones

Moderately influential areas

DEEPLIFT



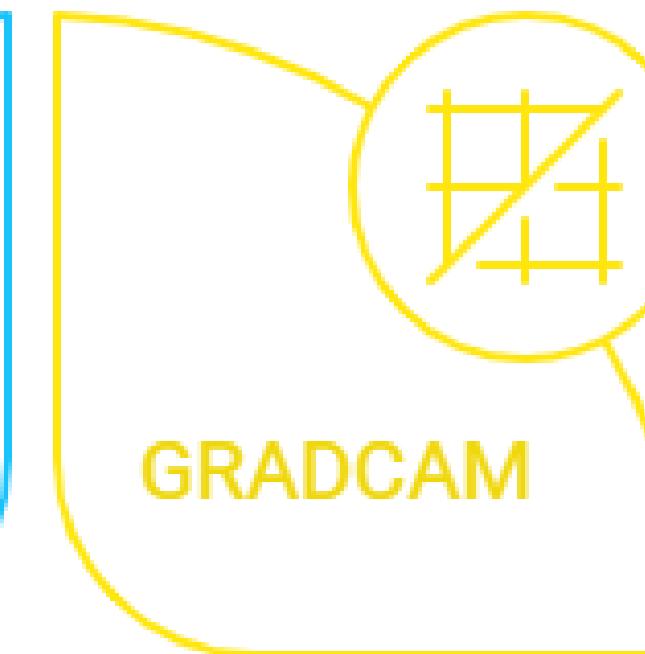
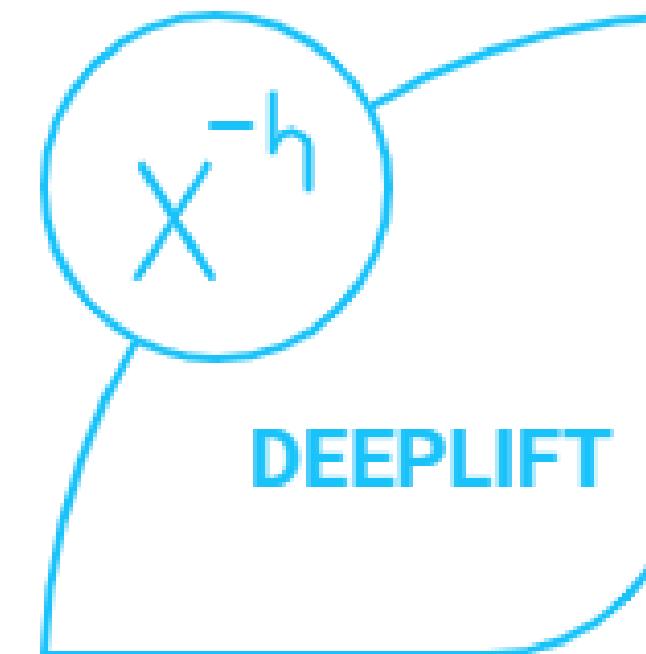
PERMUTATION IMPORTANCE



XAI COMPARISION

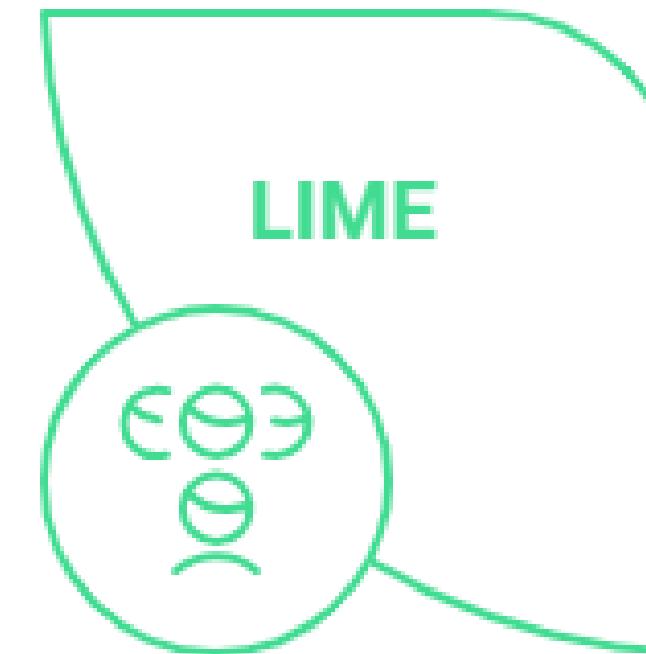
Detailed Influence Tracing

Fast, detailed, and faithful



Surrogate Model Fitting

Flexible but sometimes unstable



Pixel Level Granularity

Less fine-grained at pixel

Performance Measuring Drops

Clear ranking of features

METHODOLOGY

In this review paper, we structured the methodology into two stages:

- **Preprocessing Stage:** We merged two datasets, performed exploratory data analysis (EDA), cleaned and preprocessed the images, and applied feature selection to prepare the data for modeling.
- **Modeling Stage:** Using the preprocessed data, we trained deep learning models. We implemented 12 different research papers, each using different techniques, to capture patterns and improve classification accuracy.

PREPROCESSING STAGE

PREPROCESSING STAGE

01

MERGE TWO DATASETS

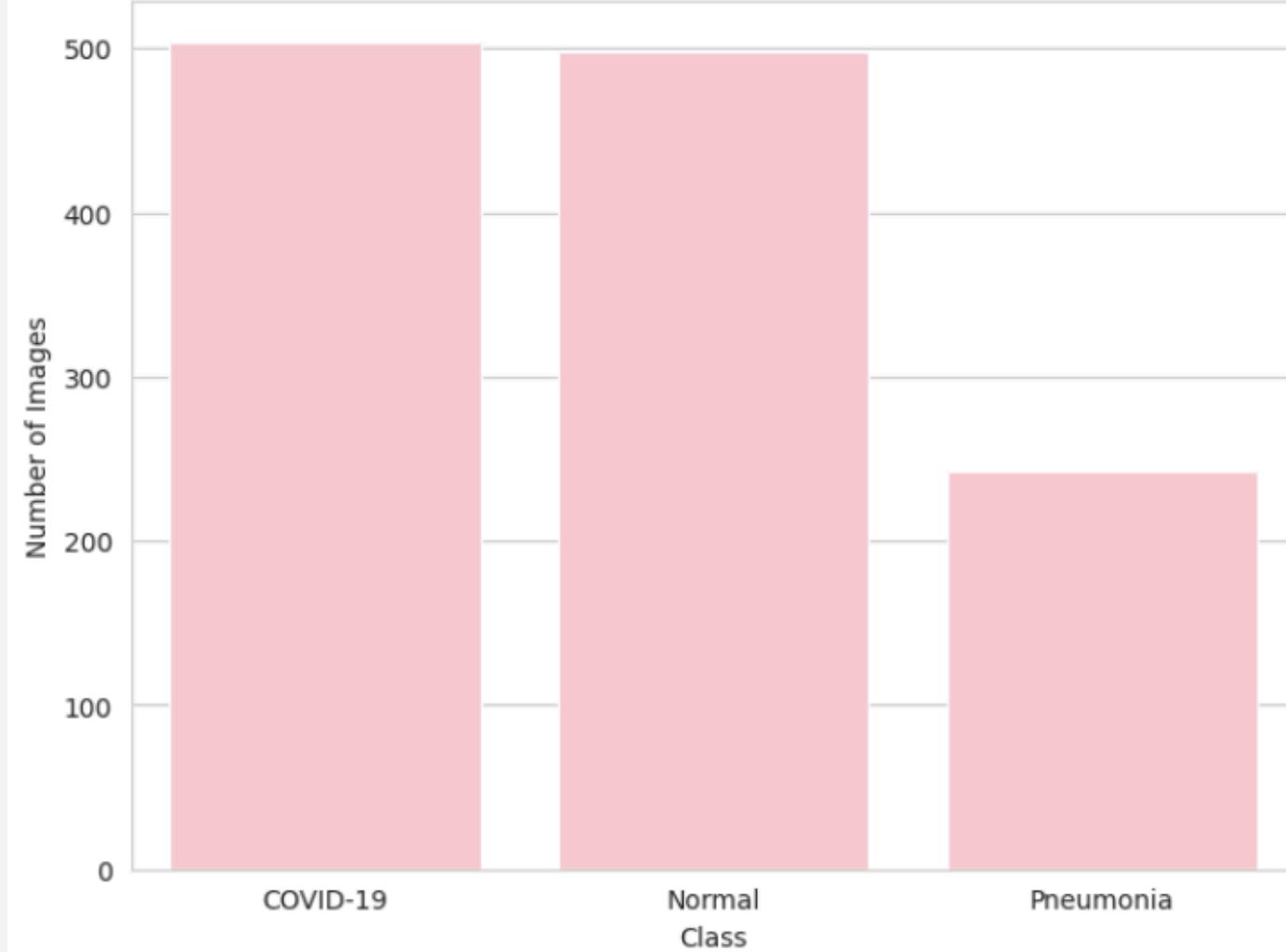
- We combined two datasets: **Kaggle dataset** of Normal class and a **GitHub dataset** of COVID-19 and pneumonia cases.
- This merging aimed to create a balanced dataset, improve generalization, and ensure fairness in model training.

02

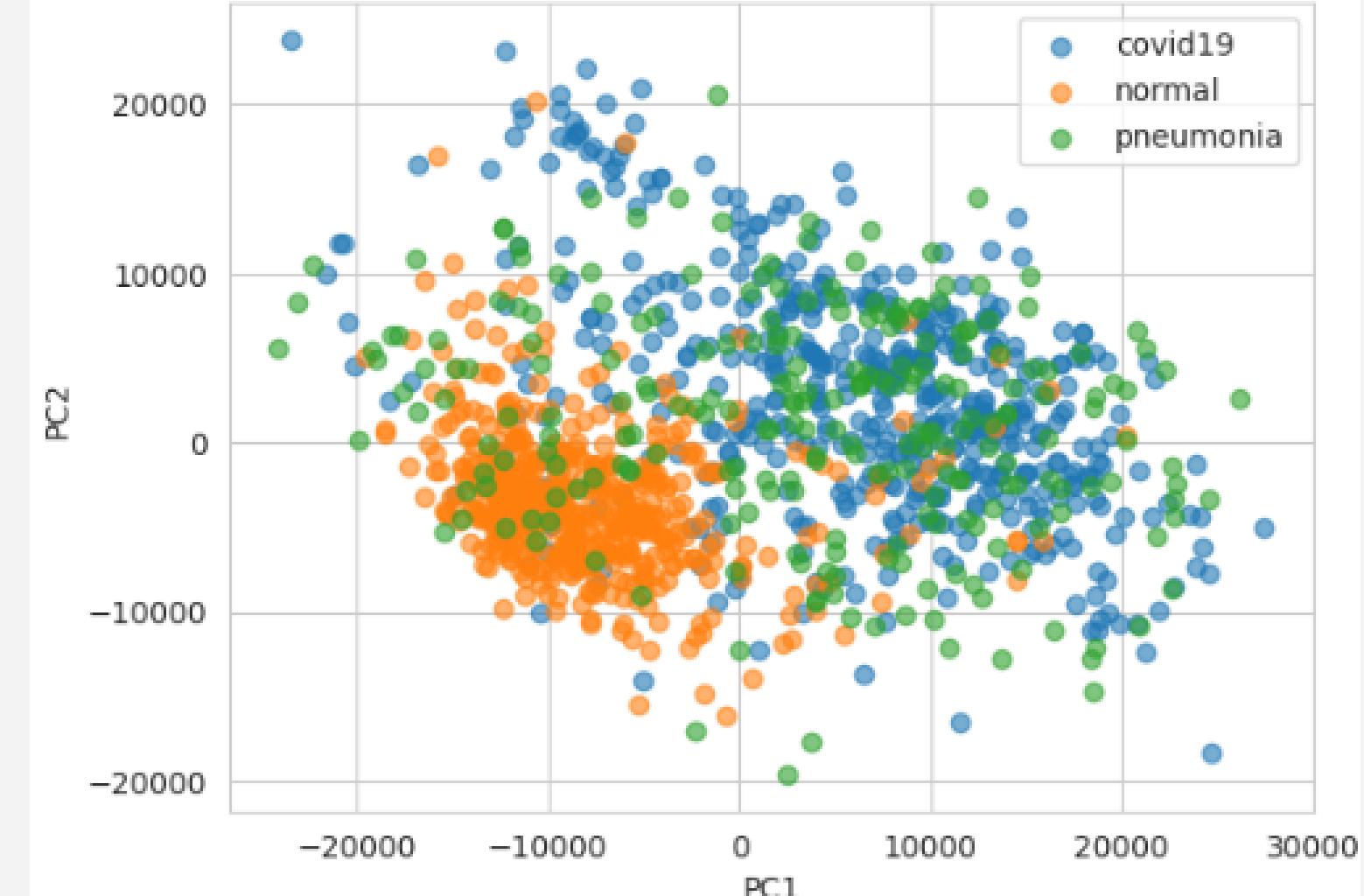
EDA

- We explored the merged dataset to understand its structure, including the number of classes, image distribution, image types, and intensity values.
- The analysis revealed an imbalanced class distribution, highlighting the need for resampling, which will be handled during preprocessing.

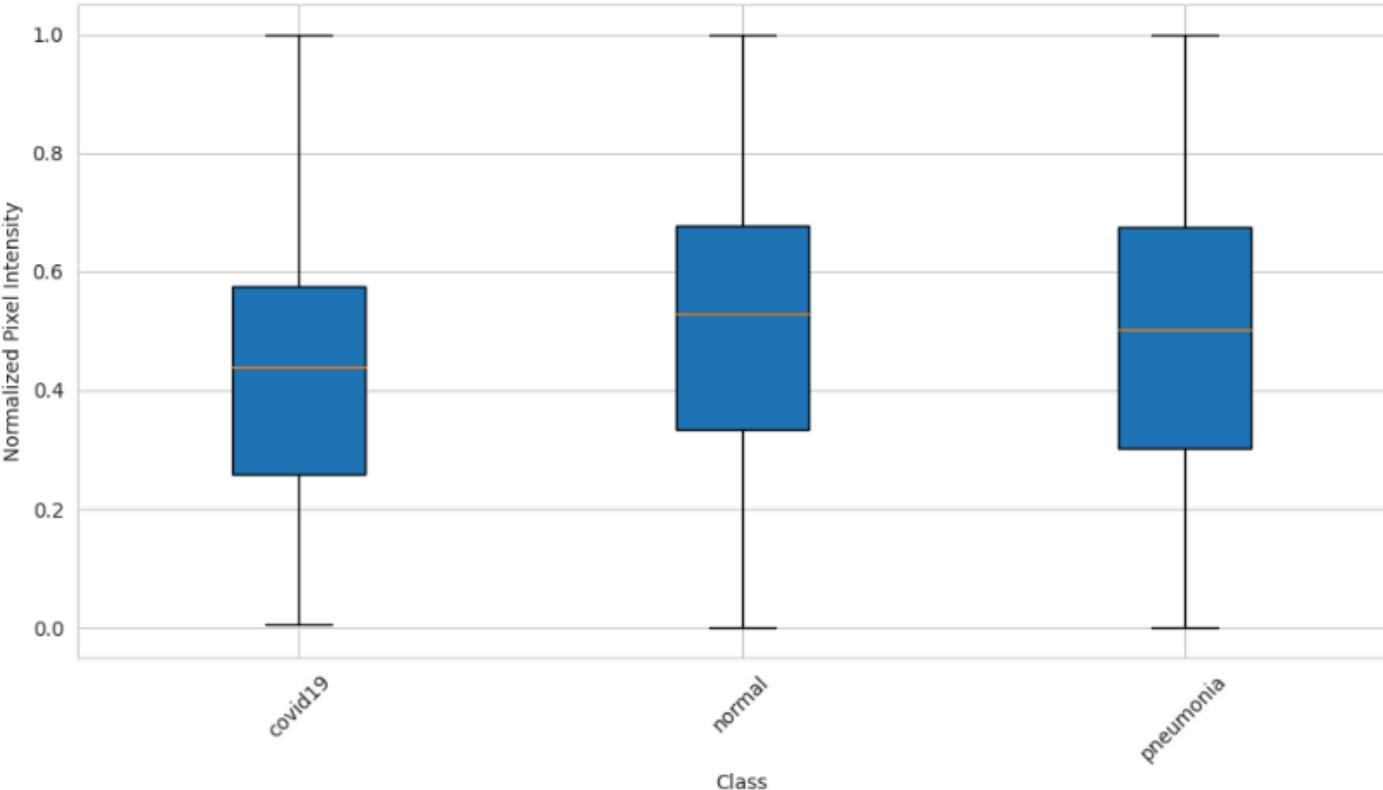
Class Distribution of Chest X-ray Images



2D PCA Projection of Image Dataset



Boxplot of Image-Level Intensities by Class



PREPROCESSING STAGE

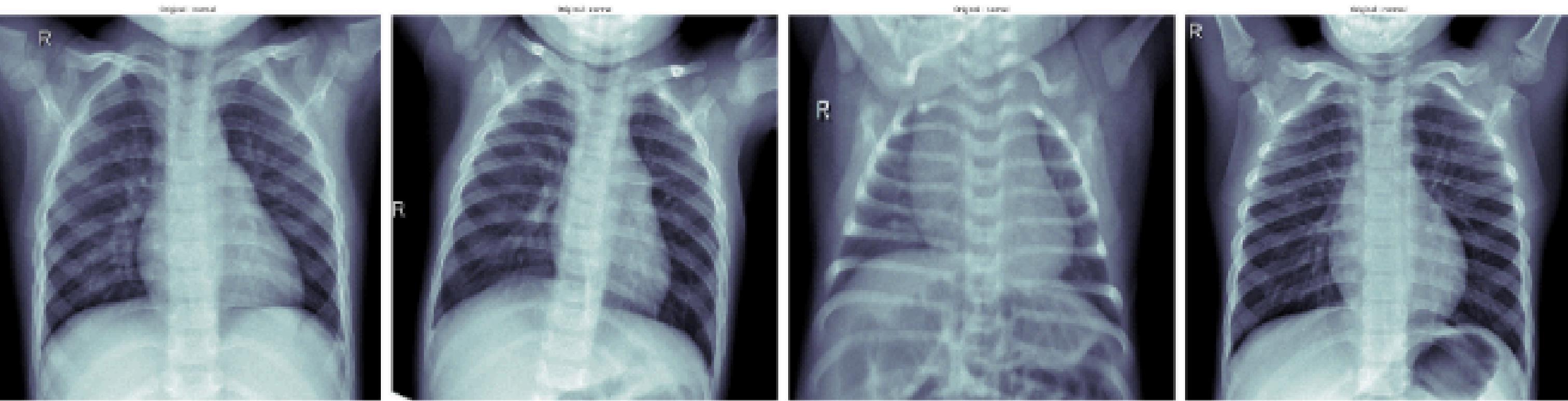
03

PREPROCESSING

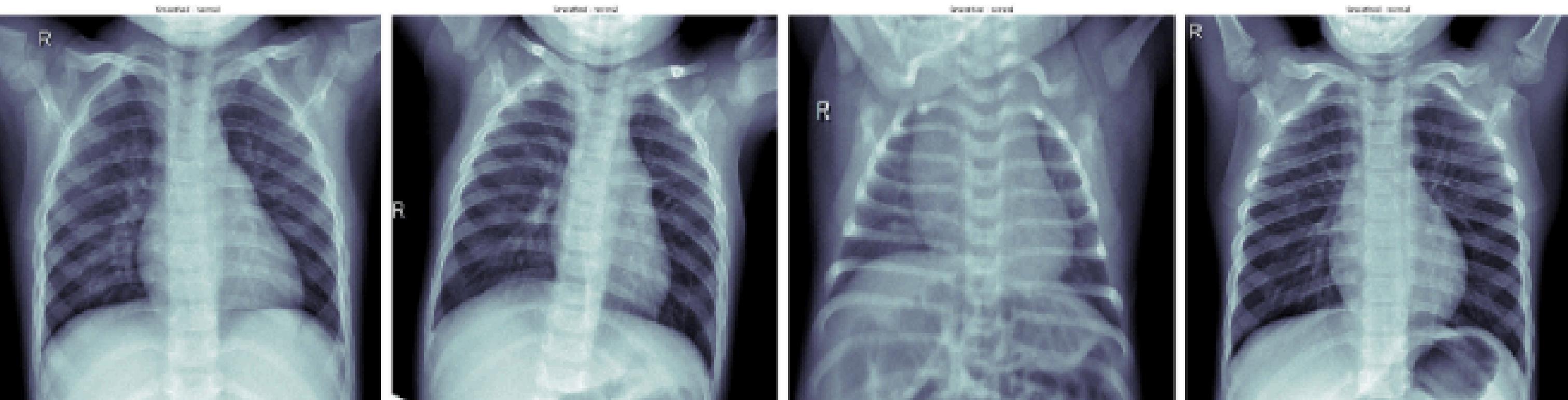
In this step, we have applied several techniques to enhance image quality and balance the data, including:

- Normalization
- Standardization.
- Gaussian Smoothing.
- Histogram Equalization.
- Gamma Correction.
- Oversampling.

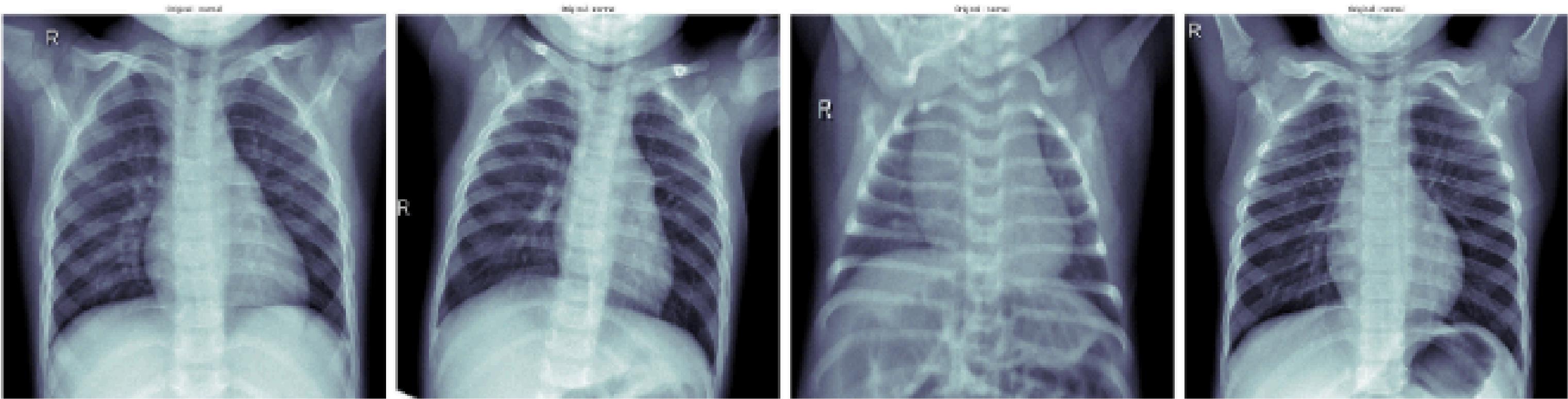
Original Images:



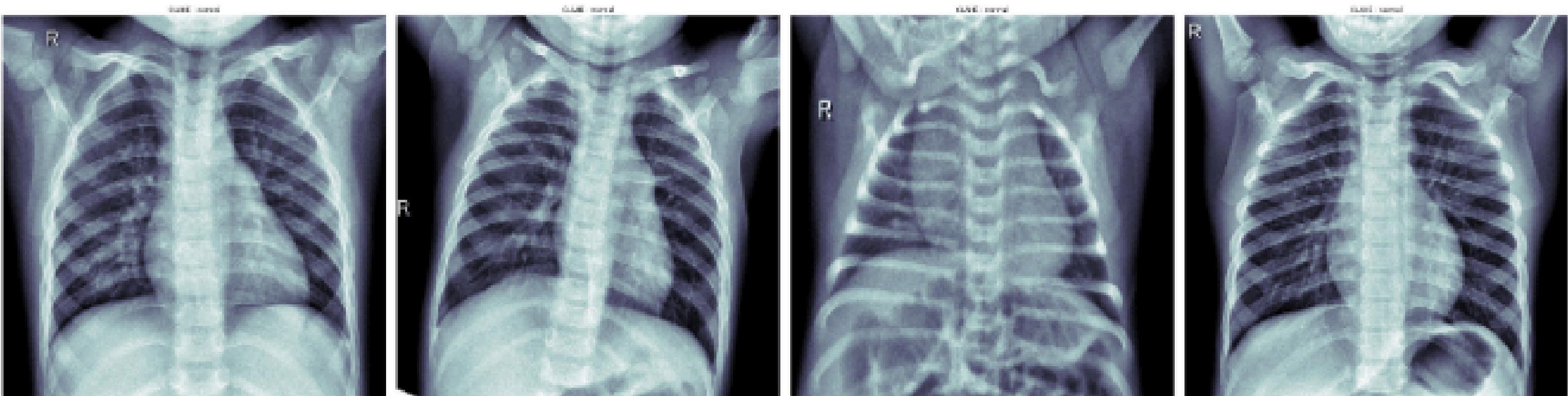
Smoothed Images:



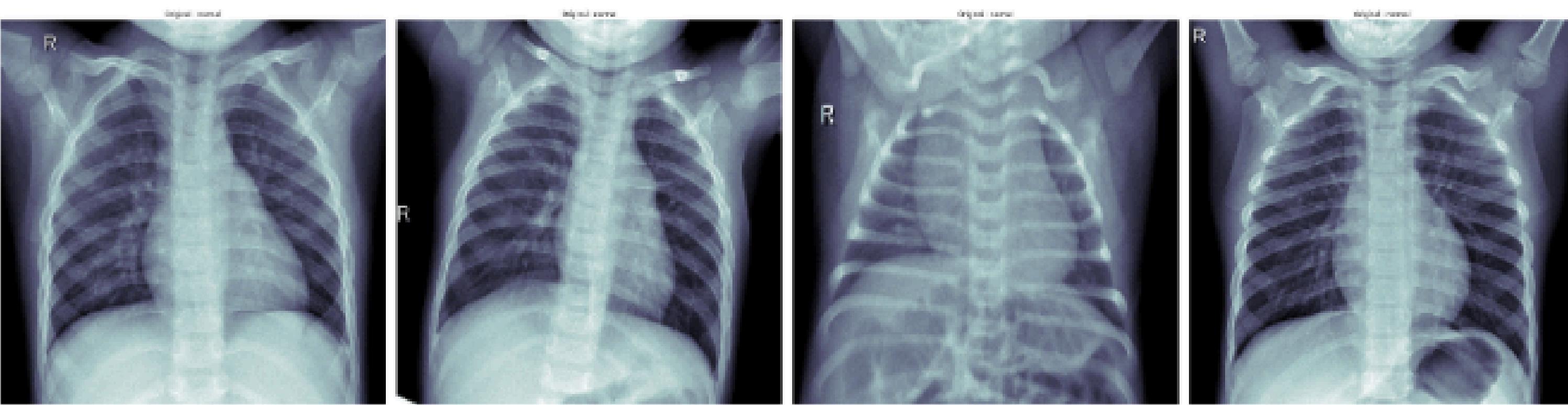
Original Images:



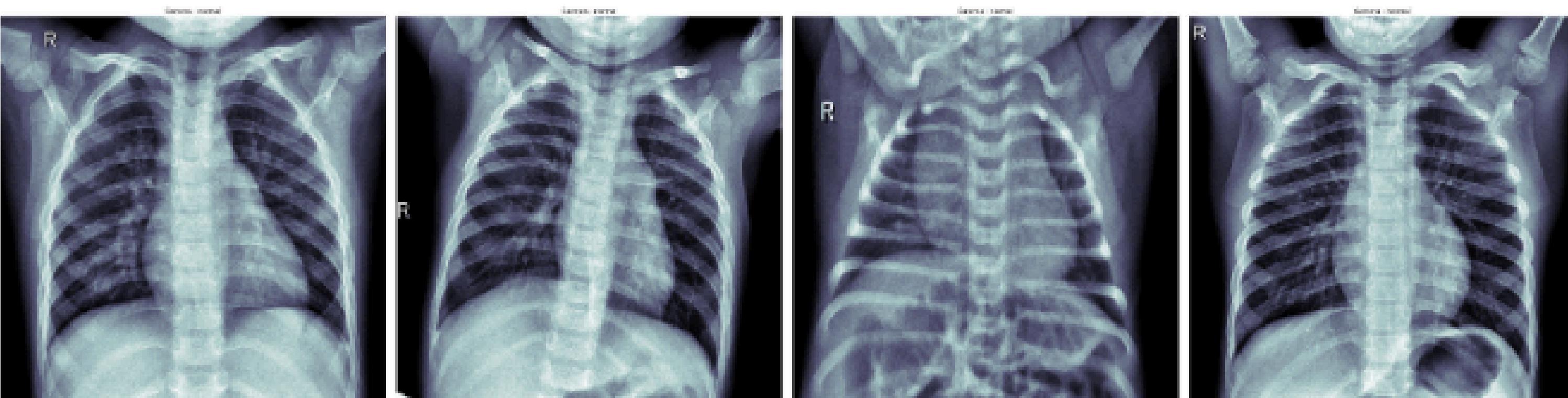
Contrast Enhanced Images:



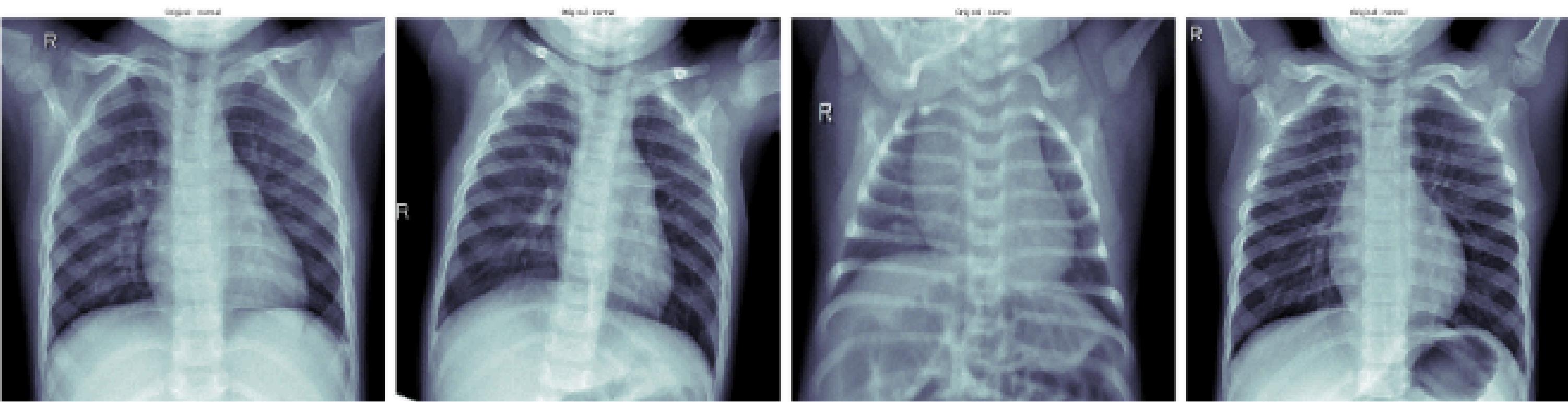
Original Images:



Gamma Corrected Images:

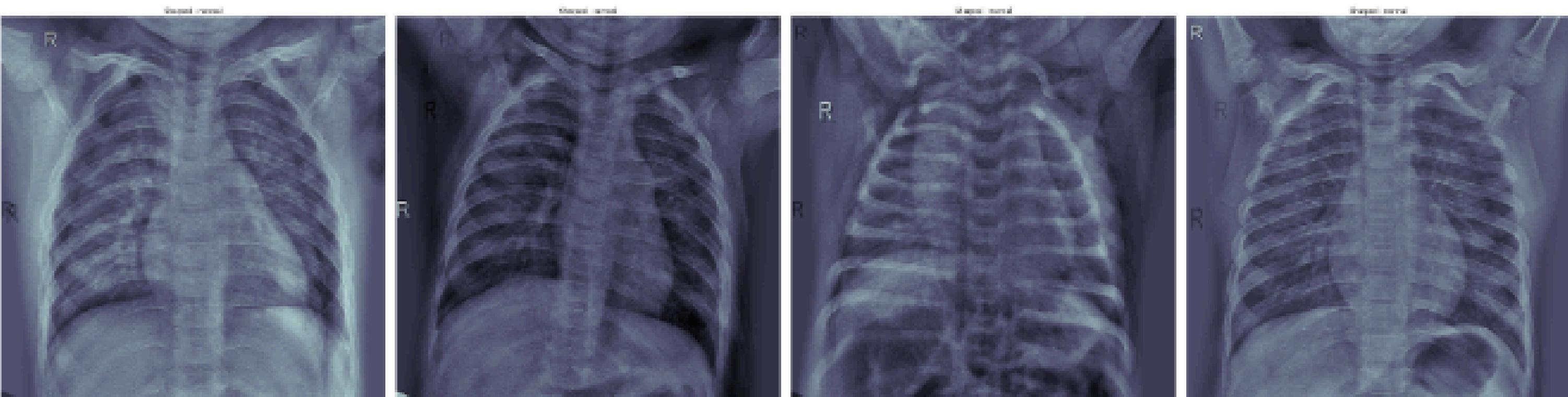


Original Images:



Excluded

Sharpened Images:

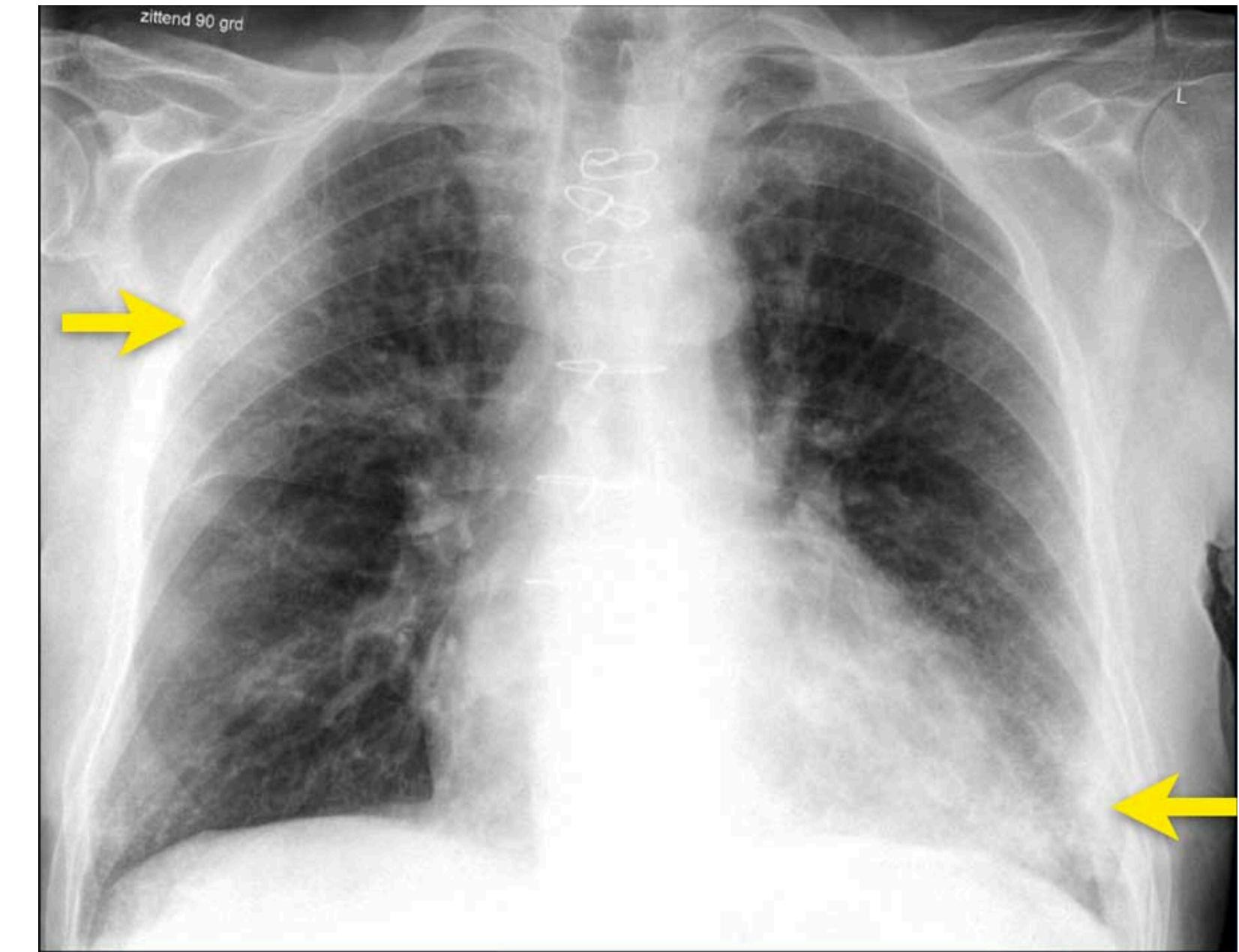


PREPROCESSING STAGE

04

FEATURE SELECTION

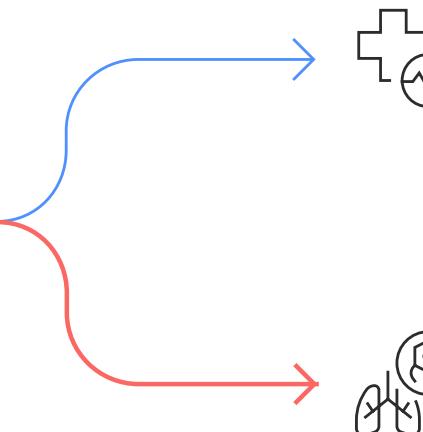
- We have identified and removed X-ray images with annotations or arrows that could cause information leakage.
- We have eliminated images that were too bright or too dark to prevent negative impacts on model training.



MODELING STAGE

TWO-STAGED VGG16 MODEL

METHODOLOGY



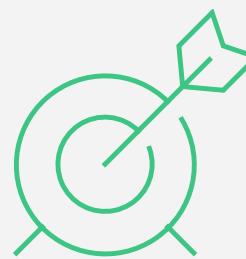
Classify Patient/Normal

Determines if the image shows a patient or normal condition.

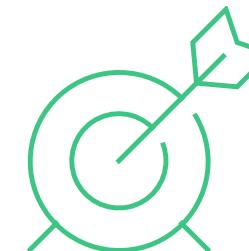
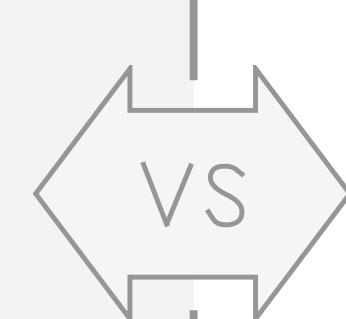
Classify COVID/Pneumonia/Normal

Identifies the specific medical condition from the image.

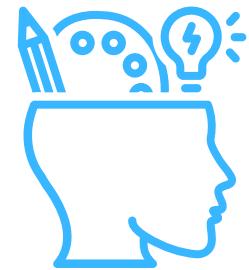
New Results



- Model 1 achieved a training accuracy of 0.9943 and a test accuracy of 0.9801, F1 Score of 0.97
- Model 2 achieved a training accuracy of 0.8618 and a test accuracy of 0.9305, F1 Score of 0.88
- Used GRADCAM, LIME, DEEPLIFT, and Permutation Importance for Explainability.



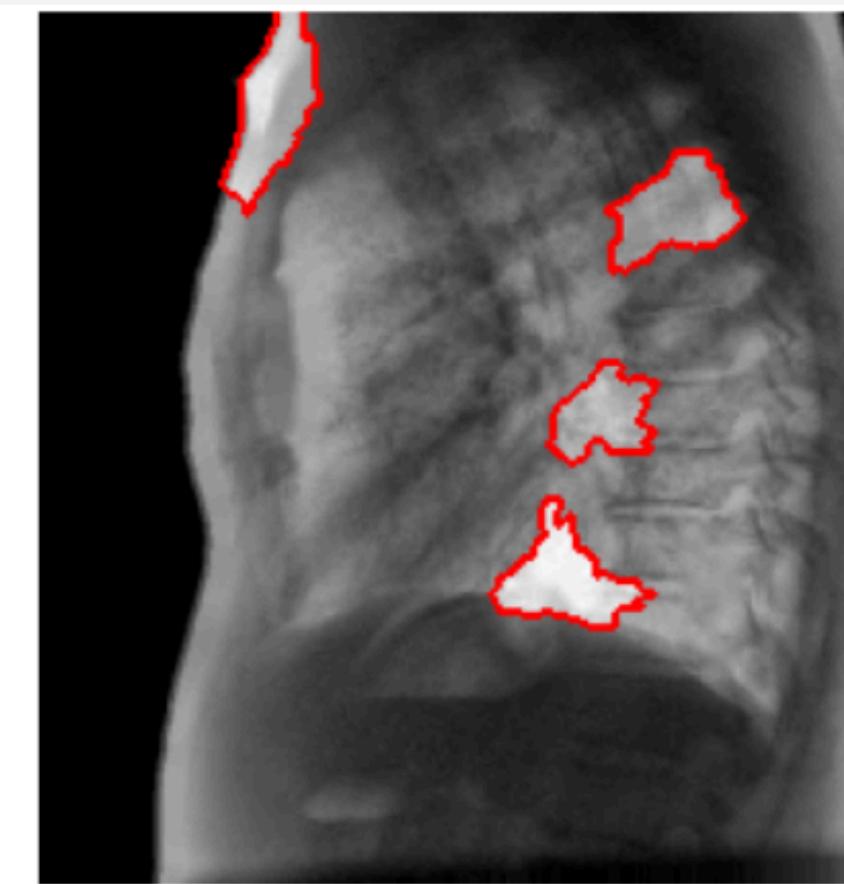
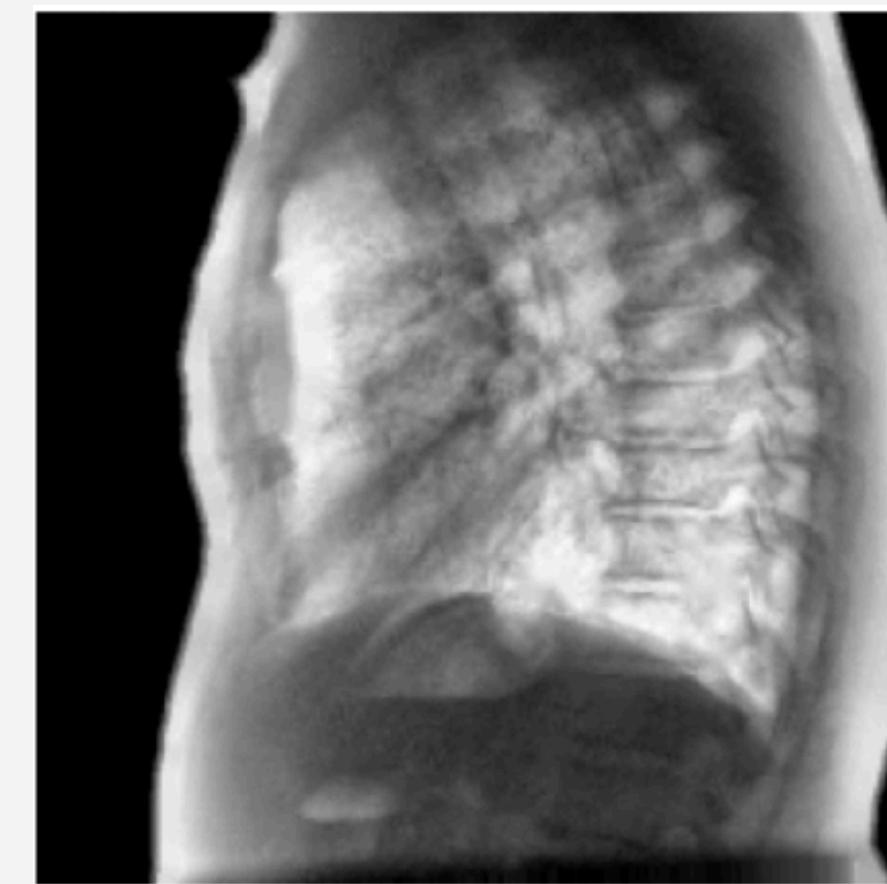
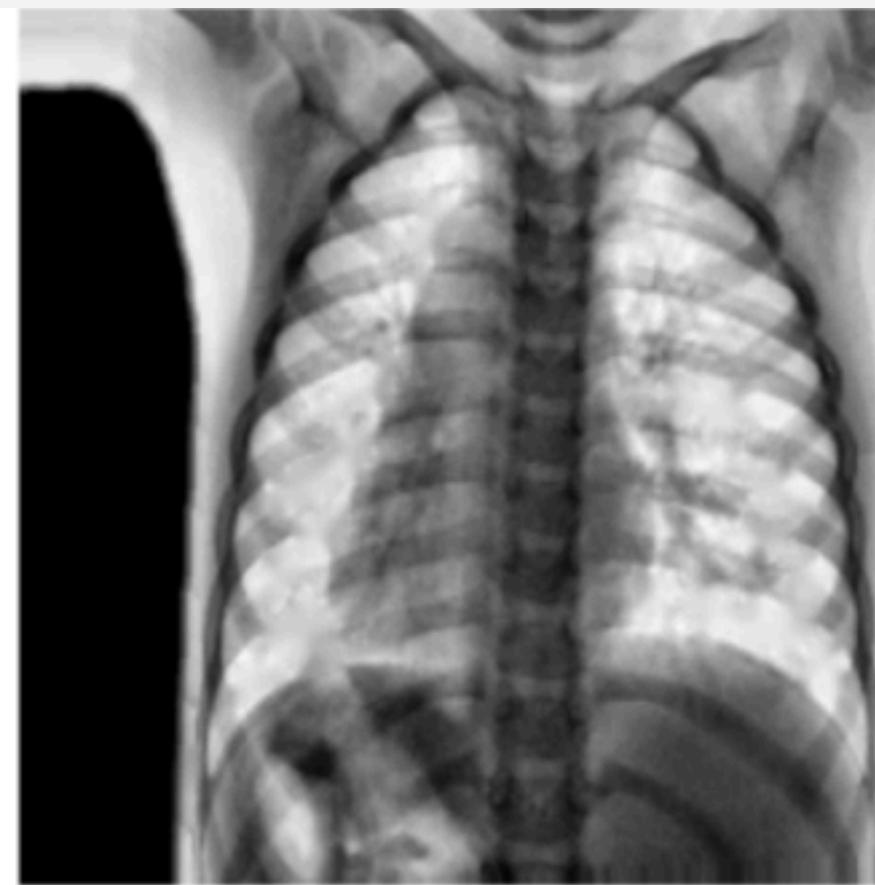
Paper Results



- Model 1: training accuracy of 0.95 and test accuracy of 0.80, F1 Score of 0.94
- Model 2: training and test accuracy both at 0.65, F1 Score of 0.89
- Used GRADCAM for Explainability.

LIME

■



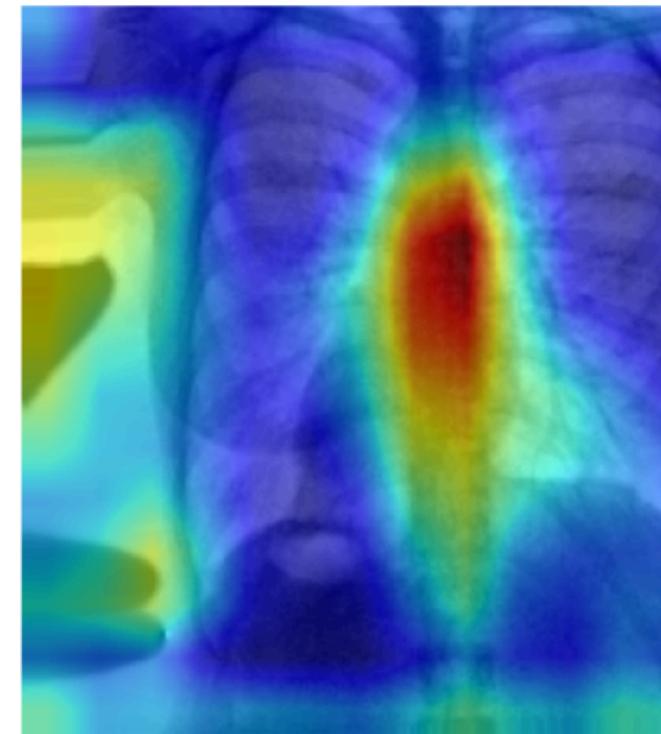
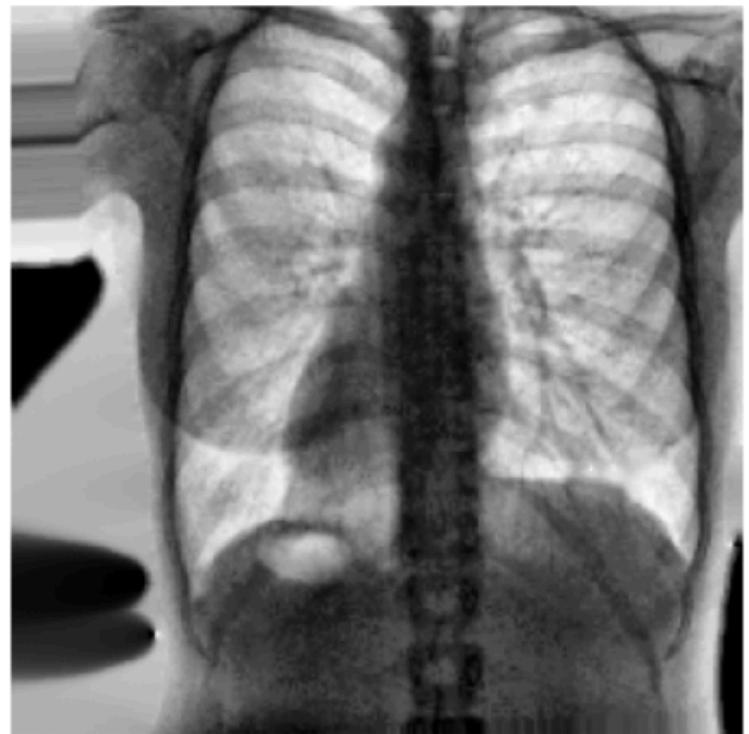
Model 1

- True : Patient, Predicted : Patient
- The first model primarily focused on the right side of the chest and the lower and upper regions when making its predictions. It focused on smaller predefined regions to explain model prediction which is right prediction.

Model 2

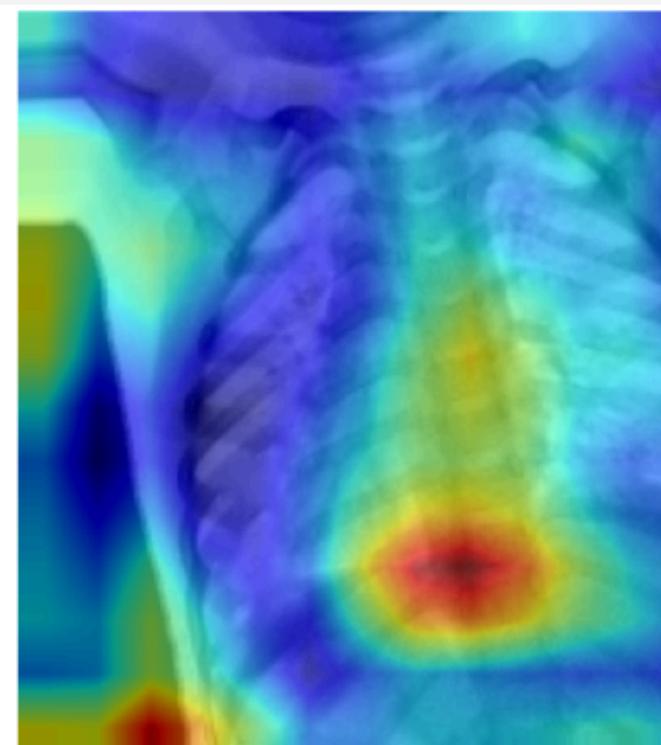
- True: Pneumonia, Predicted: Normal
- The second model primarily focused smaller regions chest and the middle regions only when making its predictions. Maybe because it is underfitting so it is not concentrating on right regions or picking regions randomly. Also this image is cross section not that good.

GRADCAM



Model 1

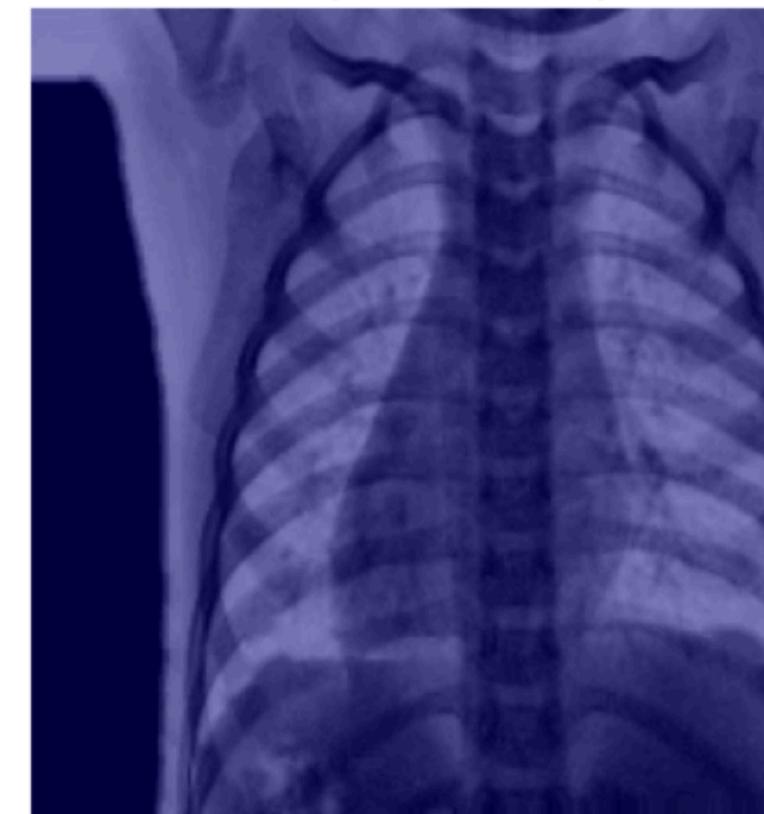
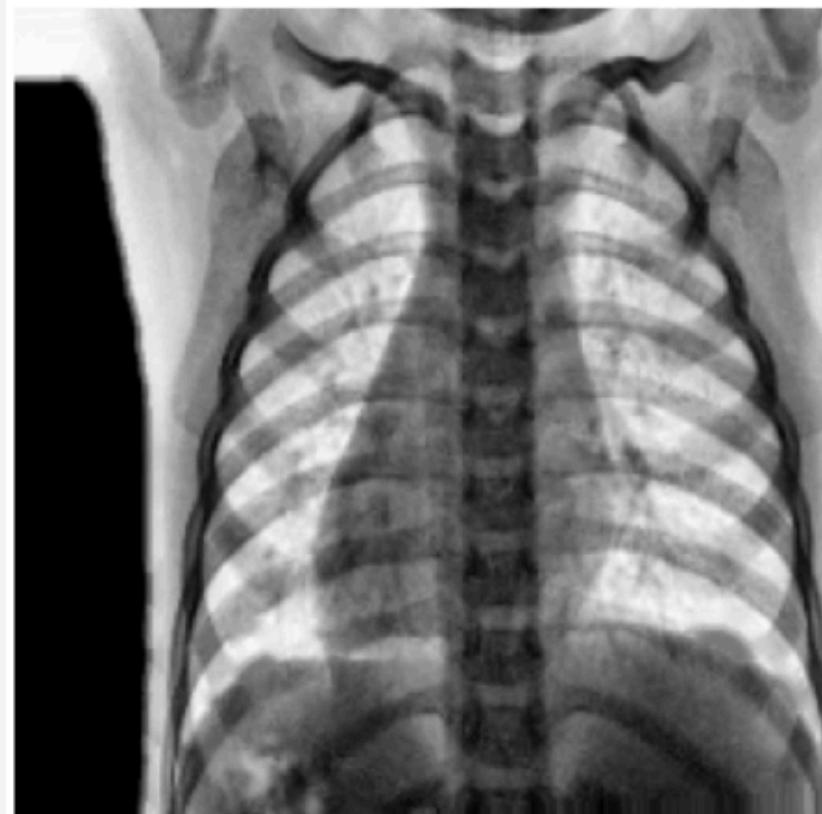
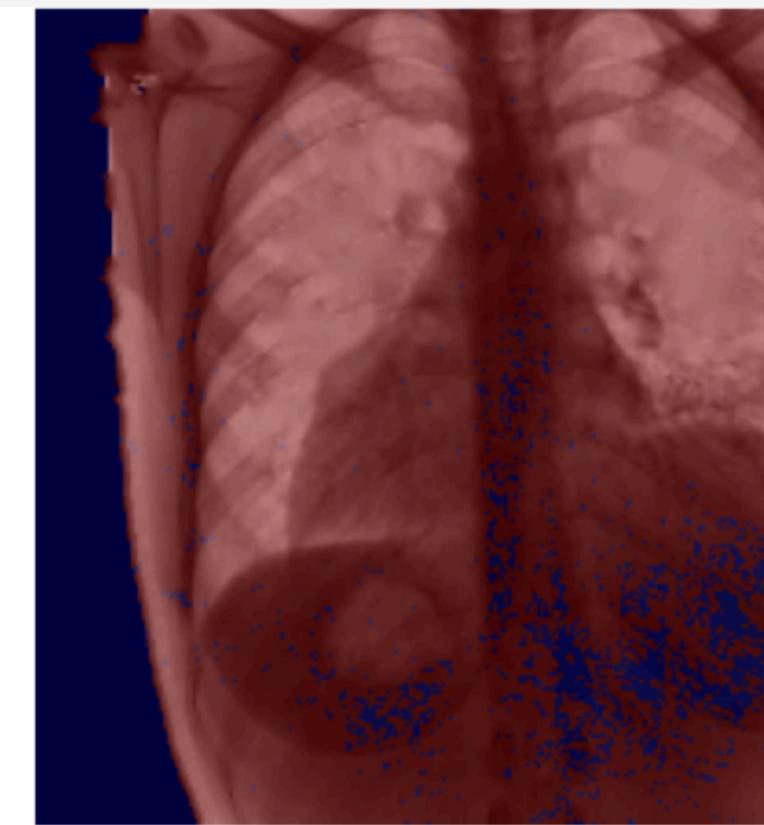
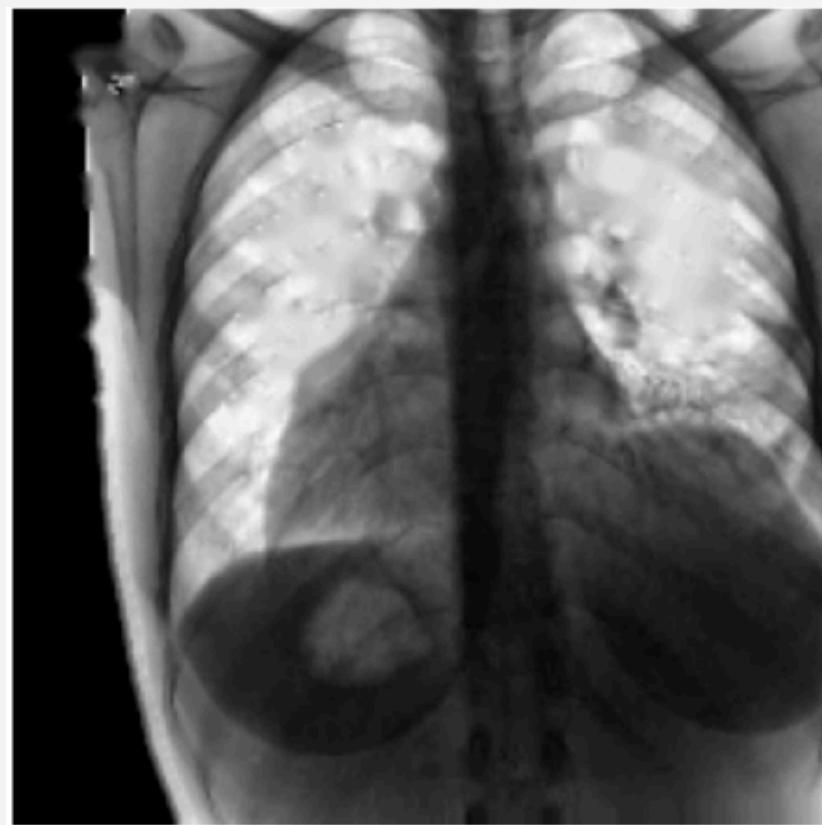
- True : Patient, Predicted : Normal
- The first model primarily focused on the middle of the chest and the lower regions when making its predictions. Maybe it had to focus more on lower regions or right and left to make the right predictions.



Model 2

- True: Pneumonia, Predicted: Pneumonia
- The second model primarily focused smaller regions chest and the lower regions only when making its predictions. That can explain why it made a correct prediction.
- However, it is underfitting which can make us not sure when taking its explanation.

DEEPLIFT



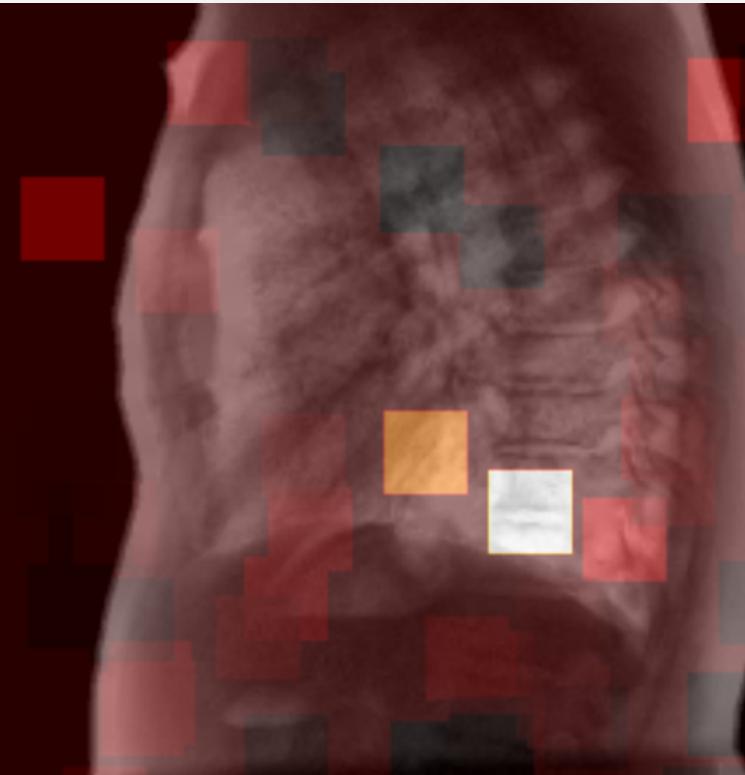
Model 1

- True : Covid19, Predicted : Covid19
- The model excluded the regions not the chest which is a good exclusion criteria that probably helped in true prediction of the patient type.

Model 2

- True : Normal, Predicted : Pneumonia
- The model considered all the image as not interested regions which probably caused him to be confused and predicted Normal while it supposed to be Pneumonia

PERMUTATION IMPORTANCE



Model 1

- True : Patient, Predicted : Patient
- The regions in middle and lower when permuted was the most important.
- The Model was a good fit which can help us consider its output.

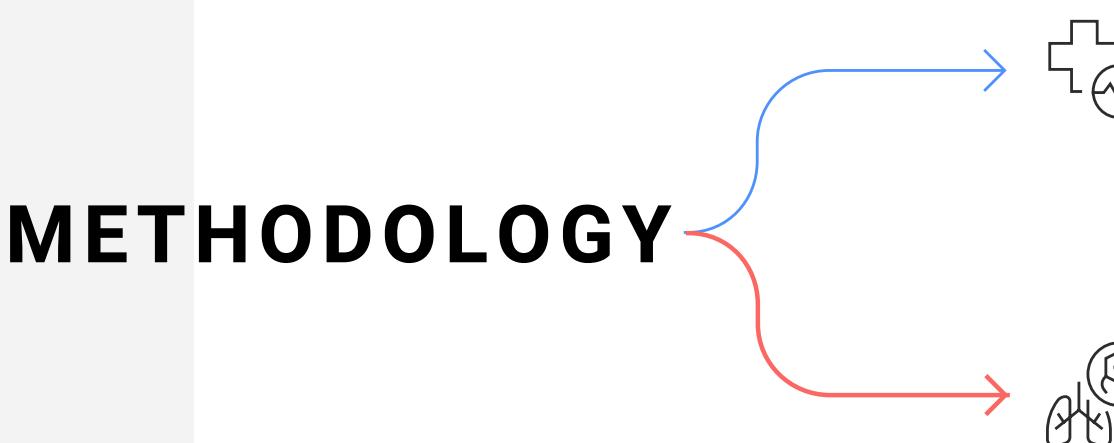


Model 2

- True : Covid19, Predicted : Covid19
- The region in lower right in chest was the most important region for model prediction.

TWO-STAGED RESNET 50 AND 101 MODELS

METHODOLOGY



New Results



- Model 1 achieved a training accuracy of 0.9080 and a test accuracy of 0.6656
- Model 2 achieved a training accuracy of 0.9012 and a test accuracy of 0.5572



- Used GRADCAM, LIME, DEEPLIFT, and Permutation Importance for Explainability.

Paper Results

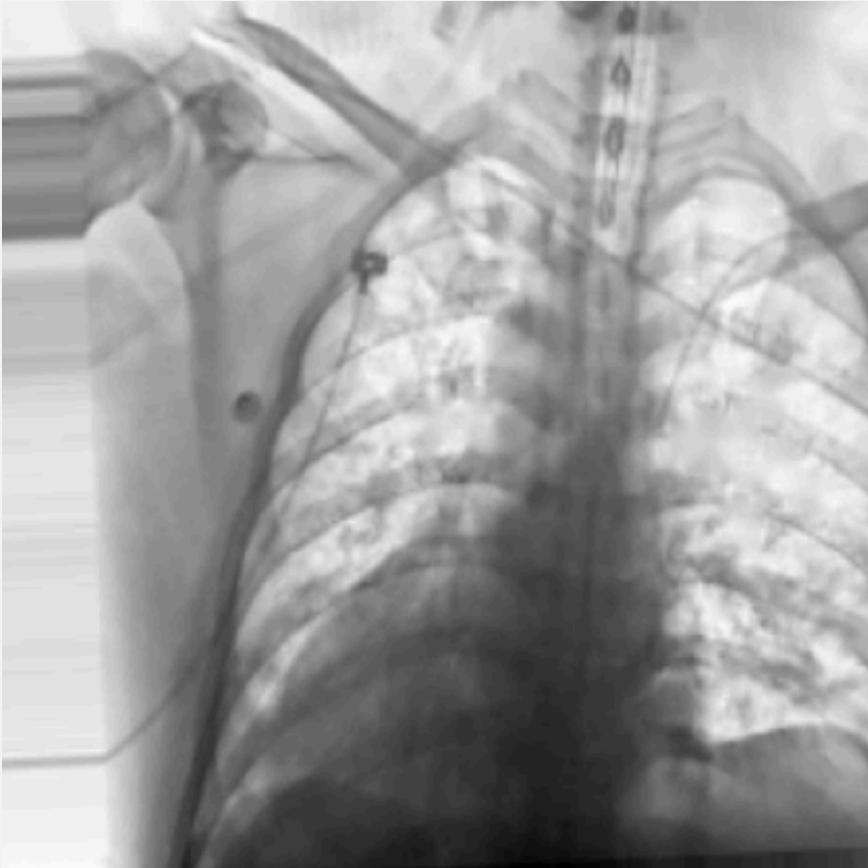
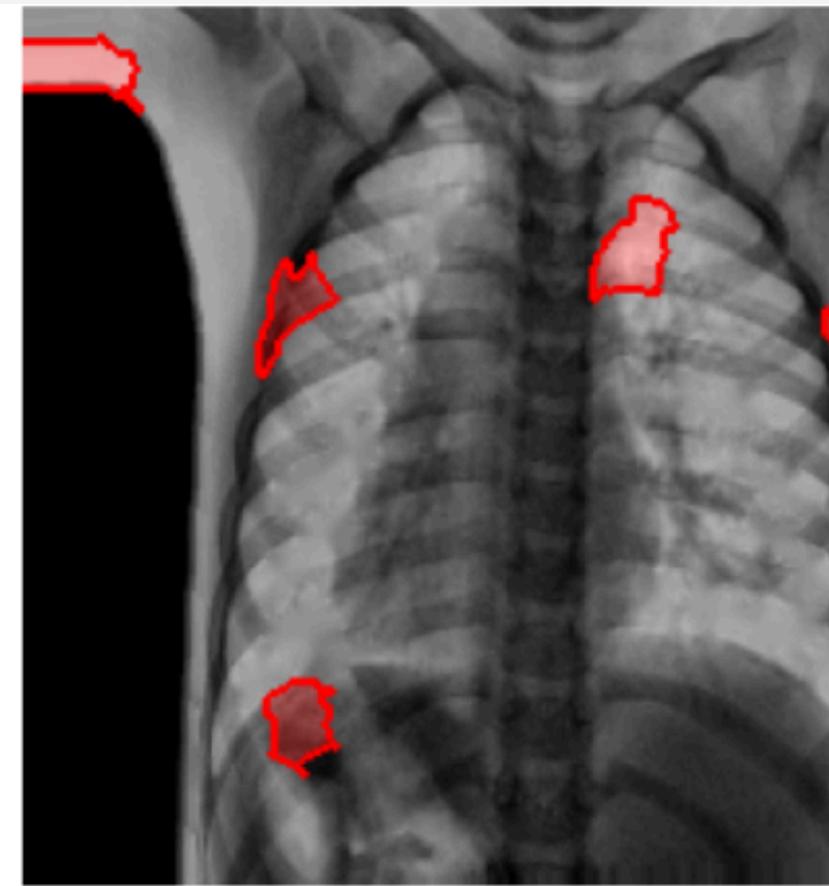


- Model 1: training accuracy of 0.953 and test accuracy of 0.93
- Model 2: training accuracy of 1 and test accuracy both at 0.9778



- Used GRADCAM for Explainability.

LIME



Model 1

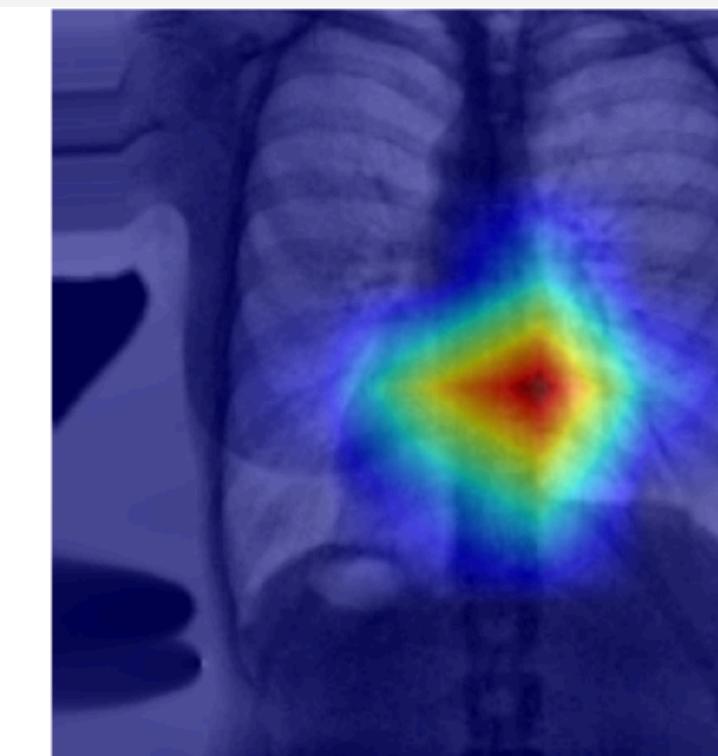
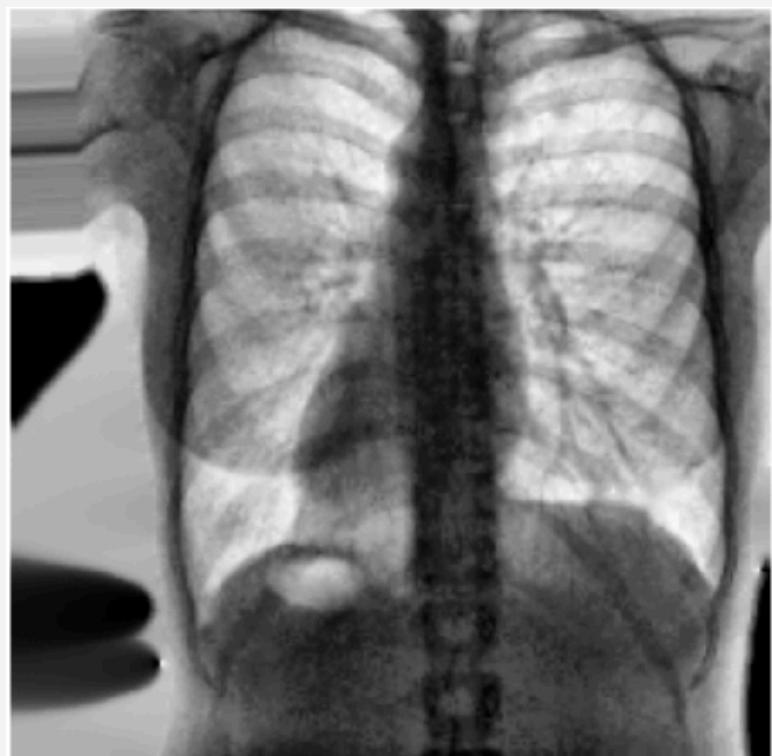
- True : Patient, Predicted : Normal
- The first model primarily focused on regions that is not the chest and small regions which may affected the model to predict wrong prediction.

Model 2

- True: Covid19, Predicted: Covid19
- The second model primarily focused smaller regions chest and the Middle and left and right regions only when making its predictions.
- The model Overfitting may cause it to make true prediction by luck.

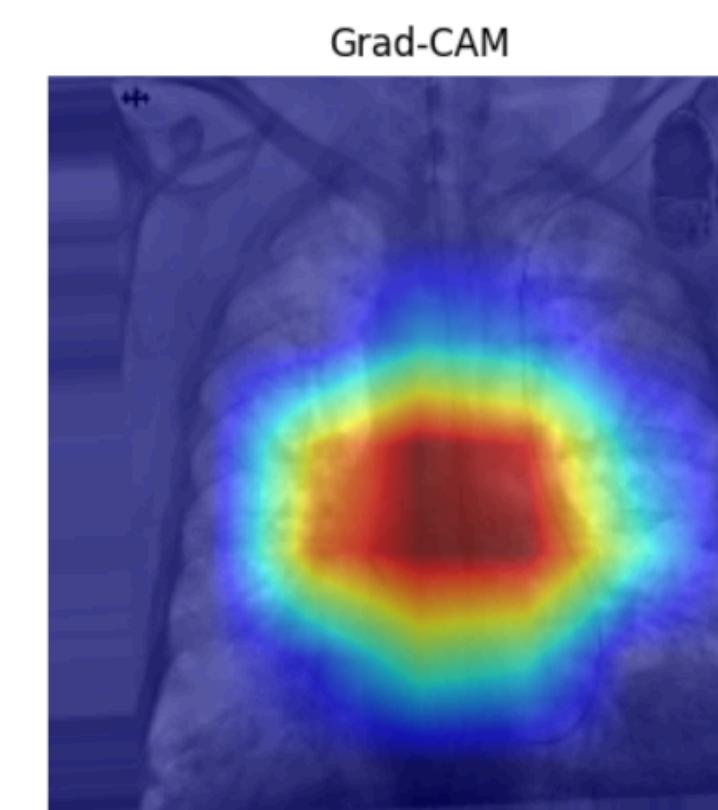
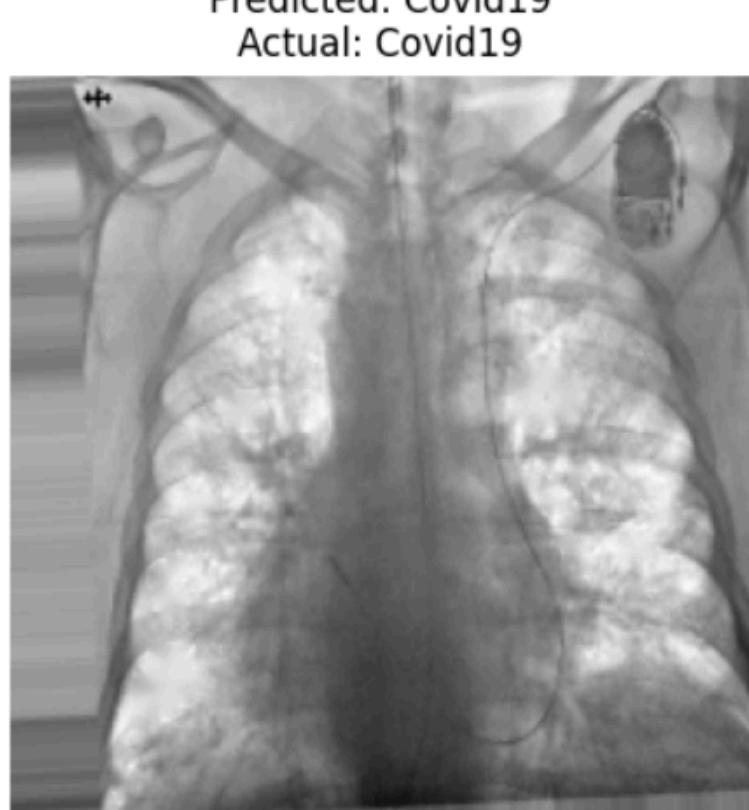
GRADCAM

■



Model 1

- True : Normal, Predicted : Patient
- The first model primarily focused on middle region but the region of interest was very small which may affected the prediction of the model. In addition the model was overfitting which make me cannot consider model prediction.

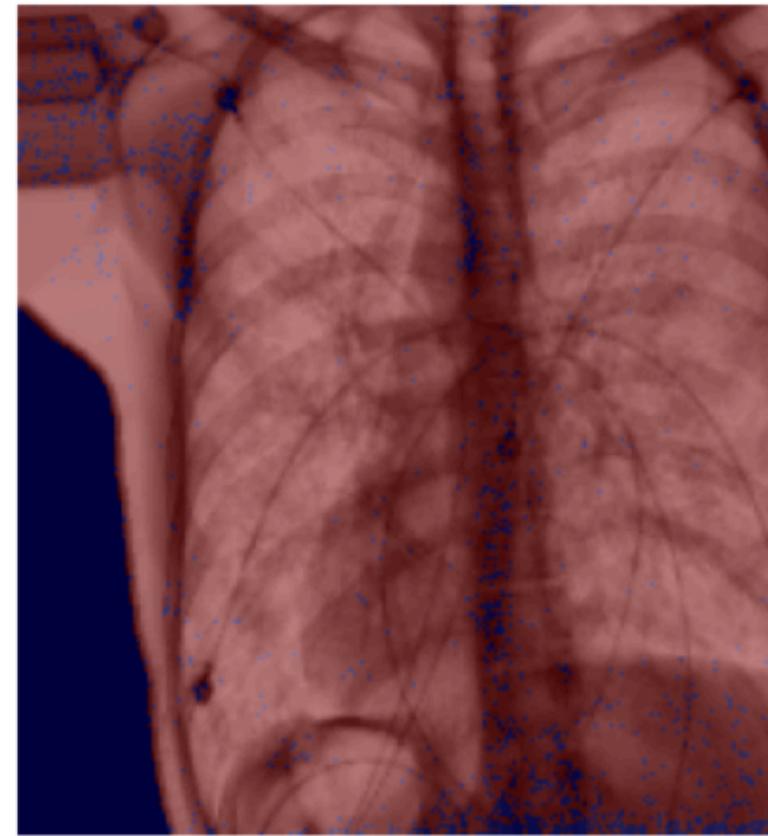
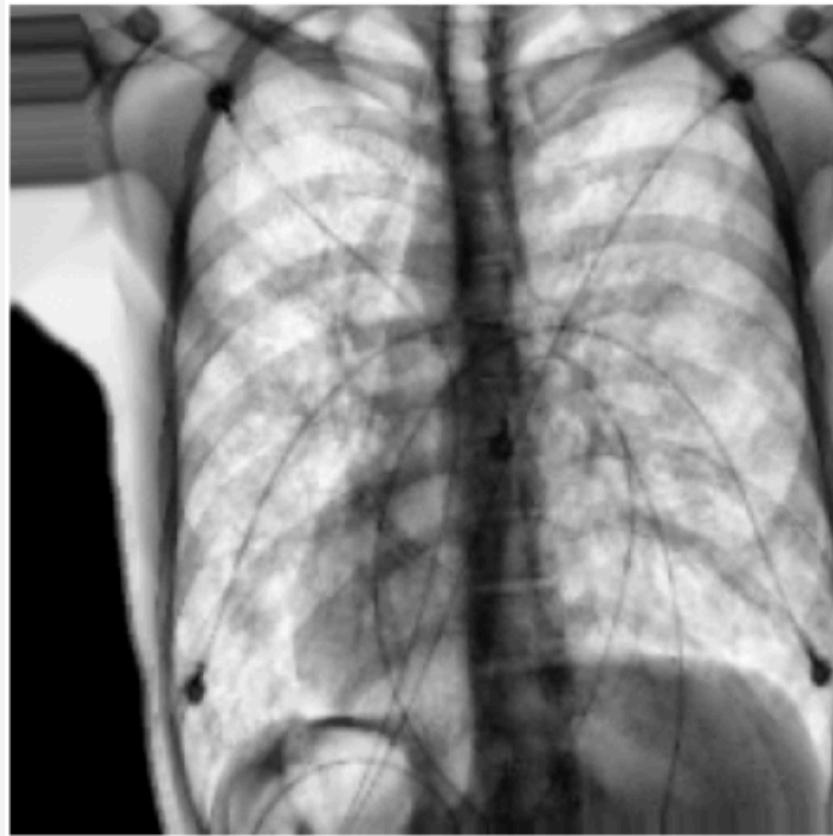


Model 2

- True: Covid19, Predicted: Covid19
- The second model primarily focused on middle region but a wider area of the chest which included left and right chest totally which may helped in the true prediction of the model.
- Still the model was overfitting which means it may gave true prediction by luck.

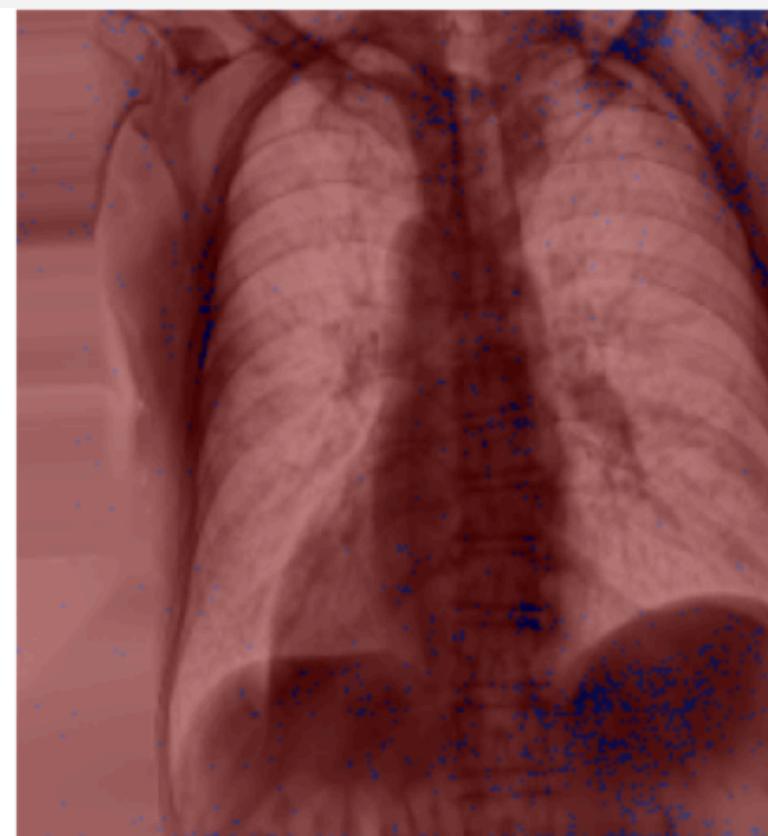
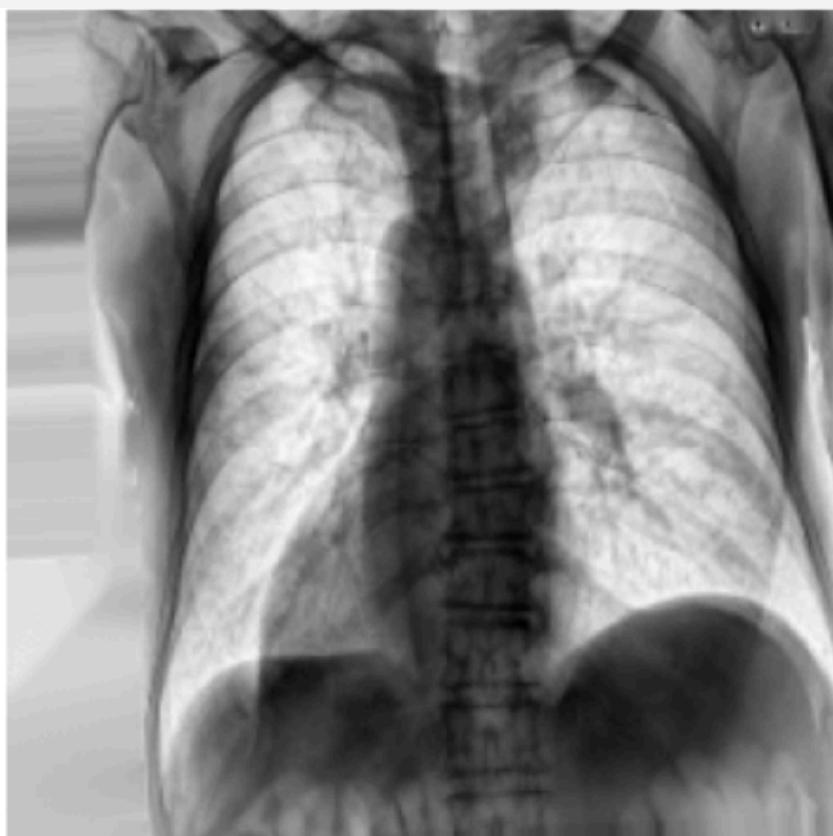
DEEPLIFT

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Model 1

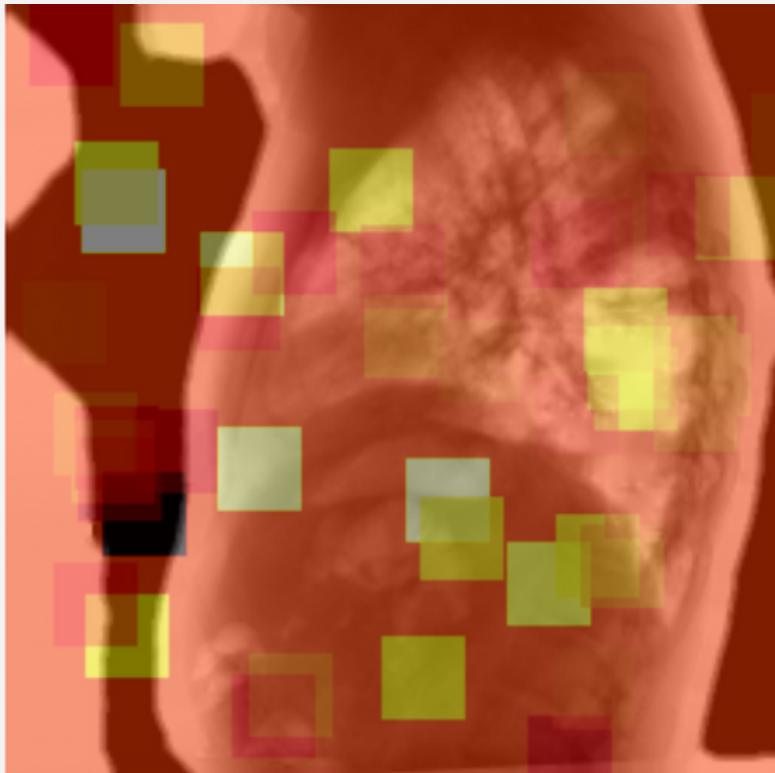
- True : Covid19, Predicted : Covid19
- The model excluded the regions not the chest which is a good exclusion criteria that probably helped in true prediction of the patient type.



Model 2

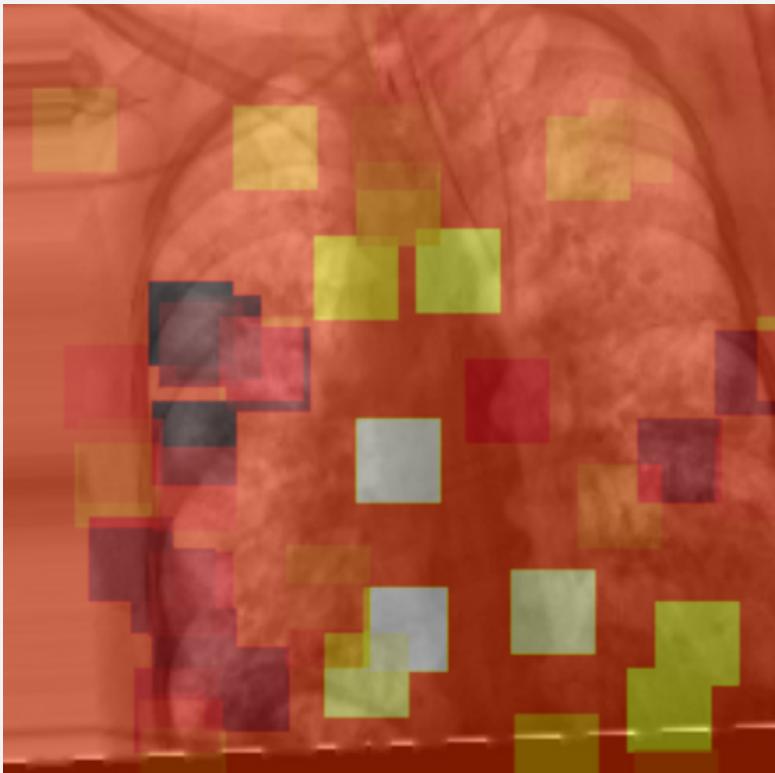
- True : Covid19, Predicted : Normal
- The model focused on regions more than the chest which probably caused him to be confused and predicted covid19 not while it supposed to be Normal

PERMUTATION IMPORTANCE



Model 1

- True : Patient, Predicted : Normal
- Model overfitting caused it to consider different regions to be important in the chest not only specific part. Also because it is a cross section may confused the model in prediction.



Model 2

- True : Normal, Predicted : Pneumonia
- Model overfitting caused it to consider different regions to be important in the chest not only specific part

VGG16 BENCHMARKING

METHODOLOGY

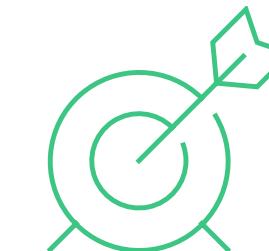
New Results



- VGG16 achieved an accuracy of 0.8224
- Xception achieved an accuracy of 0.8782, Resnet50 achieved 0.3248, Xnet achieved 0.9929, ALEXnet achieved 0.8810
- VGG16 achieved AUC of 0.97
- Used GRADCAM, LIME, DEEPLIFT, and Permutation Importance for Explainability.



Paper Results



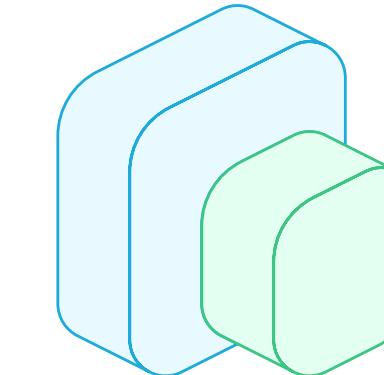
- VGG16 achieved an accuracy of 0.957
- Xception achieved an accuracy of 0.948, Resnet50 achieved 0.9, Xnet achieved 0.91, ALEXnet achieved 0.89
- VGG16 achieved AUC of 0.89
- Used LIME for Explainability.



VGG16 Classification

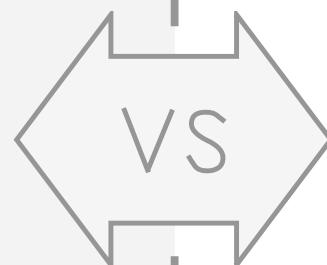


VGG16 model classifies images into Normal, Covid19, and Pneumonia

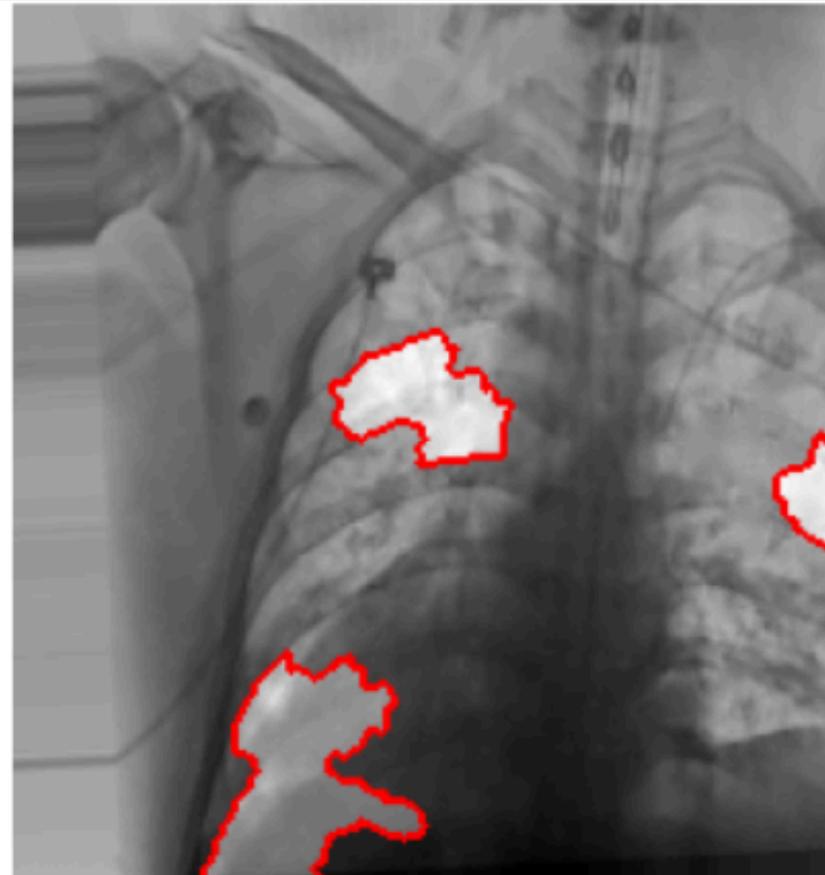


Benchmarking

VGG16 performance compared with Xception, Resnet50, Xnet, and ALEXnet



LIME

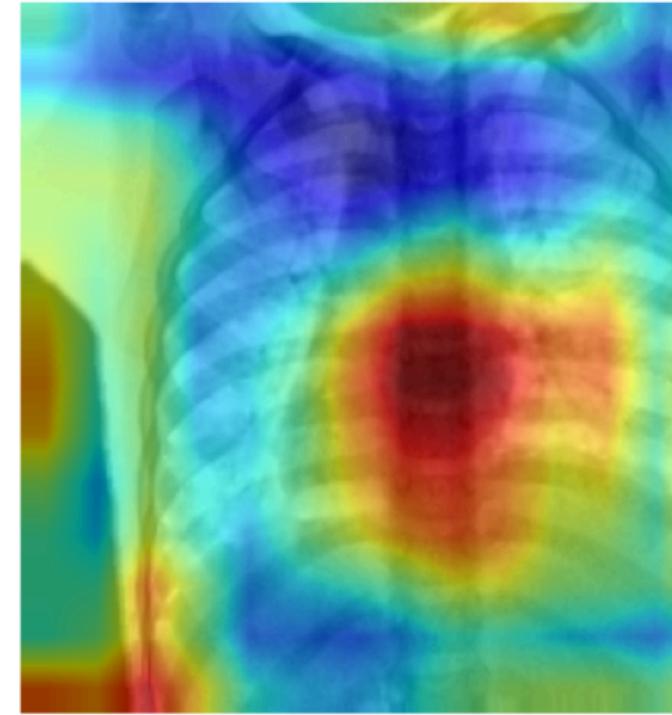
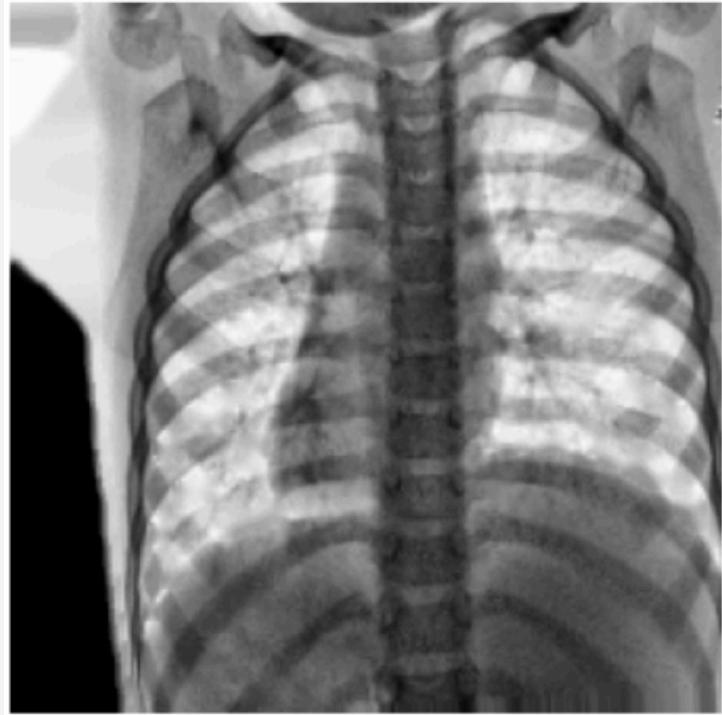


Model

- True : covid19, Predicted : covid19
- The model focused on right and left in the middle and lower zones in the chest to indicate that the final prediction is covid19
- Covid 19 indicated by seeing right and left places not the middle regions.
- Model is a good fit so its explanation can be taken into consideration.



GRADCAM

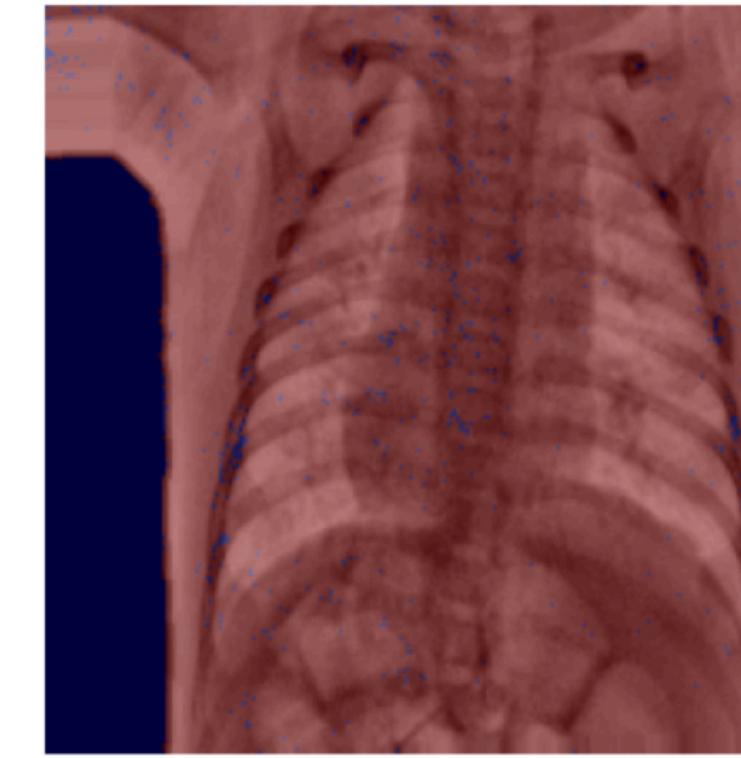
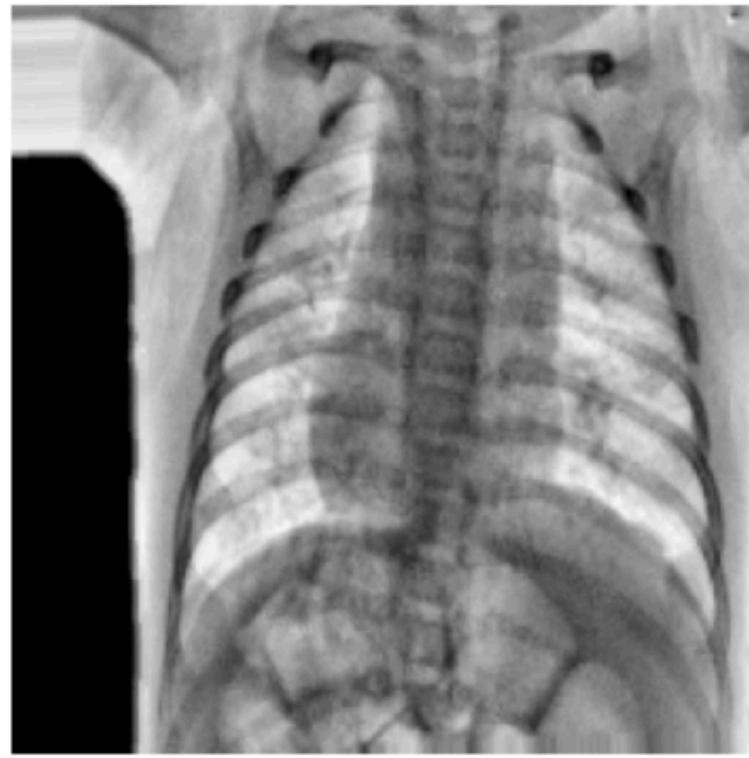


Model

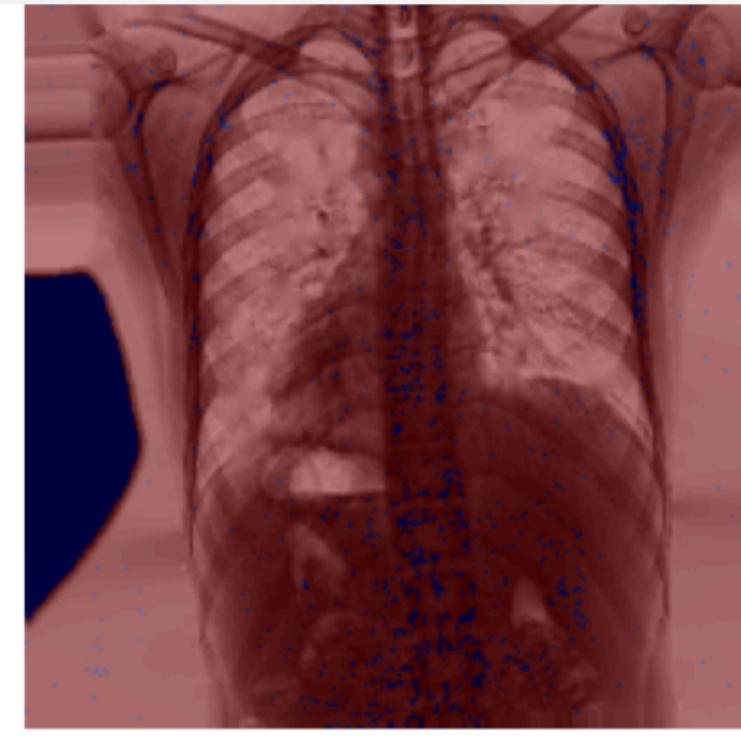
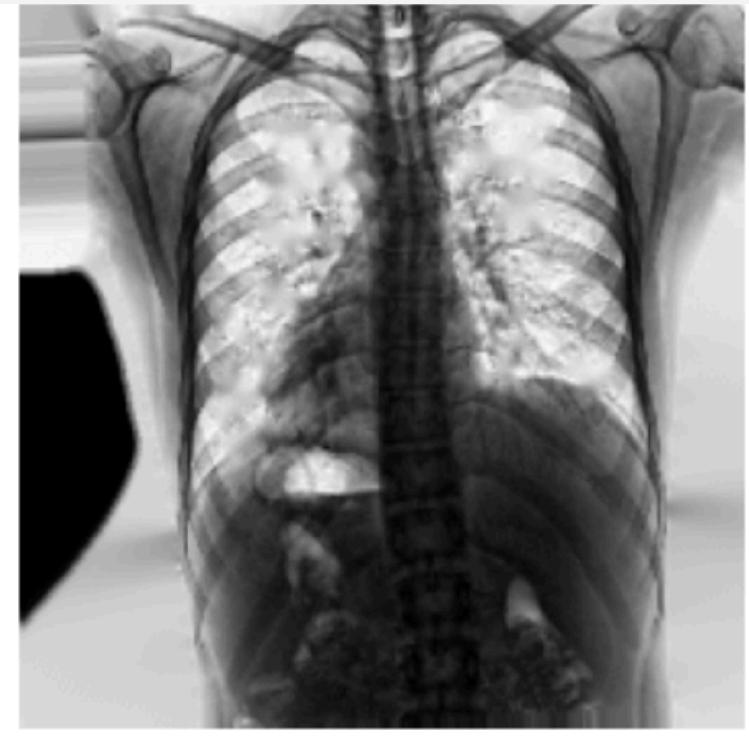
- True : Pneumonia, Predicted : Pneumonia
- The model focused on the middle zone of the chest showing red color that this region participates the most in the prediction of the model.
- Middle region of chest is important in deciding patients with pneumonia.

DEEPLIFT

Model

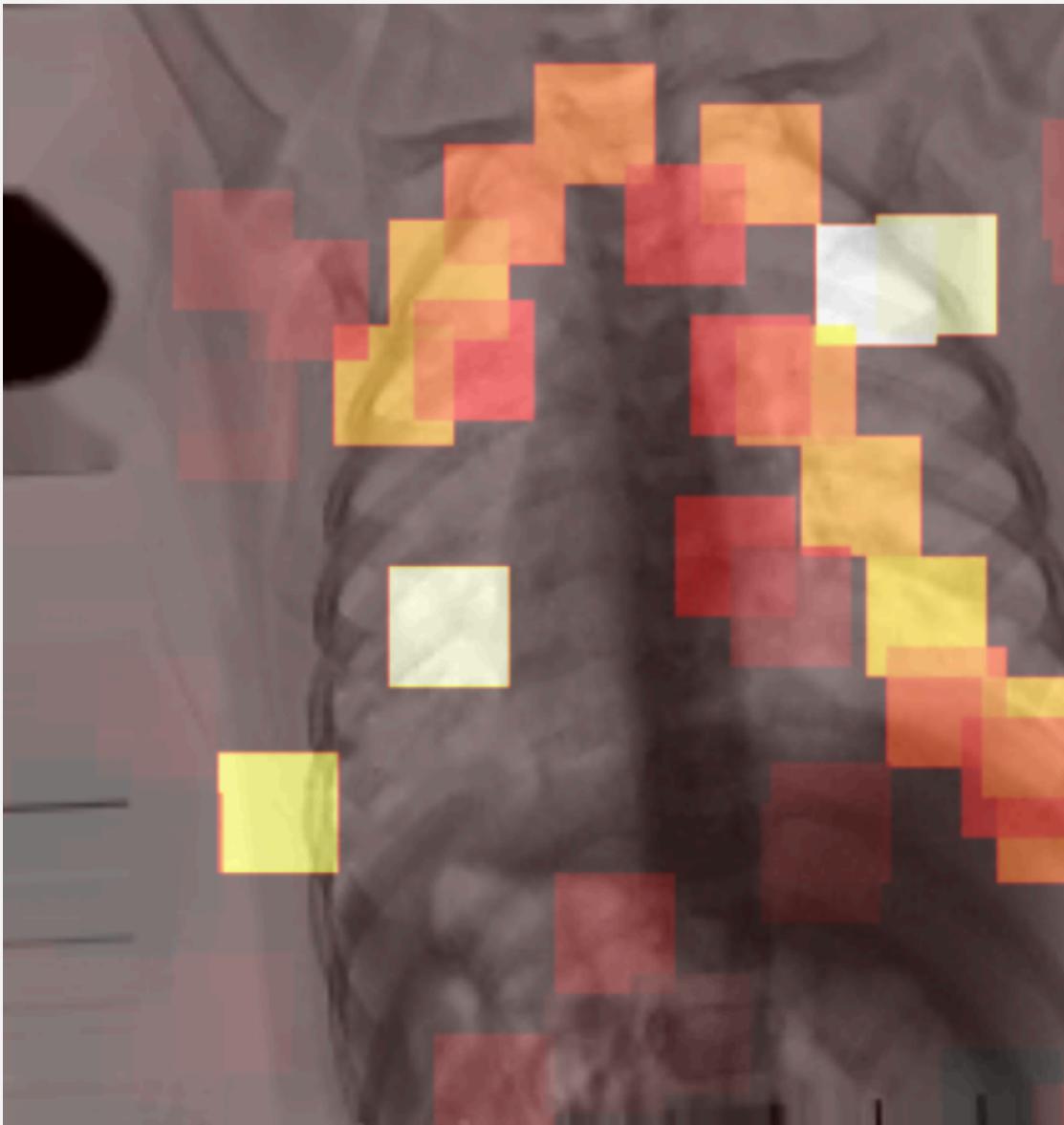


- True : Pneumonia, Predicted : Pneumonia
- The model excluded the regions not the chest which is a good exclusion criteria that probably helped in true prediction of the patient type.



- True : Covid19, Predicted : Normal
- The model focused on regions more than the chest which probably caused him to be confused and predicted covid19 not while it supposed to be Normal

PERMUTATION IMPORTANCE



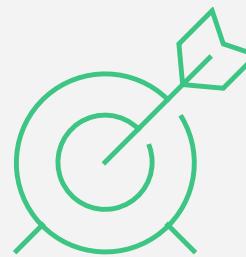
Model

- True : Covid19, Predicted : Covid19
- The regions in the right and left when permuted was the most interesting regions that caused the higher error to the model.

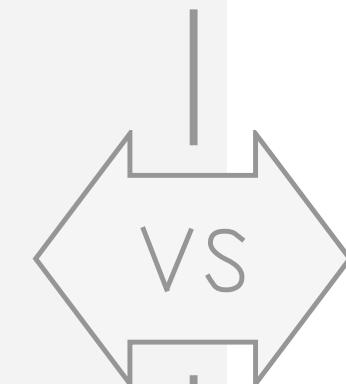
CASCADED MODEL

METHODOLOGY

New Results



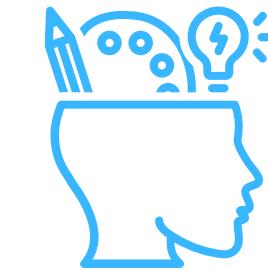
- Vgg16 achieved a training accuracy of 0.7723 and a test accuracy of 0.8038
- ResNet50V2 achieved a training accuracy of 0.9804 and a test accuracy of 0.8843
- DenseNet169 achieved a training accuracy of 0.9343 and a test accuracy of 0.8978
- Used GRADCAM, LIME, DEEPLIFT, and Permutation Importance for Explainability.



Paper Results



- Model 1: training accuracy of 0.96 and test accuracy of 0.90
- Model 2: training accuracy of 0.98 and test accuracy of 0.94
- Model 3: training accuracy of 0.97 and test accuracy of 0.92
- Used GRADCAM, LIME for Explainability.



Classify Covid19

using vgg16 model to determine if the patient covid19 or not

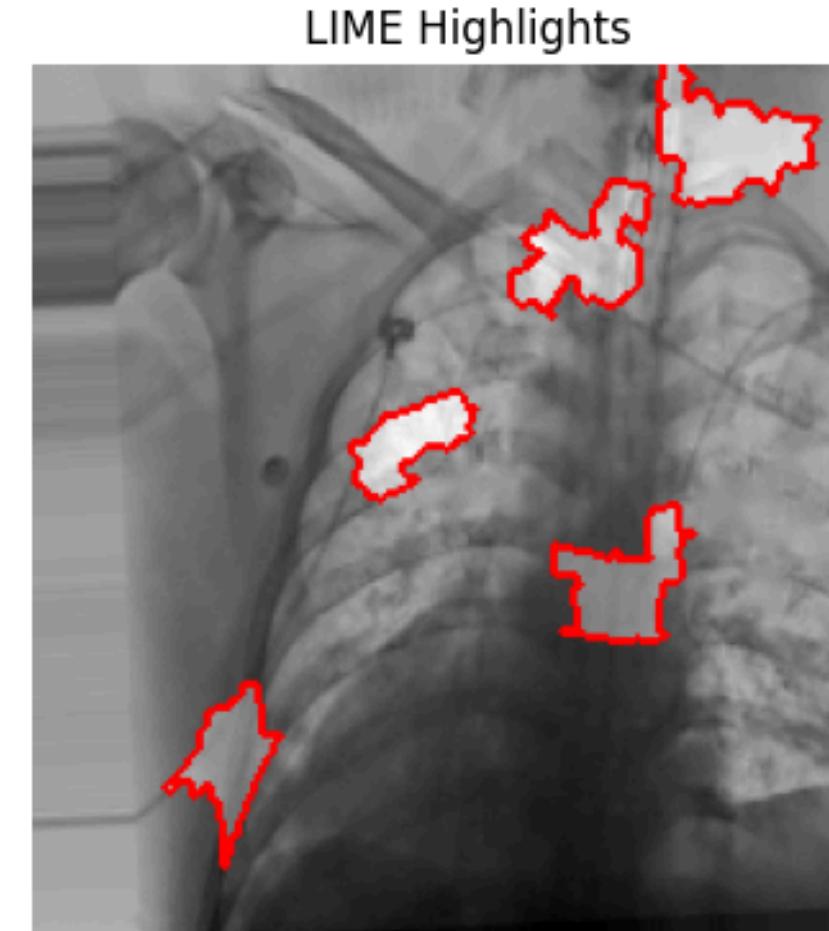
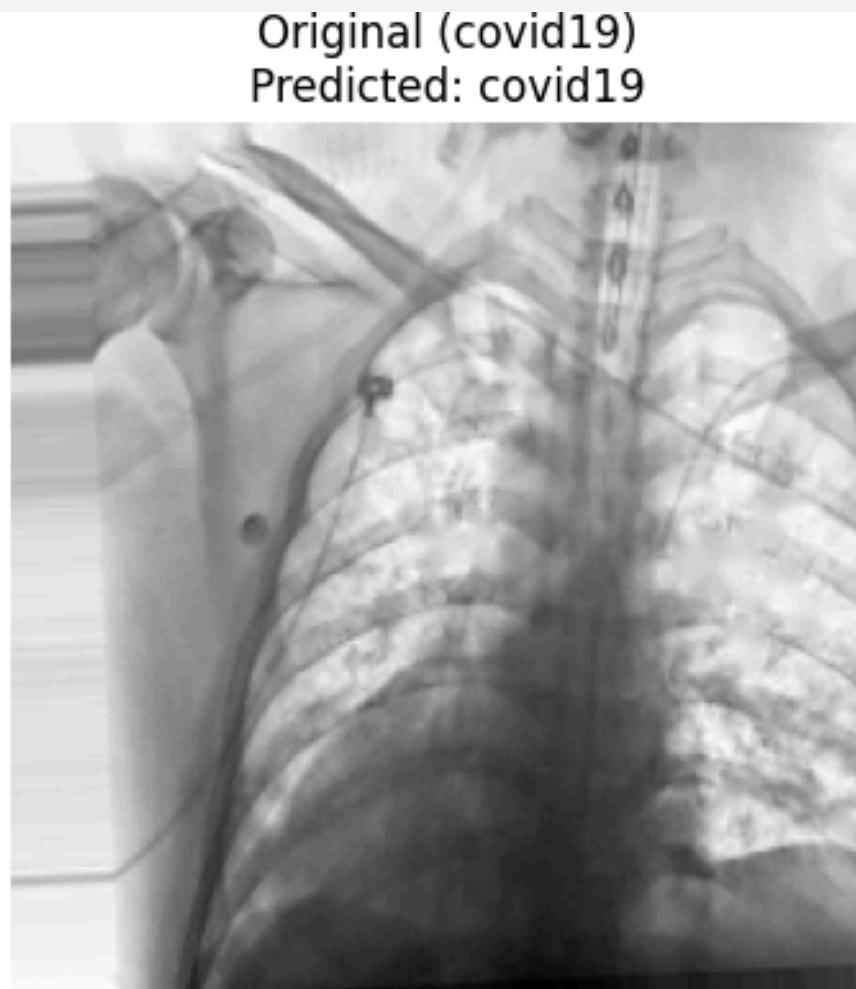
Classify Pneumonia

using ResNet50V2 to classify if the patient is pneumonia

Classify Pneumonia/normal

using DenseNet169 to classify if the patient is pneumonia or Normal

LIME



Resnet50v2

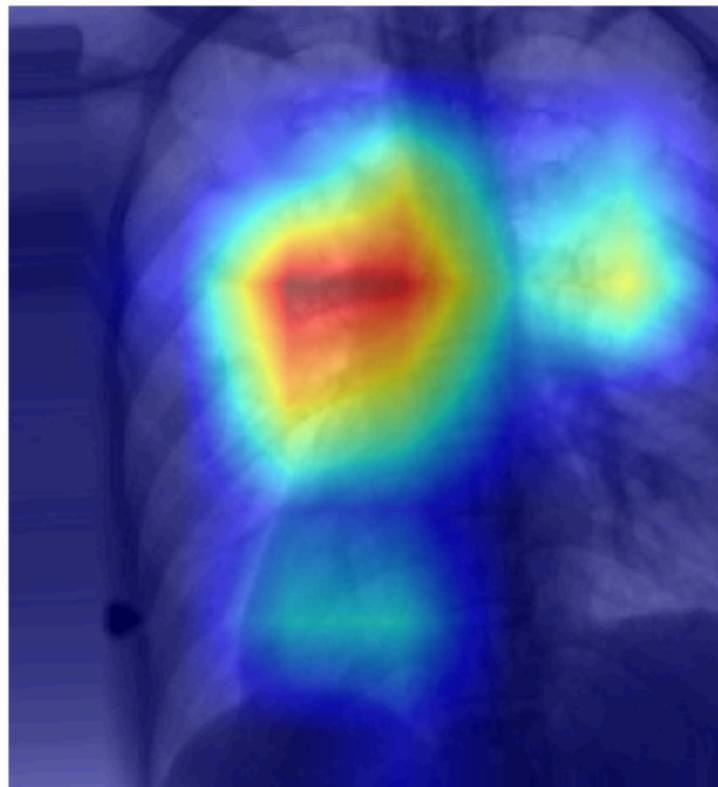
- True : Covid19, Predicted : Covid19
- Model correctly predicted Covid19 right, with highlighting regions that influenced the mode's prediction.
- Red contours mark regions in the upper, middle and lower zones of both lungs

GRAD-CAM

Predicted: covid19
Actual: covid19



Grad-CAM ResNet50V2



Resnet50v2

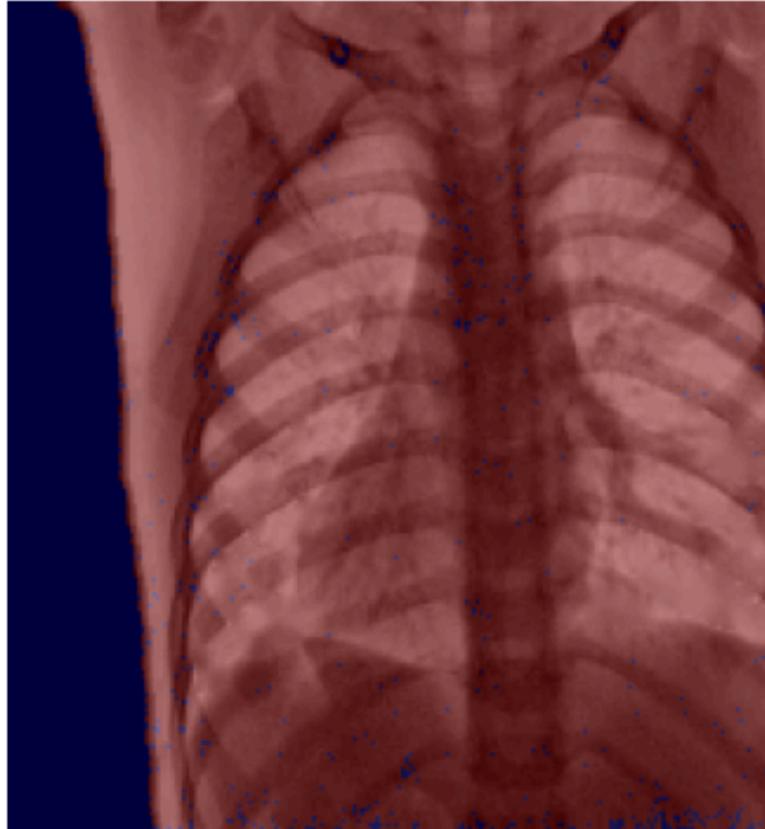
- True : Covid19, Predicted : Covid19
- Model predicted it right, The model uses color range from blue(which low importance) and red to yellow (which has high importance) which influenced the model's prediction
- The most red and yellows regions are concentrated in the upper and middle zones which model used to predict covid19 right

DEEPLIFT

True: 0, Pred: 2



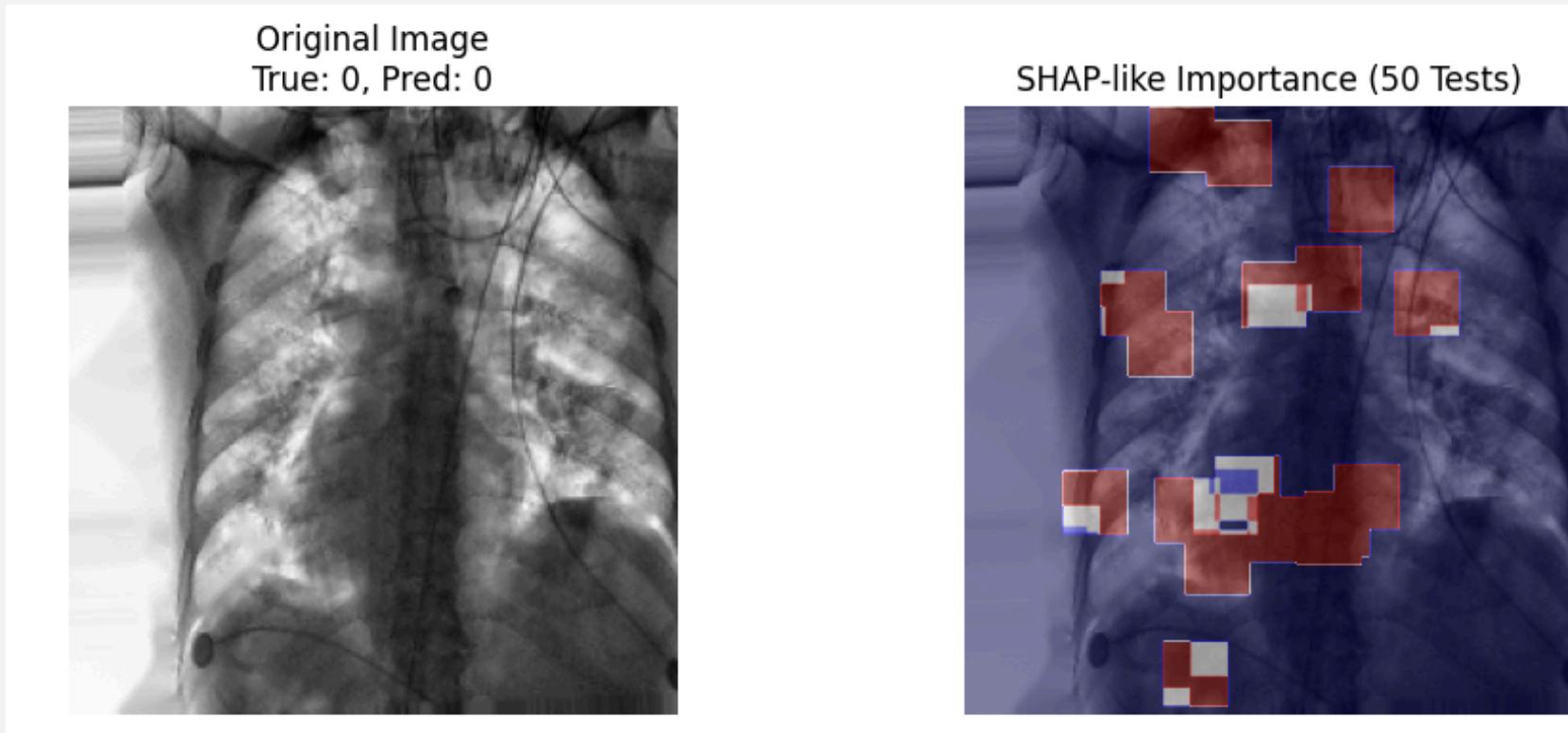
DeepLIFT Heatmap ResNet50V2



Resnet50v2 Model

- True : Covid19, Predicted : normal
- This incorrect prediction could be due to overfitting, sensitivity to noise .
- This heatmap helps us understand why the model failed, it is because it focused on wrong regions.

PERMUTATION IMPORTANCE



Resnet50v2 Model

- True : covid19, Predicted : covid19
- The middle and lower zones of both lungs, which is highlighted in gray, red or yellow, is the most influential area for the model's decision
- The Red or black boxes(low importance) indicates that these regions didn't contribute much to the prediction

COVID-NET FRAMEWORK

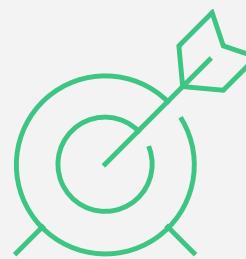
VGG19 Classification

VGG19 model classifies images into Normal, Covid19, and Pneumonia

DenseNet121 Classification

DenseNet121 model classifies images into Normal, Covid19, and Pneumonia

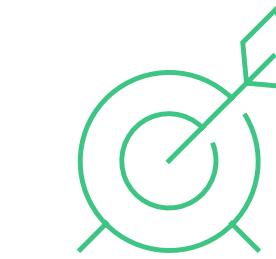
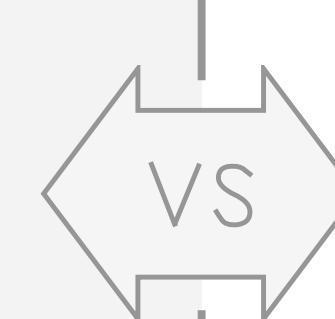
New Results



- Model 1 achieved a training accuracy of 0.6967 and a test accuracy of 0.7829
- Model 2 achieved a training accuracy of 0.8496 and a test accuracy of 0.8208



- Used GRADCAM, LIME, DEEPLIFT, and Permutation Importance for Explainability.

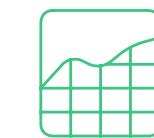
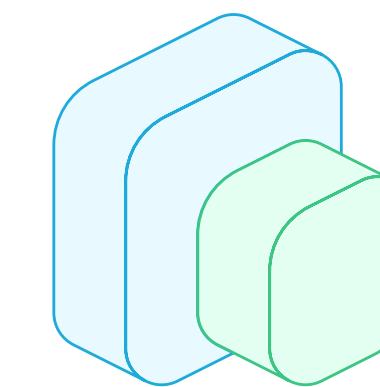


- Model 1: Both training and testing accuracy are 0.90
- Model 2: Both training and testing accuracy are 0.80



- Used GRADCAM for Explainability.

METHODOLOGY

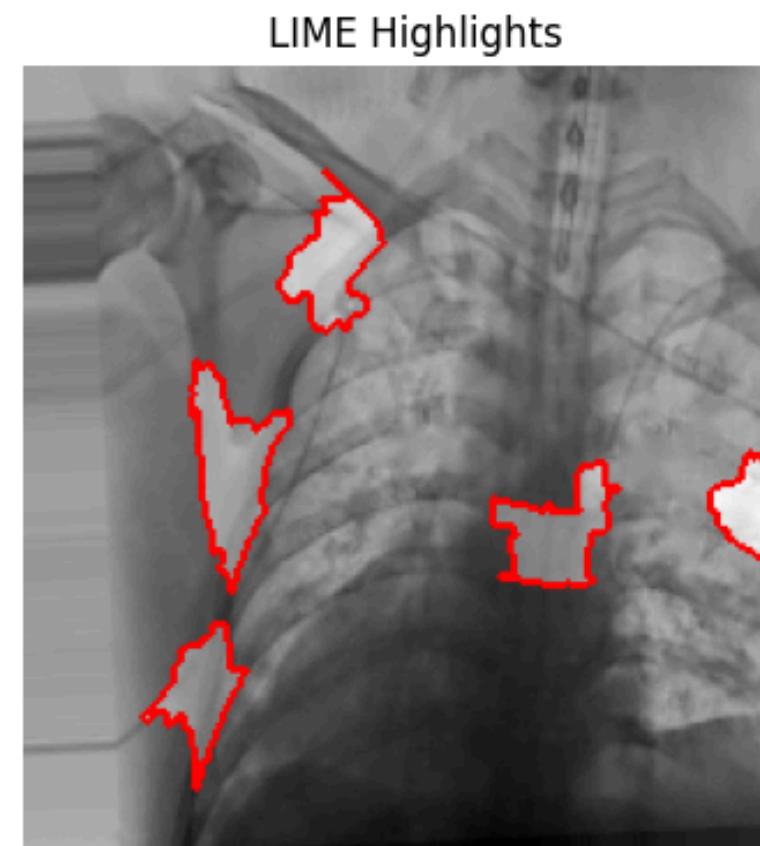
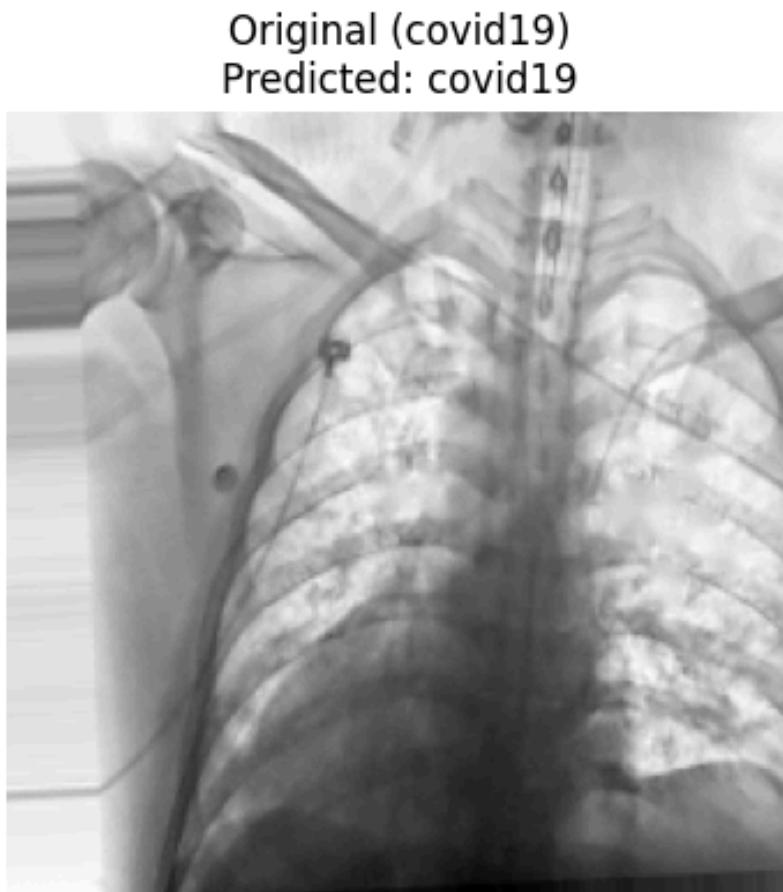


Benchmarking

VGG19 and DenseNet121 performance compared with ResNet, InceptionResNetV2, InceptionV3 and others

Paper Results

LIME

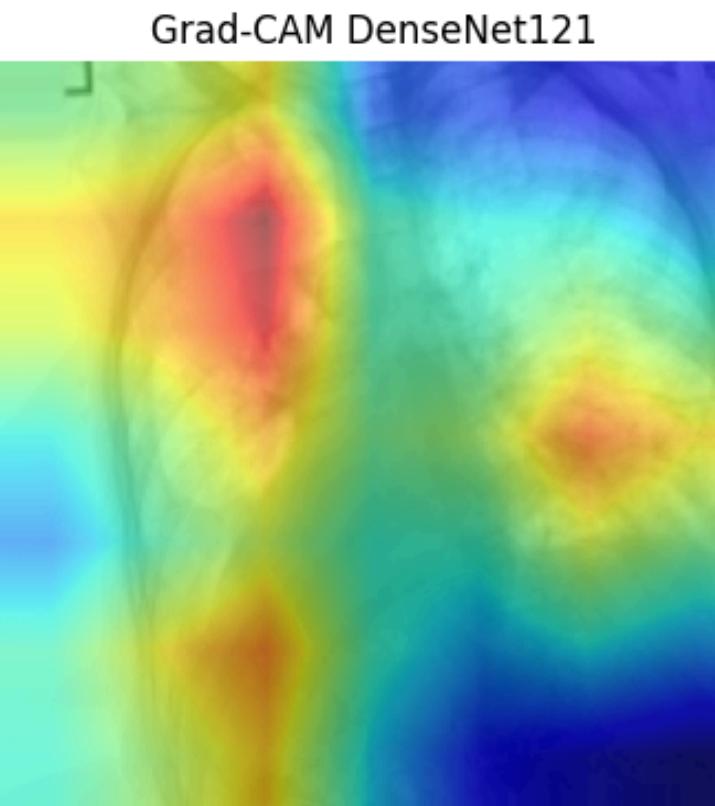


DenseNet121

- True : Covid19, Predicted : Covid19
- Model correctly predicted Covid19 right, with highlighting regions that influenced the mode's prediction.
- Red contours mark regions in the upper, middle and lower zones of both lungs

GRAD-CAM

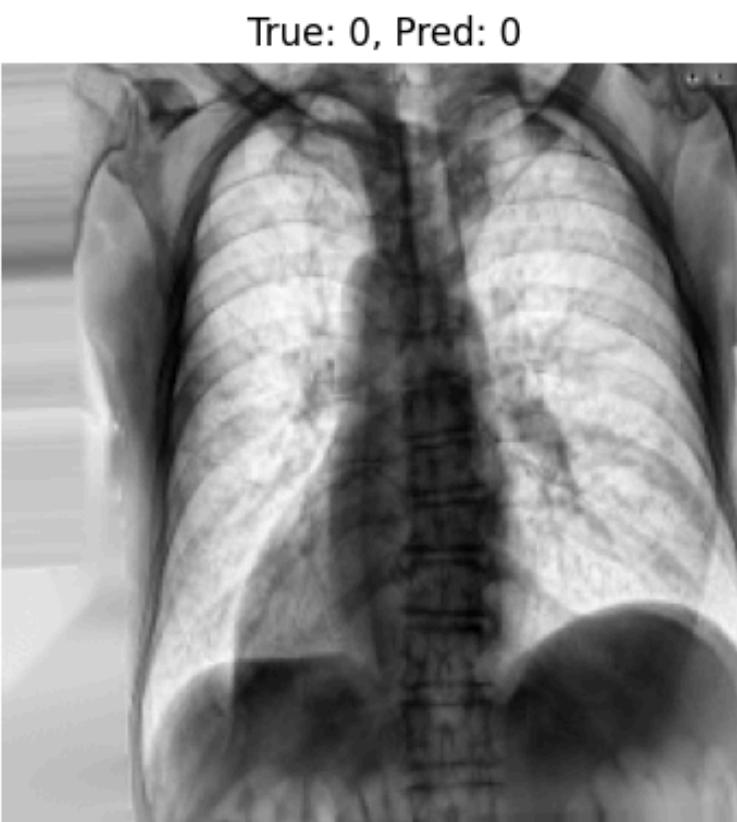
Predicted: covid19
Actual: covid19



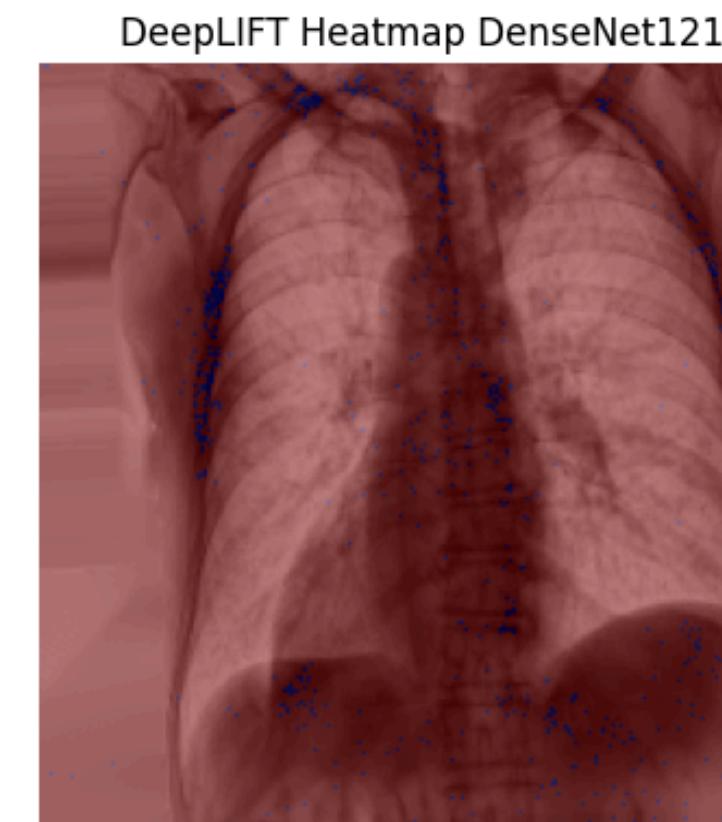
DenseNet121

- True : Covid19, Predicted : Covid19
- Model predicted it right, The model uses color range from blue(which low importance) and red to yellow (which has high importance) which influenced the model's prediction
- The most red and yellows regions are concentrated in the upper and middle zones which model used to predict covid19 right

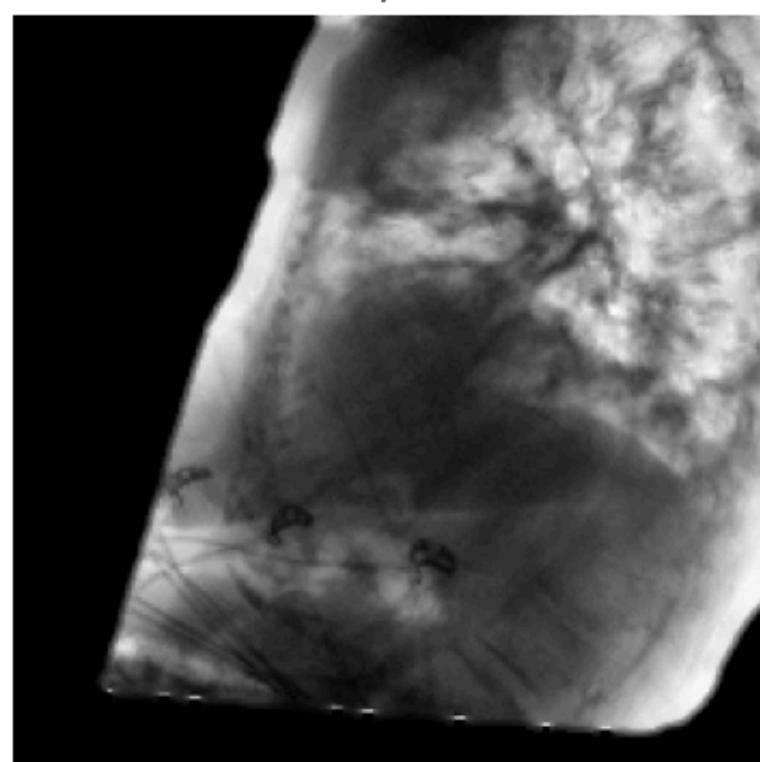
DEEPLIFT



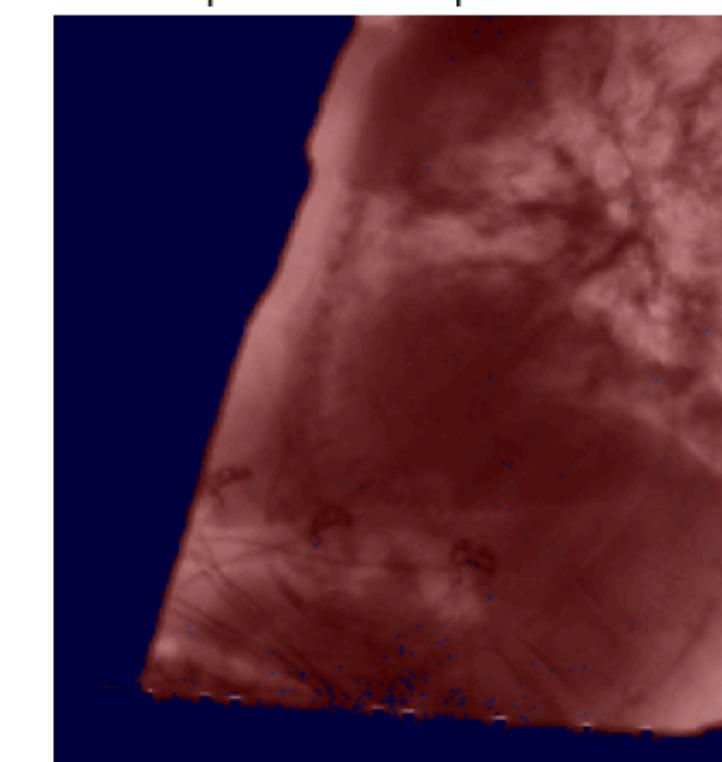
True: 0, Pred: 0



DeepLIFT Heatmap DenseNet121



True: 0, Pred: 1



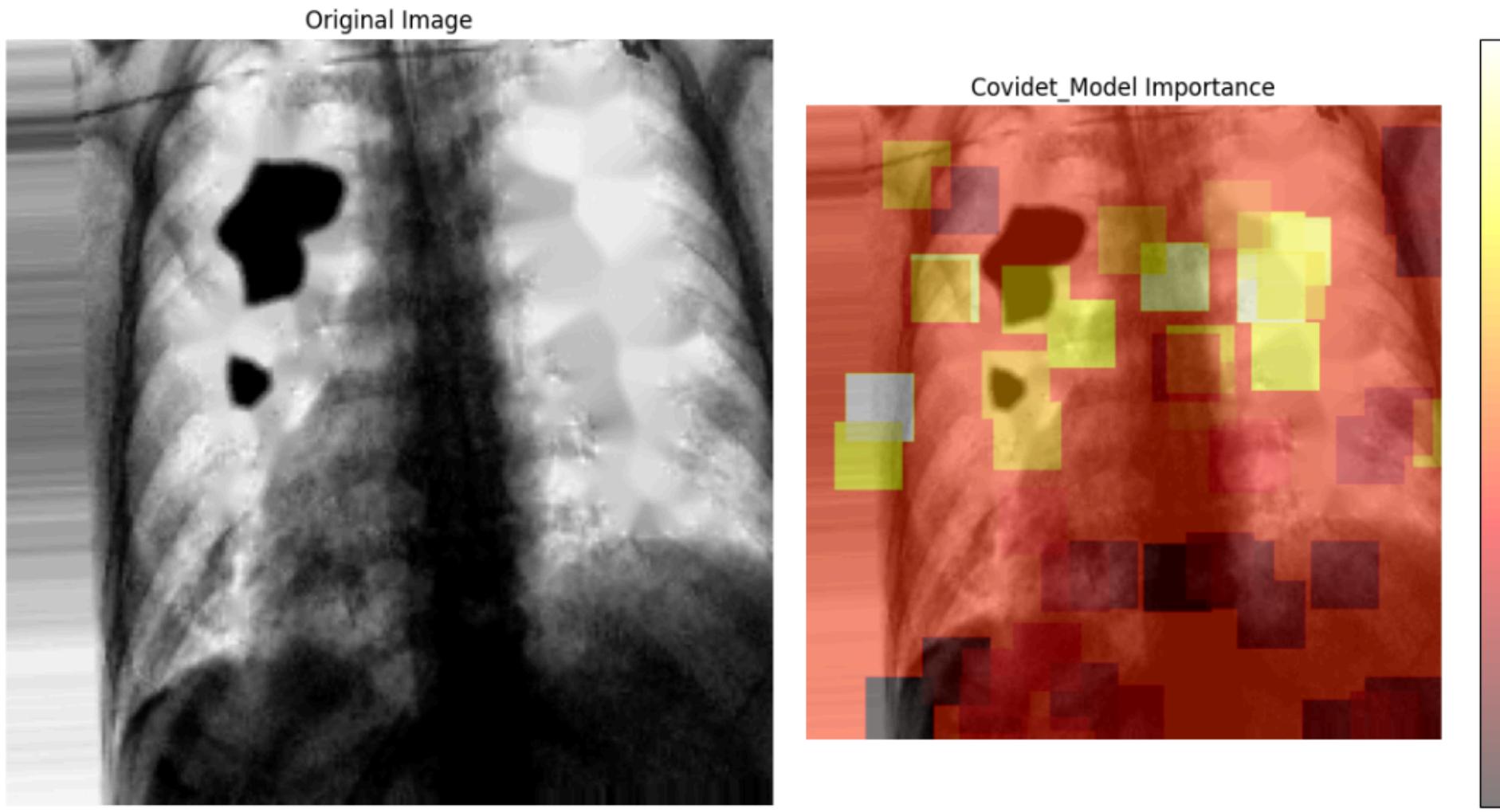
DeepLIFT Heatmap DenseNet121

DenseNet121 Model

- True : Covid19, Predicted : Covid19
- The DenseNet121 model excluded regions that is not the chest and regions which may not affect on the model prediction.

- True : Covid19, Predicted : normal
- This incorrect prediction could be due to overfitting, sensitivity to noise .
- This heatmap helps us understand why the model failed, it is because it is not focused on chest only or not in the important regions only

PERMUTATION IMPORTANCE

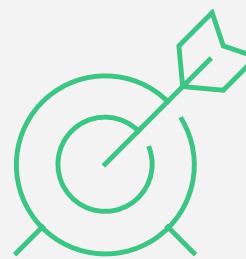


DenseNet121 Model

- True : Normal, Predicted : Normal
- The middle zone of the chest, which is highlighted in yellow, is the most influential area for the model's decision
- The Red or black boxes(low importance) indicates that these regions didn't contribute much to the prediction

COVIDET

New Results



- Covidet achieved a training accuracy of 0.9995 and a test accuracy of 0.8521
-



- Used GRADCAM, LIME, DEEPLIFT, and Permutation Importance for Explainability.

VS



- Covidet achieved a training accuracy of 0.985 and a test accuracy of 0.967



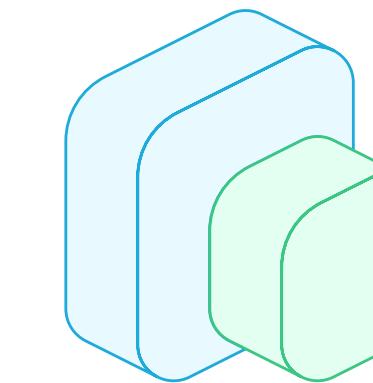
- Used GRADCAM for Explainability.

METHODOLOGY

Covidet Classification



Covidet model classifies images into Normal, Covid19, and Pneumonia



Benchmarking

covidet performance compared with Inception V3, residual Network 50 „ vgg19

LIME



Original (covid19)
Predicted: covid19



LIME Highlights



Covidet Model

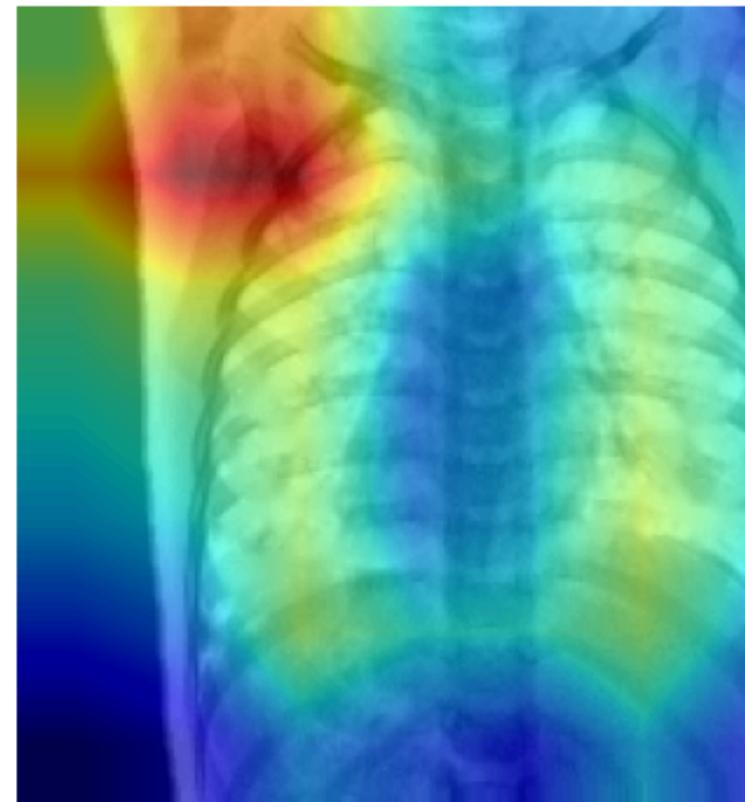
- True : Covid19, Predicted : Covid19
- Model correctly predicted Covid19 right, with highlighting regions that influenced the mode's prediction.
- Red contours mark regions in the upper-left, middle-right, and lower zones

GRAD-CAM

Predicted: pneumonia
Actual: covid19



Grad-CAM DenseNet121

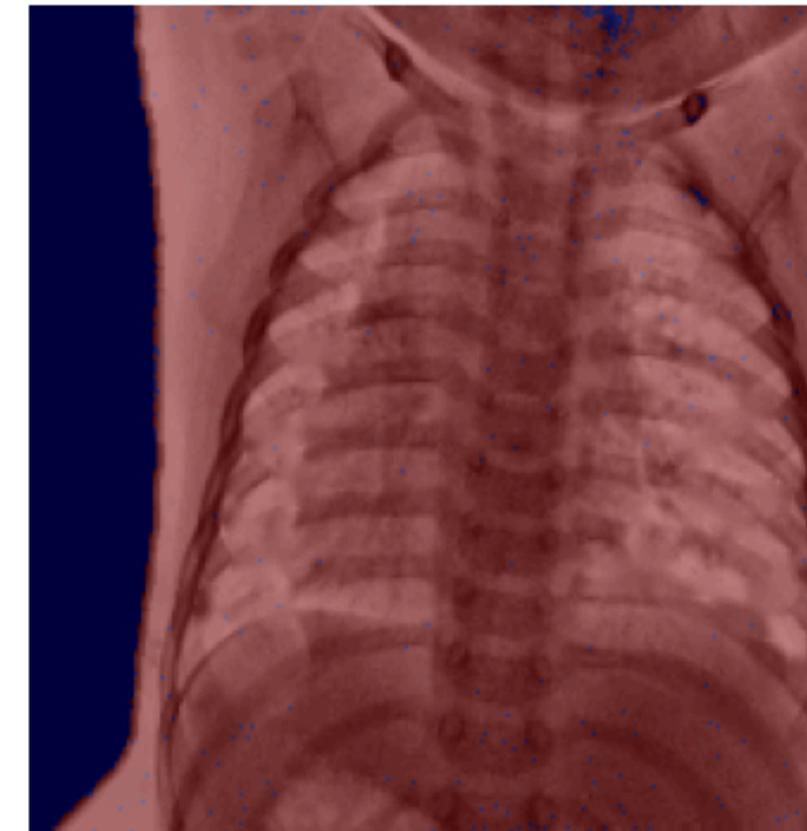
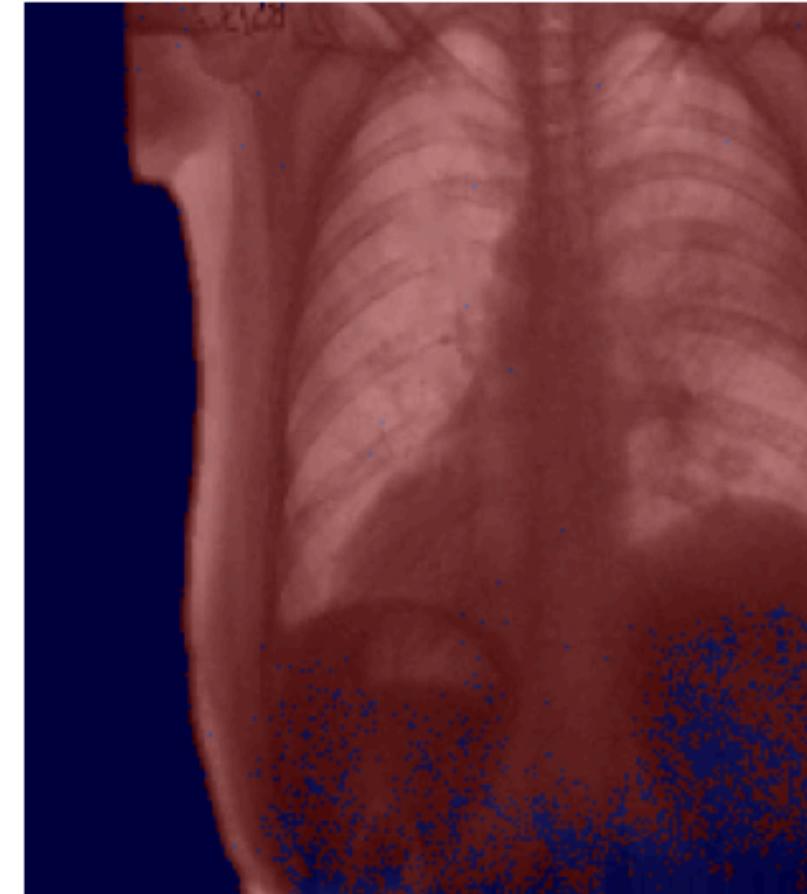
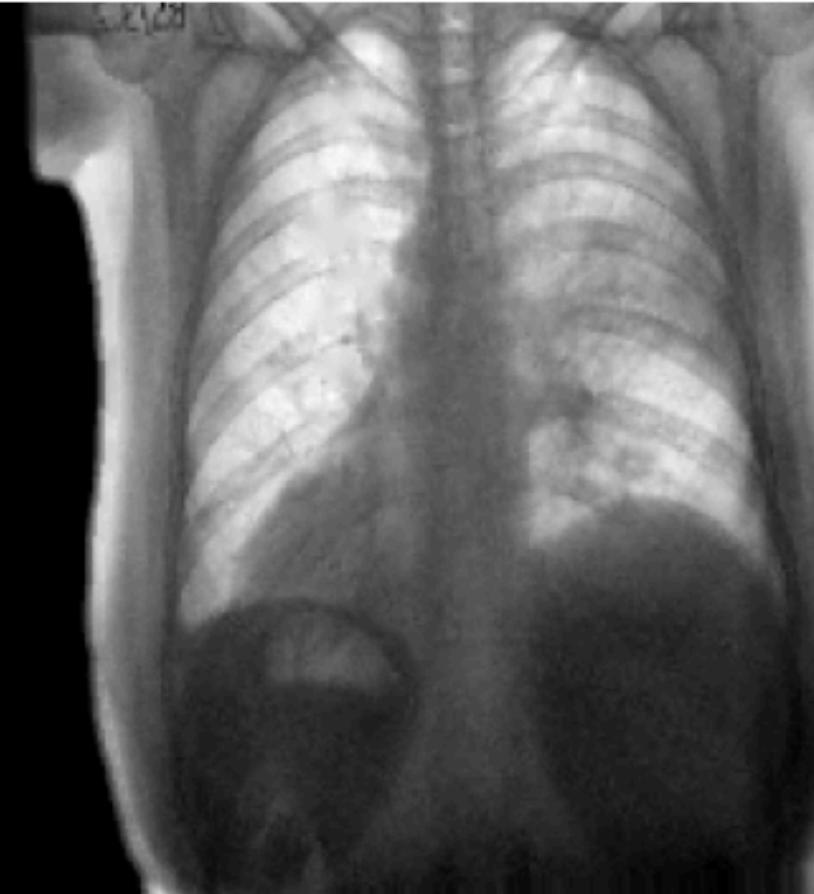


Covidet Model

- True : Penumonia, Predicted : Covid19
- Model predicted it wrong, The model uses color range from blue(which low importance) and red to yellow (which has high importance) which influenced the model's prediction
- The most red and yellows regions are concentrated in upper-right and middle zones of the lungs which model used to predict but Model got affected negatively

DEEPLIFT

■

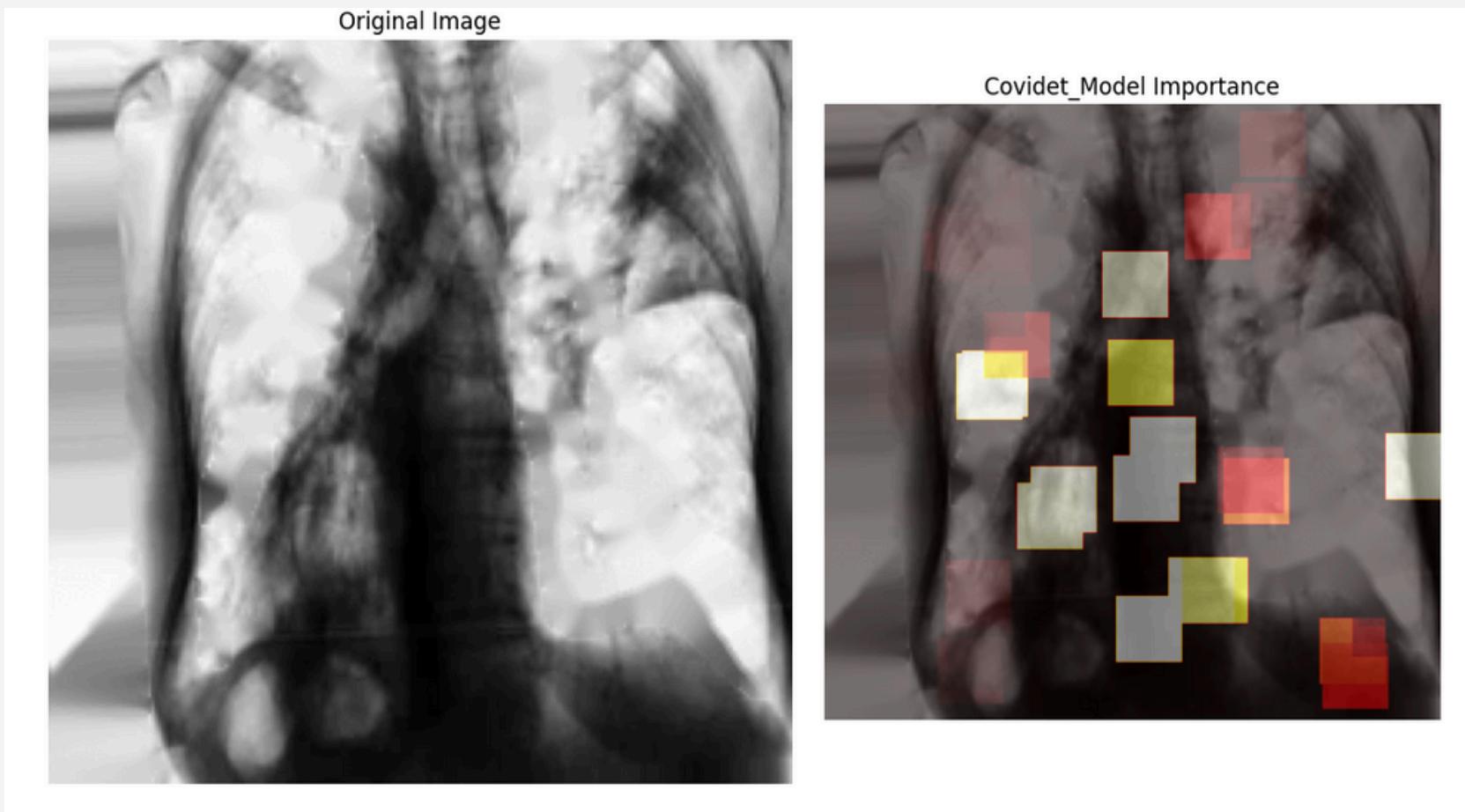


Covidet Model

- True : Covid19, Predicted : Covid19
- The covidet model excluded regions that is not the chest(background) and regions which may not affect on the model prediction.

- True : Covid19, Predicted : pneumonia
- This incorrect prediction could be due to overfitting, sensitivity to noise .
- This heatmap helps us understand why the model failed, it is because it is not focused on chest only or not in the important regions only

PERMUTATION IMPORTANCE

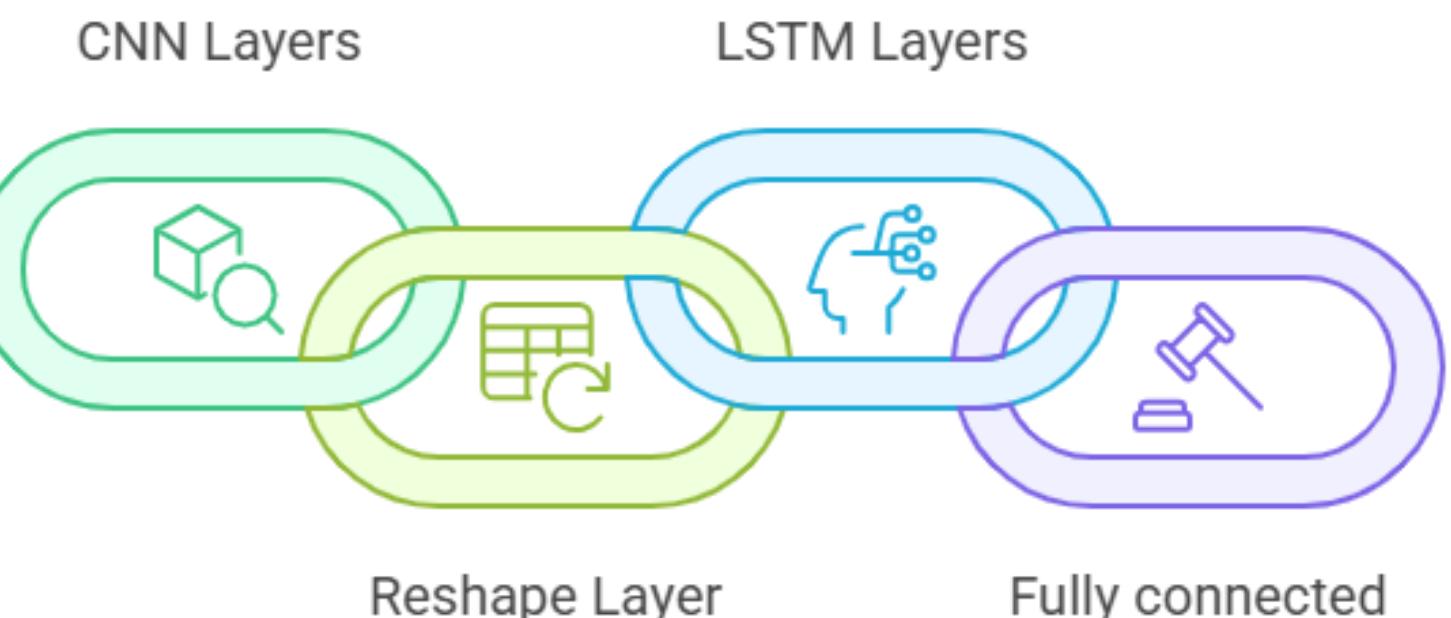


Covidet Model

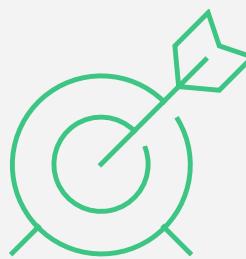
- True : Covid19, Predicted : Covid19
- The middle and lower zone of the chest, which is highlighted in yellow, white and gray, is the most influential area for the model's decision
- The Red or black boxes(low importance) indicates that these regions didn't contribute much to the prediction

CNN-LSTM HYBRID NETWORK ARCHITECTURE

METHODOLOGY



New Results



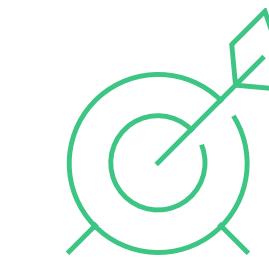
- the model achieved test Accuracy of 81%, AP of 97% for one class and around 80% in the other two.



- Used Accuracy, Loss, Confusion Matrix, ROC and PR curves as performance evaluation
- t-SNE Visualization as partial XAI
- LIME, Permutation Importance, GRAD_CAM and DeepLift as XAI techniques

VS

Paper Results



- The model achieved over 90% Accuracy on binary.



- Used Accuracy, Loss, Specificity, Sensitivity and Confusion Matrix as performance evaluation.



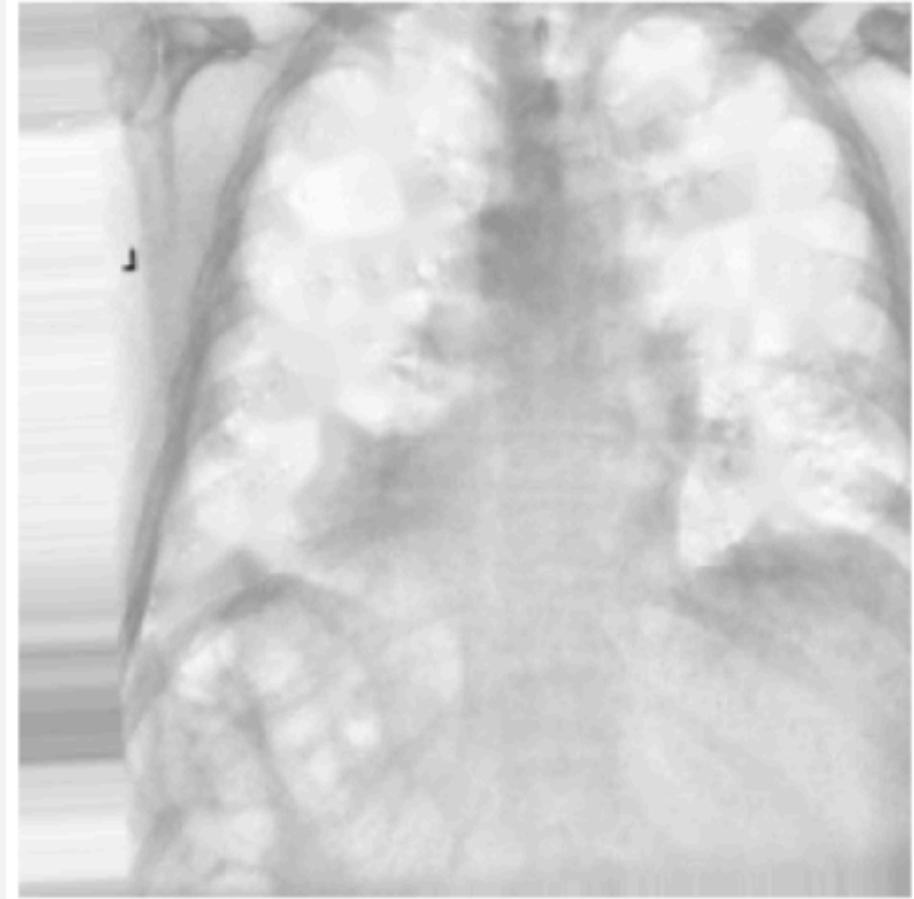
LIME

- 15 epoch train



False Prediction

Original (covid19)
Predicted: pneumonia

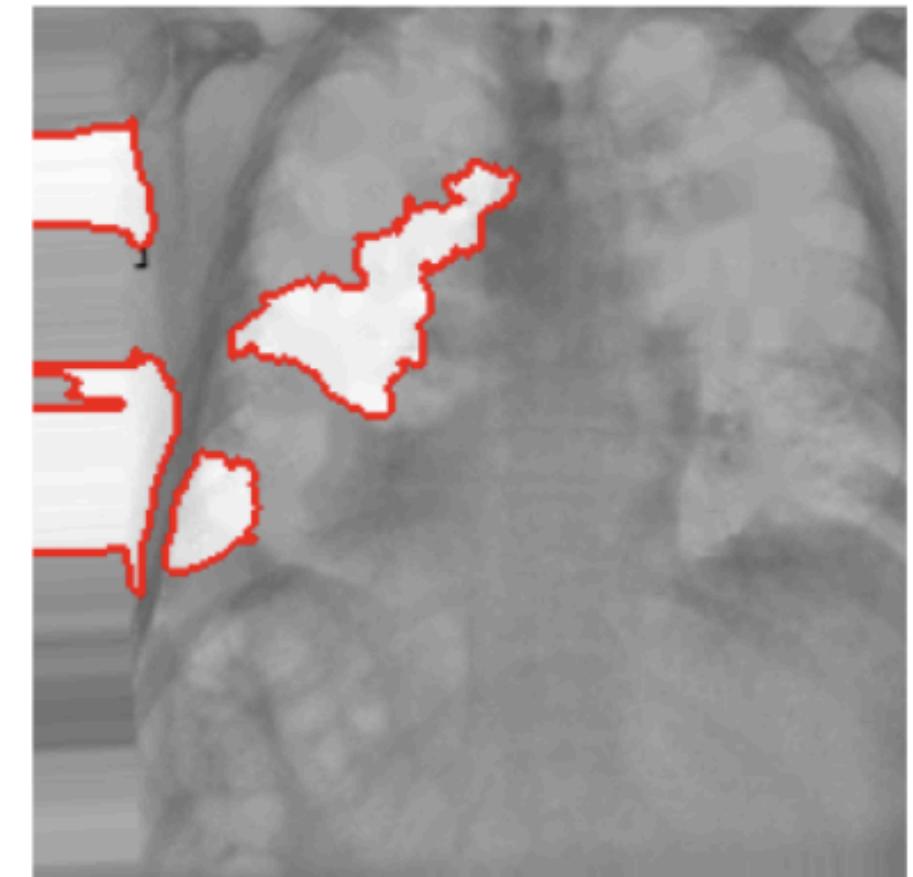
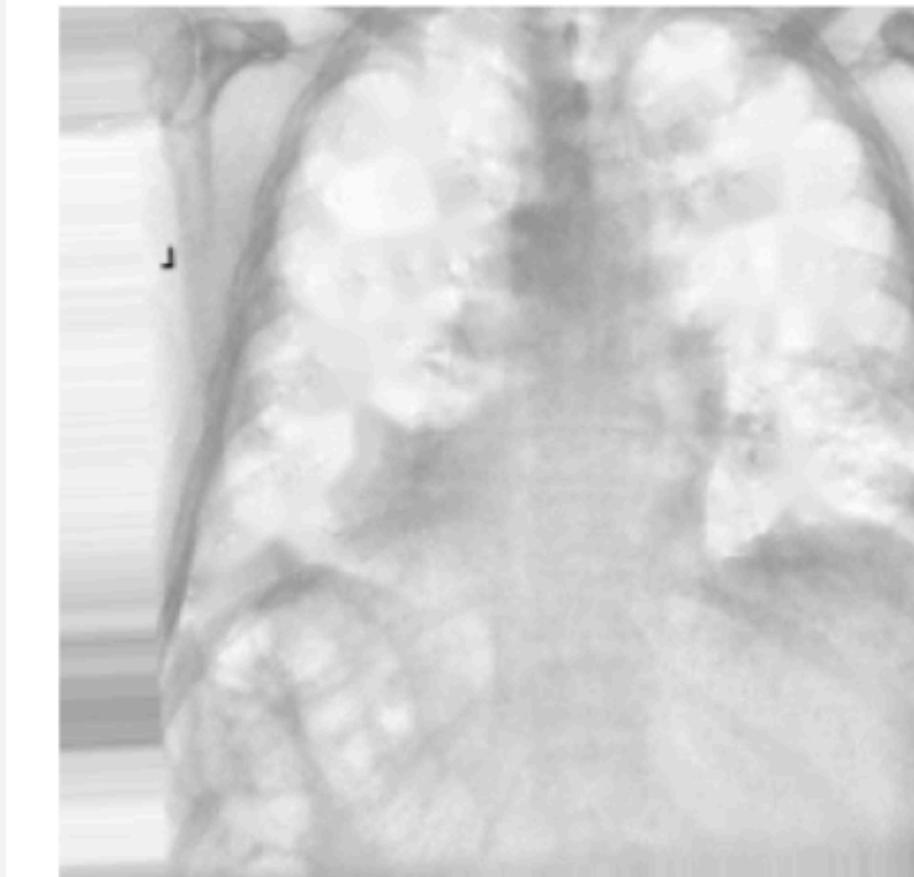


- 400 epoch train



Right Prediction

Original (covid19)
Predicted: covid19



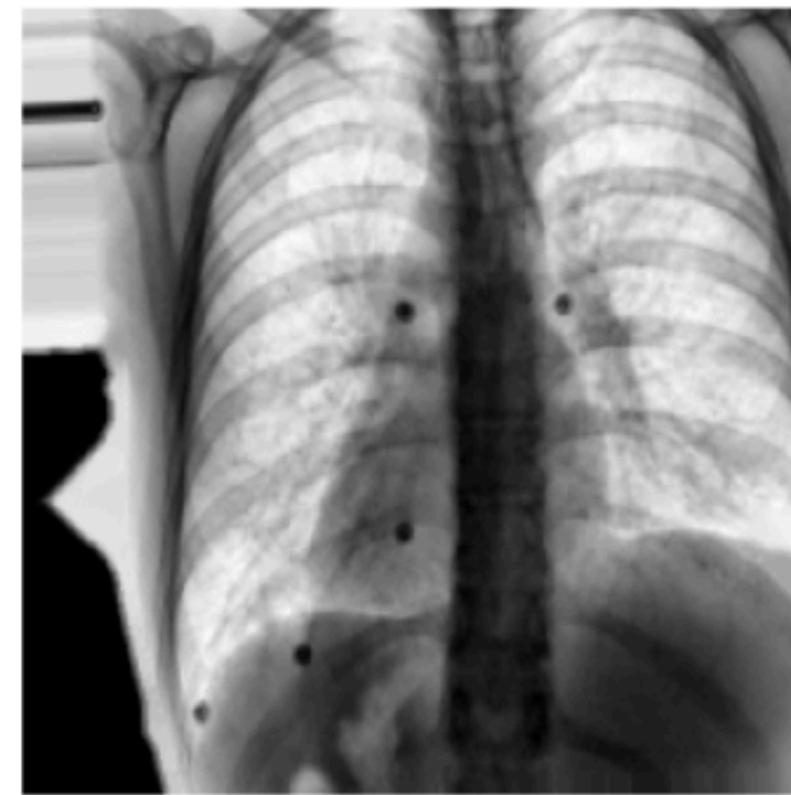
GRAD-CAM

- 15 epoch train

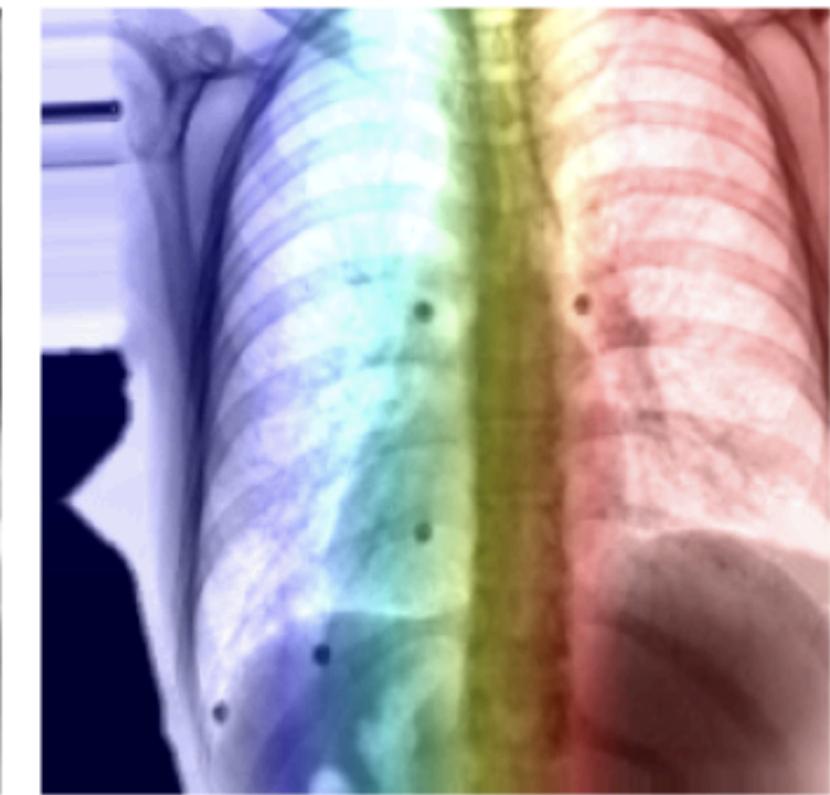


False Prediction

Original Image
(True: pneumonia)



Grad-CAM
(Pred: pneumonia)

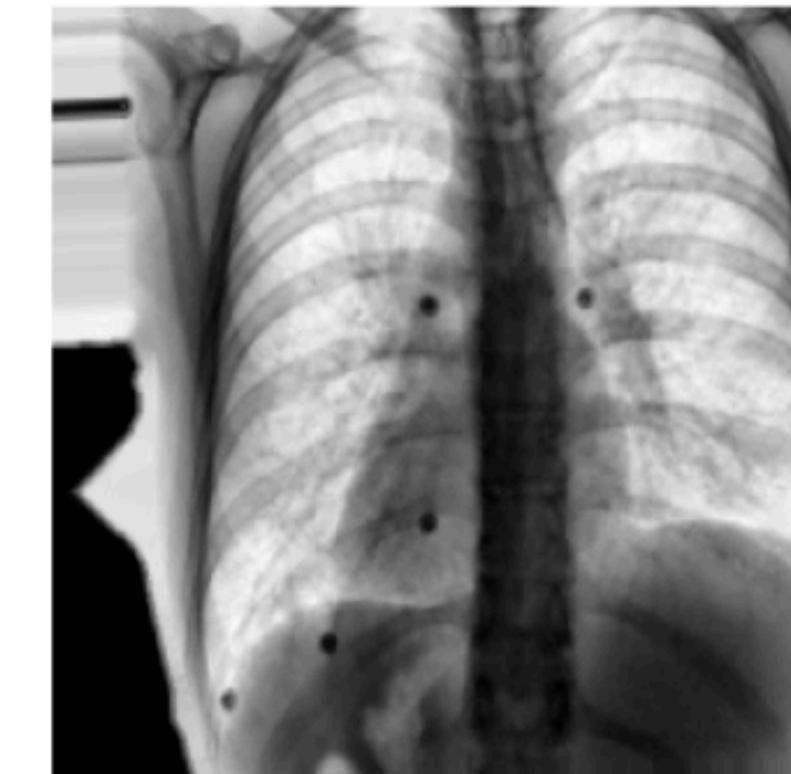


- 400 epoch train

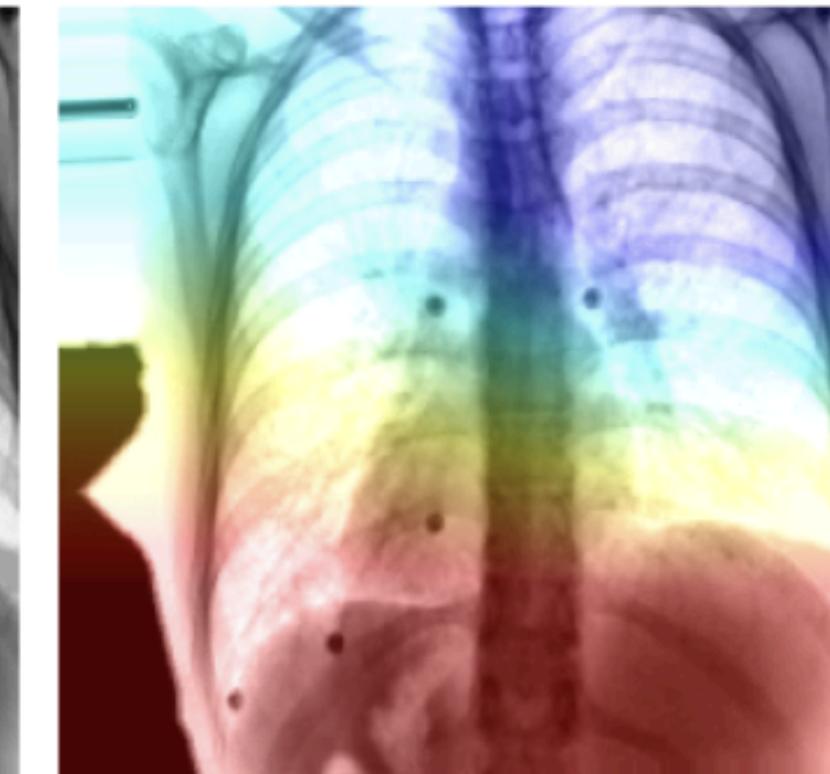


Right Prediction

Original Image
(True: pneumonia)



Grad-CAM
(Pred: pneumonia)



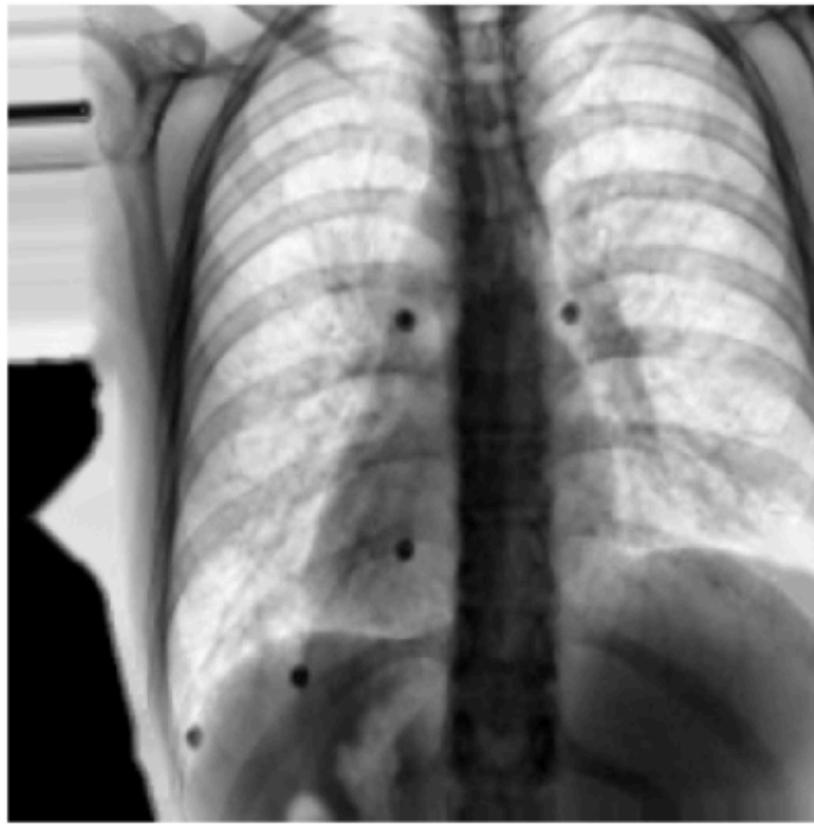
DEEP-LIFT

- 15 epoch train

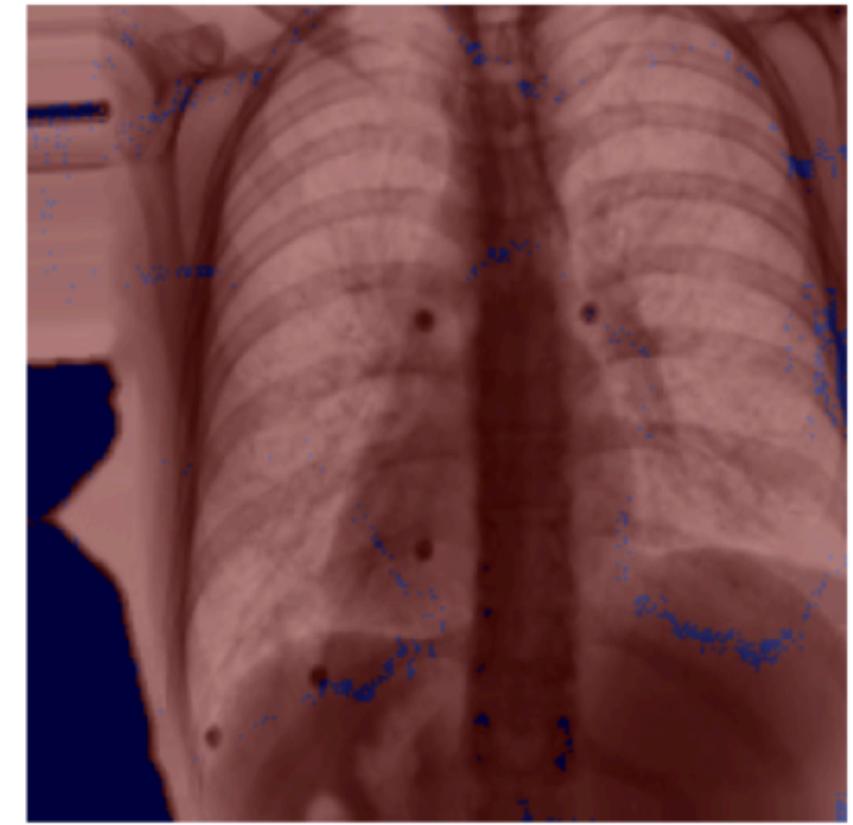


False Prediction

True: pneumonia, Pred: pneumonia



DeepLIFT Heatmap

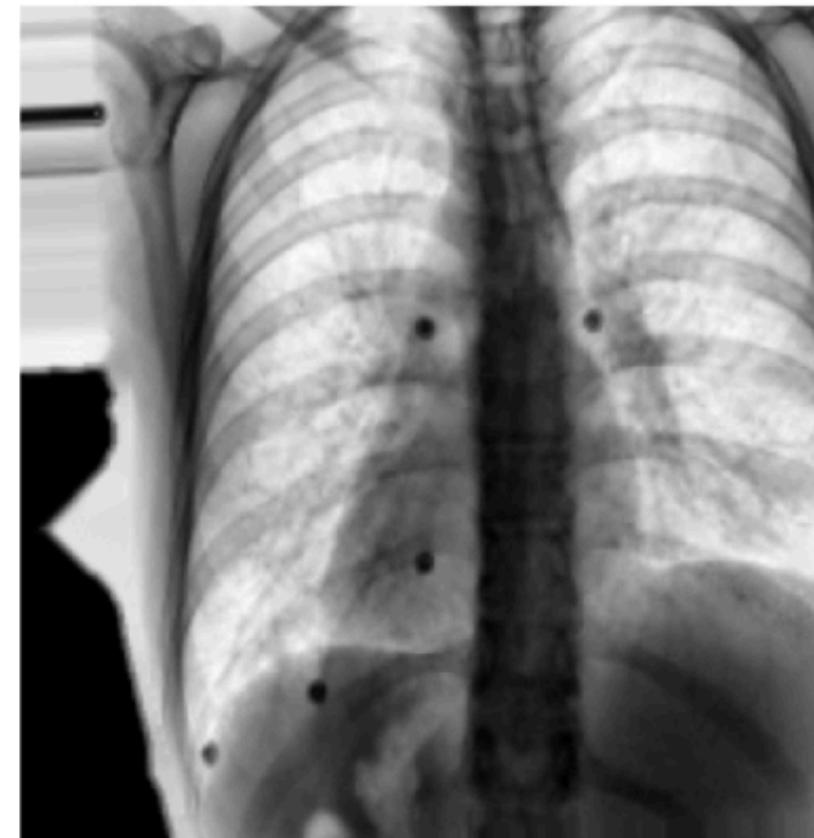


- 400 epoch train

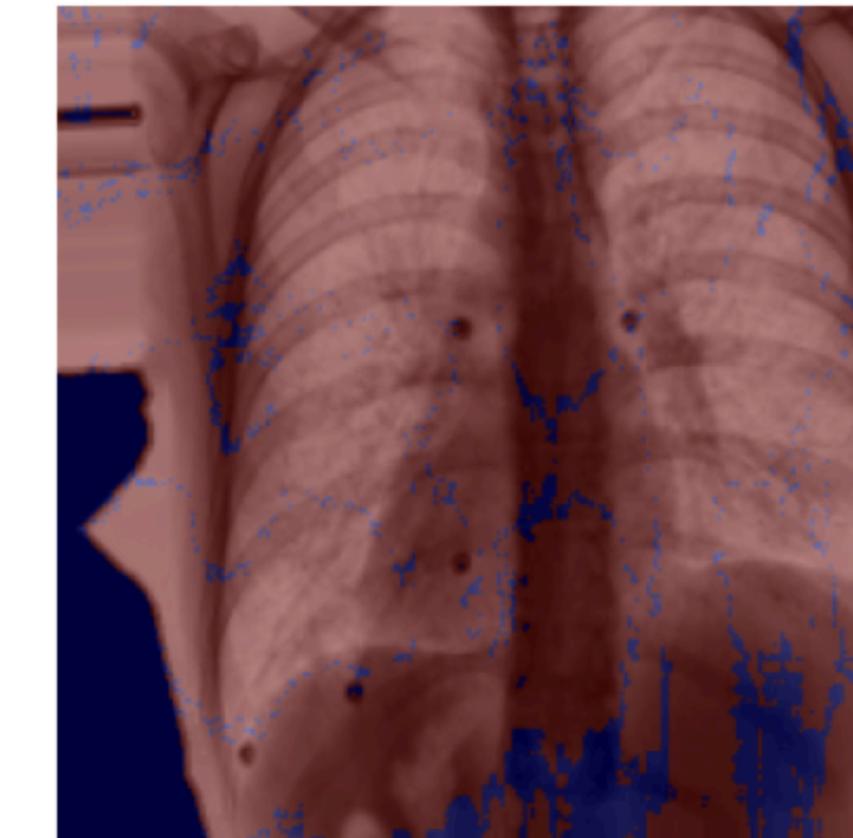


Right Prediction

True: pneumonia, Pred: pneumonia

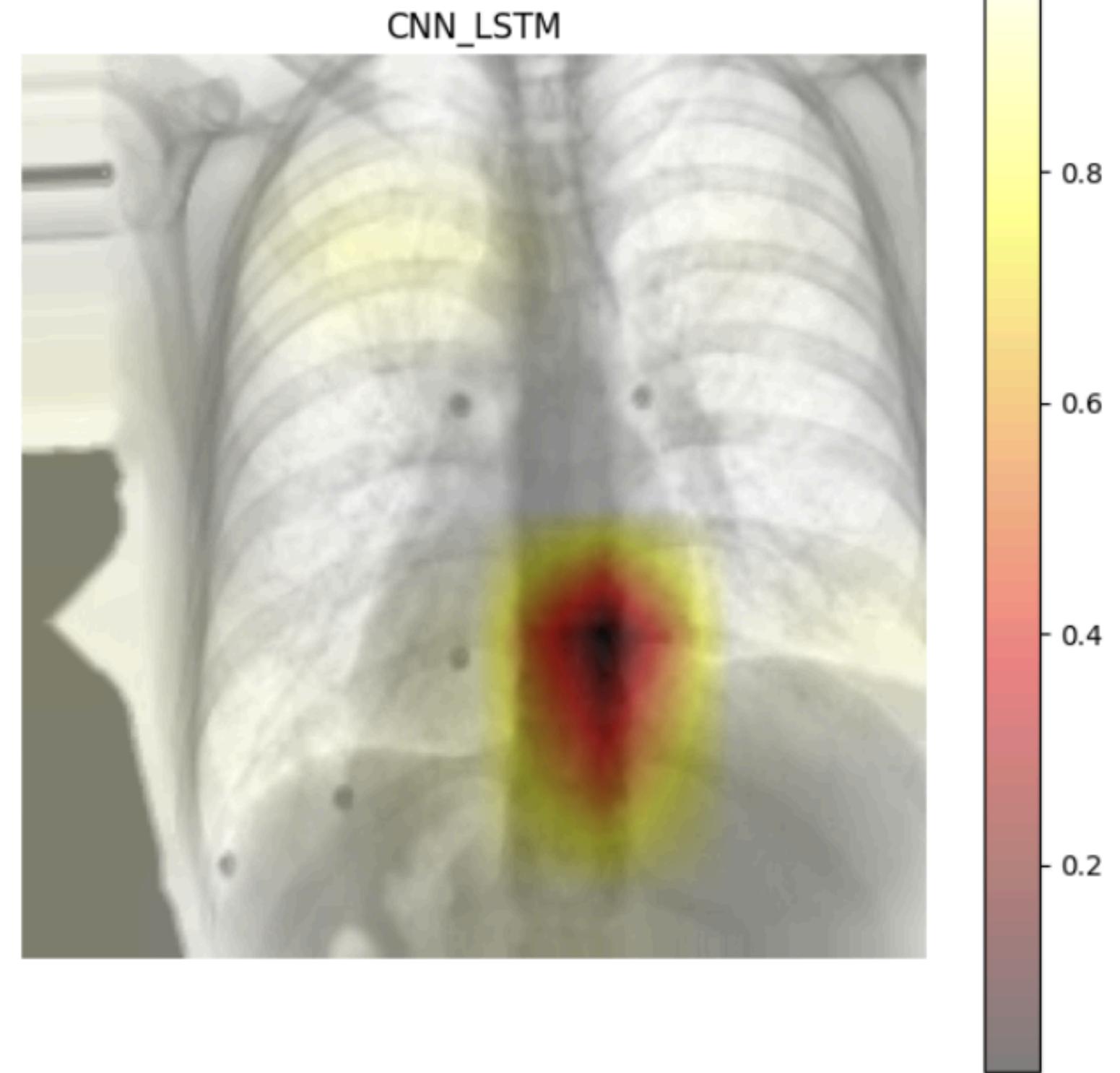


DeepLIFT Heatmap



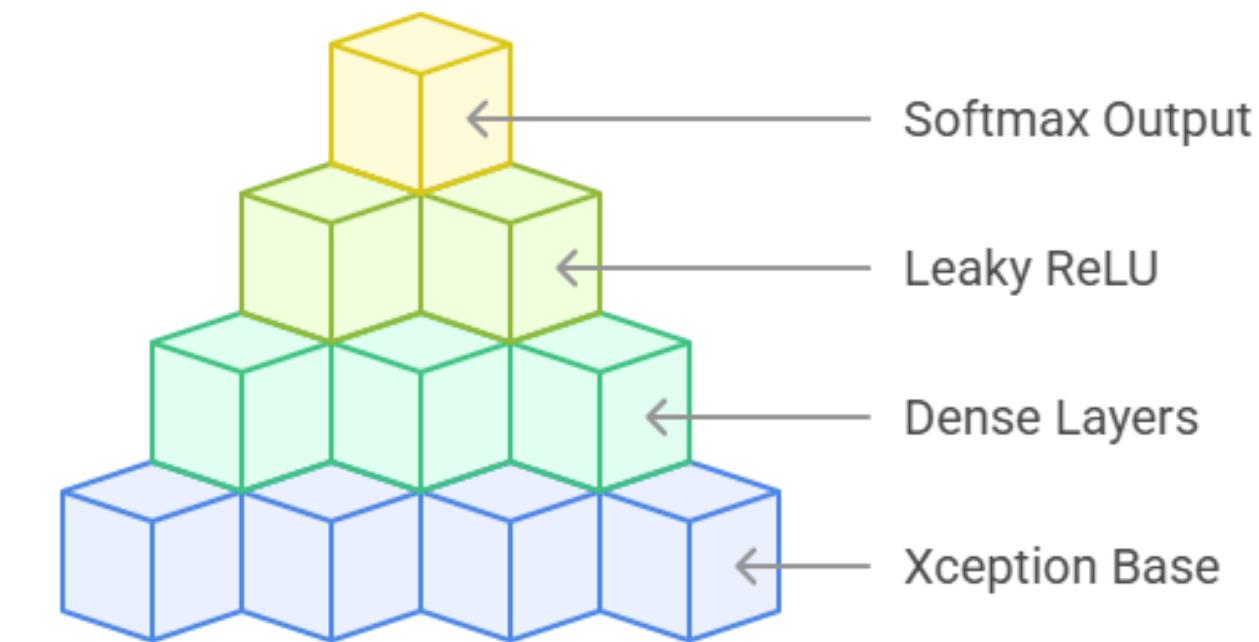
PERMUTATION IMPORTANCE

- 400 epoch train



XCEPTION NET BENCHMARKING

METHODOLOGY



New Results



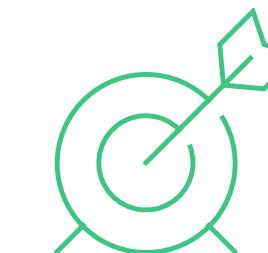
- the model achieved test Accuracy of 84%, AP of 99% for one class and around 86% in the other two.



- Used Accuracy, loss, confusion matrix, ROC and PR curves as Performance Evaluation
- t-SNE Visualization as partial XAI
- LIME, Permutation Importance, GRAD_CAM and DeepLift as XAI Techniques

VS

Paper Results



- The model Achieved over 97% accuracy, 95% F1-score in most scenarios.



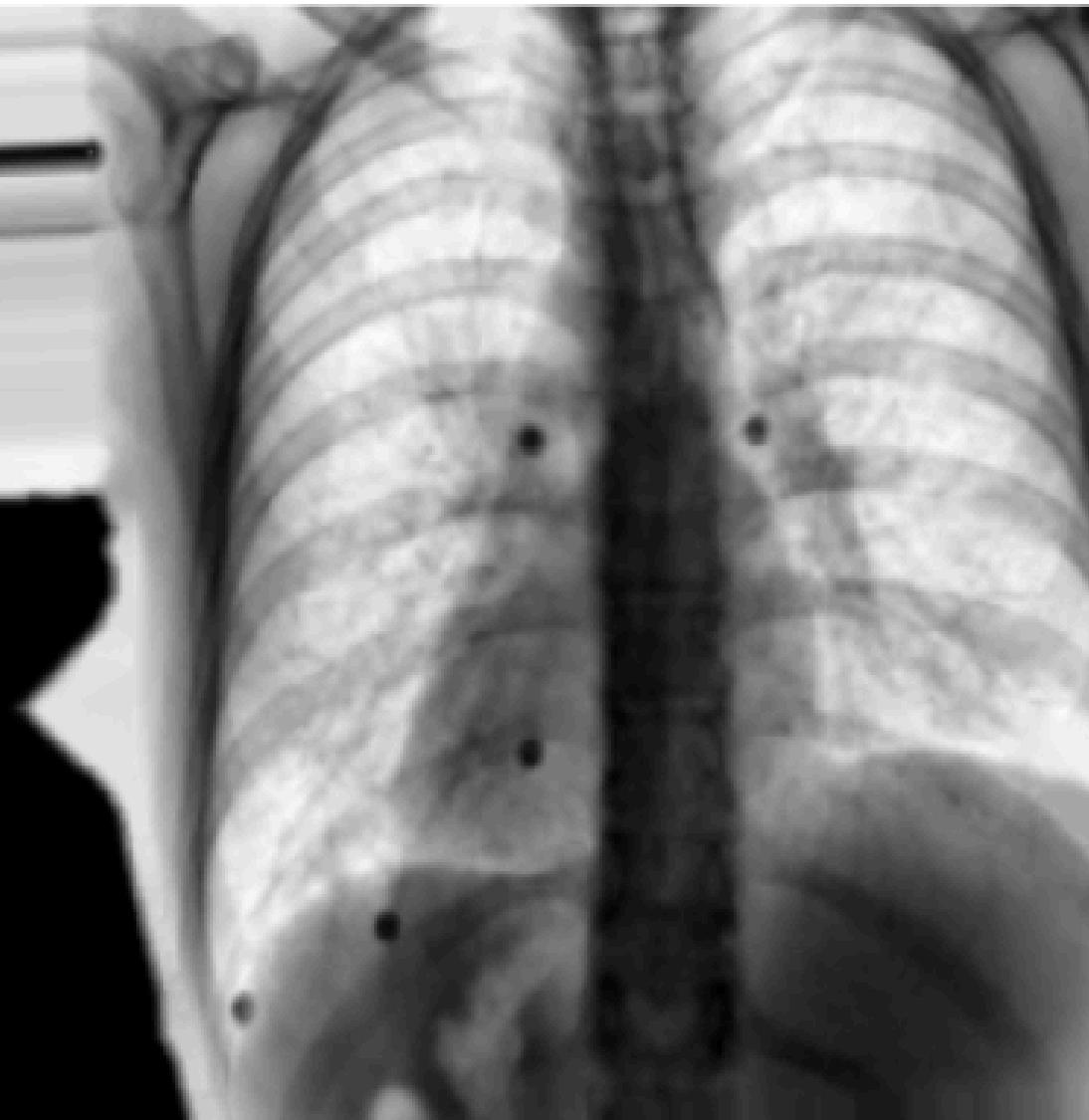
- Used Accuracy, loss, Precision, Recall, F1-score and confusion matrix as Performance Evaluation.



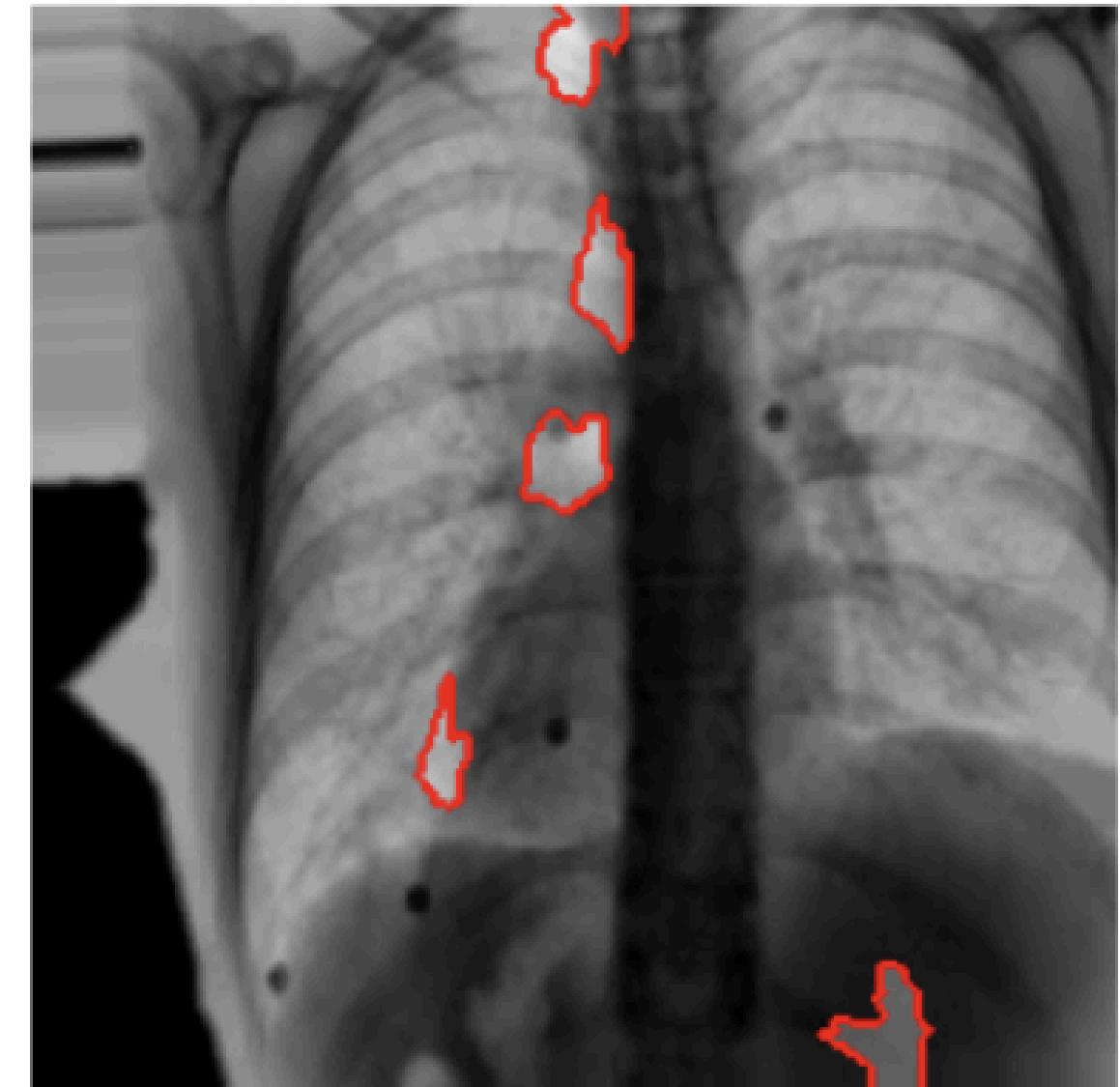
LIME

- 15 epoch train

Original (pneumonia)
Predicted: pneumonia



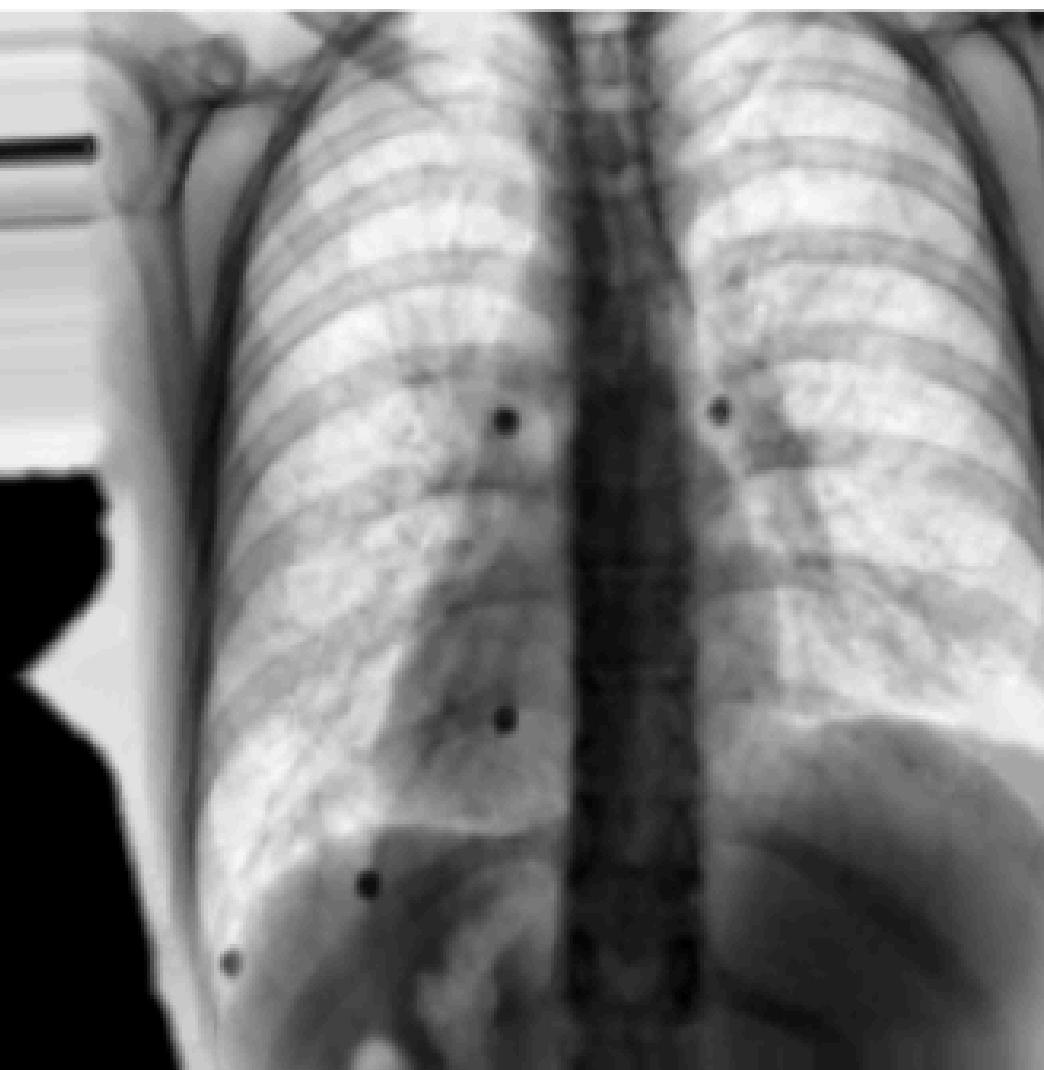
LIME Highlights



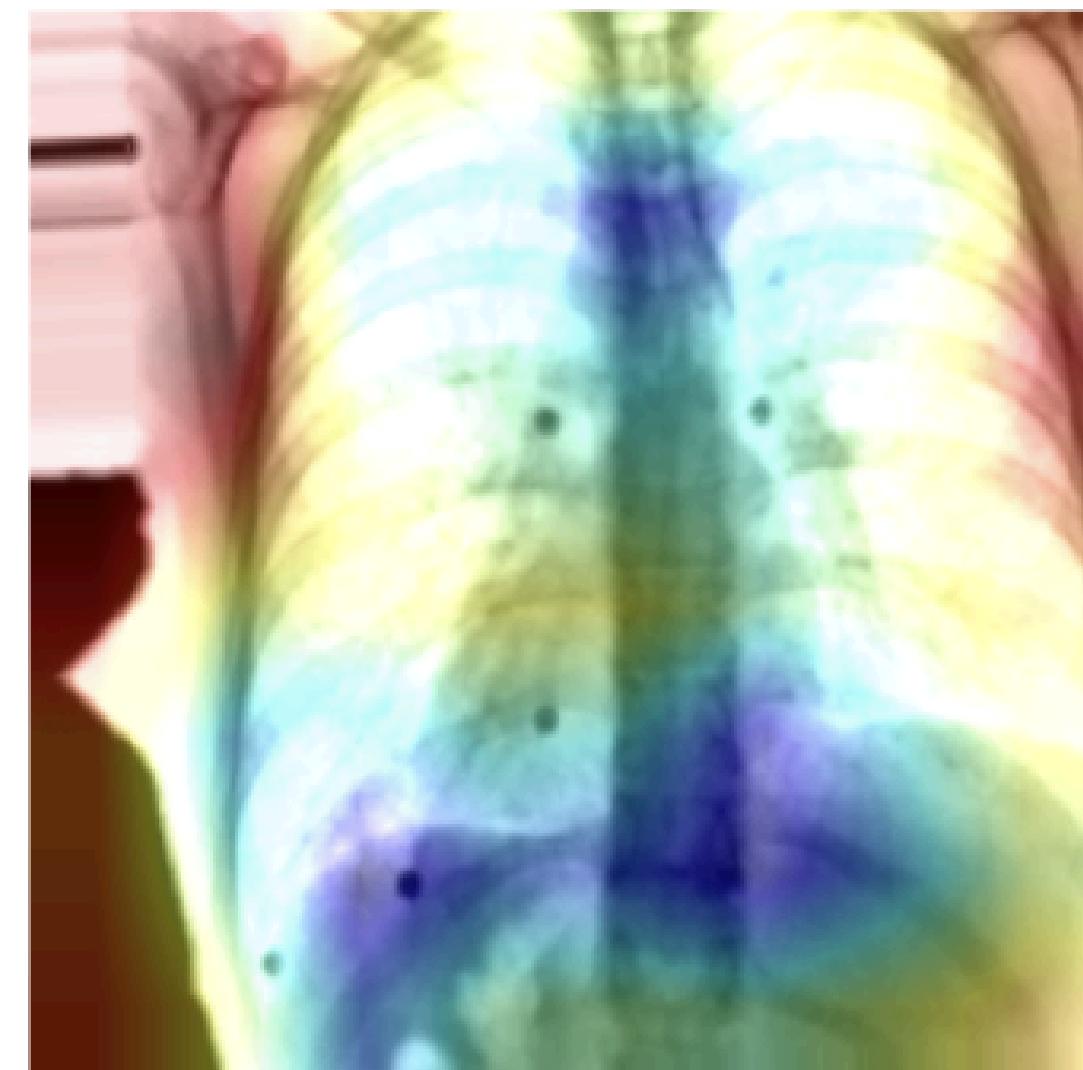
GRAD-CAM

- 15 epoch train

Original Image
(True: pneumonia)



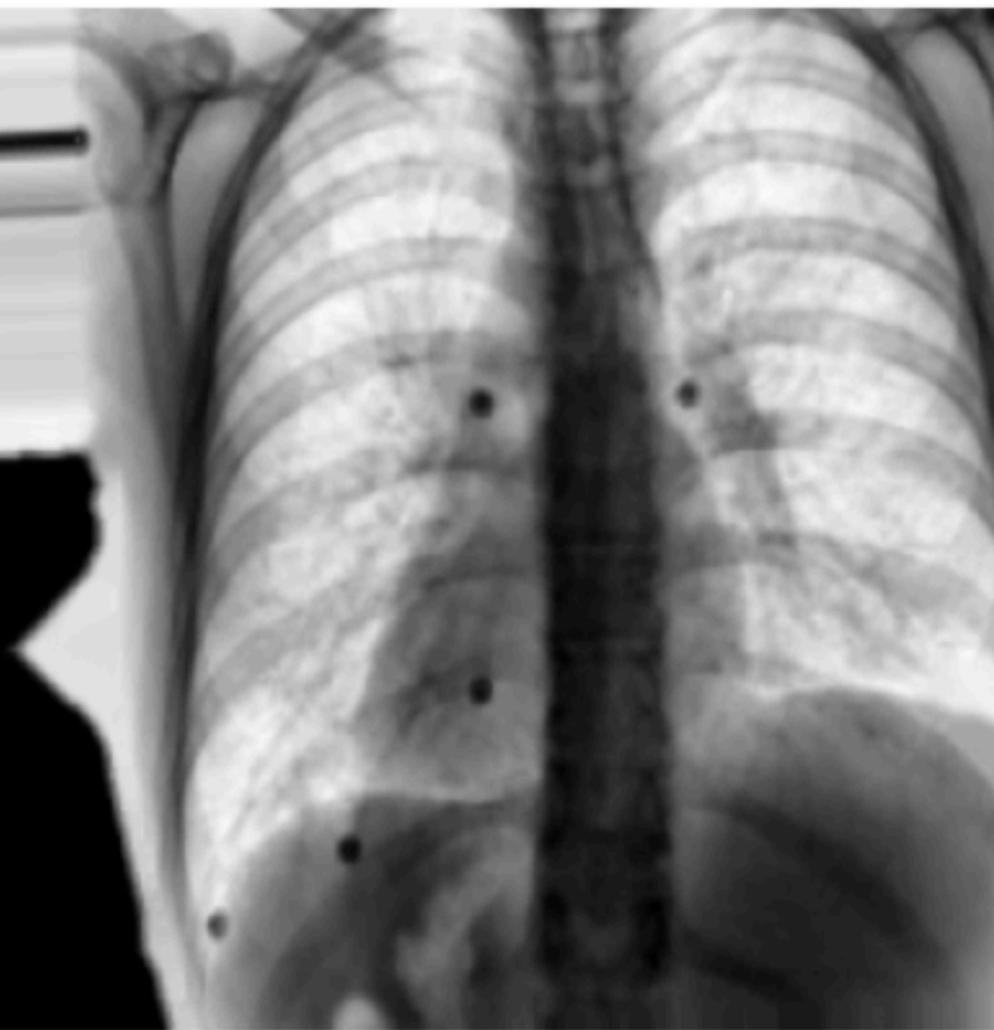
Grad-CAM
(Pred: pneumonia)



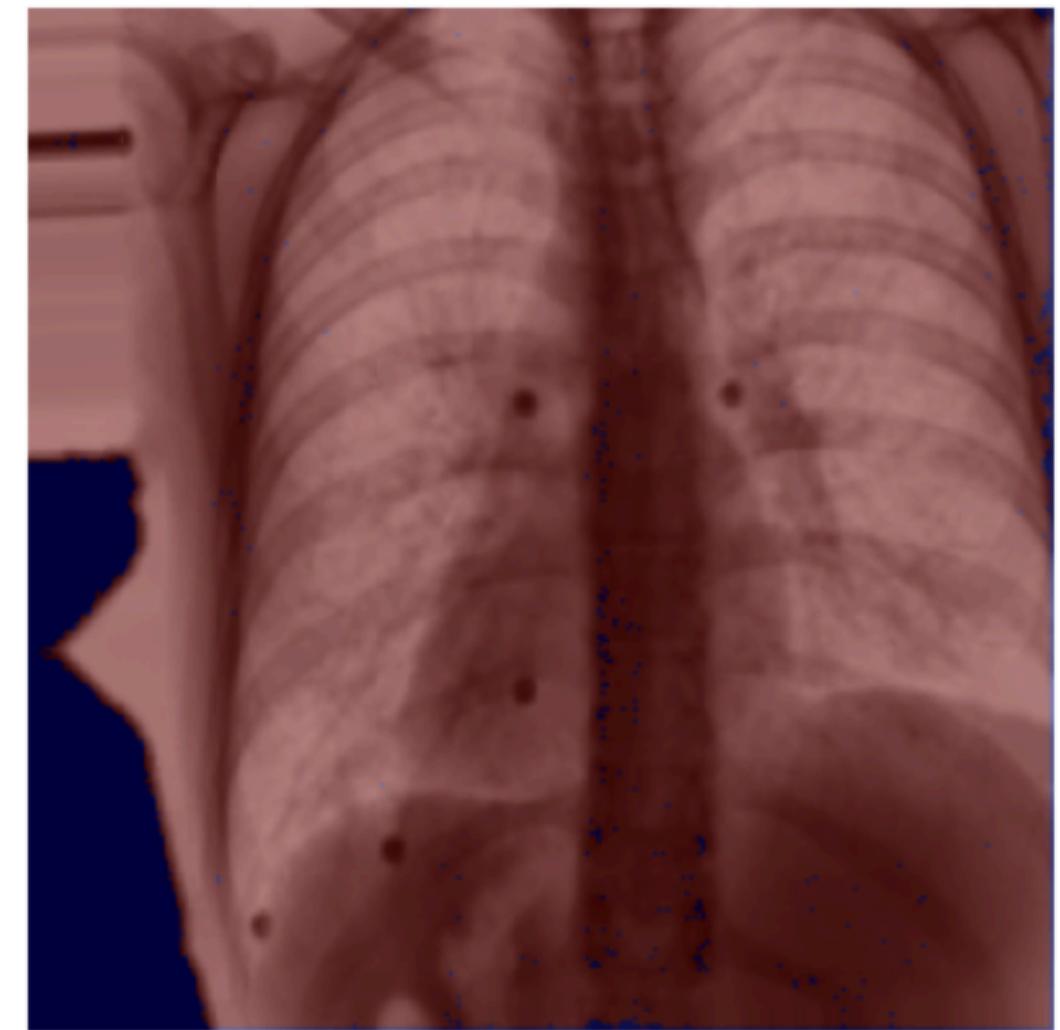
DEEP-LIFT

- 15 epoch train

True: pneumonia, Pred: pneumonia

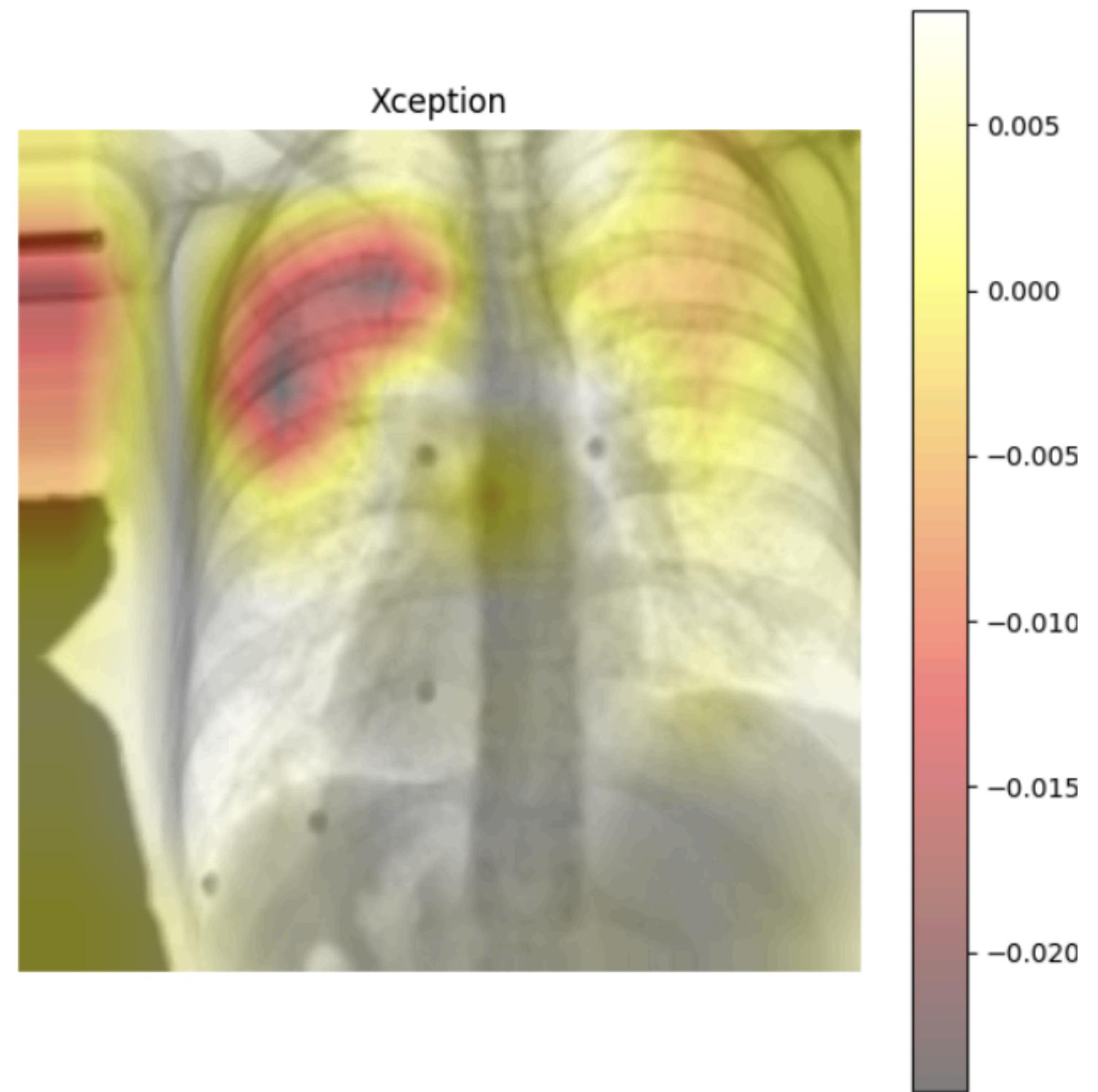


DeepLIFT Heatmap



PERMUTATION IMPORTANCE

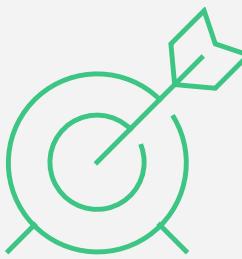
- 15 epoch train



METHODOLOGY

SIMPLE ONE CONV LAYER

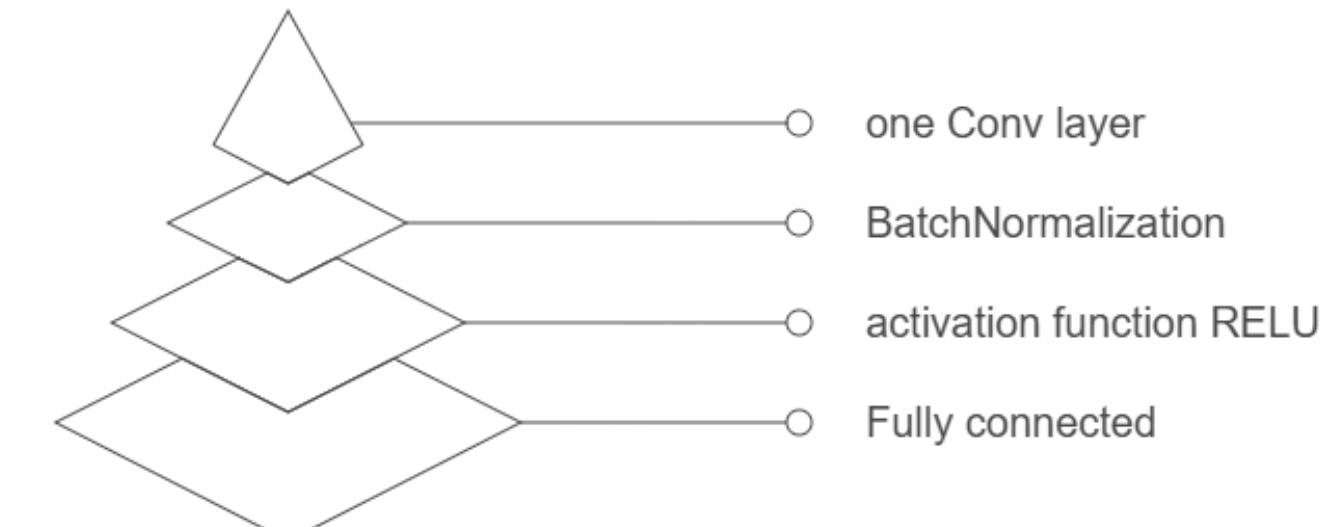
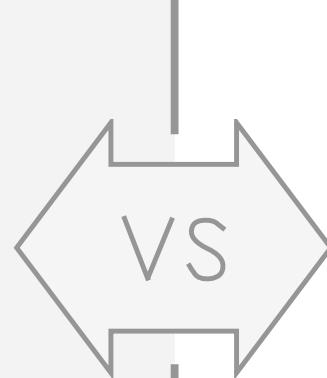
New Results



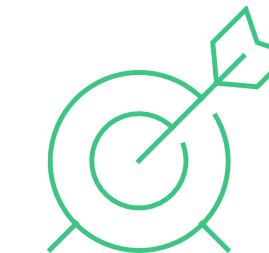
- the model achieved test Accuracy of 89%, AP of 98% for one class and around 90% in the other two.



- Used Accuracy, loss, confusion matrix, ROC and PR curves as Performance Evaluation
- t-SNE Visualization as partial XAI
- LIME, Permutation Importance, GRAD_CAM and DeepLift as XAI Techniques



Paper Results



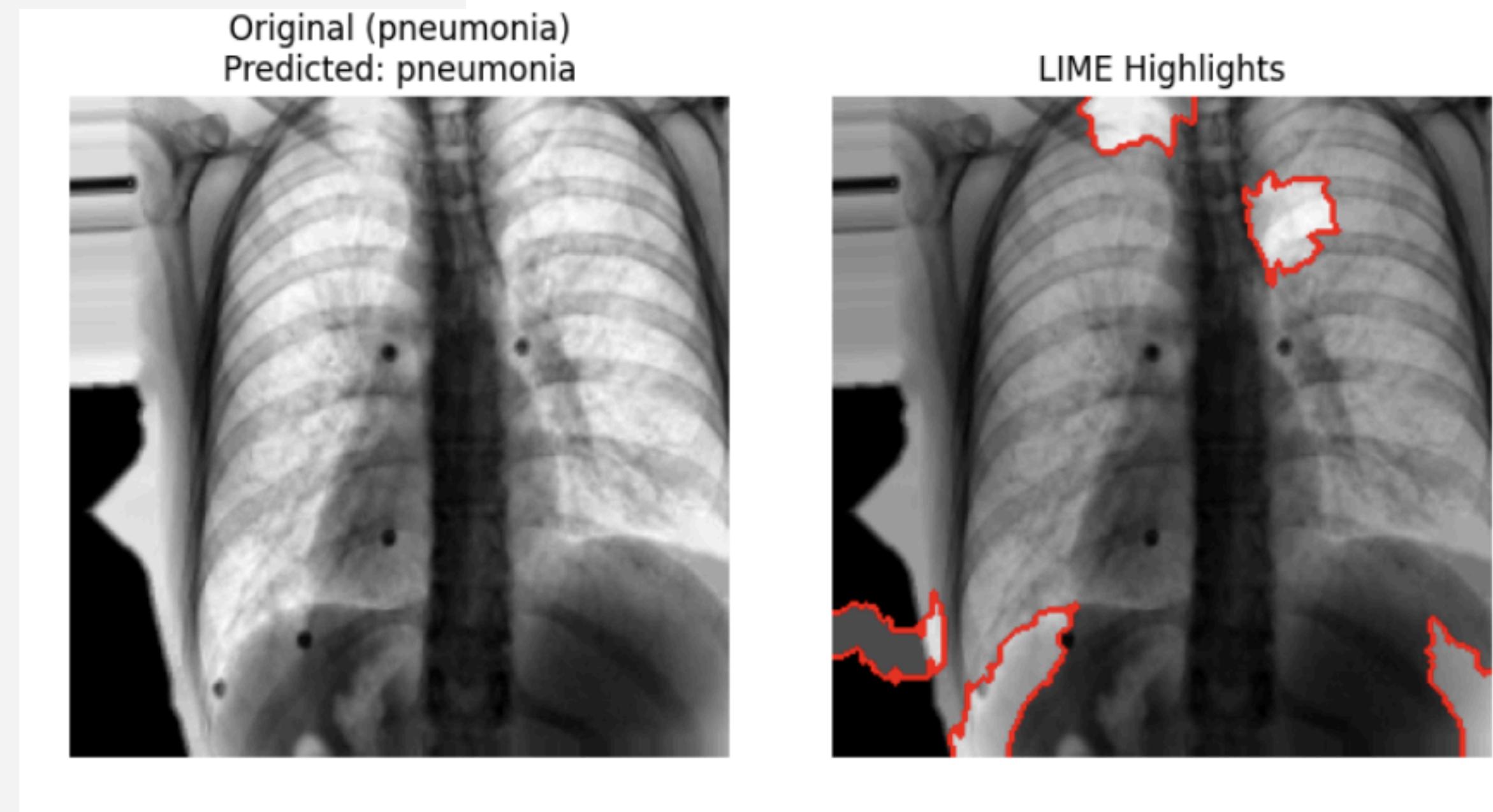
- The model Achieved 95% accuracy, 96% F1-score in most scenarios.



- Used Accuracy, loss, Precision, Recall, F1-score, Specificity, Sensitivity and confusion matrix as Performance Evaluation.

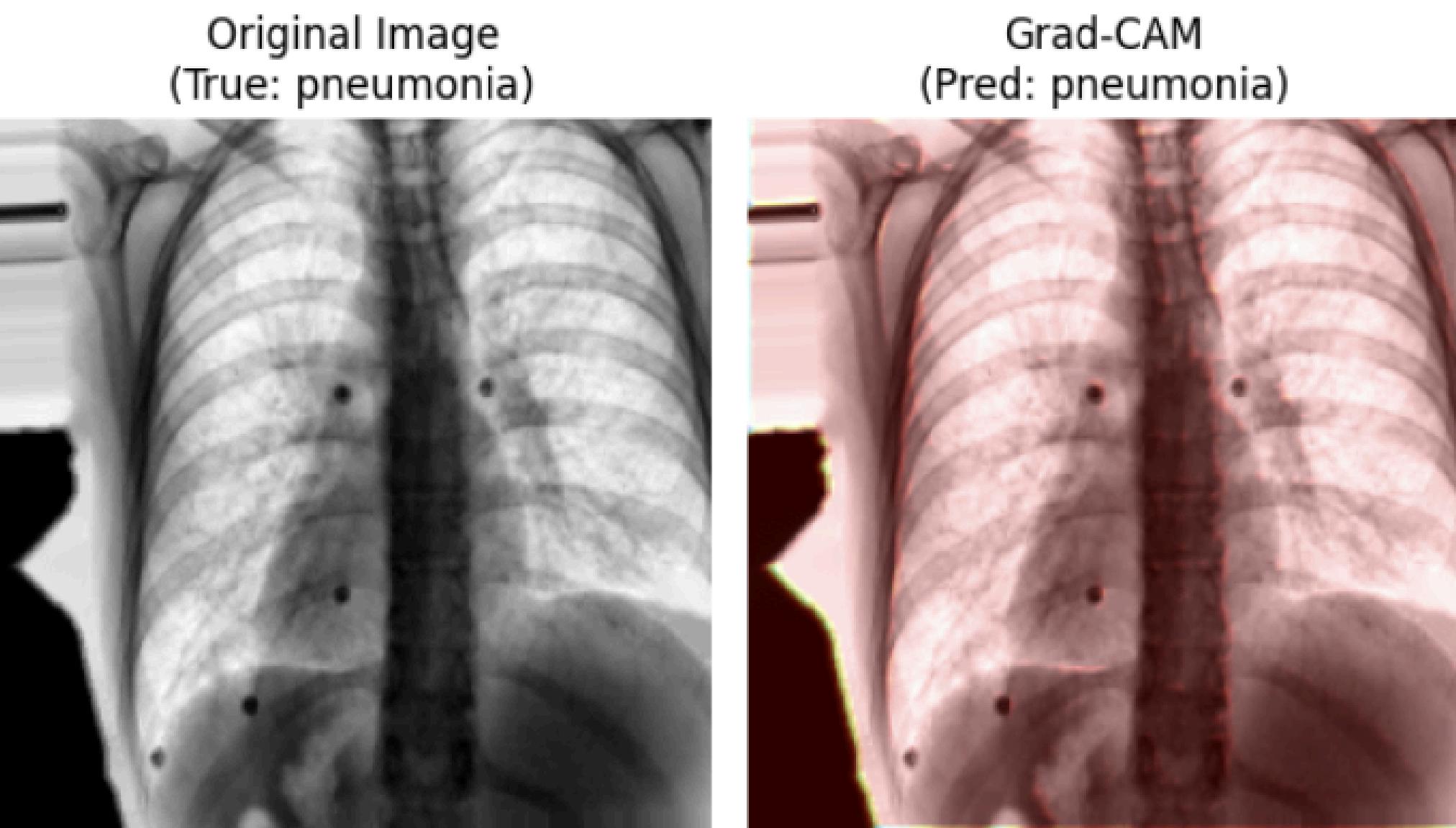
LIME

- 500 epoch train



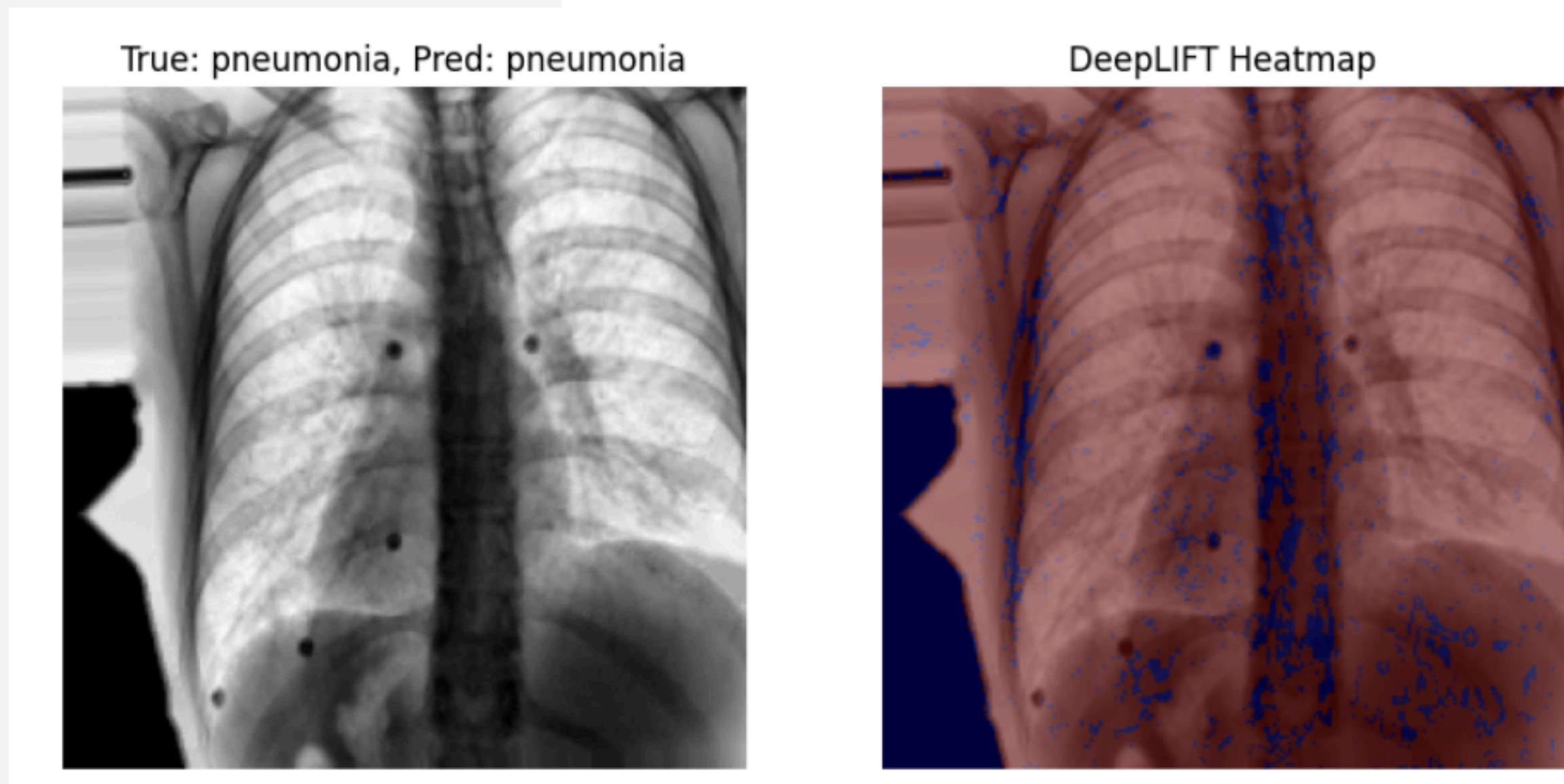
GRAD-CAM

- 500 epoch train



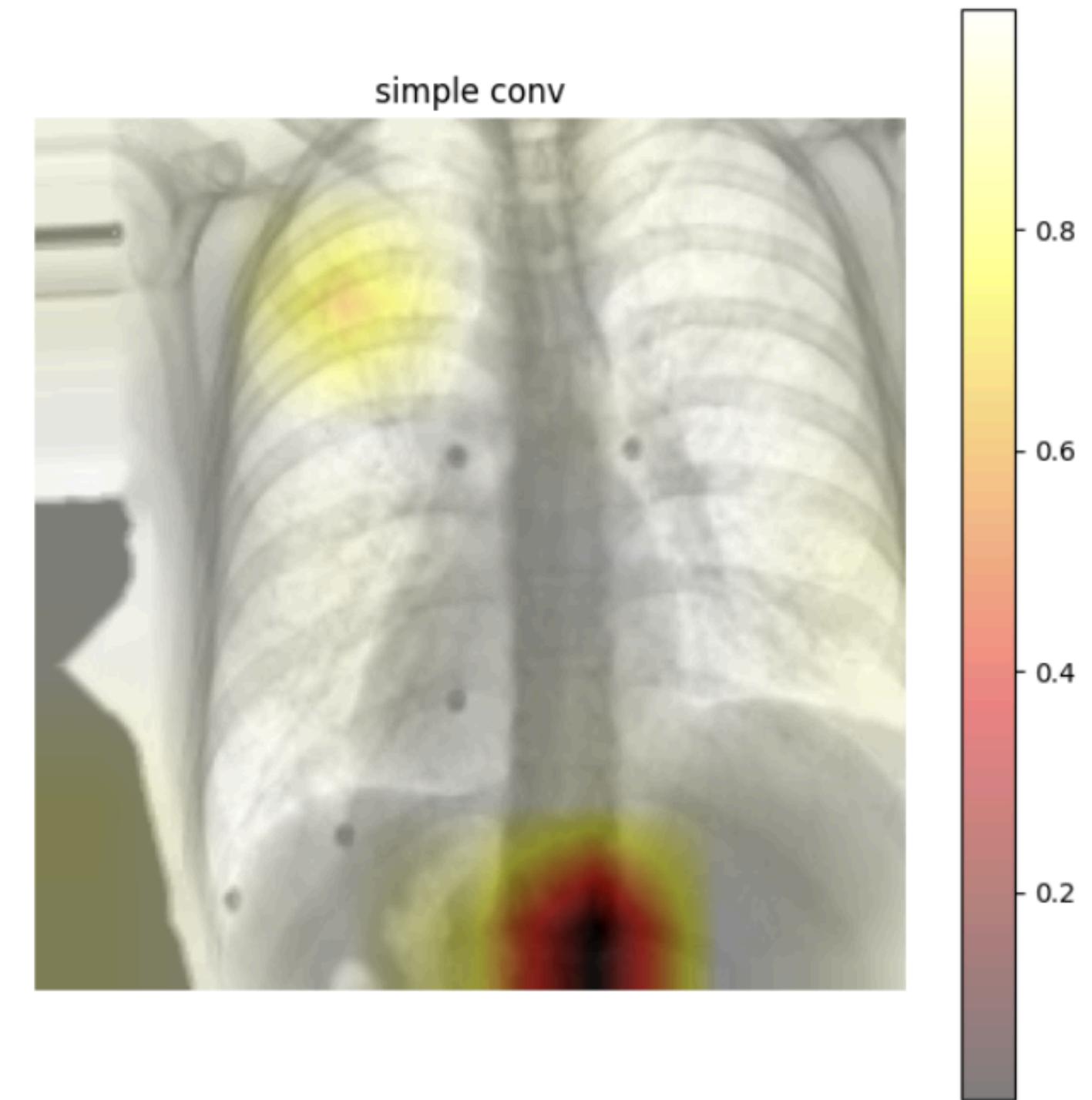
DEEP-LIFT

- 500 epoch train



PERMUTATION IMPORTANCE

- 400 epoch train



APPLICATION OF DEEP LEARNING FOR FAST DETECTION OF COVID-19 IN X-RAYS USING NCOVNET

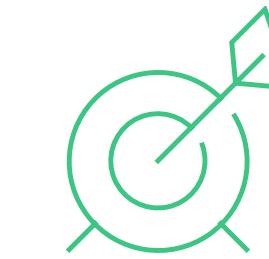
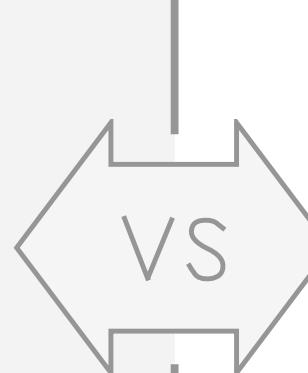
New Results



- The model achieved an overall Accuracy of 81%, and 90% for Covid-19 class. It also achieved an AUC of 0.92, sensitivity of 82% , and specificity of 82% for Covid-19 class.



- Used Accuracy, Loss, Specificity, Sensitivity and Confusion Matrix, Precision, AUC, and ROC.
- LIME, Permutation Importance, GRAD_CAM and DeepLift as XAI techniques.



- The model achieved an overall Accuracy of 88%, and 97% for Covid-19 class. It also achieved an AUC of 0.88, sensitivity of 97.62% , and specificity of 78.57% for Covid-19 class.



- Used Accuracy, Loss, Specificity, Sensitivity and Confusion Matrix, Precision, AUC, and ROC.

METHODOLOGY

Convolutional Layers

Feature extraction using CNN layers



Max Pooling

Reducing dimensionality and complexity

Transfer Learning

Adapting model to COVID-19 dataset



ReLU Activation

Applying non-linear activation functions



VGG16 Feature Extraction

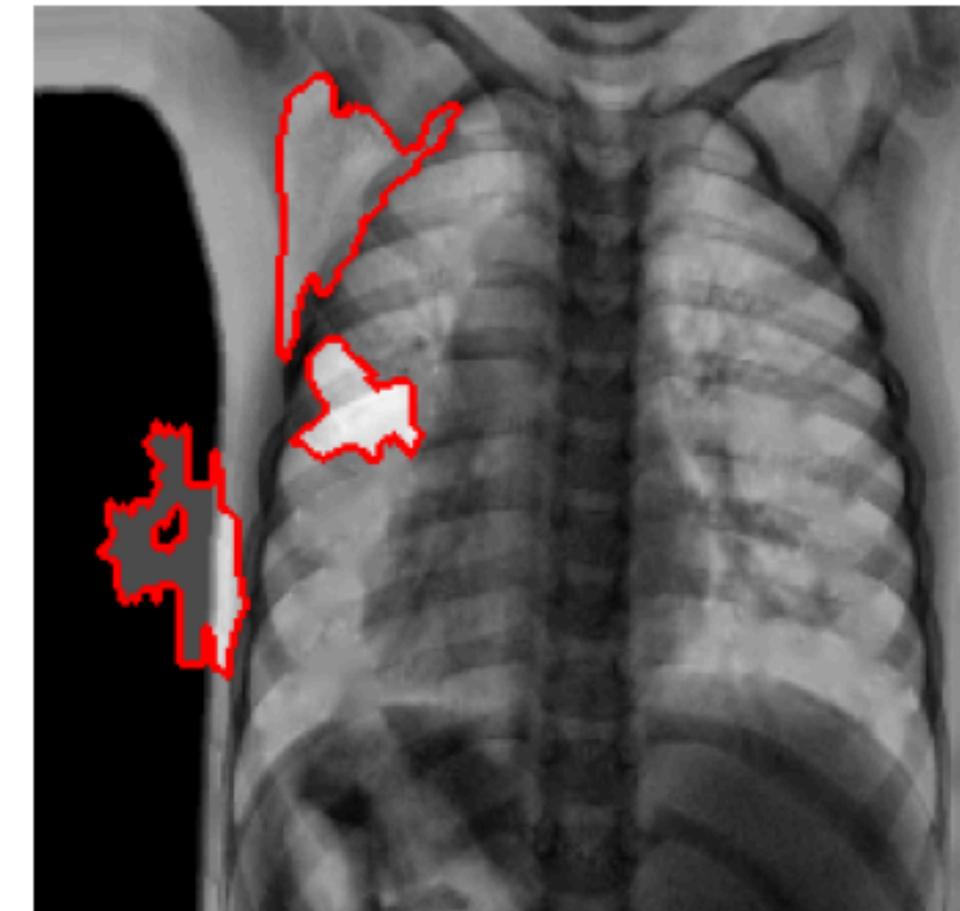
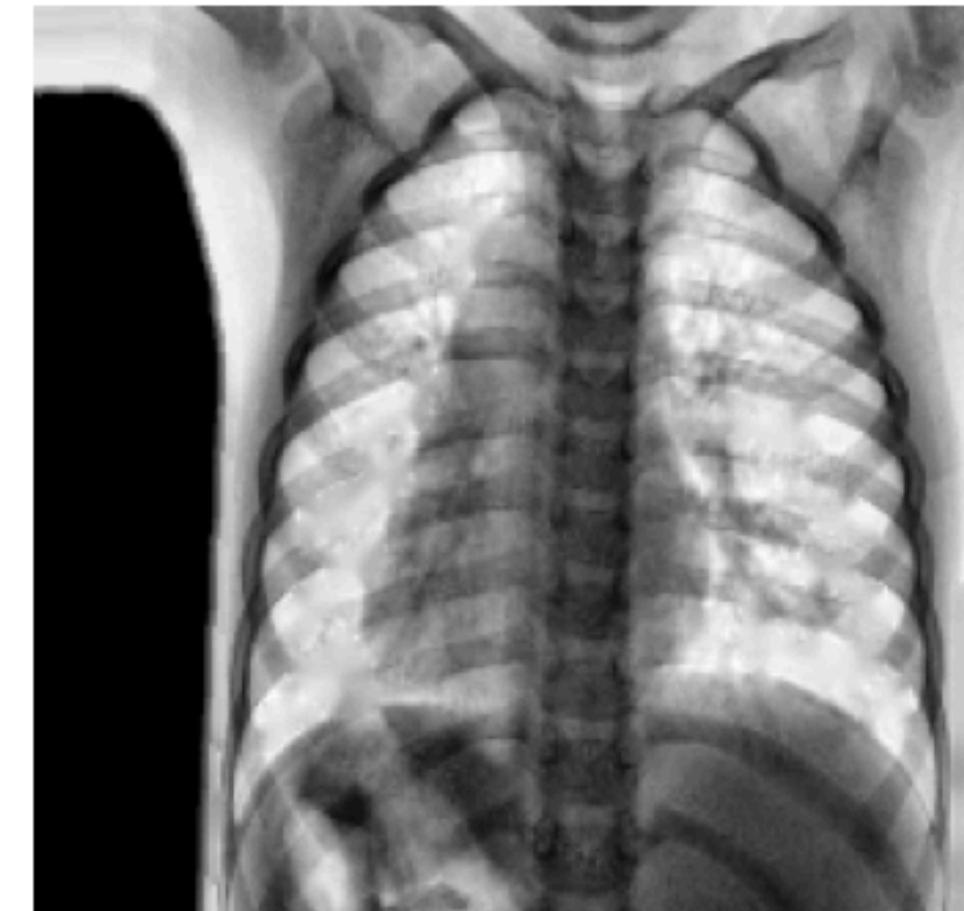
Utilizing pre-trained VGG16 model

LIME

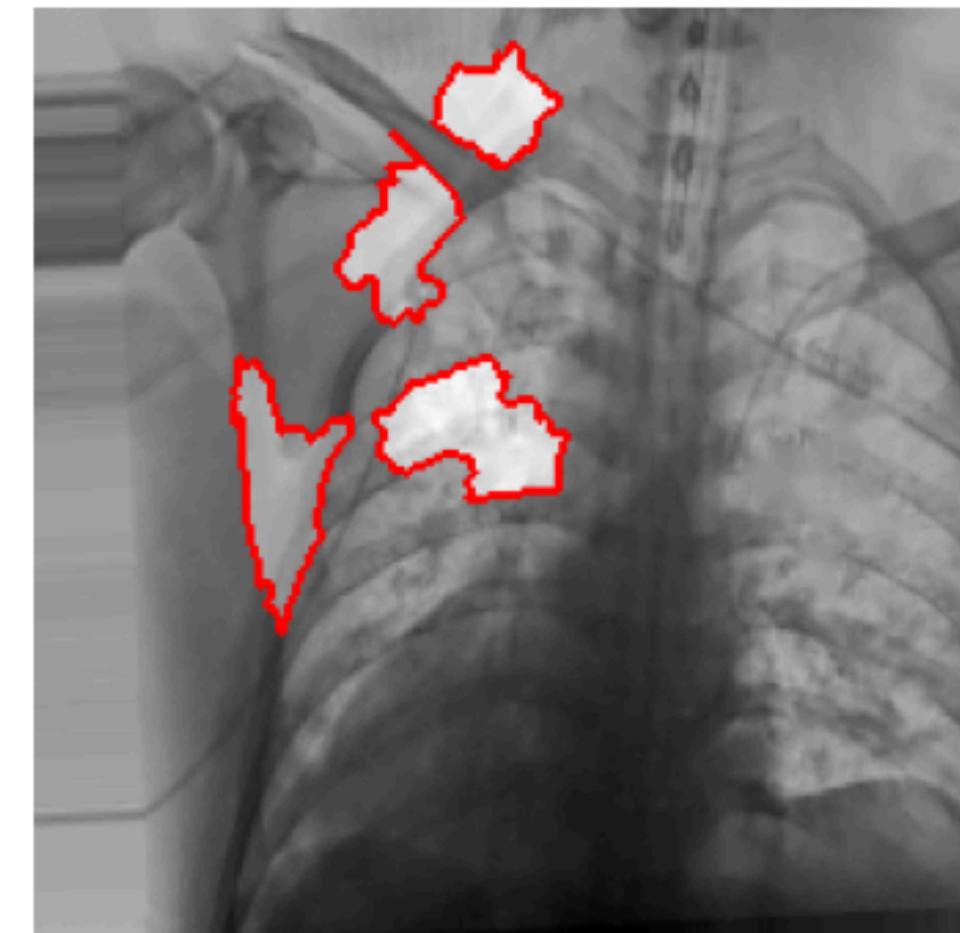
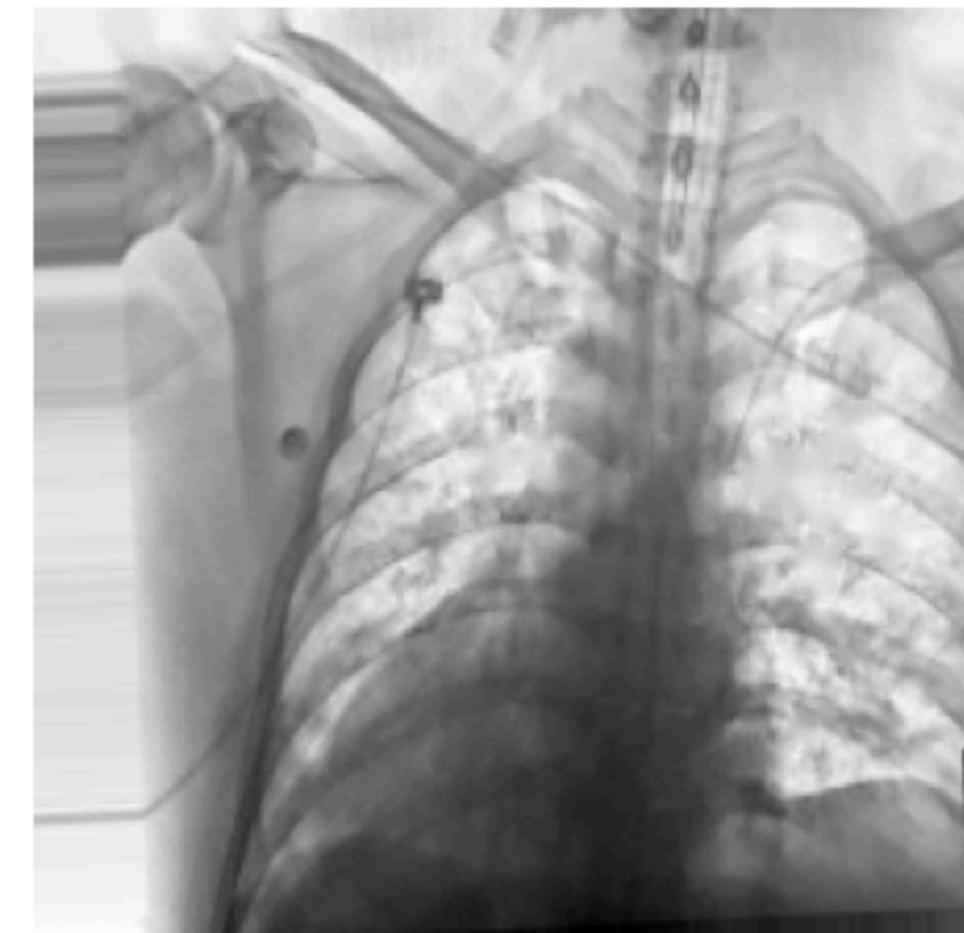


False Prediction

Original (normal)
Predicted: pneumonia



Right Prediction

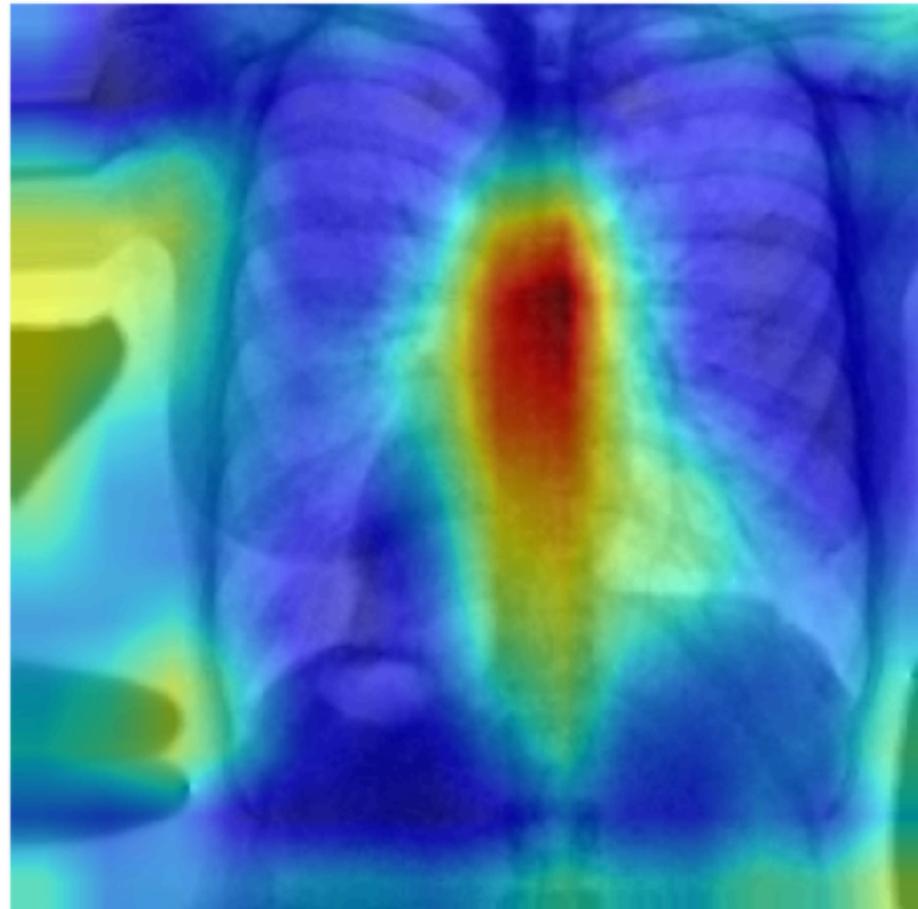
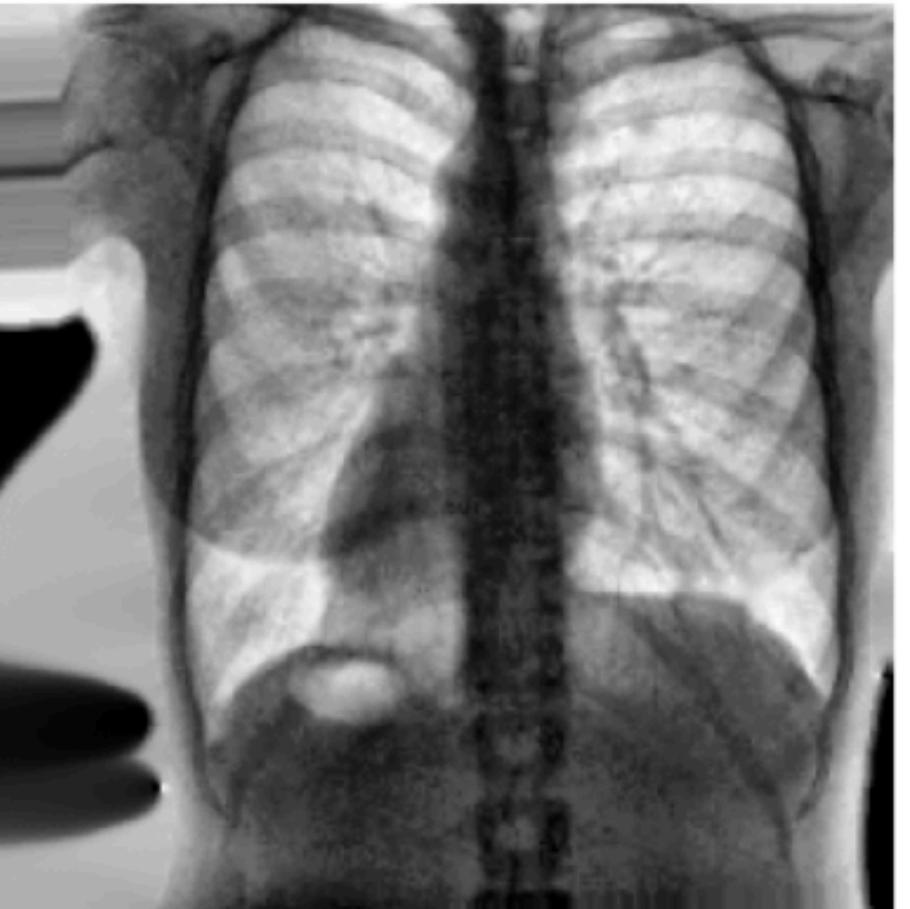


GRAD-CAM



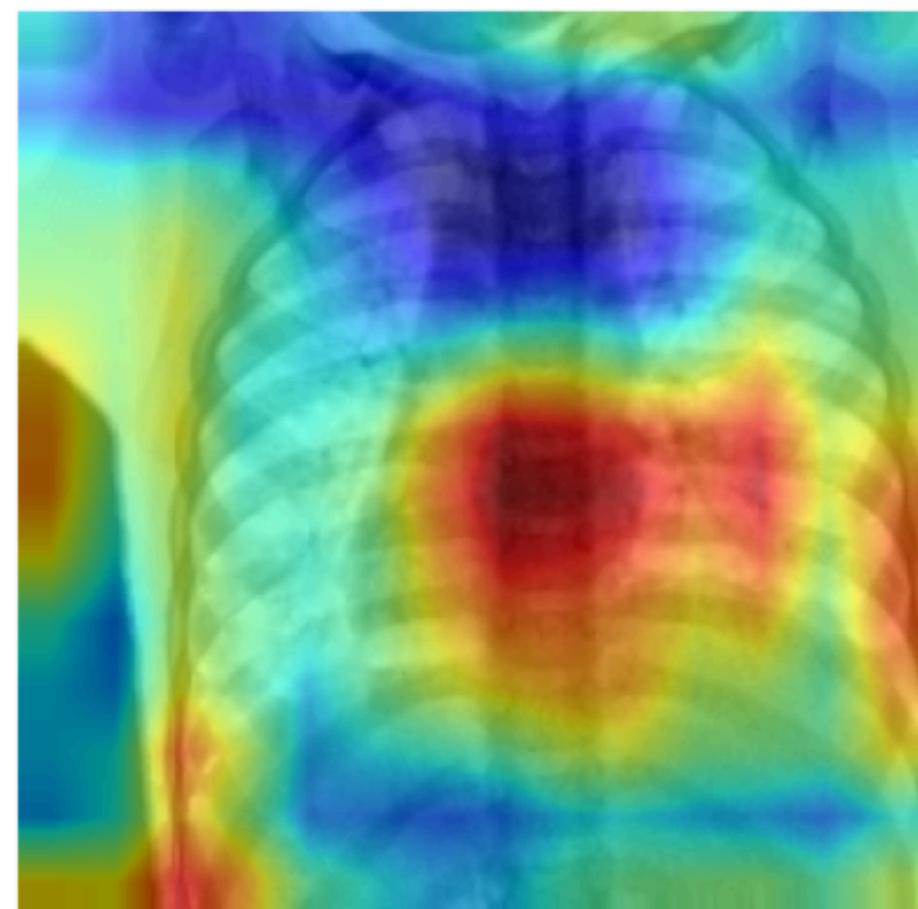
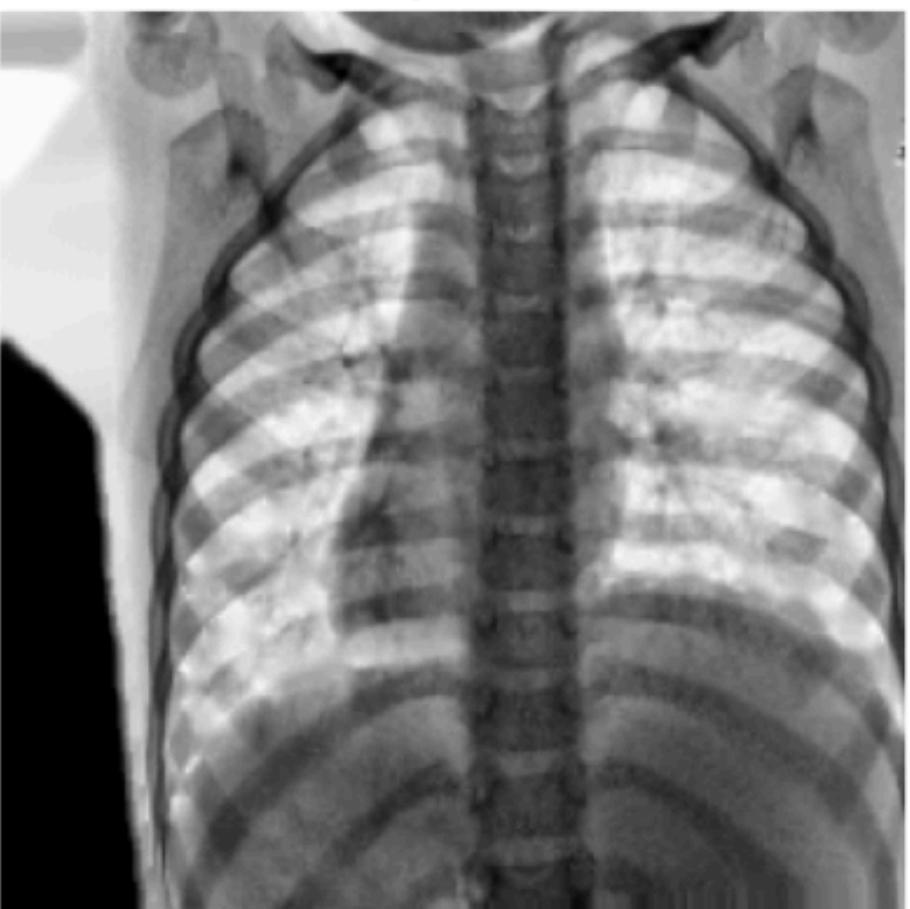
False Prediction

Predicted: normal
Actual: pneumonia



Right Prediction

Predicted: pneumonia
Actual: pneumonia

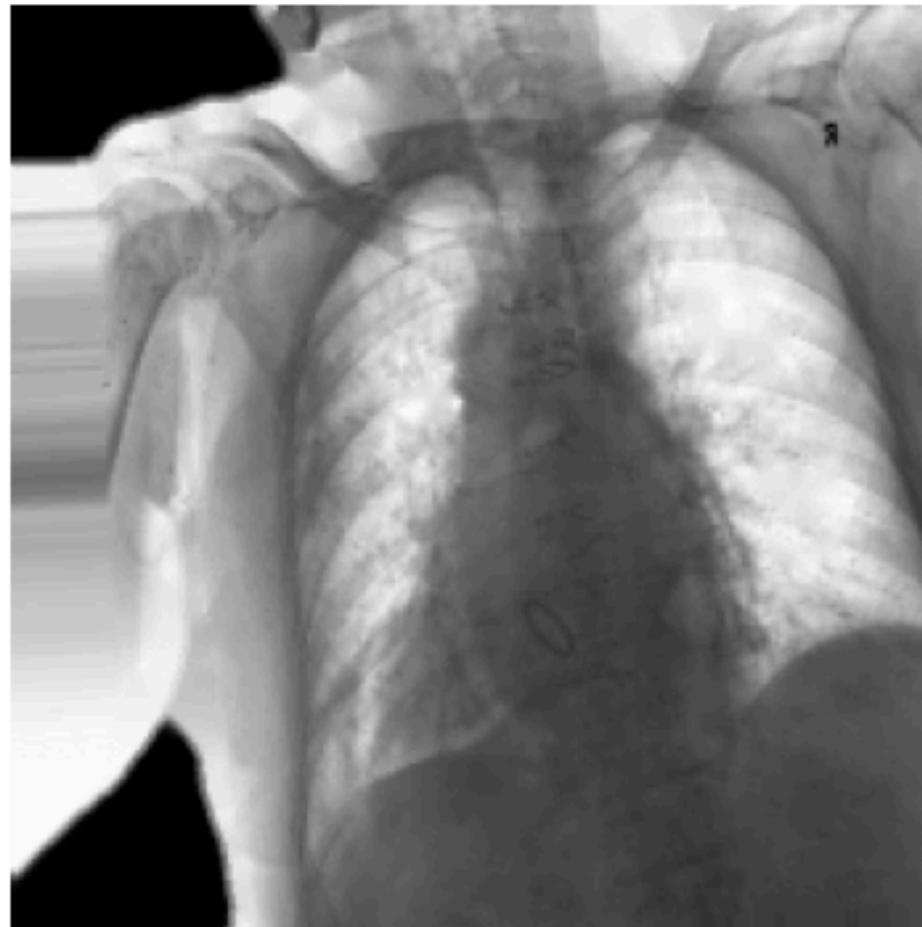


DEEPLIFT

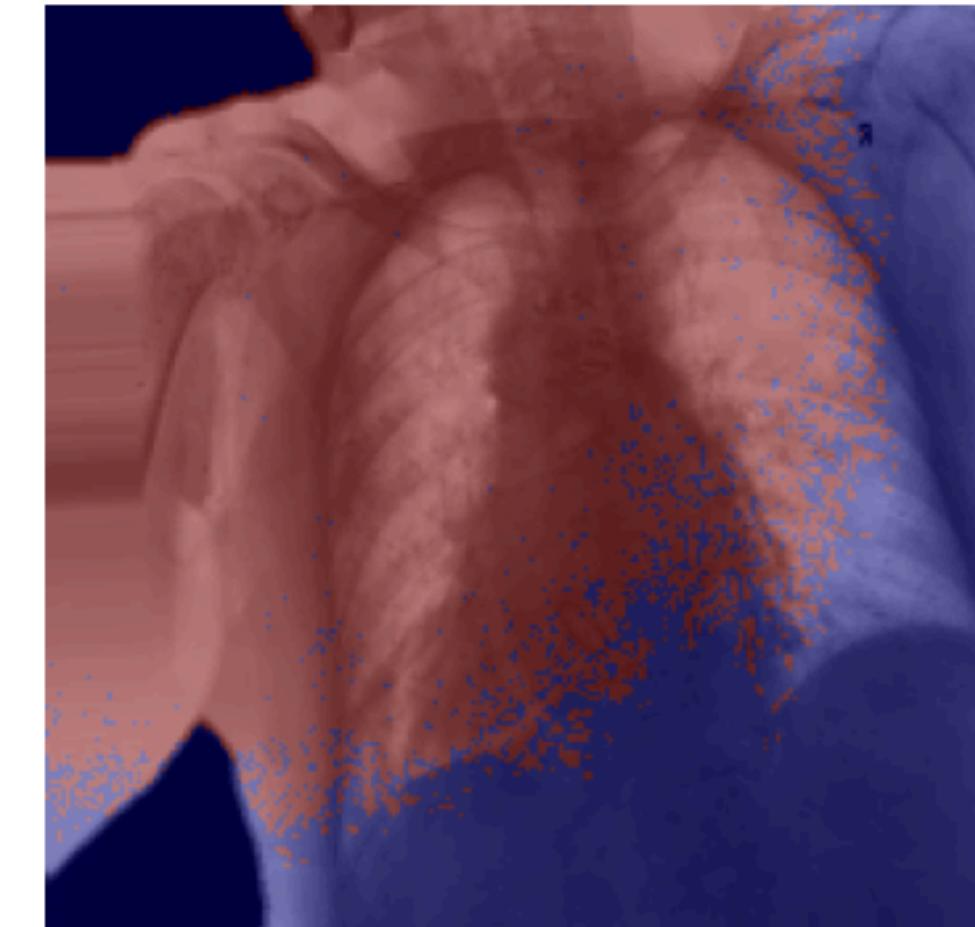


False Prediction

True: 0, Pred: 1

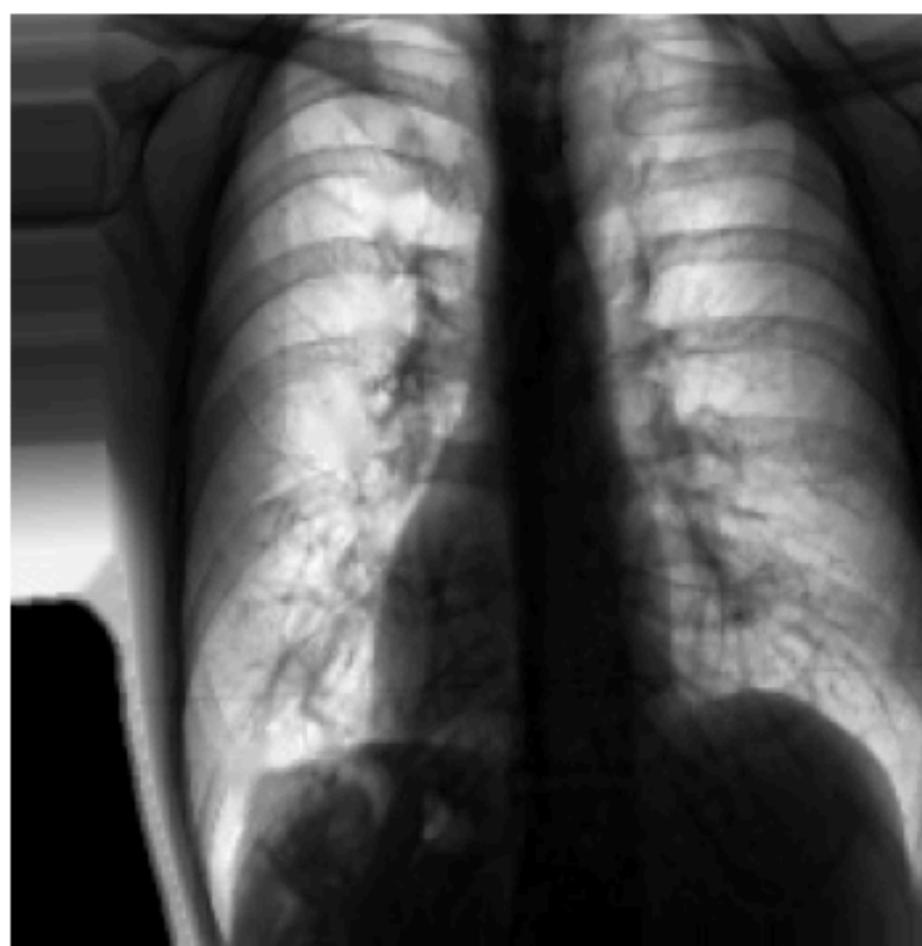


DeepLIFT Heatmap

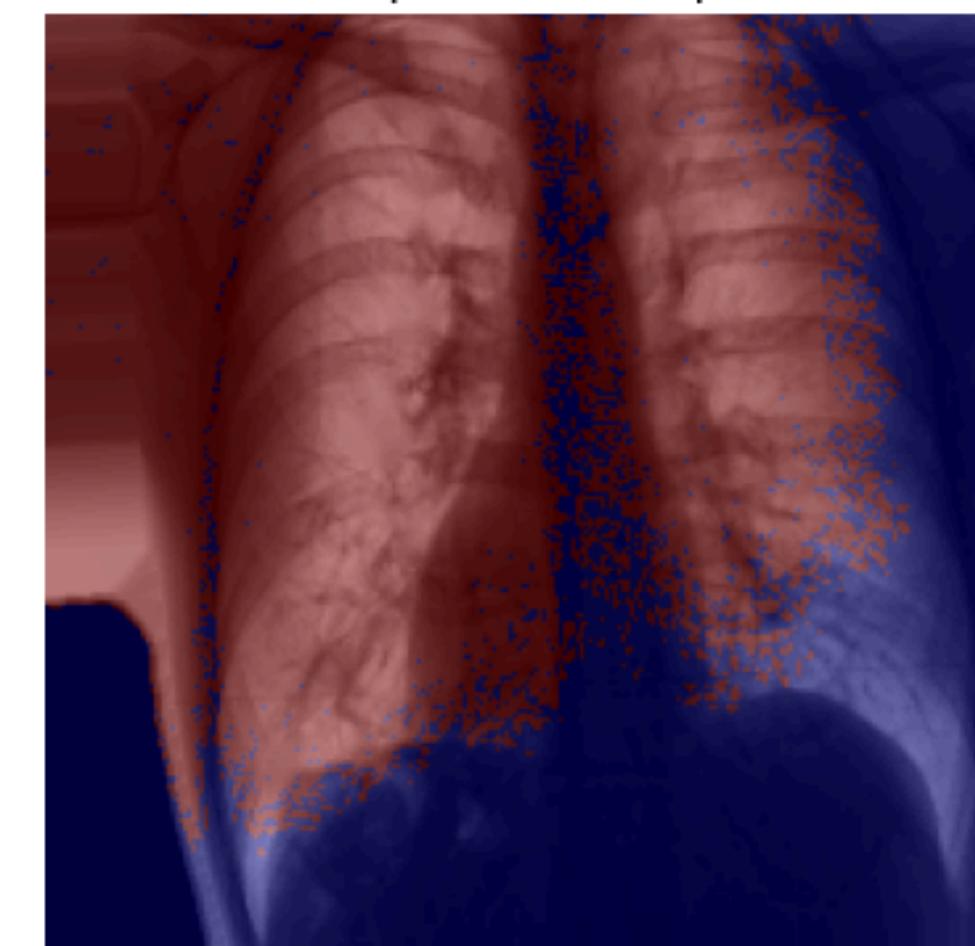


Right Prediction

True: 1, Pred: 1



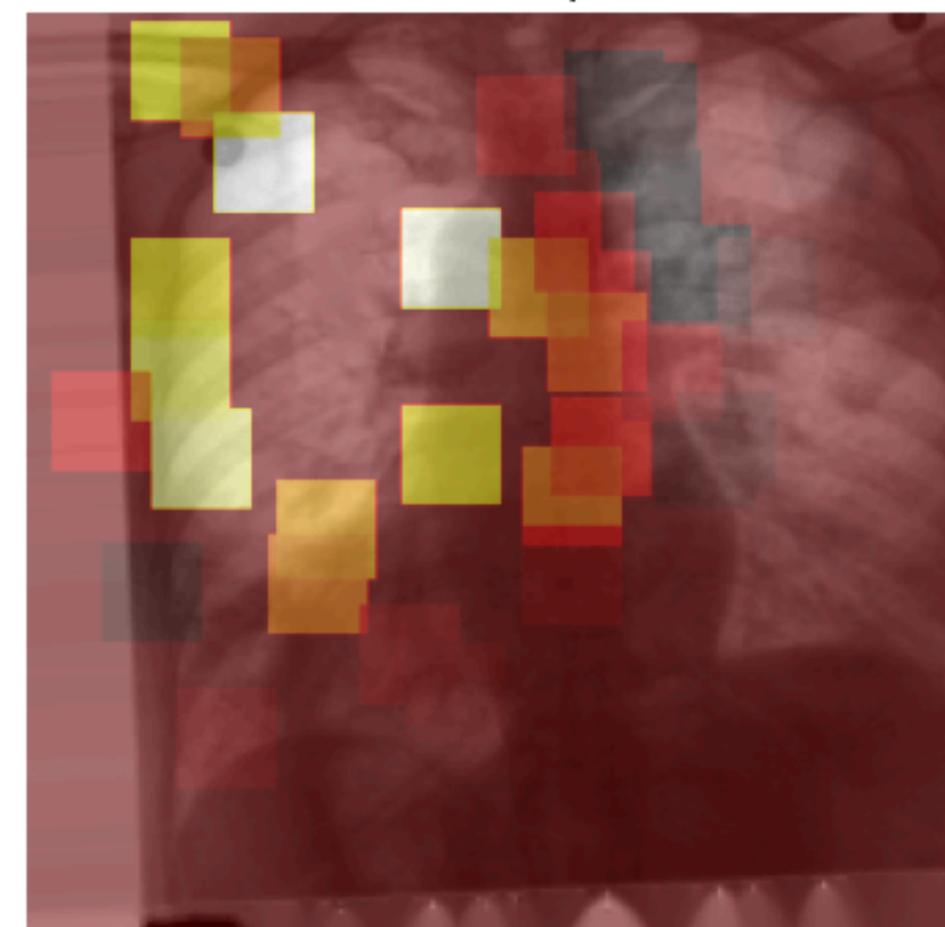
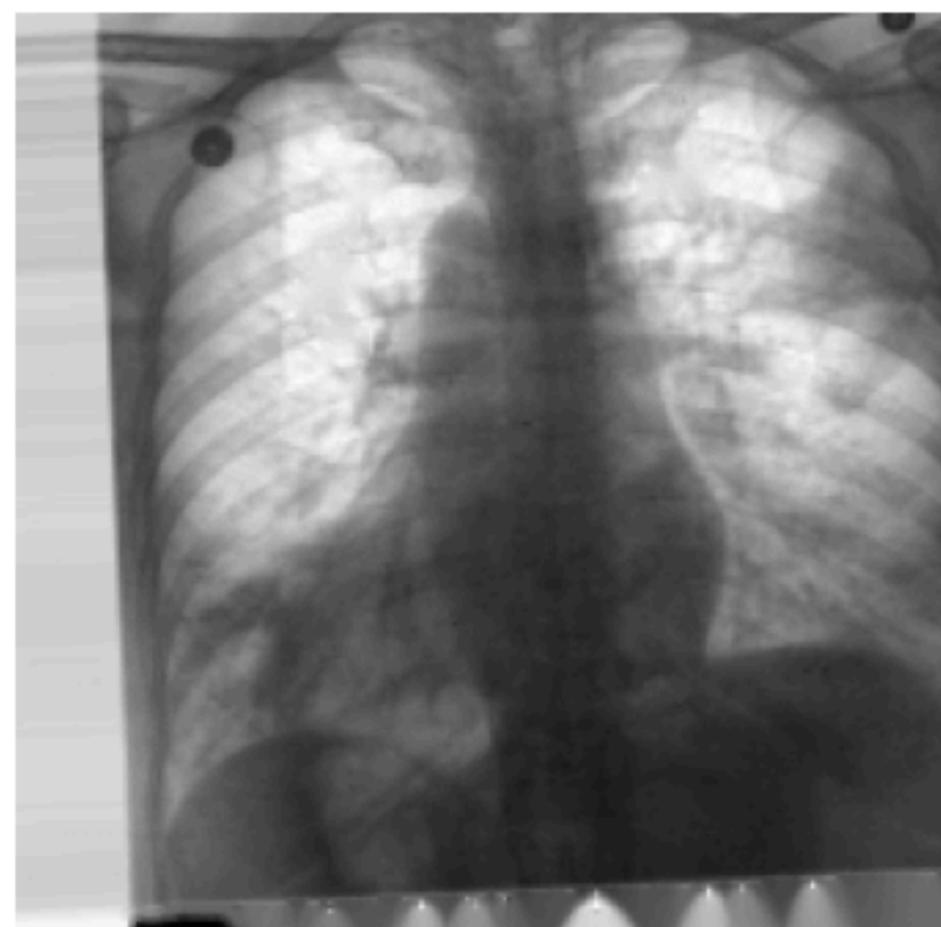
DeepLIFT Heatmap



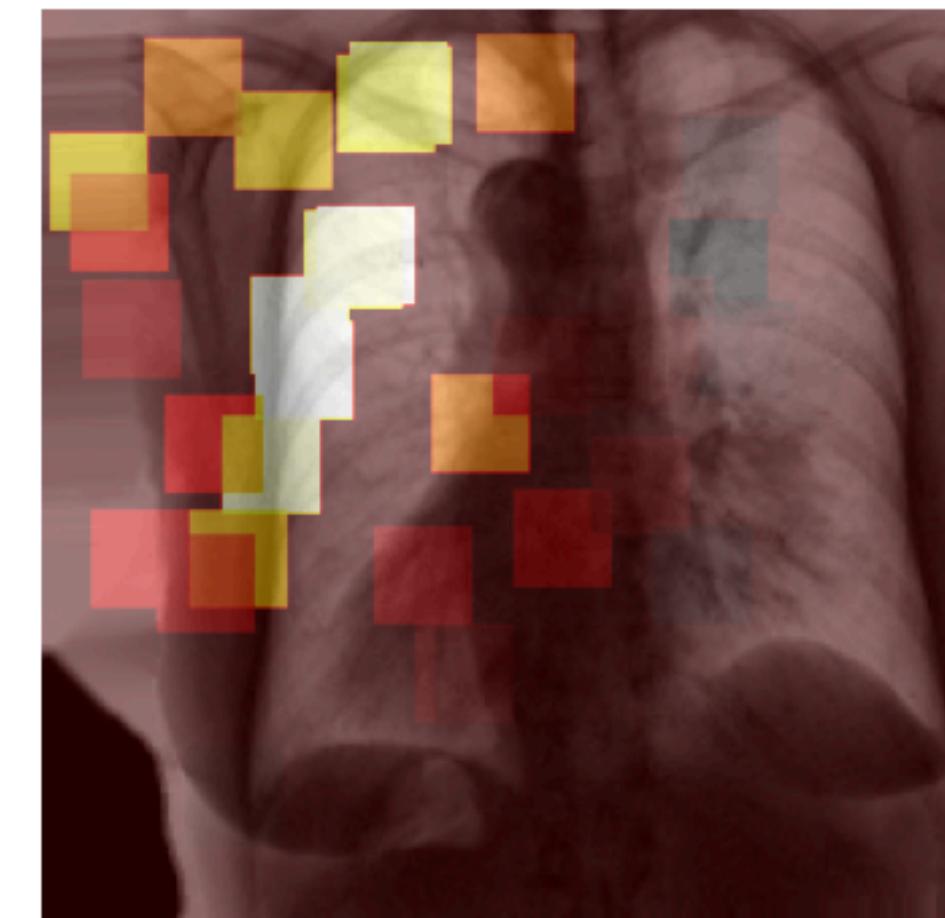
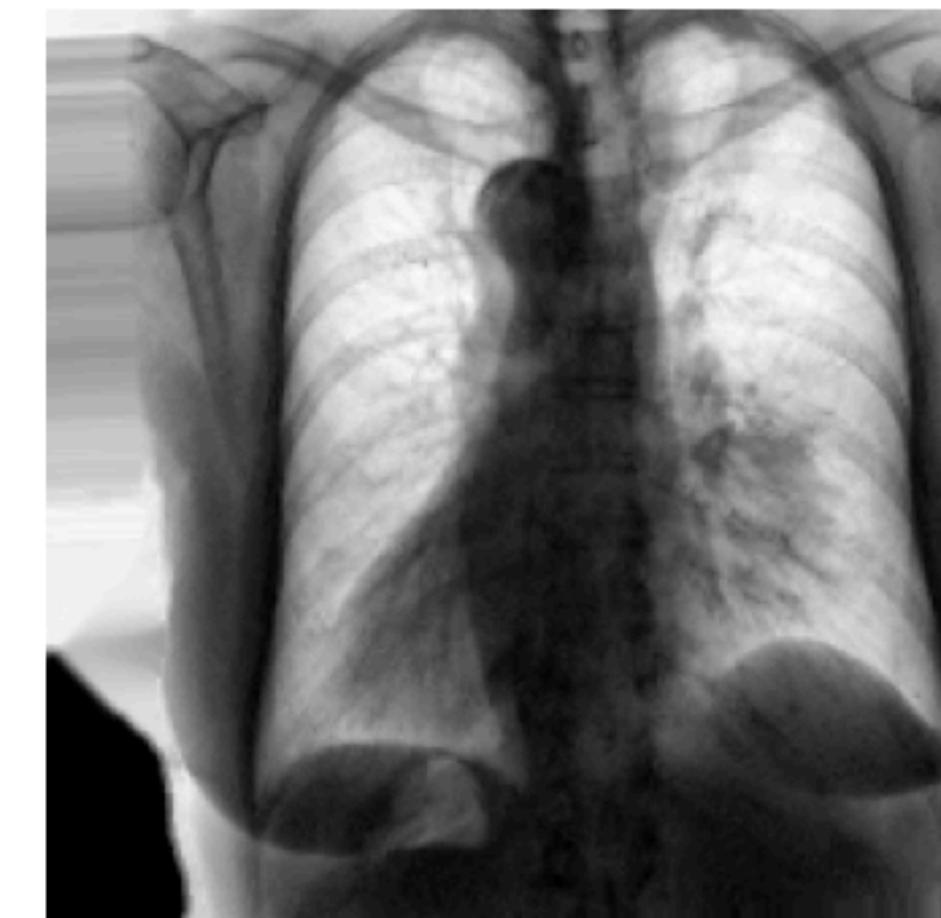
PERMUTATION IMPORTANCE



False Prediction



Right Prediction

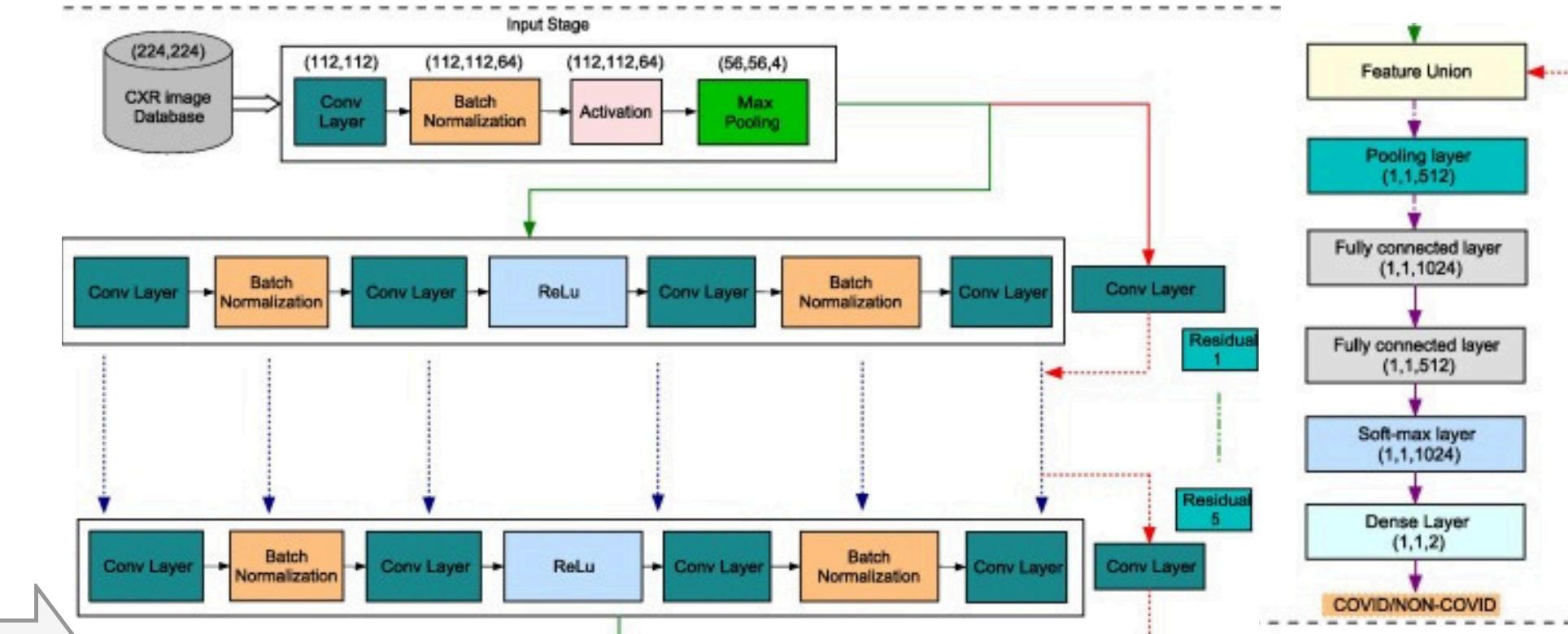


METHODOLOGY

SCOVNET: A SKIP CONNECTION-BASED FEATURE UNION DEEP LEARNING TECHNIQUE WITH STATISTICAL APPROACH ANALYSIS FOR THE DETECTION OF COVID-19

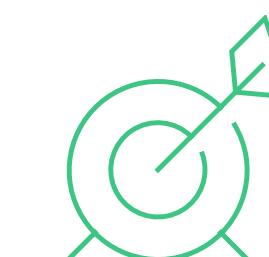
VS

Paper Results



New Results

- The model achieved an overall Accuracy of 90.39%. It also achieved an AUC of 0.96, sensitivity of 94.06% , and specificity of 90.05% for Covid-19 class.
- Used Accuracy, Loss, Specificity, Sensitivity and Confusion Matrix, Precision, AUC, and ROC.
- LIME, Permutation Importance, GRAD_CAM and DeepLift as XAI techniques.



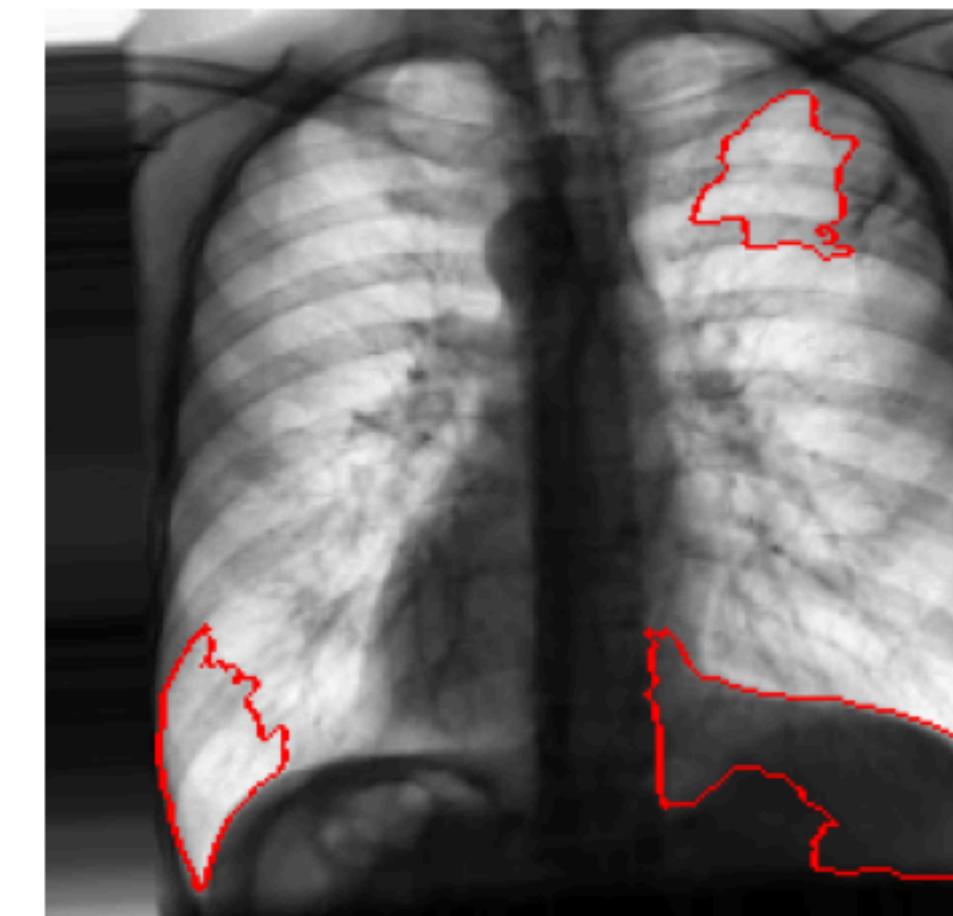
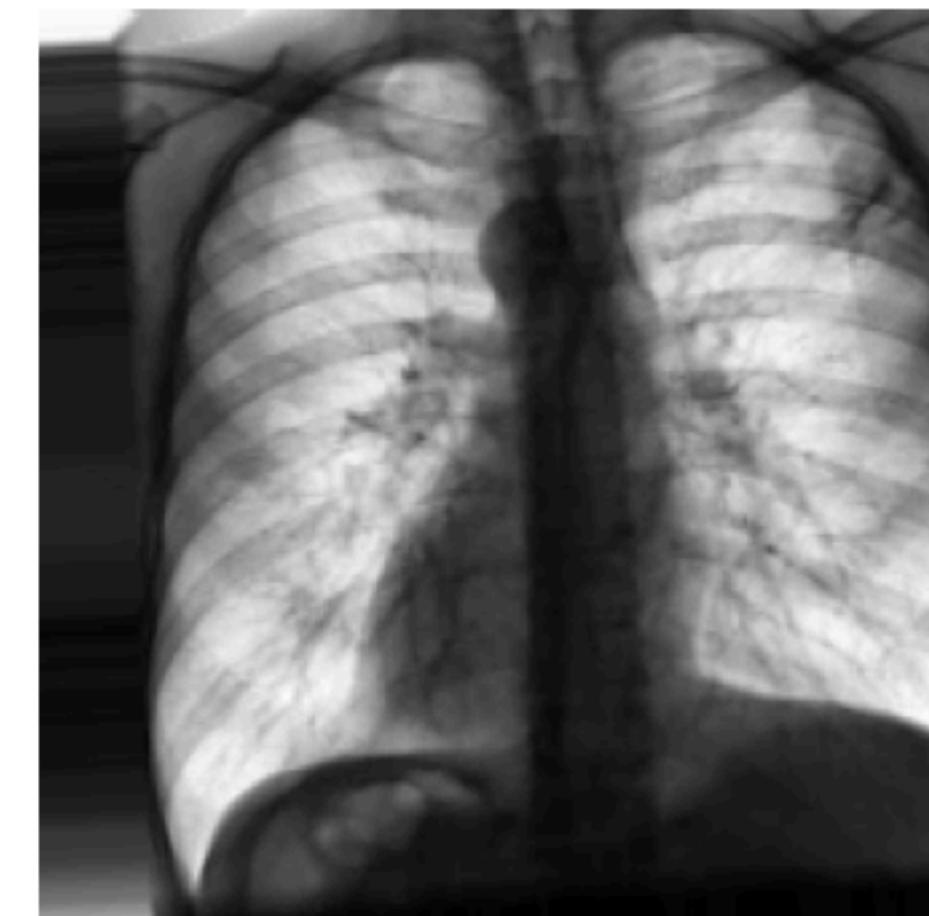
- The model was binary classification and achieved an overall Accuracy of 98.67%. It also achieved an AUC of 0.99, sensitivity of 98.81% , and specificity of 98.36%.
- Used Accuracy, Loss, Specificity, Sensitivity and Confusion Matrix, Precision, AUC, and ROC.

LIME



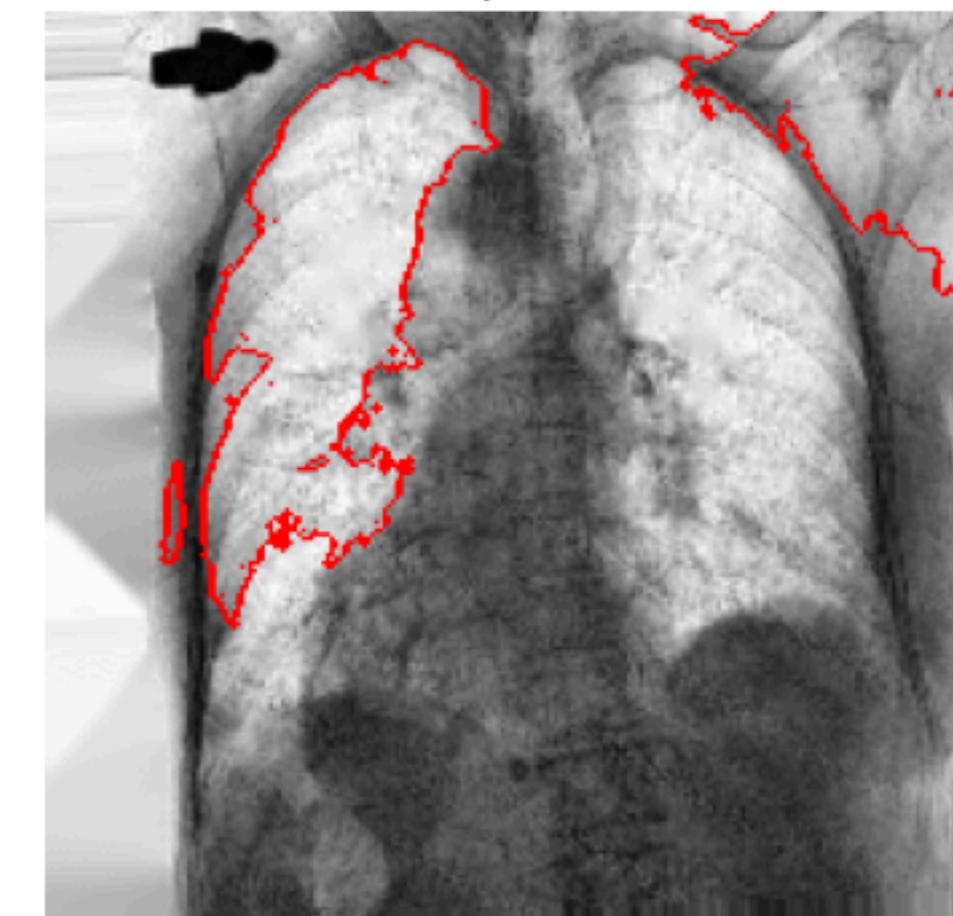
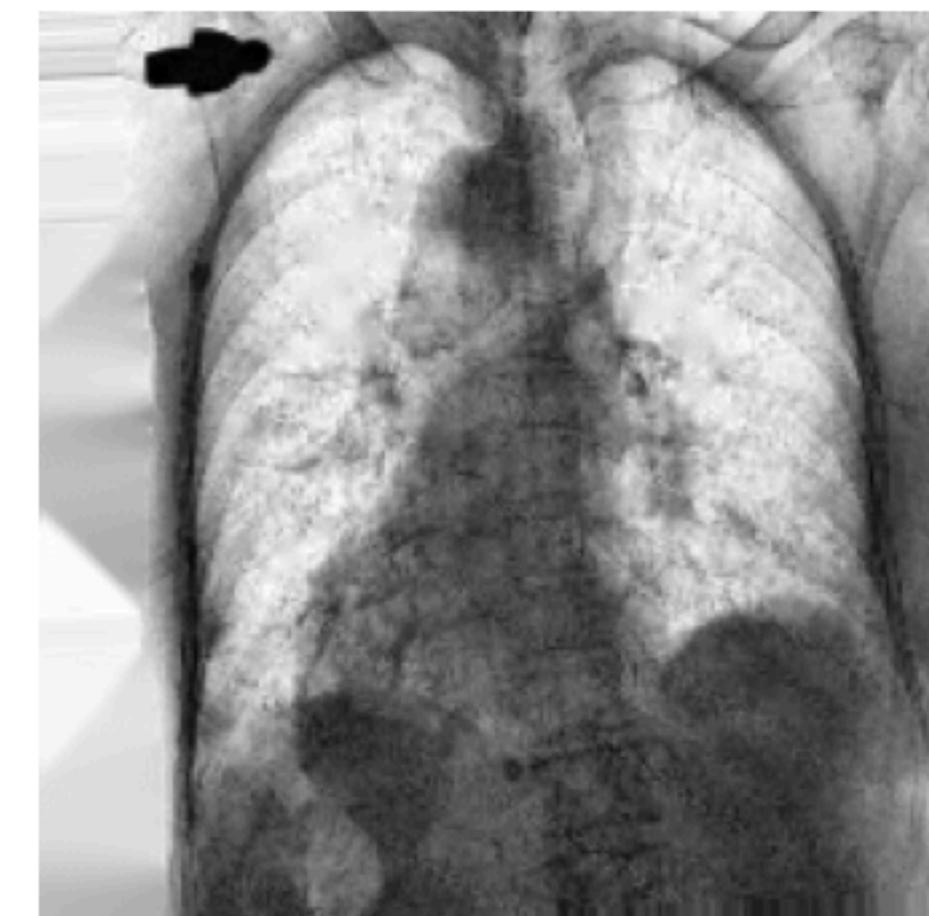
False Prediction

Original (Pneumonia) #4
Predicted: Normal



Right Prediction

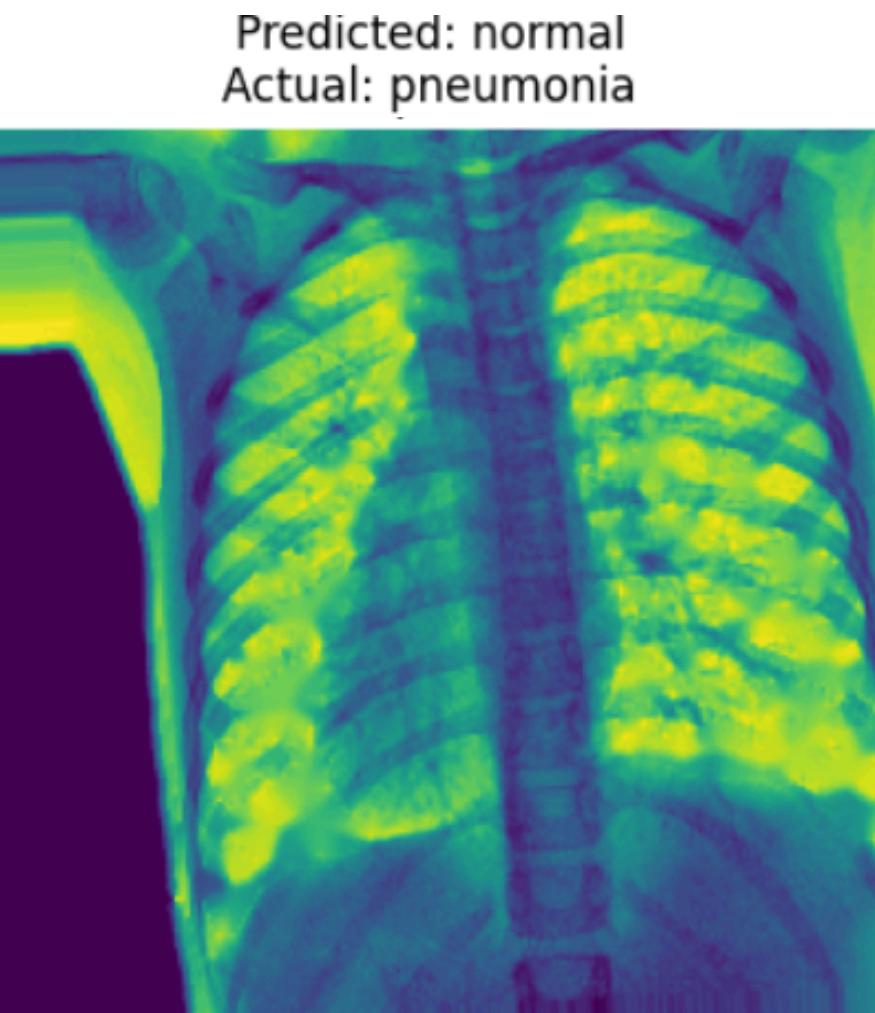
Original (Pneumonia) #2
Predicted: Pneumonia



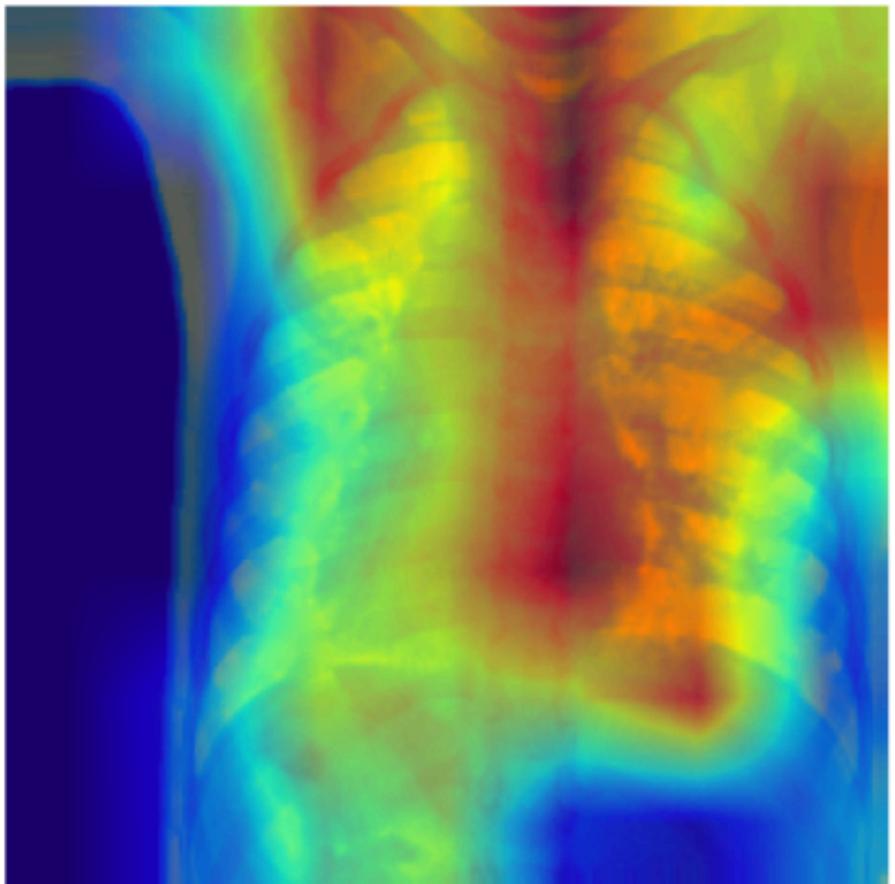
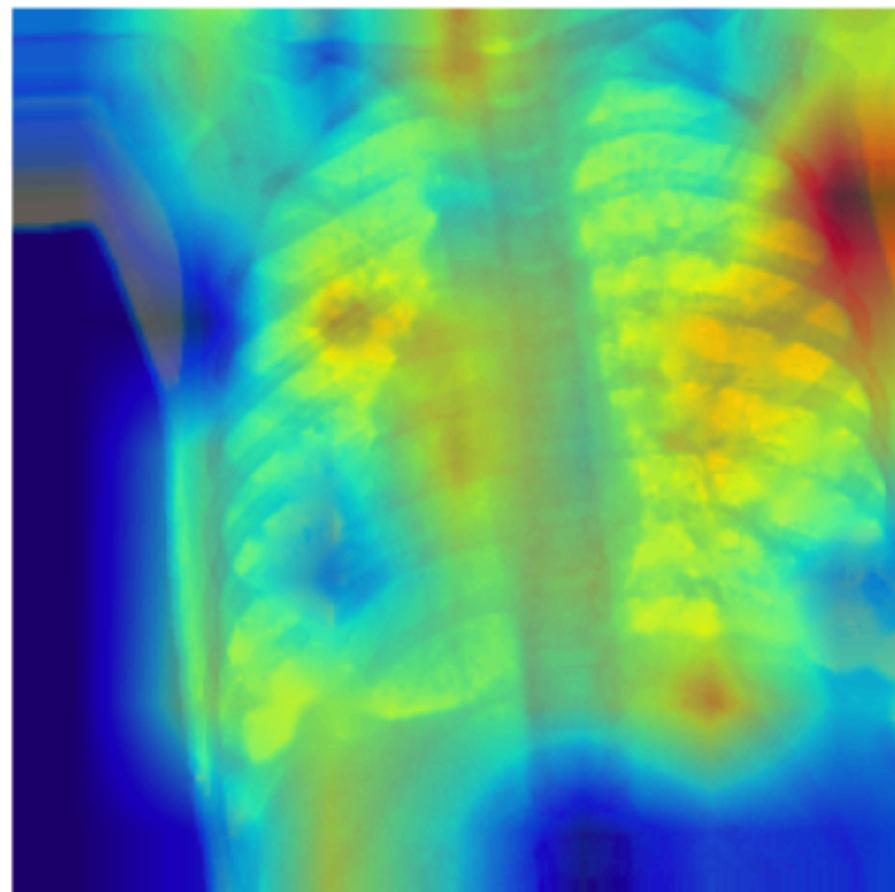
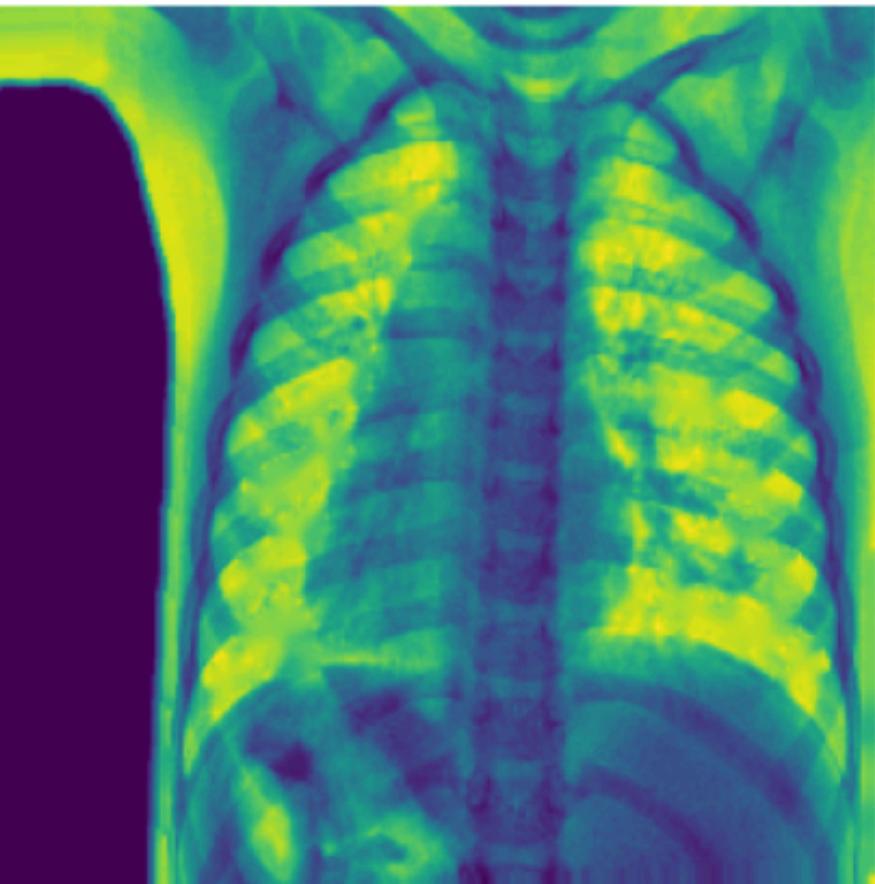
GRAD-CAM



False Prediction



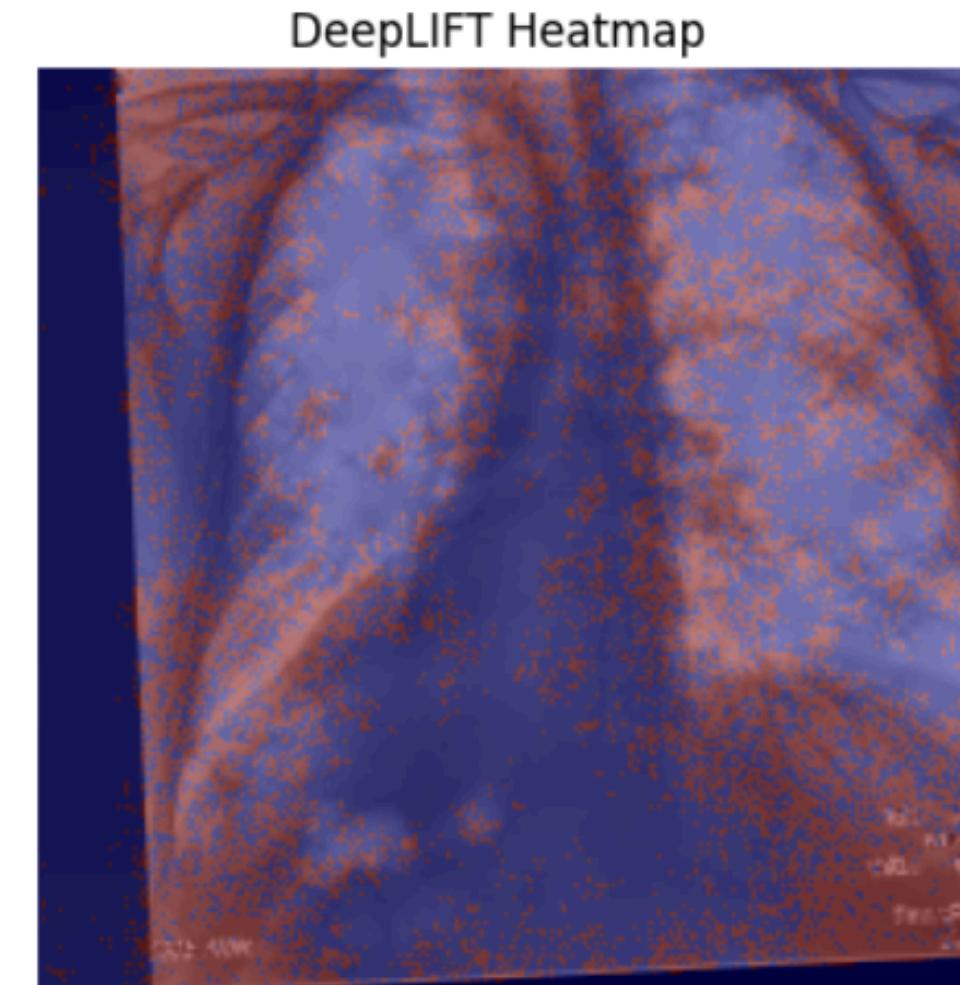
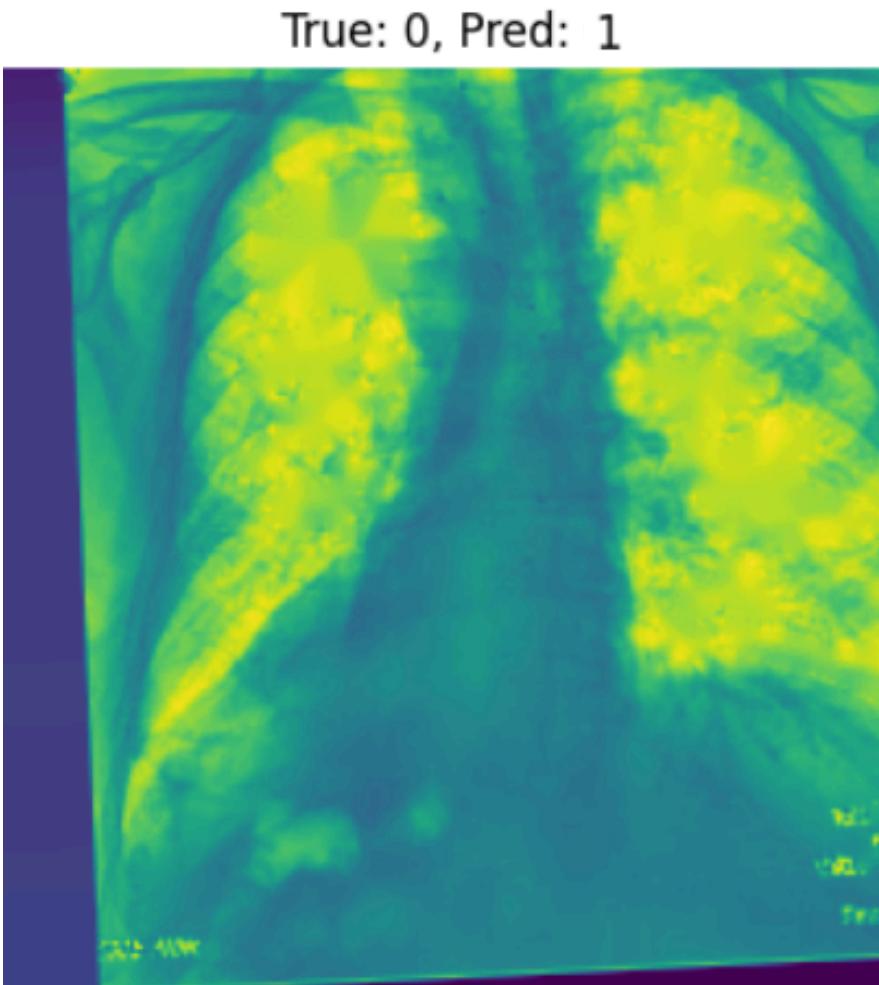
Right Prediction



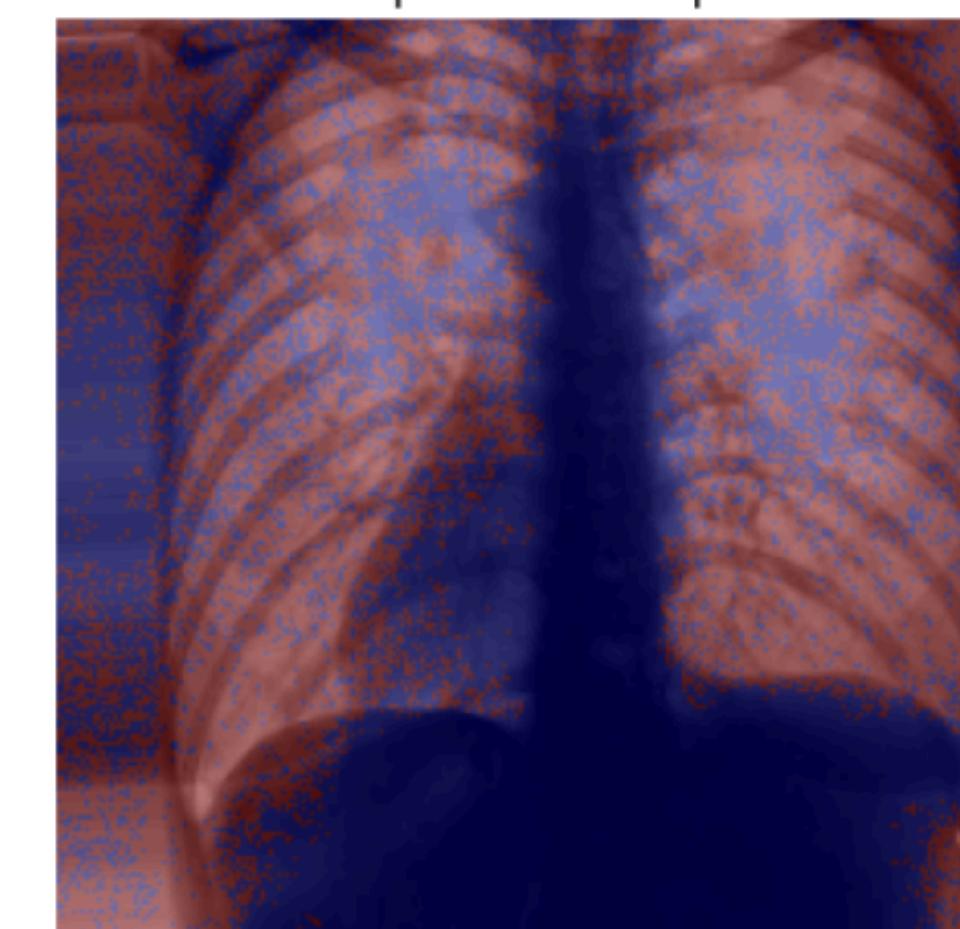
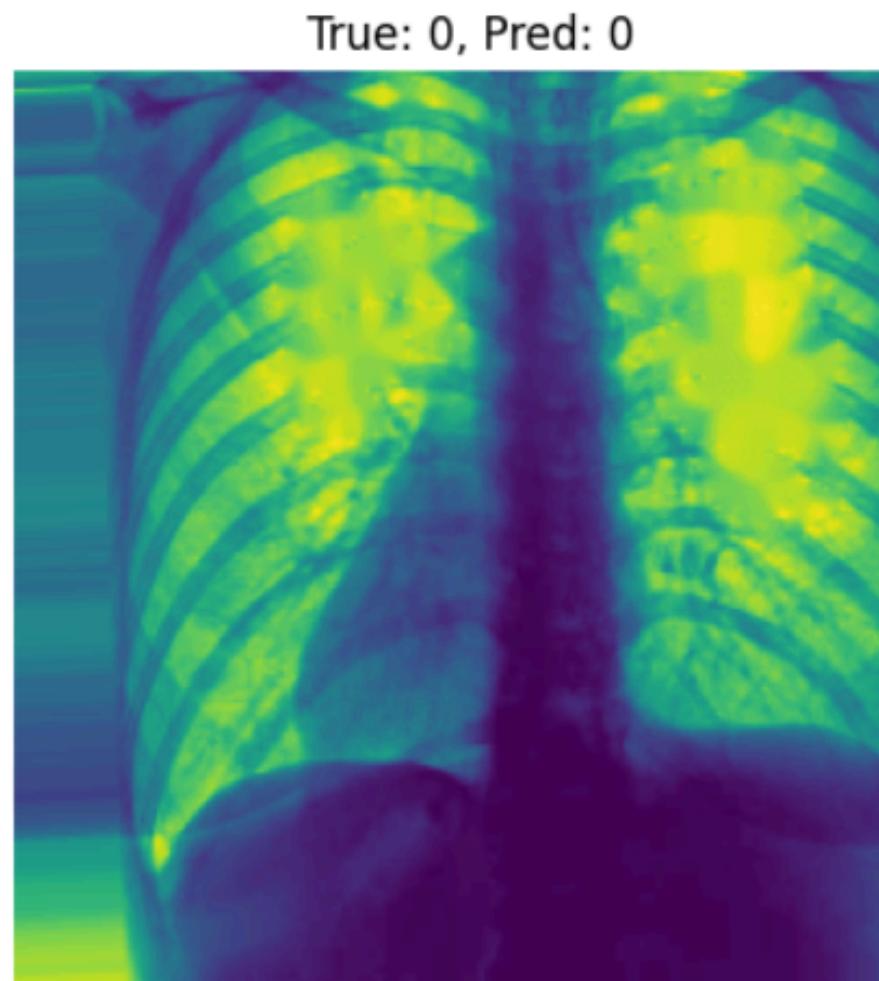
DEEPLIFT



False Prediction



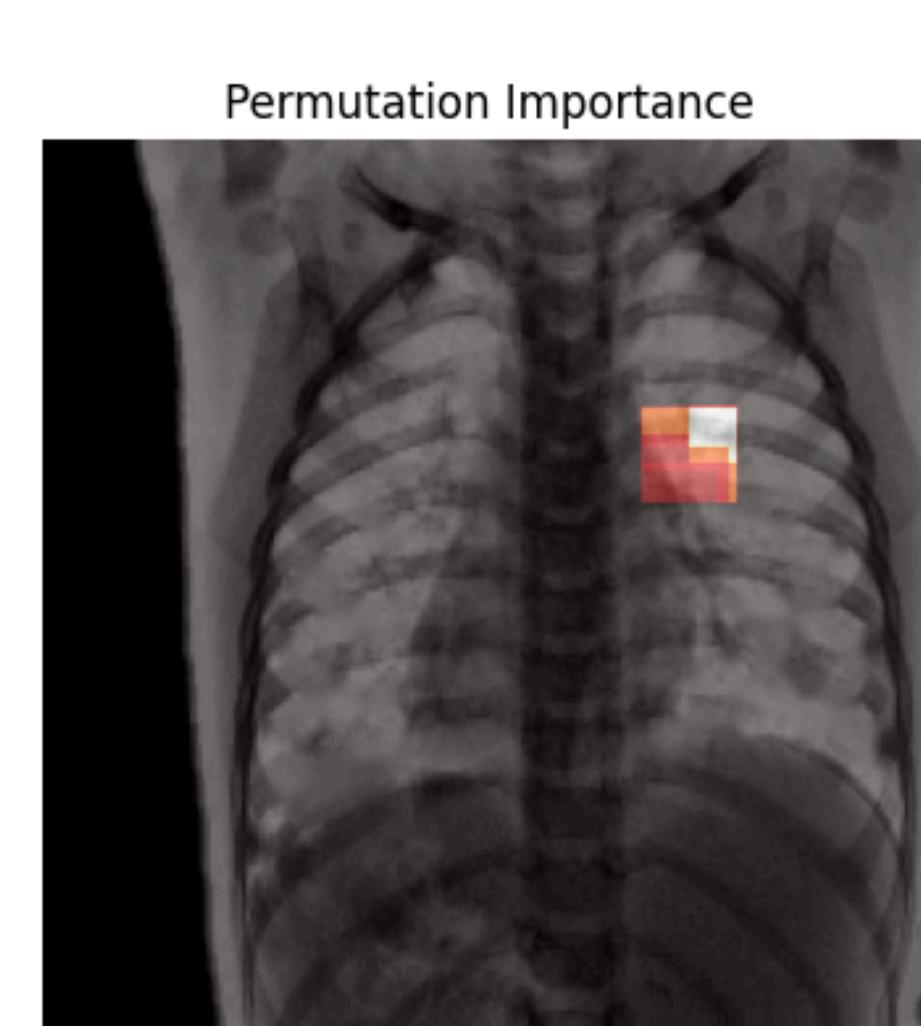
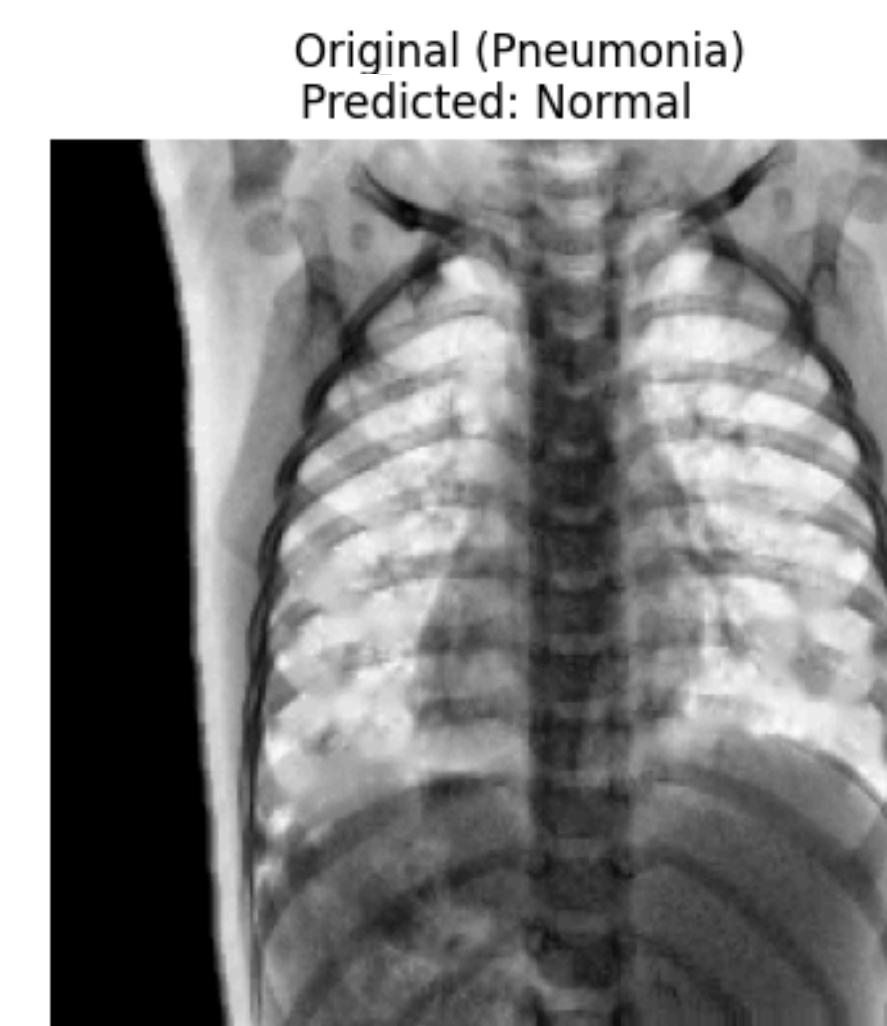
Right Prediction



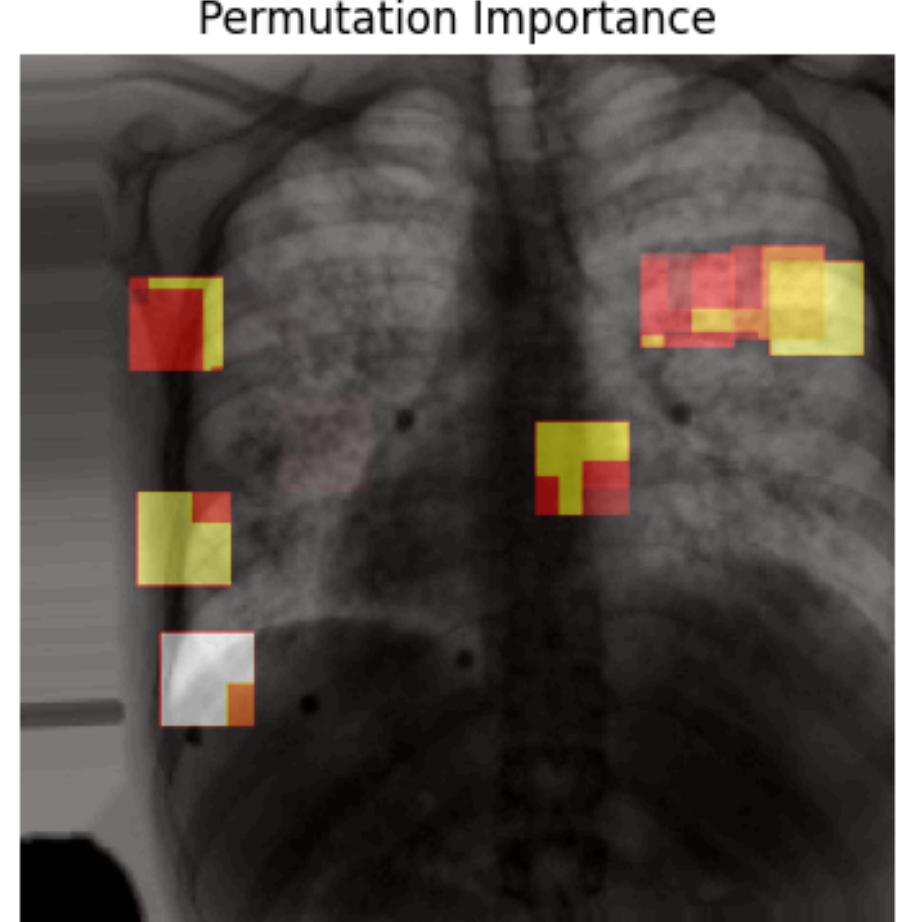
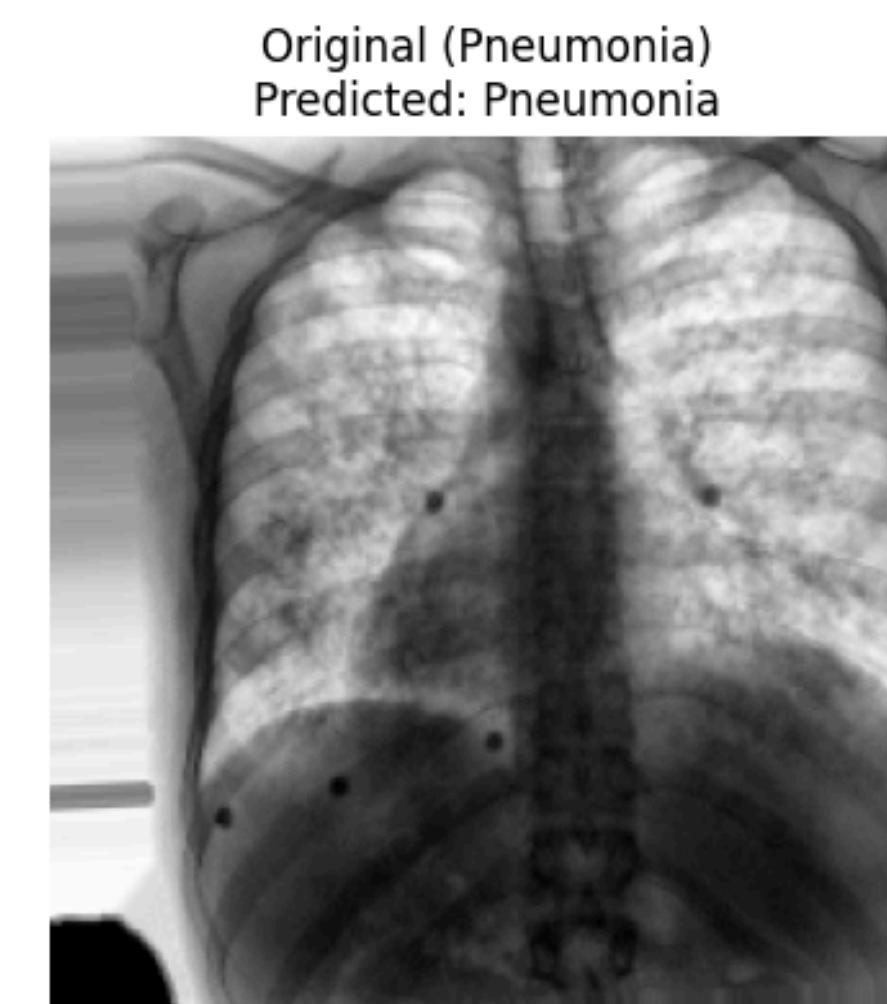
PERMUTATION IMPORTANCE



False Prediction



Right Prediction



DETECTION OF COVID-19 IN X-RAY IMAGES USING DENSELY CONNECTED SQUEEZE CONVOLUTIONAL NEURAL NETWORK (DCSCNN)

New Results

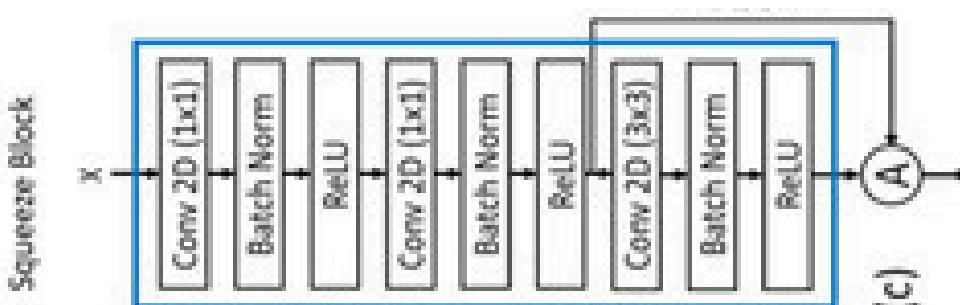
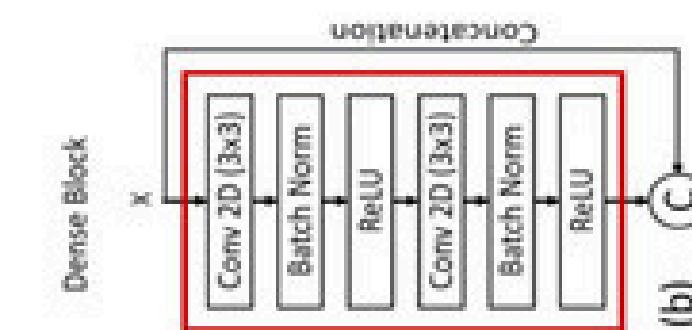
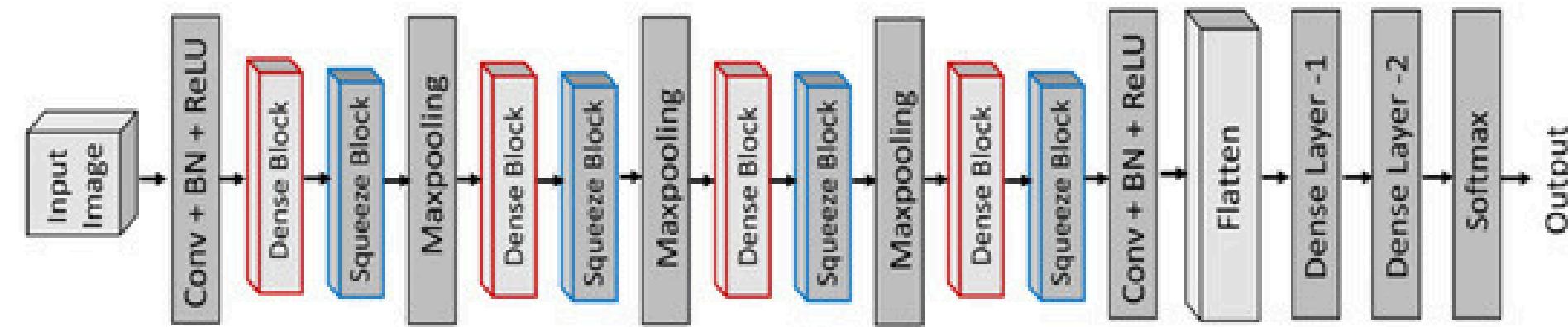


- The model achieved an overall Accuracy of 81%. It also achieved a sensitivity of 82% , and specificity of 82% for Covid-19 class.
- Used Accuracy, Loss, Specificity, Sensitivity and Confusion Matrix, Precision, AUC, and ROC.
- LIME, Permutation Importance, GRAD_CAM and DeepLift as XAI techniques.



VS

METHODOLOGY



Paper Results



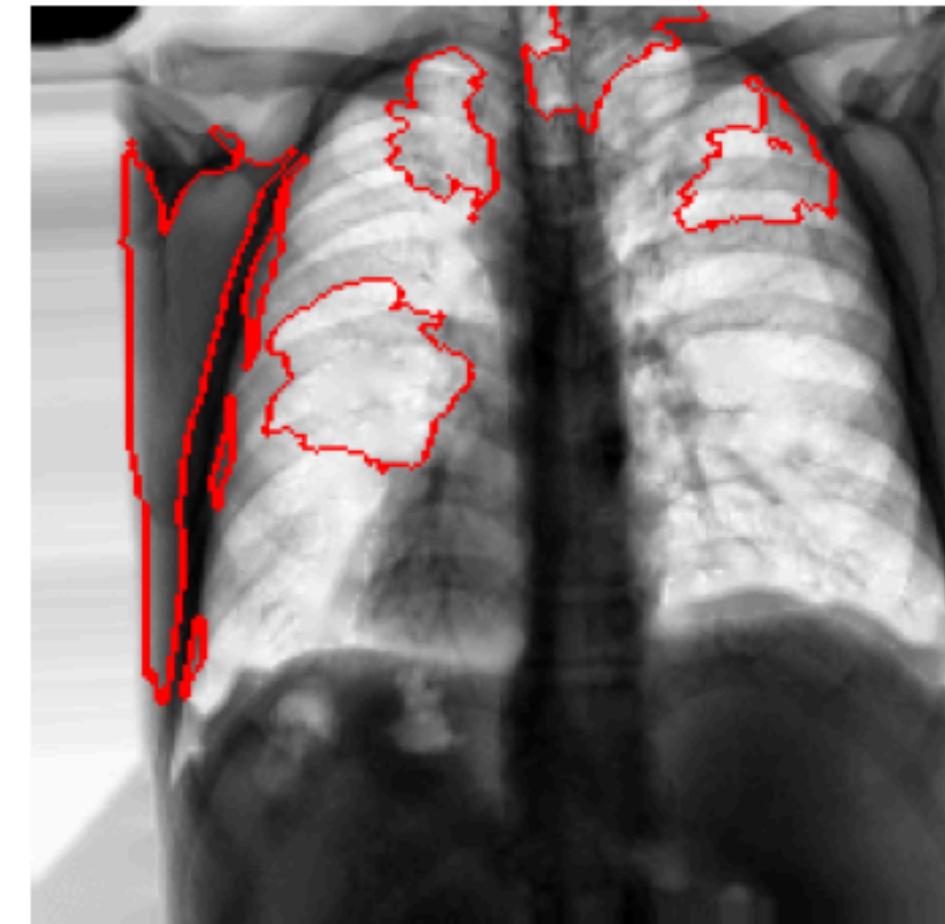
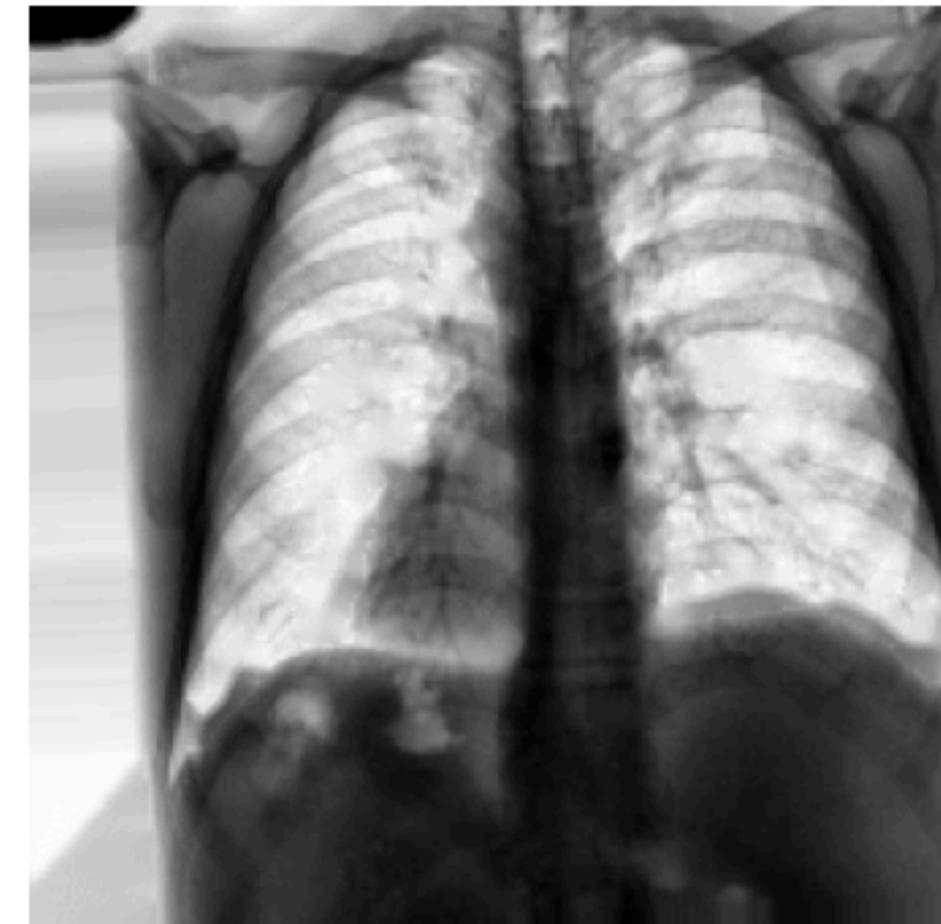
- The model was binary classification and achieved an overall Accuracy of 98.8%. It also achieved a sensitivity of 98.8% , and specificity of 98.8%.
- Used Accuracy, Loss, Specificity, Sensitivity and Confusion Matrix, Precision, AUC, and ROC.
- Grad-CAM and LIME as XAI techniques.

LIME



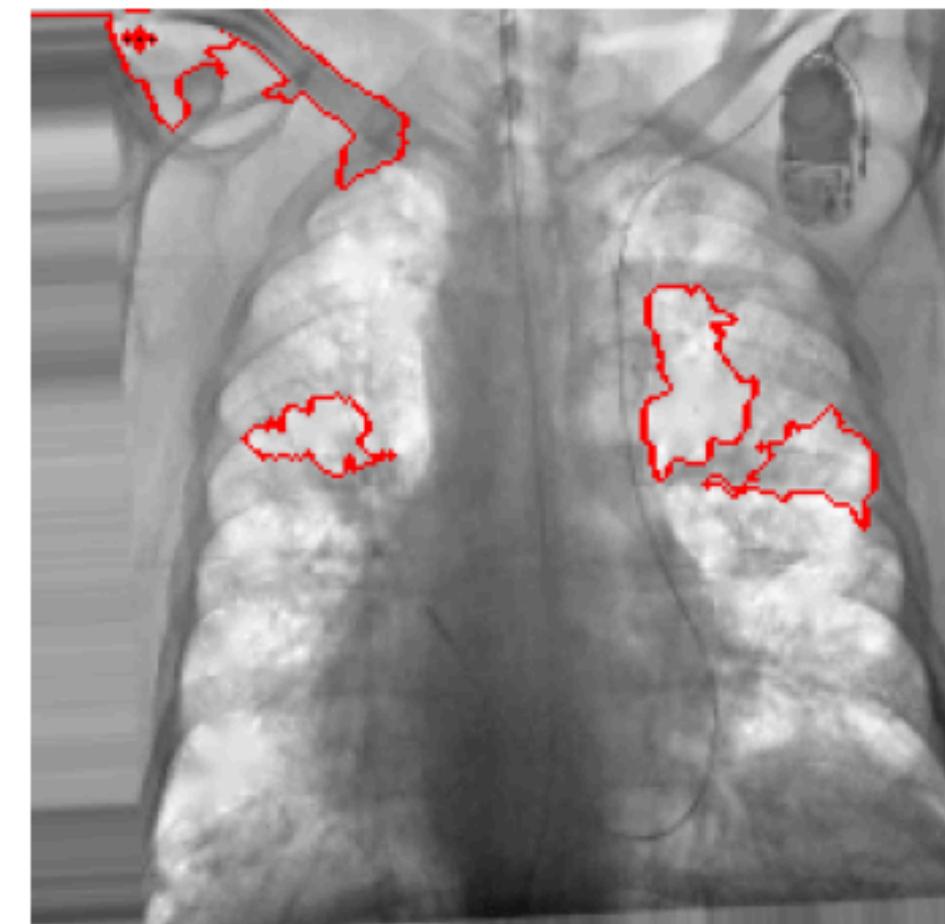
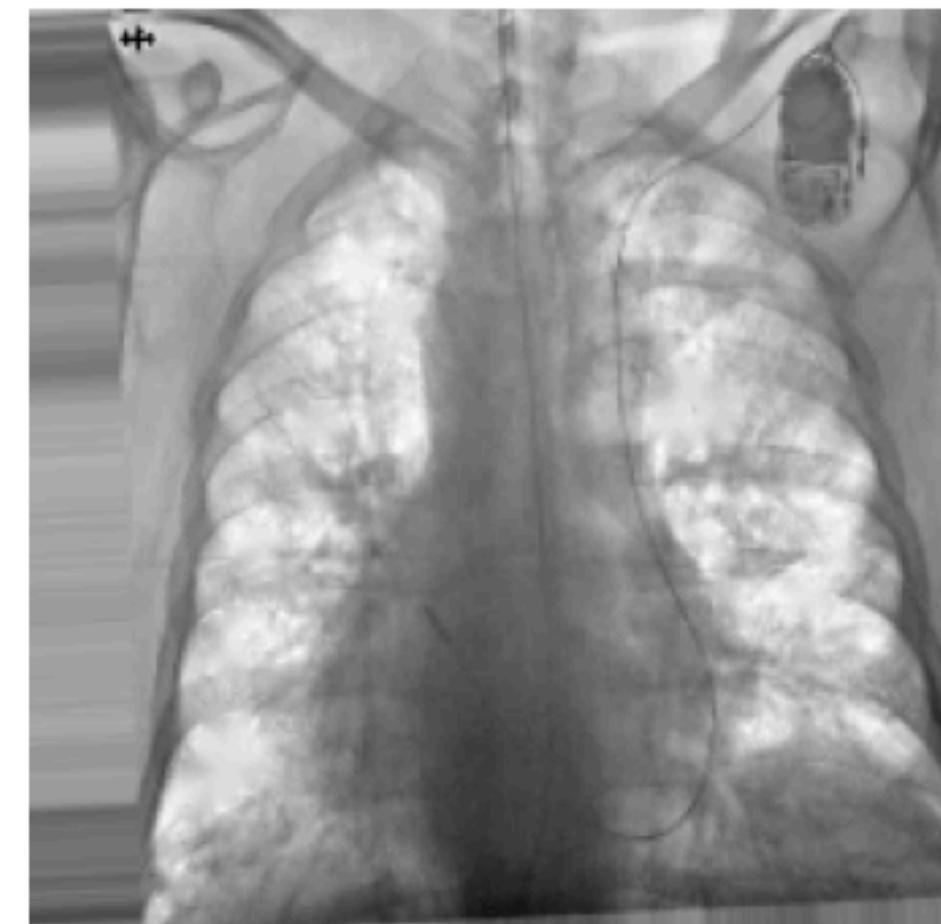
False Prediction

Original (COVID-19) #2
Predicted: Pneumonia



Right Prediction

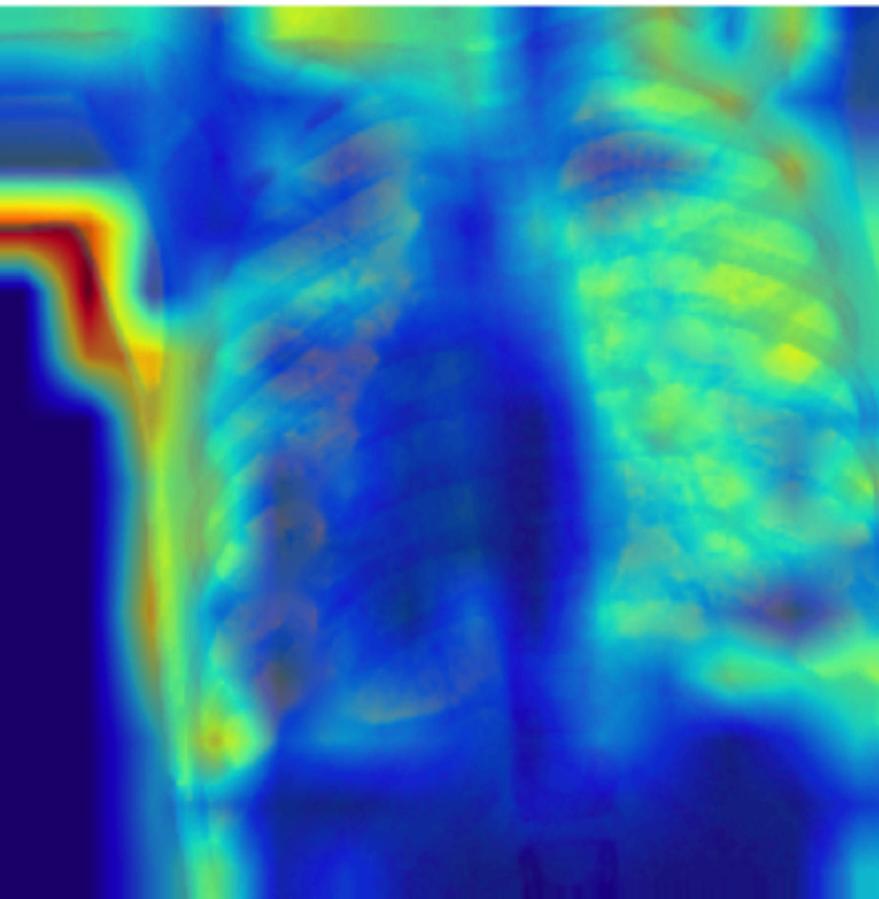
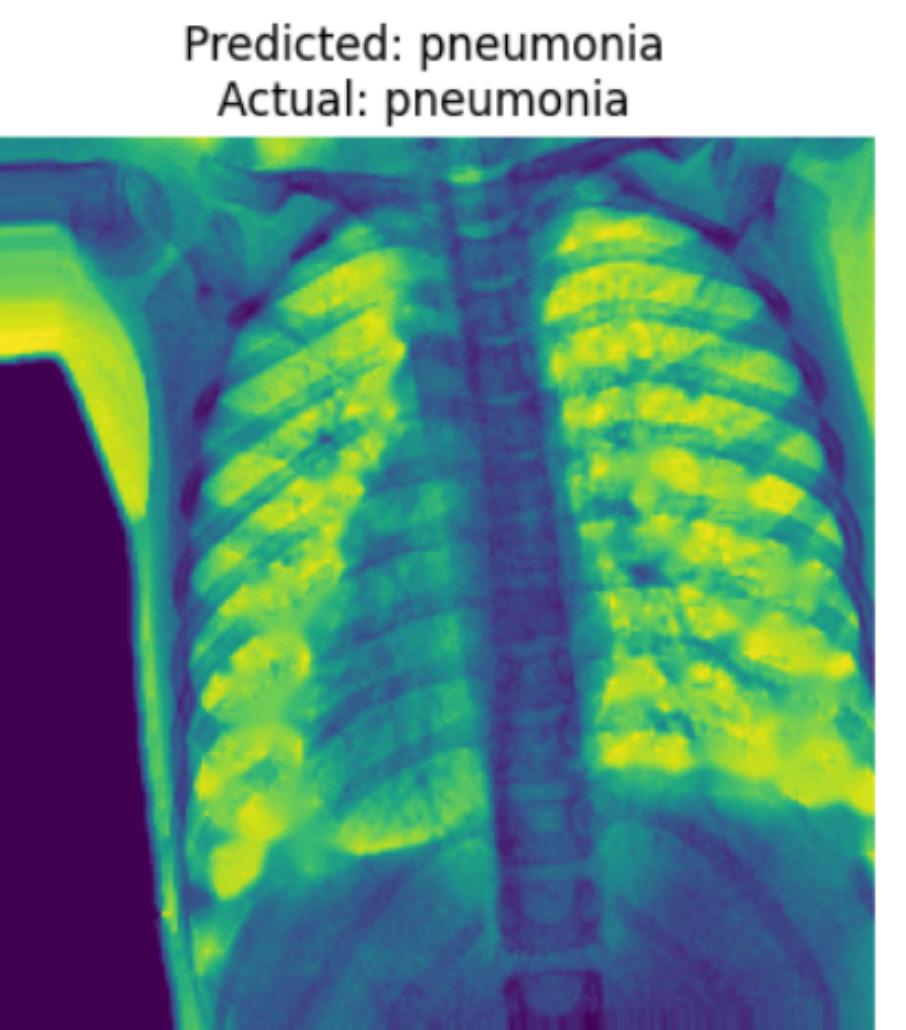
Original (COVID-19) #4
Predicted: COVID-19



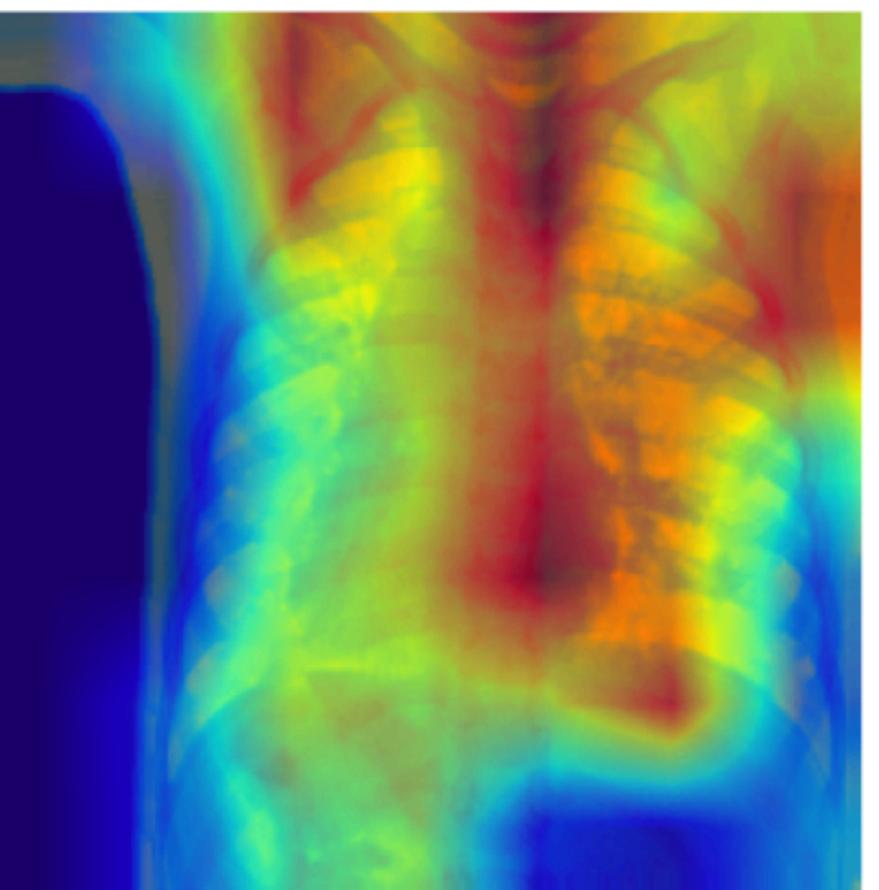
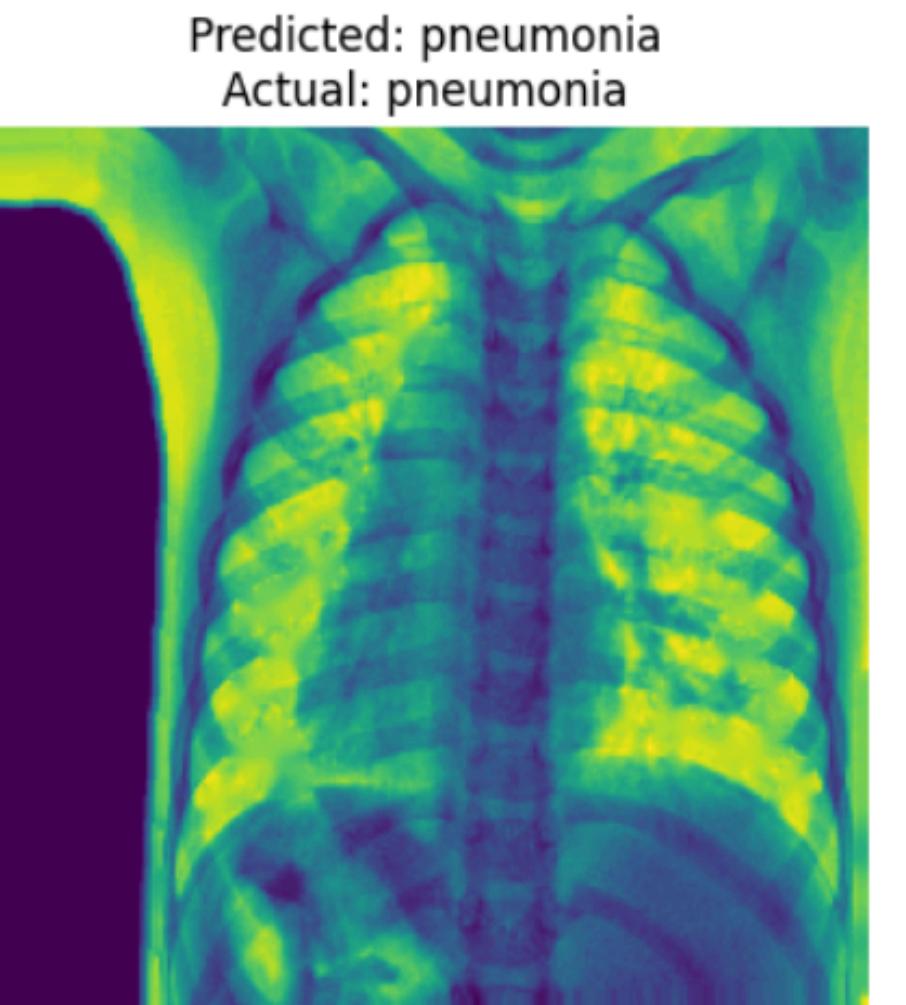
GRAD-CAM



False Prediction



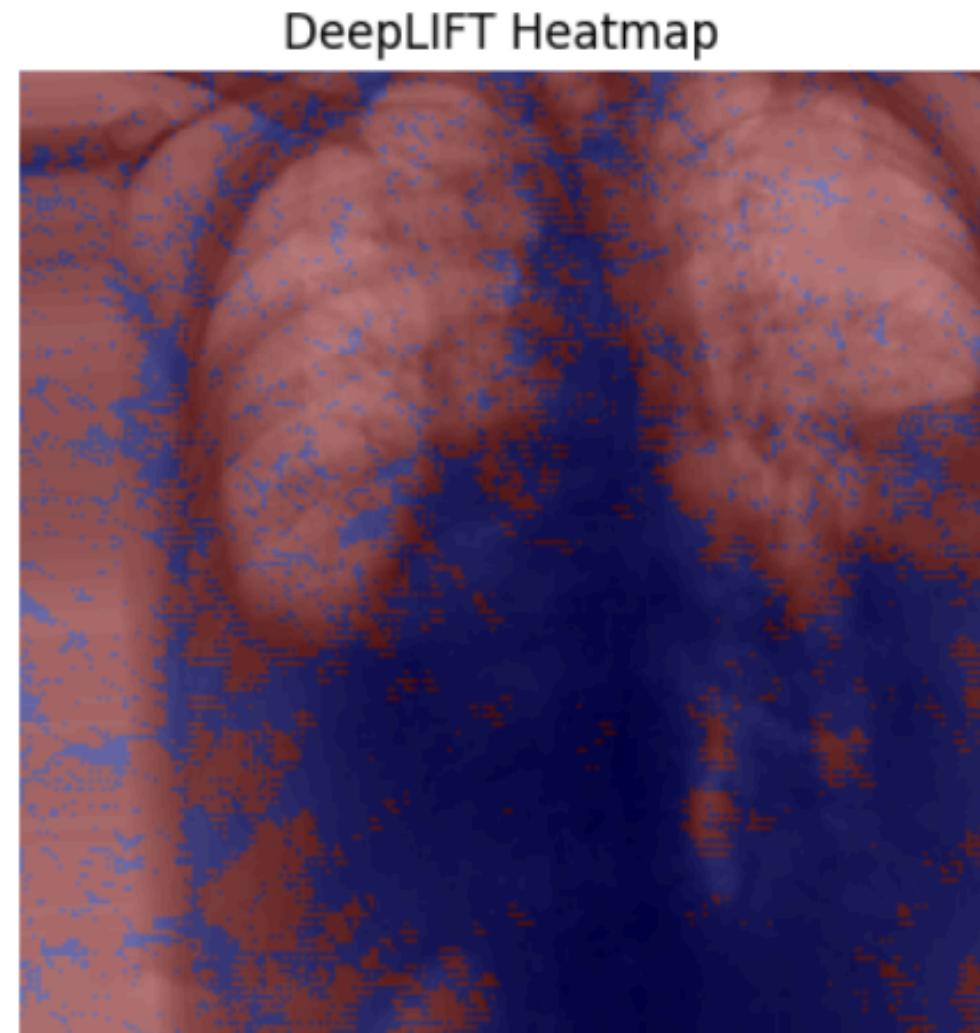
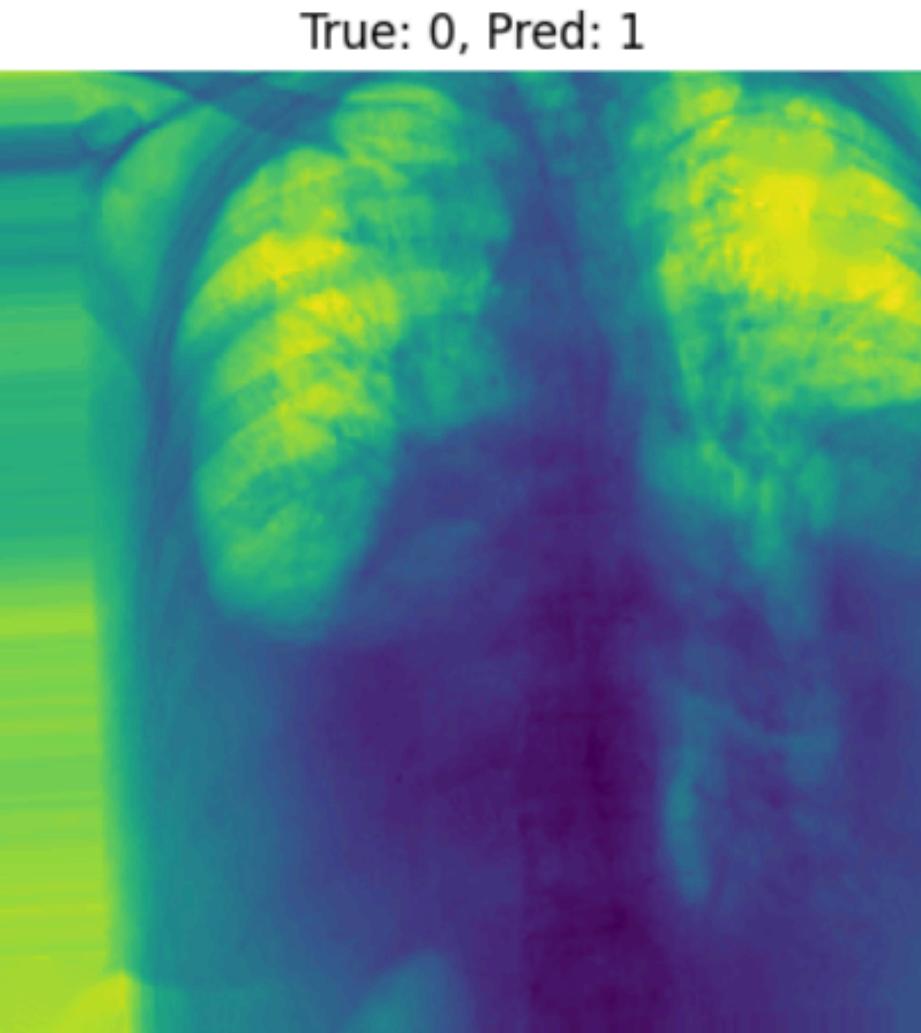
Right Prediction



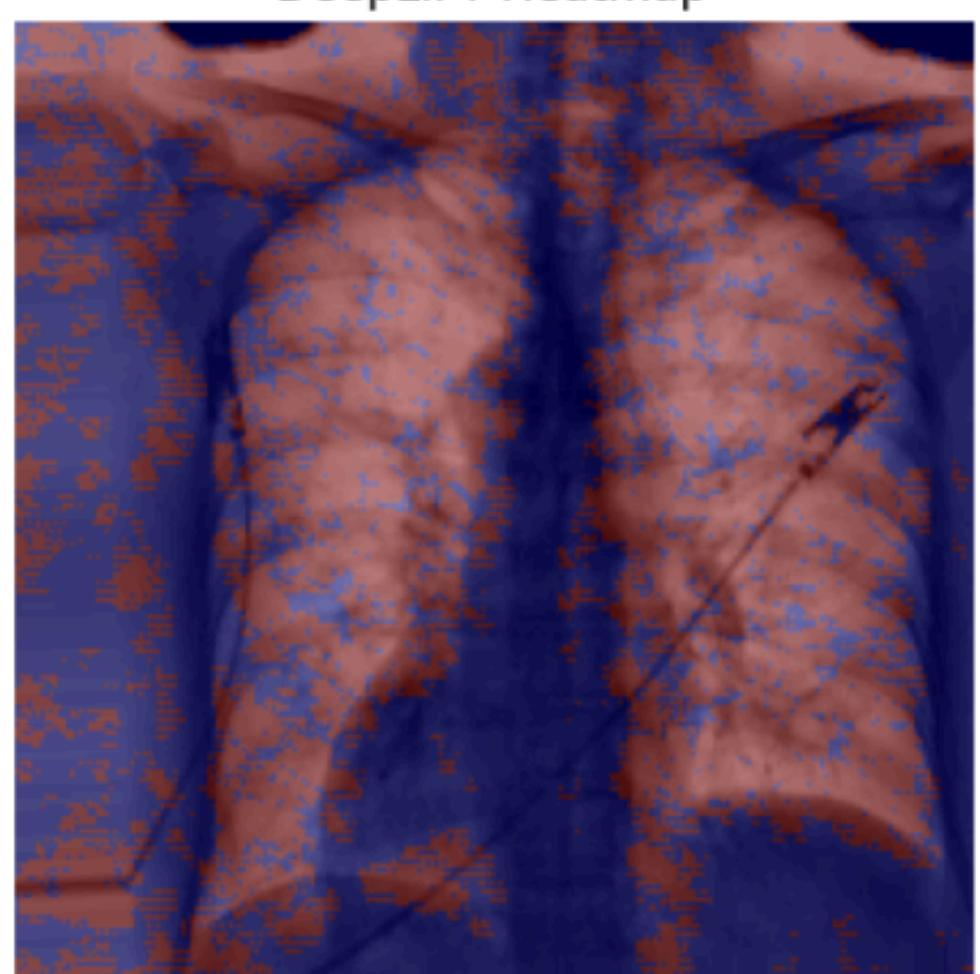
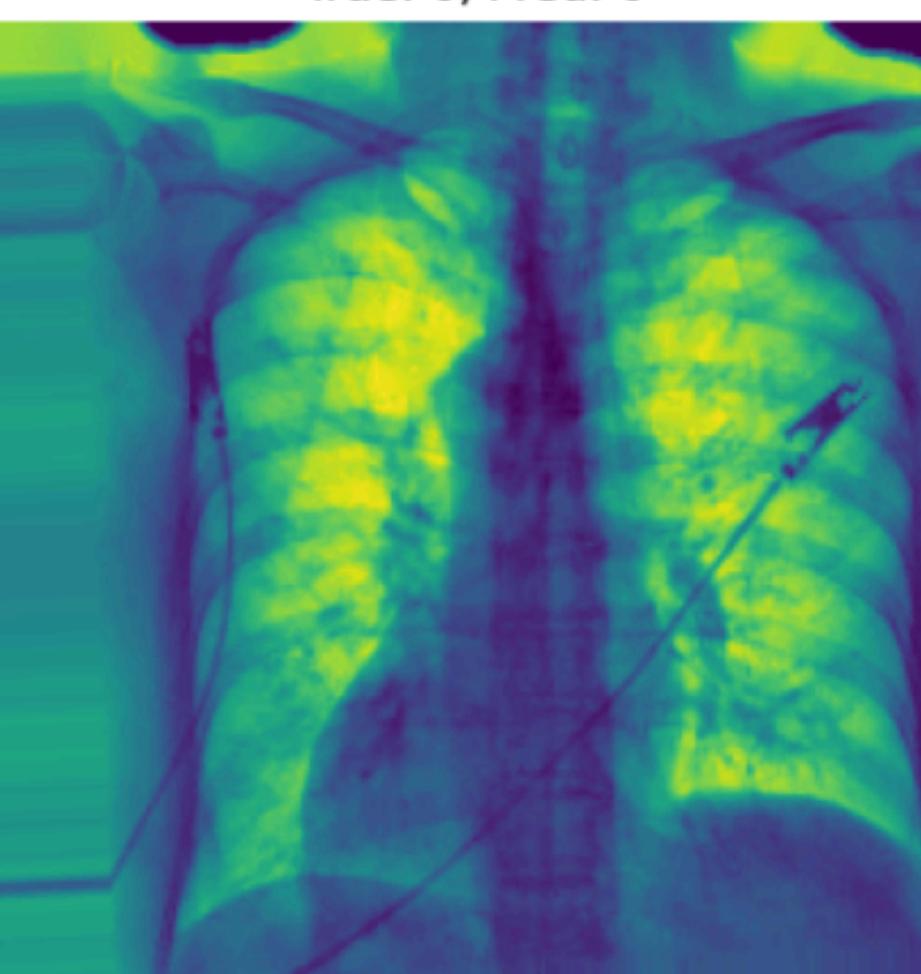
DEEPLIFT



False Prediction



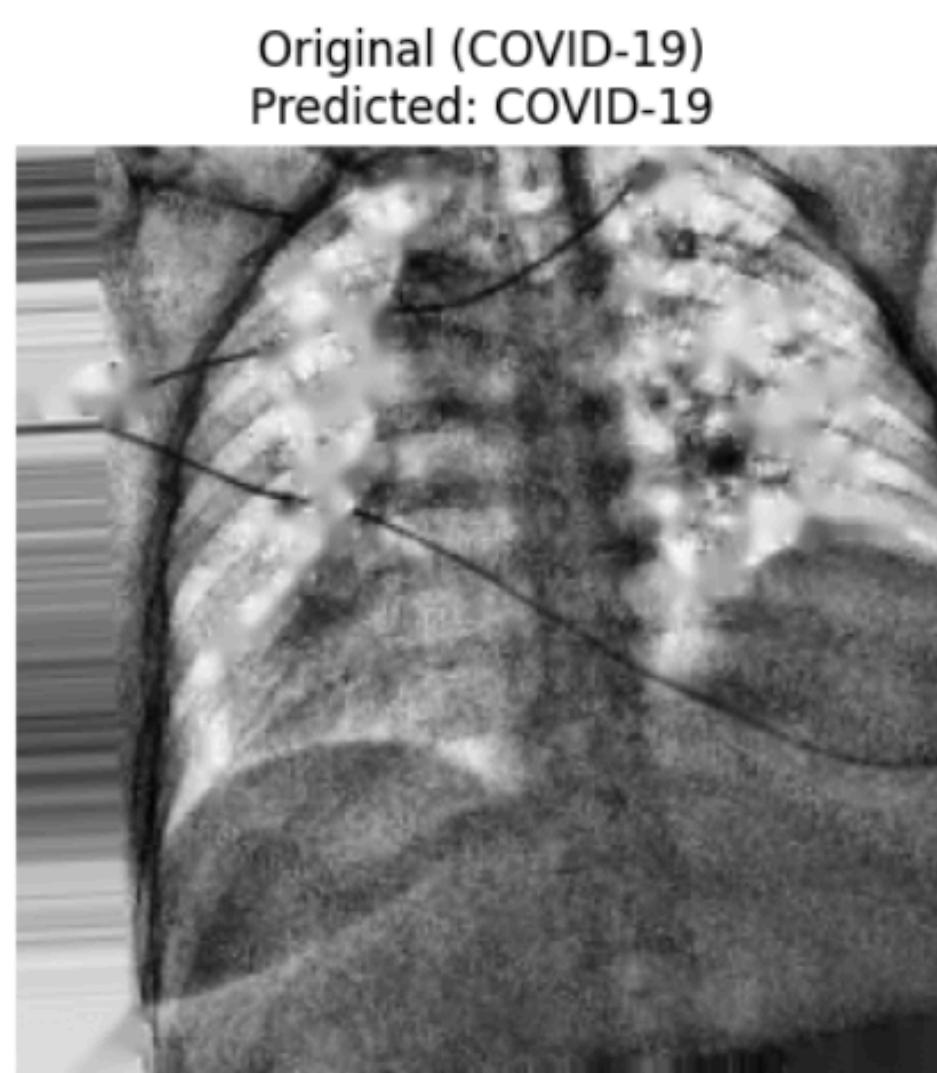
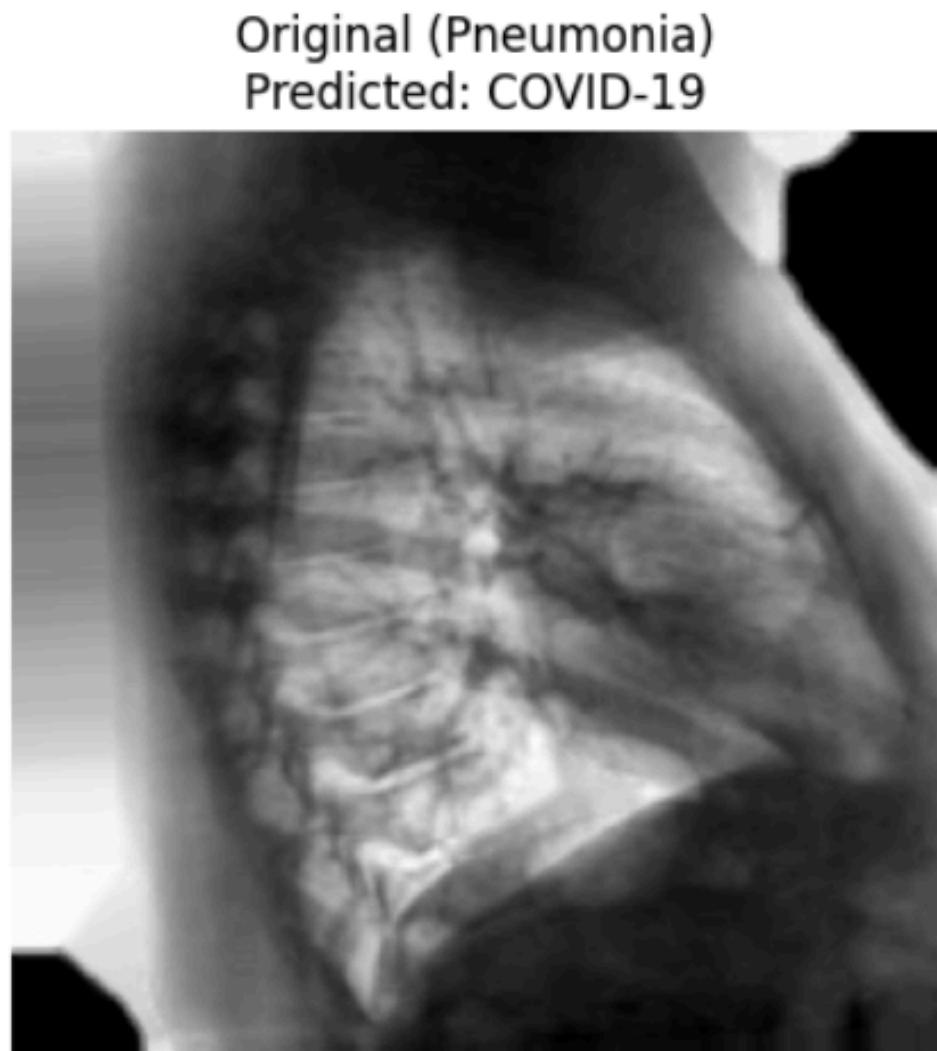
Right Prediction



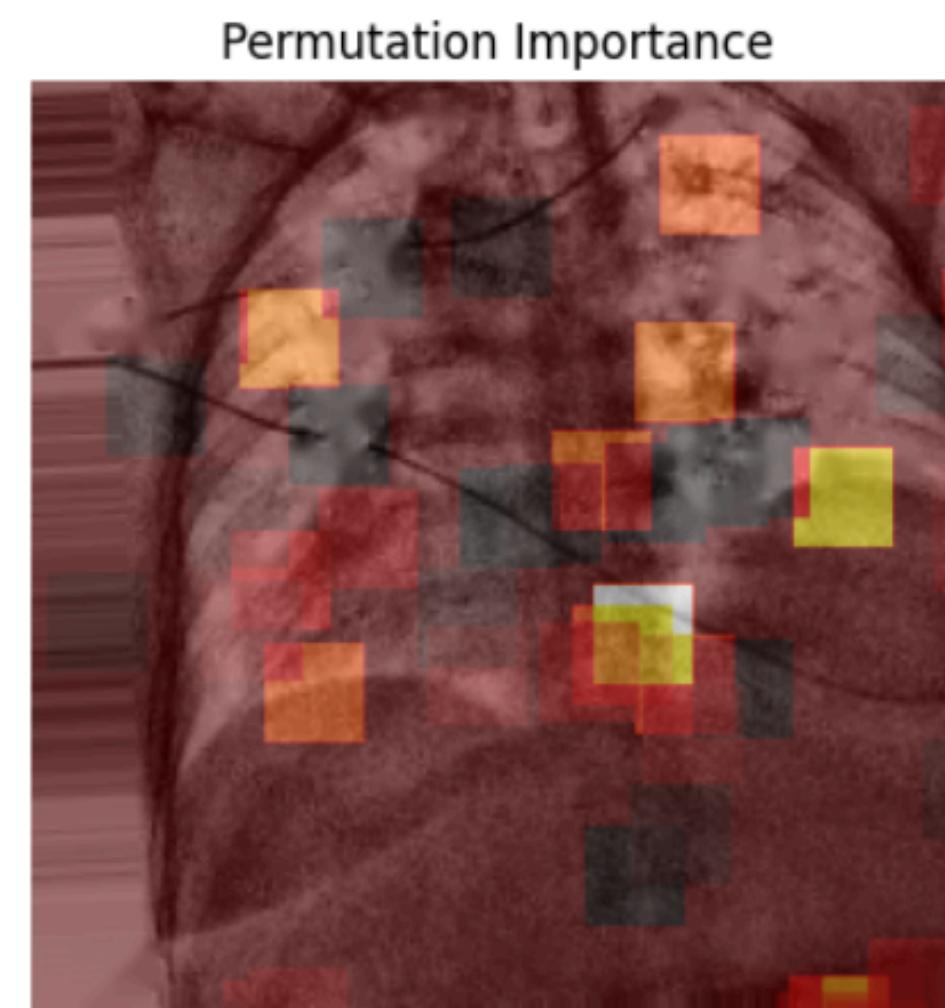
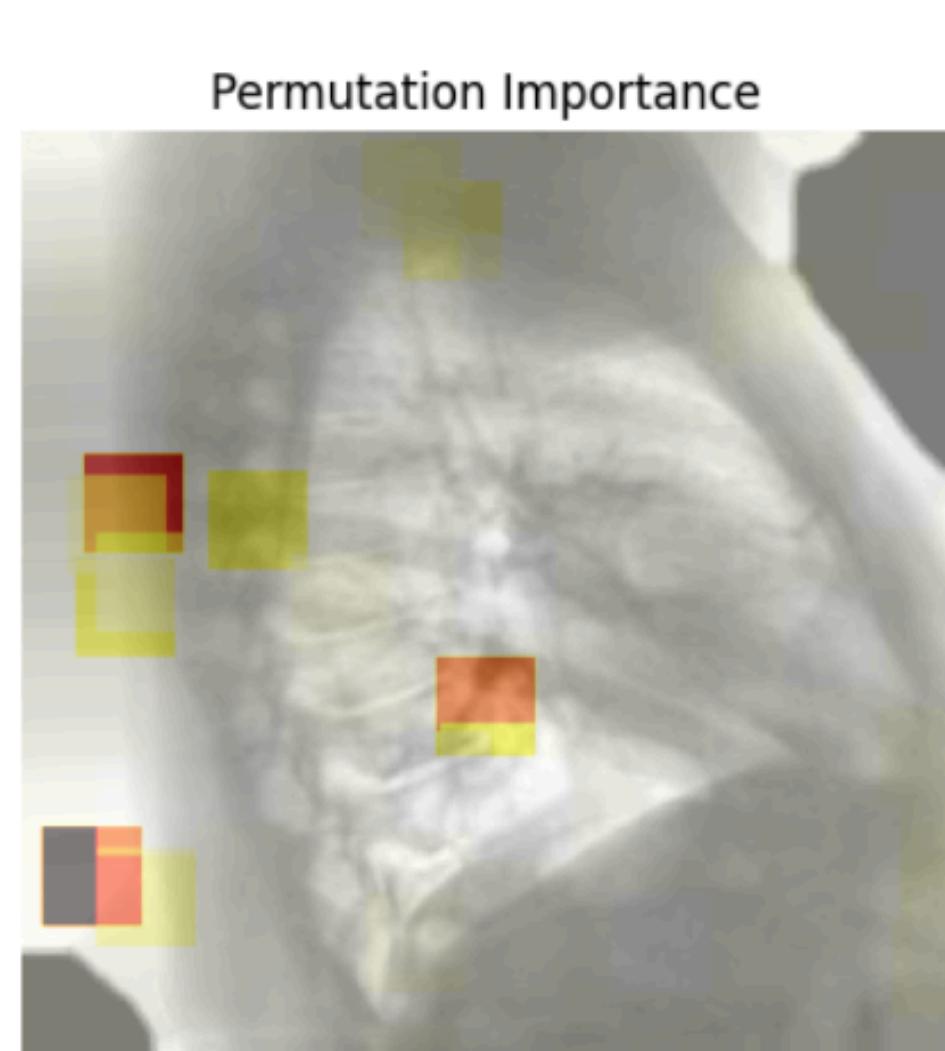
PERMUTATION IMPORTANCE



False Prediction

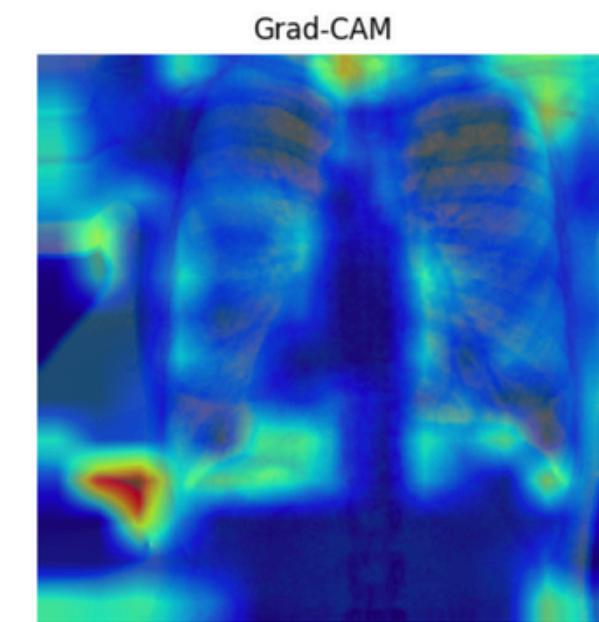
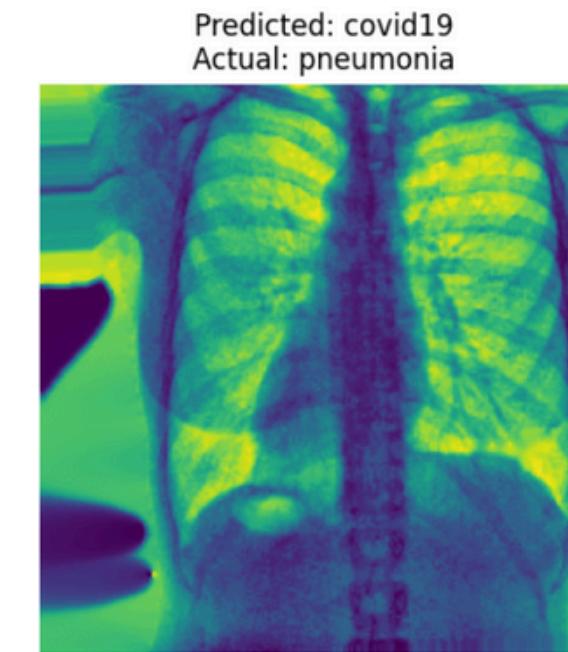
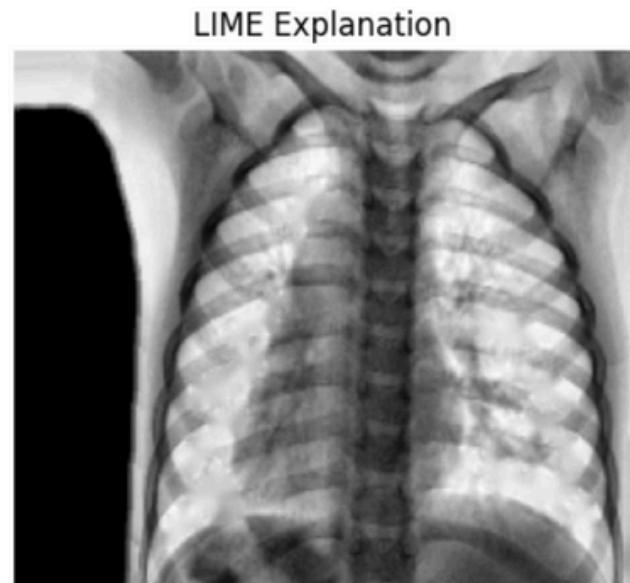


Right Prediction

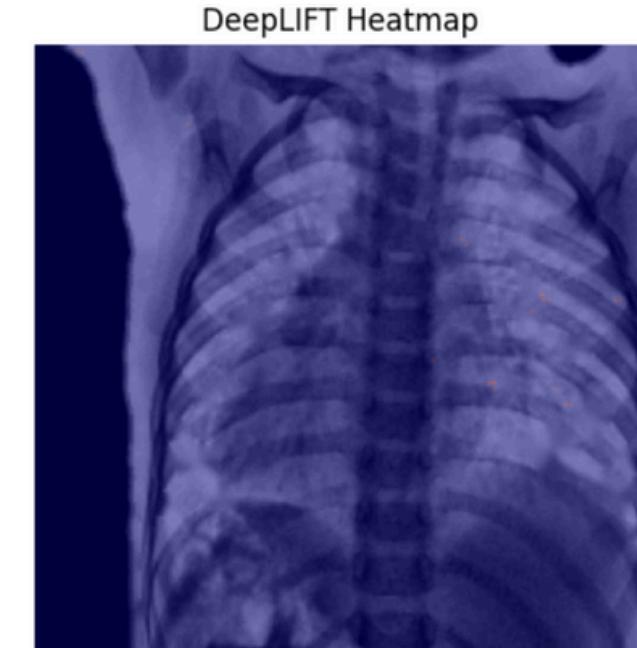
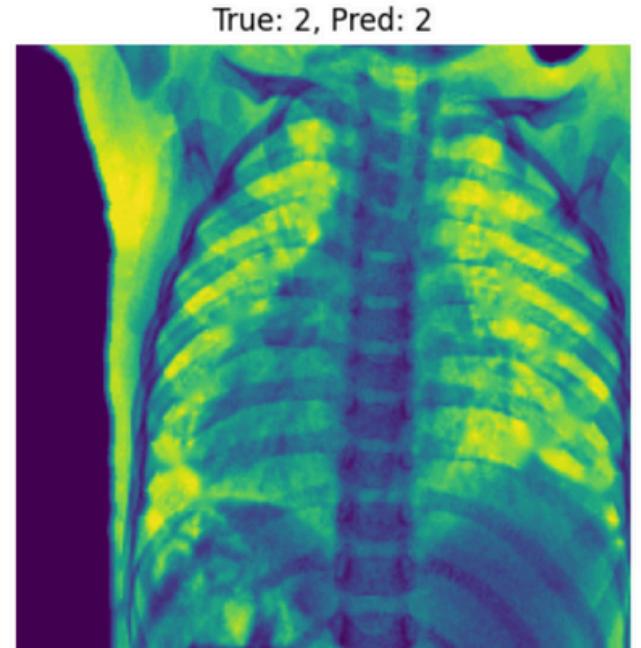


Some Times XAI techniques Fails to Explain the prediction

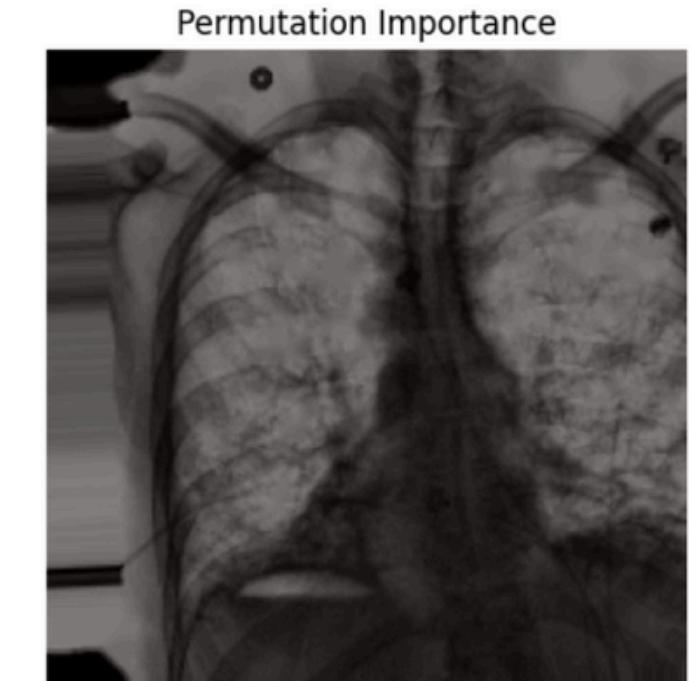
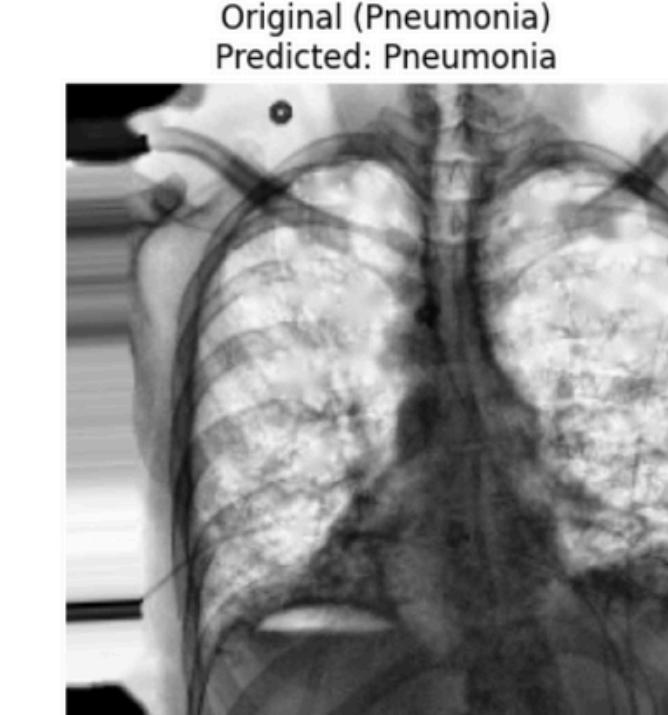
Lime



DeepLift



Permutation Importance



CONCLUSION

[1] Best Pre-Trained Model is VGG16:

- High Accuracy in Train and Test
- No Over Fitting or Underfitting
- Good Classification for Complex images
- Provide good Explanations

[2] Best Novel Model:

- High Accuracy in Train and less for Test
- Slight Over Fitting
- Good Classification for Complex images
- Provide good Explanations



■ [1] Brunese, L., Mercaldo, F., Reginelli, A., & Santone, A. (2020). Explainable Deep Learning for Pulmonary Disease and Coronavirus COVID-19 Detection from X-rays. *Computer Methods and Programs in Biomedicine*, 196, 105608. <https://doi.org/10.1016/j.cmpb.2020.105608>

[2] Patro, K. K., Allam, J. P., Hammad, M., Tadeusiewicz, R., & Pławiak, P. (2023). SCovNet: A skip connection-based feature union deep learning technique with statistical approach analysis for the detection of COVID-19. *Journal of Applied Biomedicine*, 43(1), 352–368. <https://doi.org/10.1016/j.jbbe.2023.01.005>

ANY QUESTIONS?

THANK YOU

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