Classifying Pulmonary embolism cases in chest CT scans using VGG16 and XGBOOST

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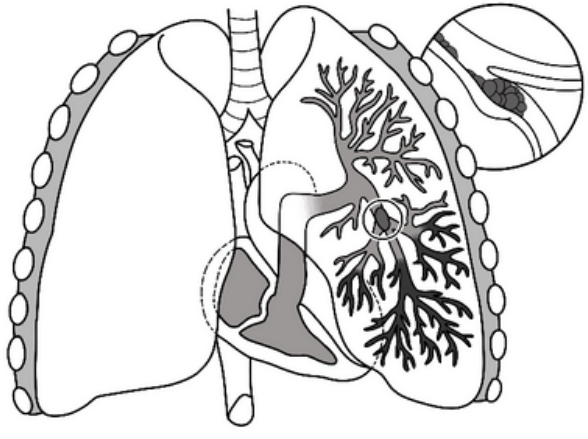
Contents

What is PE ?

Pulmonary Embolism (PE) refers to a situation when a blood clot becomes lodged in one of the arteries that go from the heart to the lungs. The result is reduced blood flow to the lungs,increased blood pressure in the pulmonary arteries, and lower oxygen levels in the vital organs and becomes life-threatening. Computed tomography pulmonary angiography (CTPA) is used for diagnosing PE .



Abstract:

Objective:

- **Build a model to Classify the CT scan images into two classes (PE and No_PE)**
- **To evaluate the model using metrics like precision, recall and f1score.**

Model

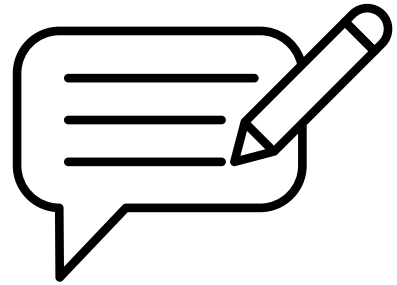
“VGG16 in combination with XGboost:

- **VGG16 - Feature Extraction**
- **XGboost - Classification**

Metrics

- **Accuracy**
- **Sensitivity**
- **misclassification rate**

Literature Review

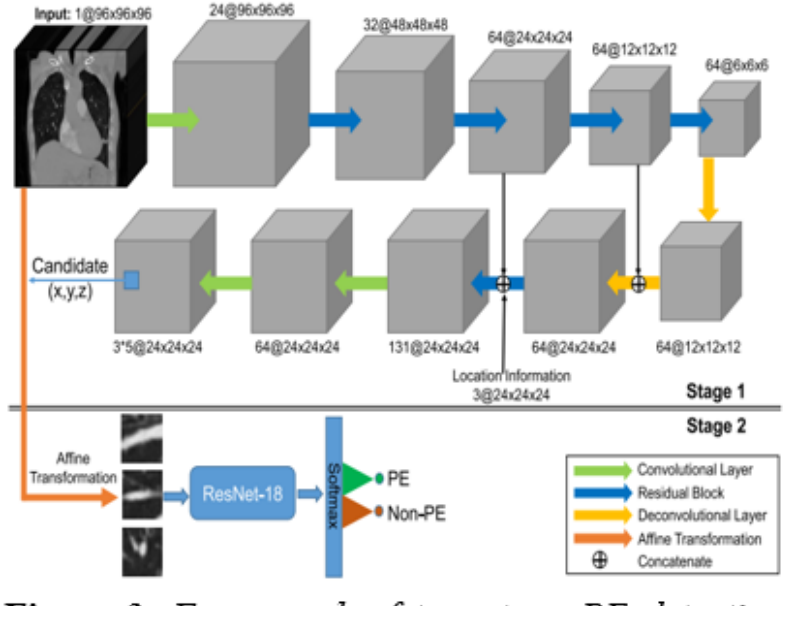


- **15 other papers that address similar issues were studied to gain insights.**
- **Most of the papers focussed on Classification, Deep Neural networks, training criterion to minimise classification error.**
- **One such papers with similar objective was given by Yang *et al,* which deals with Detection of PE in CTPA images using a two stage approach.**

Base Paper:

"A Two-Stage Convolutional Neural Network for Pulmonary Embolism Detection From CTPA Images"

- **Two Stage approach.**
- **For PE detection, Yang *et al* developed a 3D fully convolutional neural network (FCN) to suggest candidate regions.**
- **second stage that uses a 2D cross-section of the vessel-aligned cubes and a ResNet-18 model for classification to extract vessel-aligned 3D candidate cubes and remove false positives.**



Comparative Study:

Paper	Methodology	Evaluation Metric
A Two-Stage Convolutional Neural Network for Pulmonary Embolism Detection From CTPA Images	Resnet-18	Sensitivity (75.4%)
Computer-aided pulmonary embolism detection using a novel vessel-aligned multi-planar image representation and convolutional neural networks	CNN	Sensitivity (83%)
U-net: Convolutional networks for biomedical image segmentation,	U-net	accuracy (77.5)
Artificial Intelligence Algorithm with SVM Classification using Dermascopic Images for Melanoma Diagnosis	AI with SVM	sensitivity (100%) specificity (70%)
Accurate Pulmonary Nodule Detection in Computed Tomography Images Using Deep Convolutional Neural Networks	CAD system	FROC-score (89%)
U-net: Convolutional networks for biomedical image segmentation,	RPN and Faster R-CNN	accuracy(70.4%)
A novel method for pulmonary embolism detection in CTA images	CAD	sensitivity (95.1%)
Analysis of Convolutional Neural Network based Image Classification Techniques	DenseNet	training accuracy: (99.25%) testing accuracy: (100%)
Deep convolutional neural network based medical image classifcation for disease diagnosis	Capsnet	74%

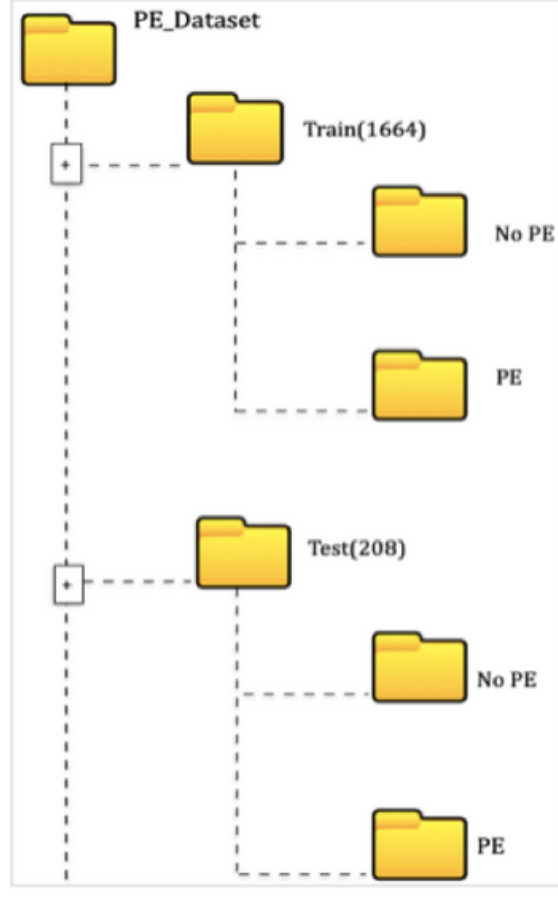
Dataset Description

RSNA-STR Pulmonary Embolism Dataset - Kaggle

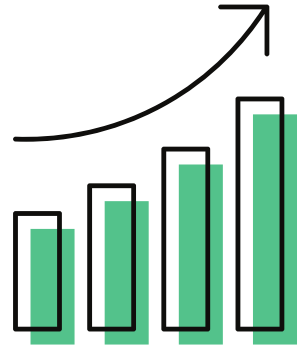
File Description

- **train.csv - contains meta data**
- **Dataset - contains directories with unique Study Instance, Series Instance and SOP Instance ID**

pe_present_on_image - column in train.csv indicating PE present or absent in an image.



Medical Image Classification



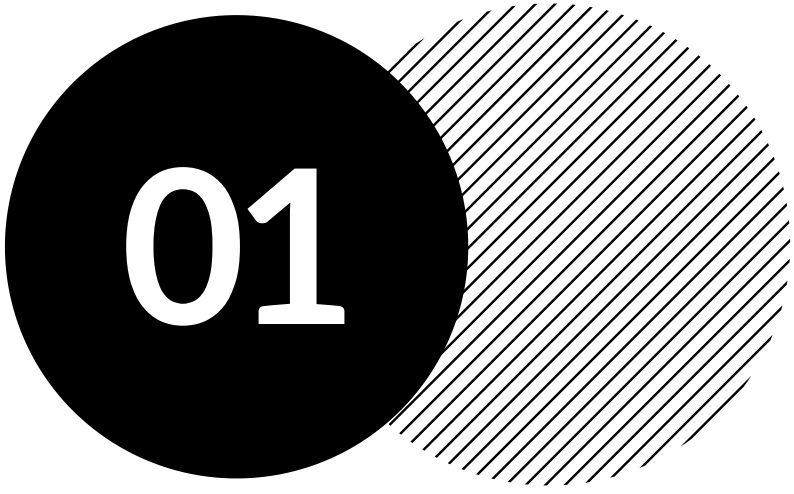
- Quite a challenging task in deep learning
- Two stages to classify medical images-

  Stage 1 : Extract information from the image

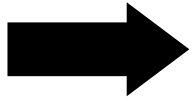
  Stage 2: The characteristics are then used to classify images

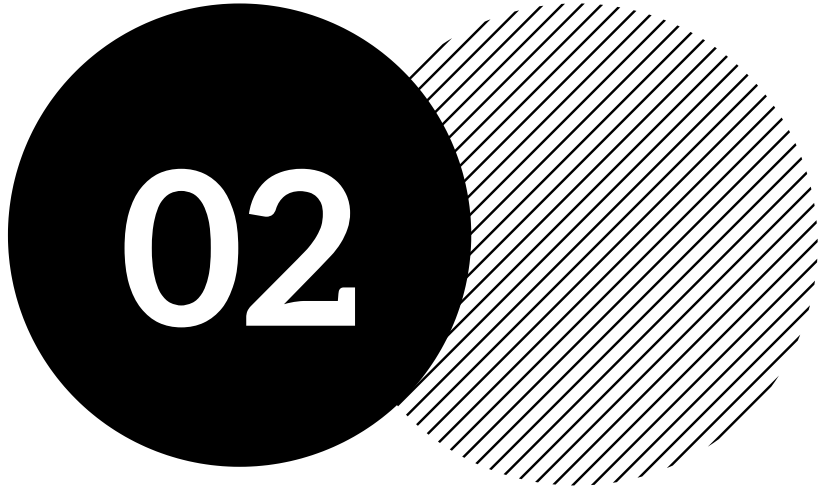
- Manually classifying images is tedious hence we propose a method to automate the process.

Proposed Methodology



VGG-16 -> Transfer Learning for Feature Extraction

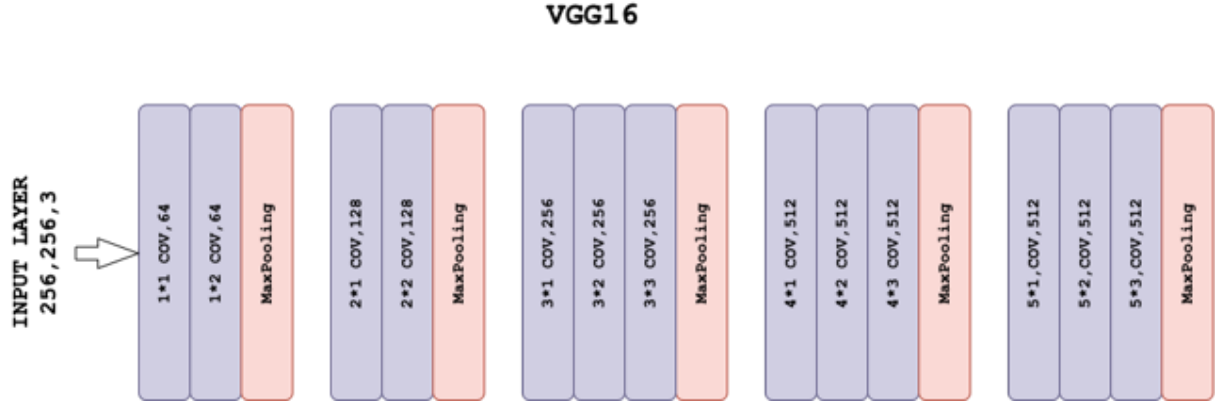




Extreme Gradient Boosting to classify CTPA images

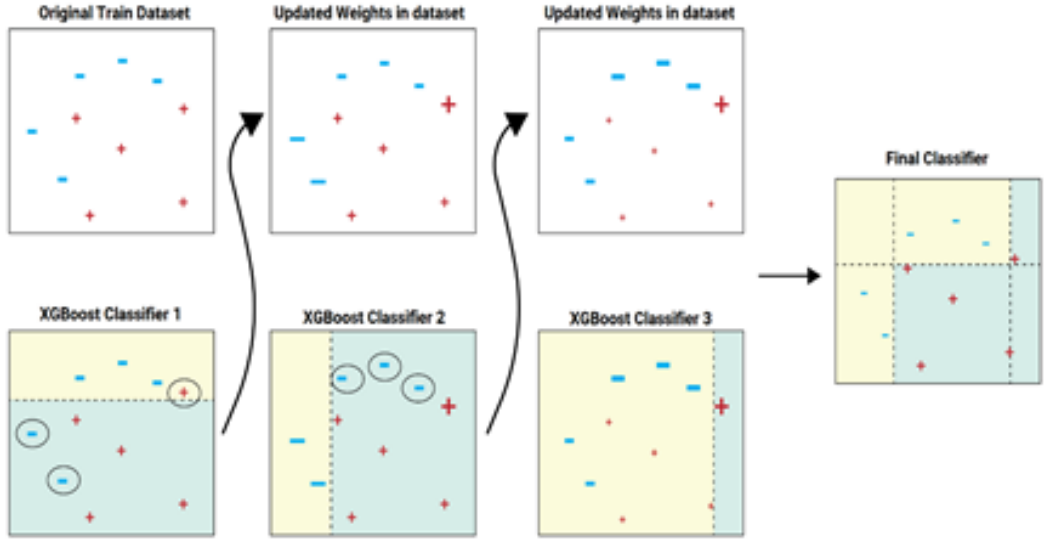
Steps Involved to classify CTPA images

- Train and test splits each containing PE and No PE CTPA images
- Resize all images to 256
- Convert RGB images to Gray-scale
- Normalise pixel values to between 0 and 1
- Load VGG16 model without classifier /fully connected layers



VGG-16 model for feature extraction(without classifier)

- **Use features from Convolutional network for XGBOOST to classify images**



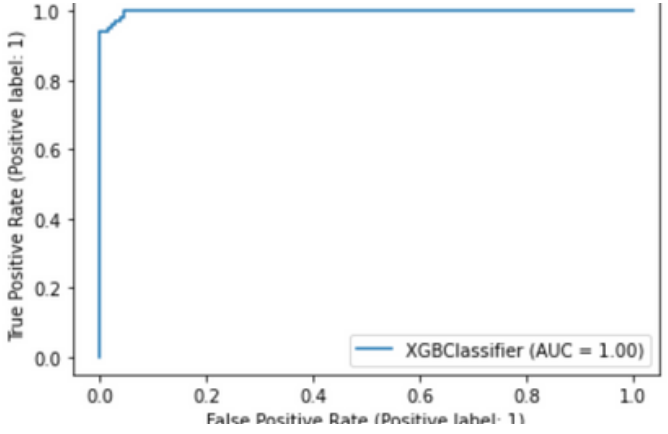
Working of XGBOOST

- **Evaluate the performance of the model**

Result

	Precision	Recall	f1-score
No PE	0.97	0.98	0.98
PE	0.98	0.97	0.98
Accuracy			0.98

Classification Report



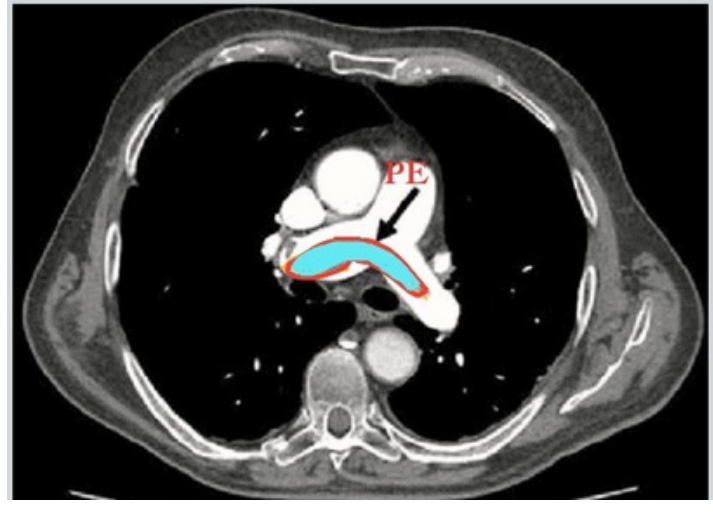
ROC Curve

Classification report that is used to assess the quality of predictions made by the algorithm. Our method achieves an accuracy of 97.59% and a sensitivity of 97.00% for PE class and 98.00% for No PE class respectively.

Future Work and Conclusion

Mask RCNN:

- It is a deep neural network used for image segmentation.
- It can identify clots in an image and generates high quality segmentation mask for each instance.
- It achieves instance segmentation



Annotation

- VGG annotator tool

Thank You.

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