Pneumonia detection from chest X-rays using deep neural networks

Shivangi Prasad (Ph.D., Medium Energy Physics, UIUC)

Course project (AI for healthcare)

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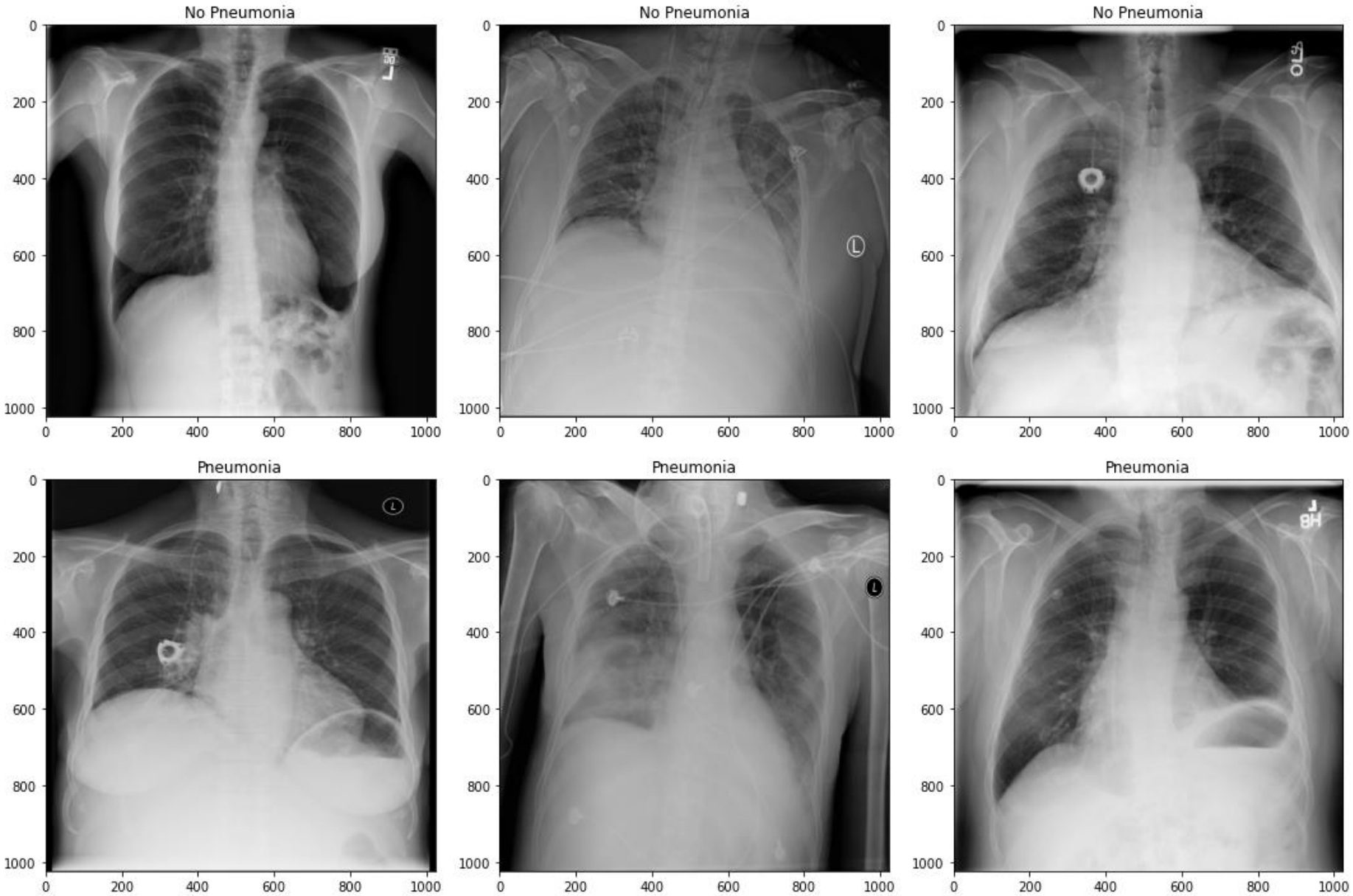
Goal

- To assist radiologists in prioritizing which x-ray scans require more immediate attention.
- Scans with detected Pneumonia can be addressed earlier than the rest.

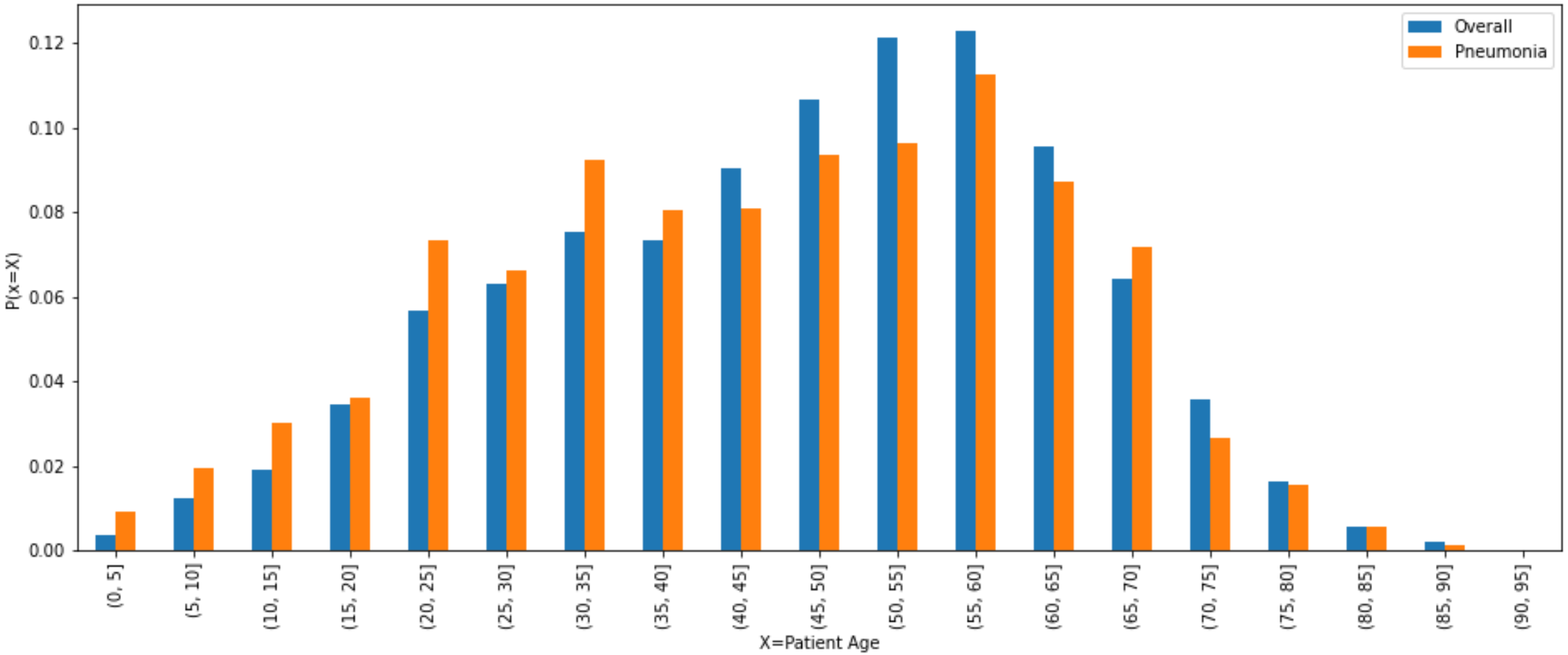
Dataset

- NIH chest x-ray data
  - https://www.nih.gov/news-events/news-releases/nih-clinical-center-provides-one-largest-publicly-available-chest-x-ray-datasets-scientific-community
- 112,000 x-rays with disease labels (radiology report) for ~30,000 patients
- Training/Validation data: The data was split as 80/20 for training and validation data

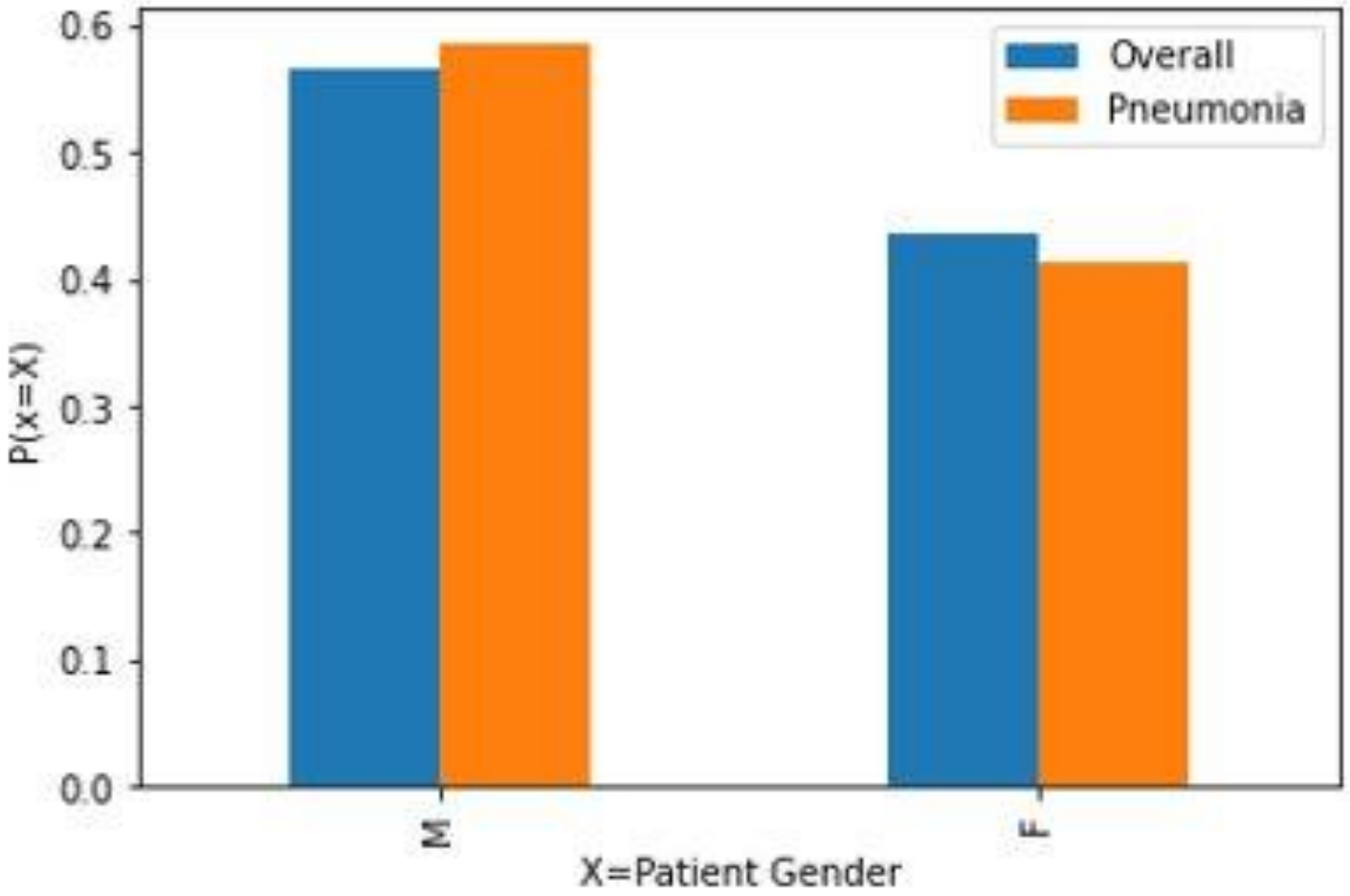
Sample images



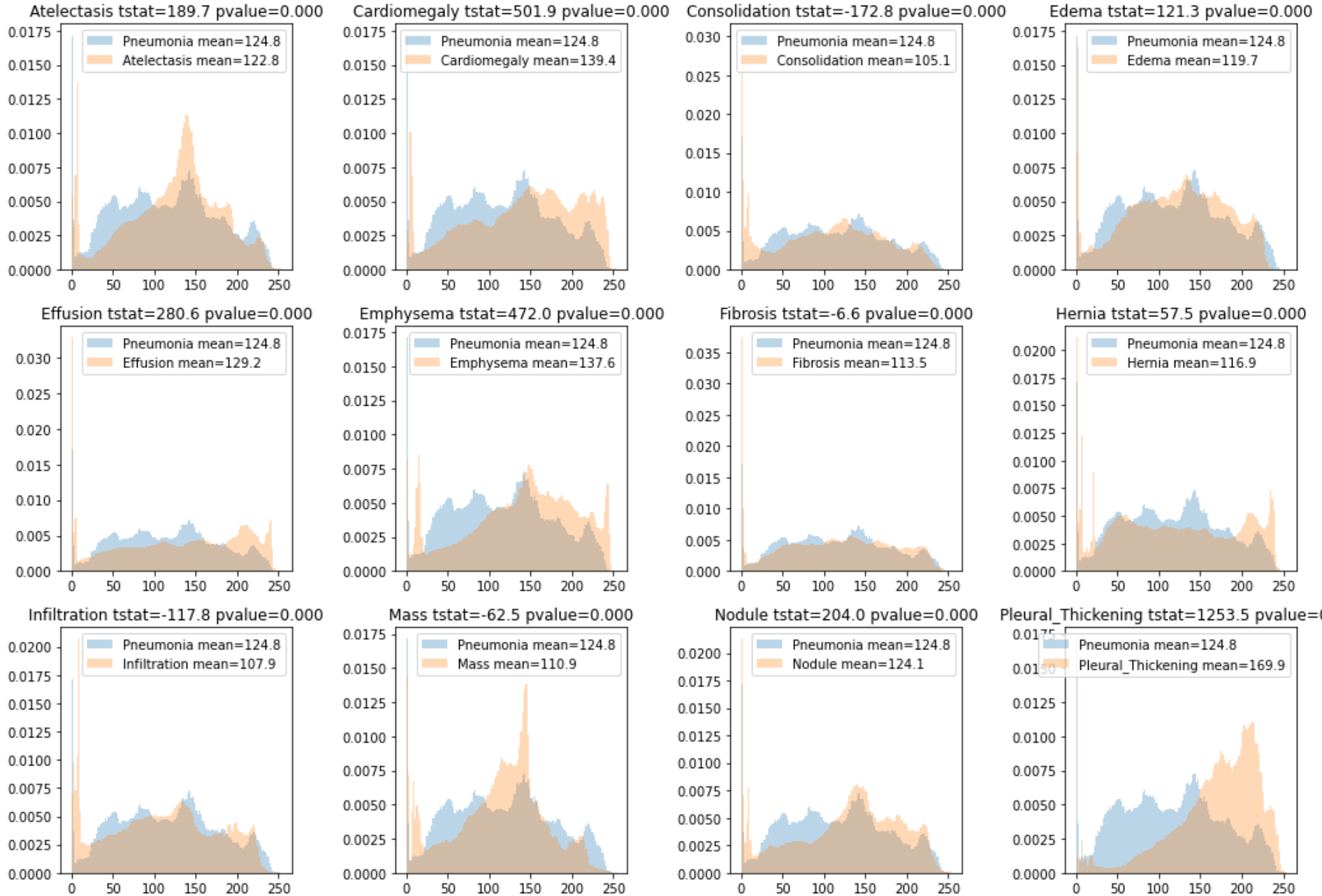
Exploratory data analysis (age distribution)



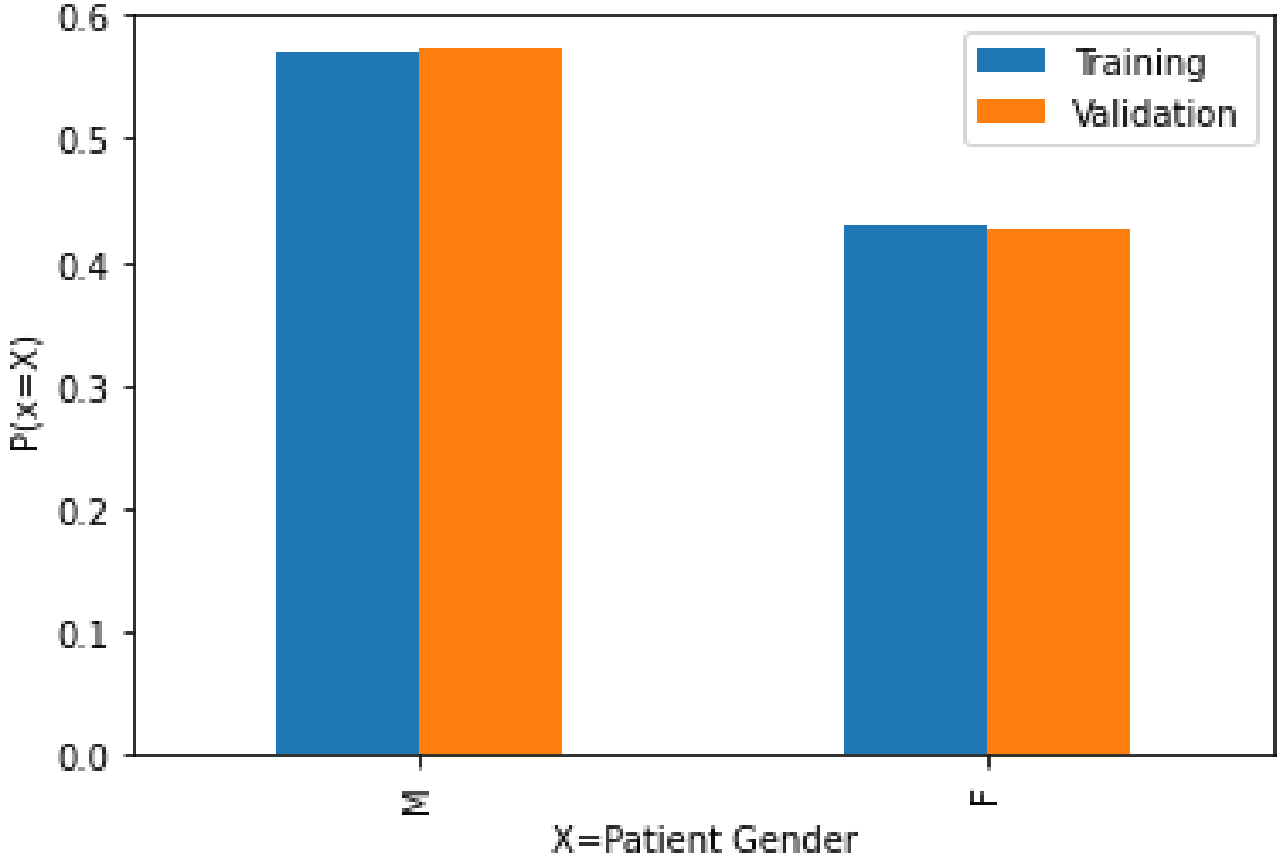
Exploratory data analysis (gender distribution)



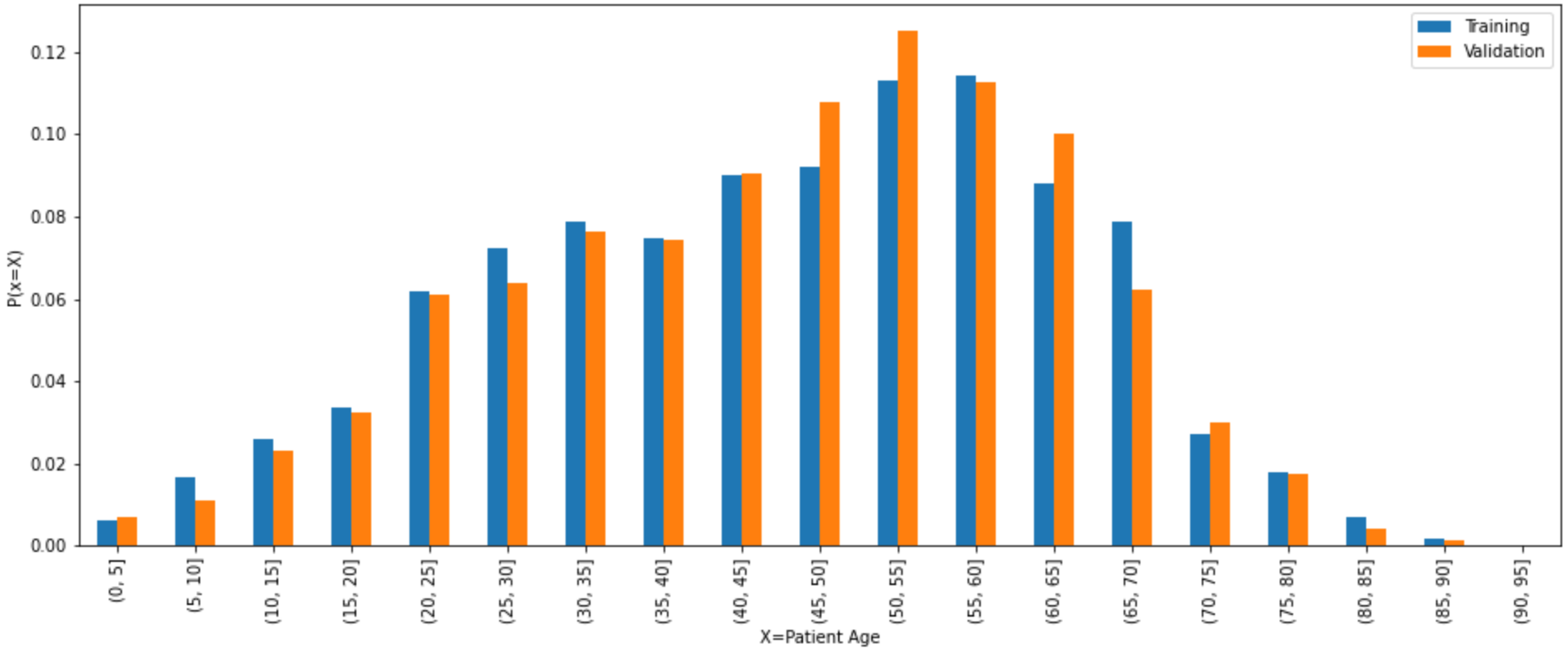
Exploratory data analysis (intensity distribution)



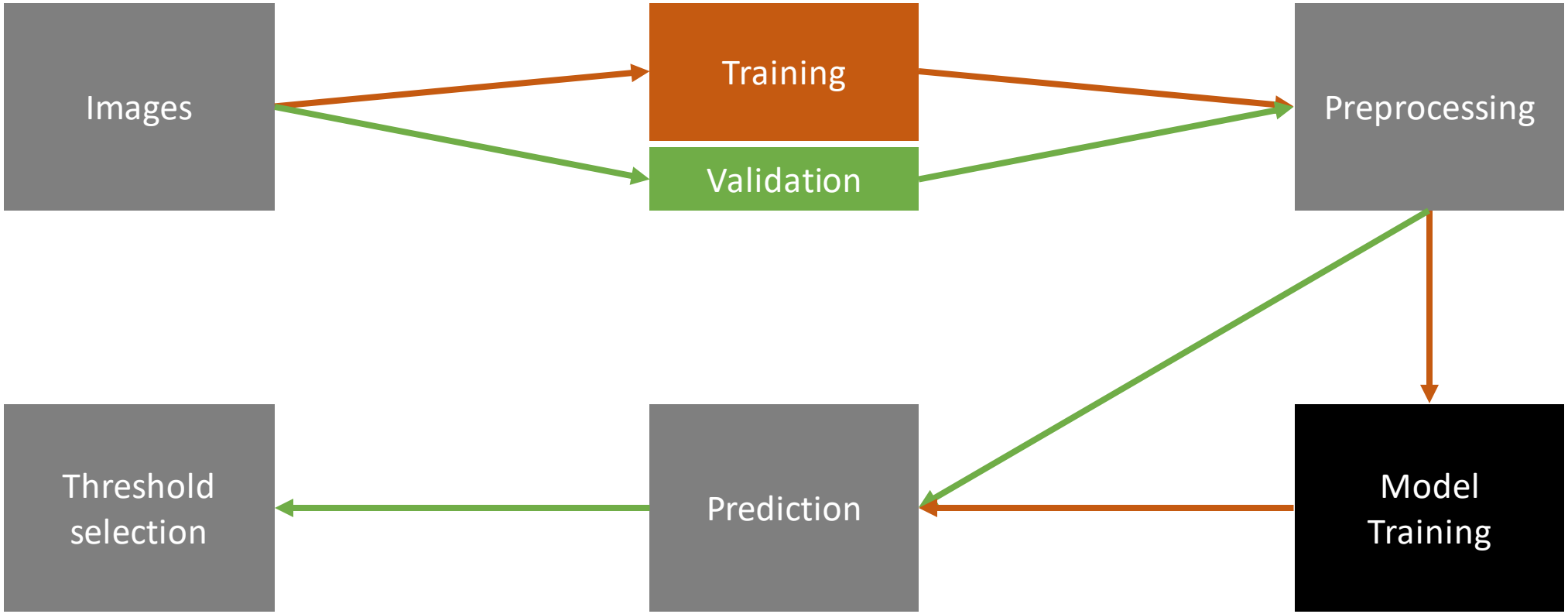
Train/Validation split (gender distribution)



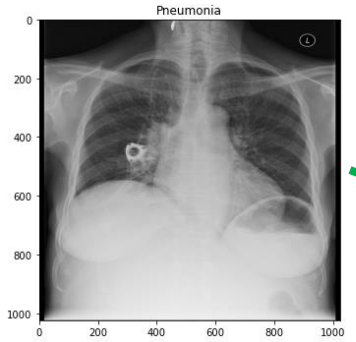
Train/Validation split (Age distribution)



Flowchart


Images
Training
Validation
Preprocessing
Threshold selection
Prediction
Model Training

Model



Model
$f_\theta(X_i)$

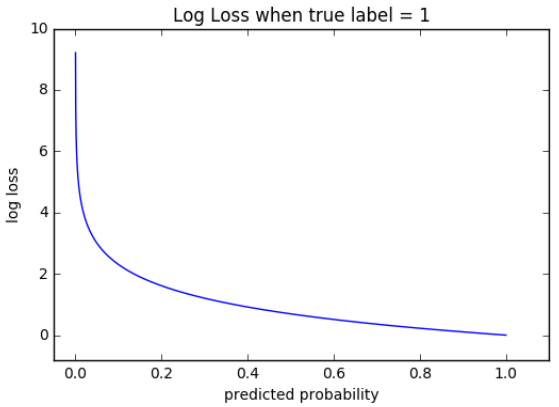
Cross Entropy Loss

$l(p_i, y_i) = -[y_i \log(p_i) + (1 - y_i)\log(1 - p_i)]$

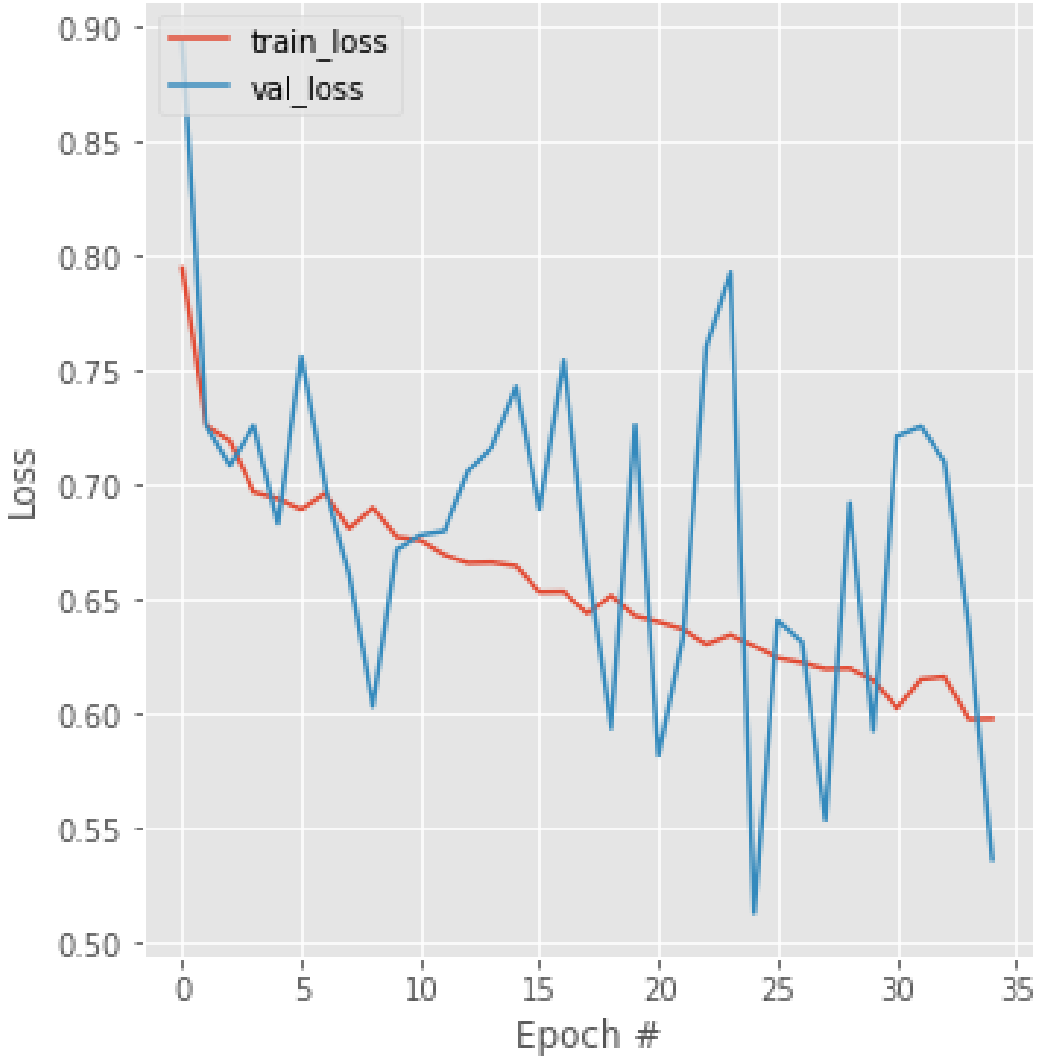
p_i y_i

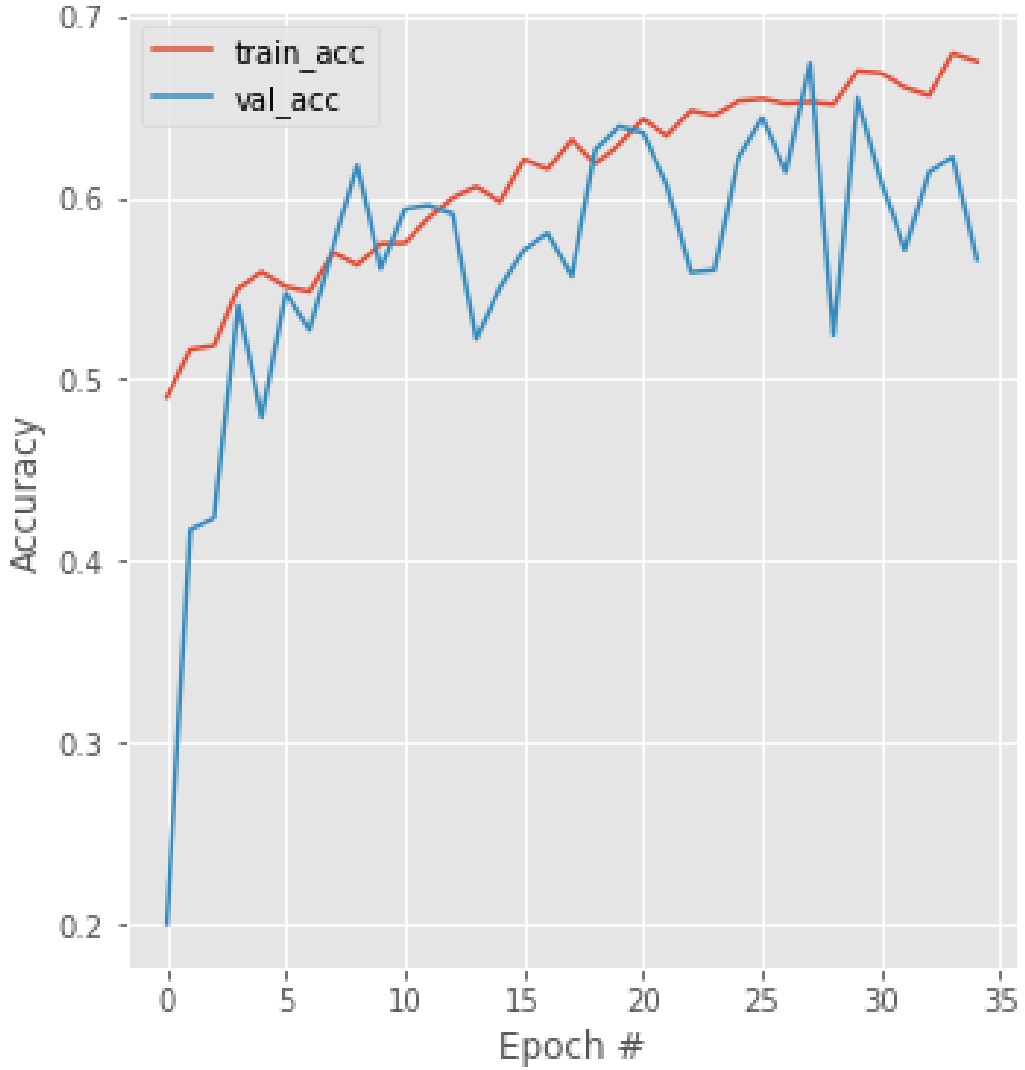
Update model

$$\theta = \theta - \alpha * \frac{\partial l}{\partial \theta}$$



Training loss and accuracy



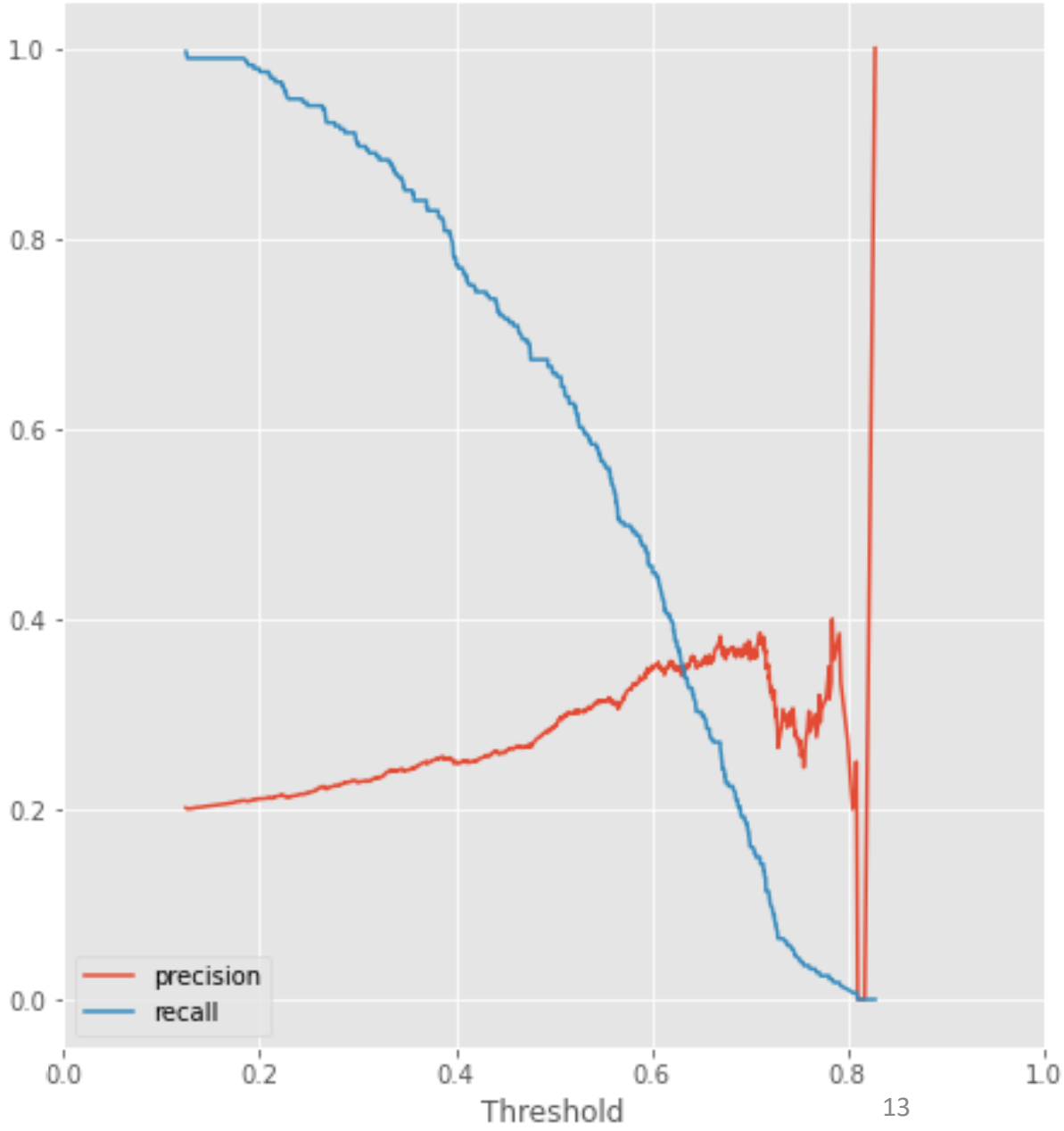


Precision-recall curve

		Actual	
		Positive	Negative
Predicted	Positive	**True Positive**	**False Positive**
	Negative	**False Negative**	**True Negative**

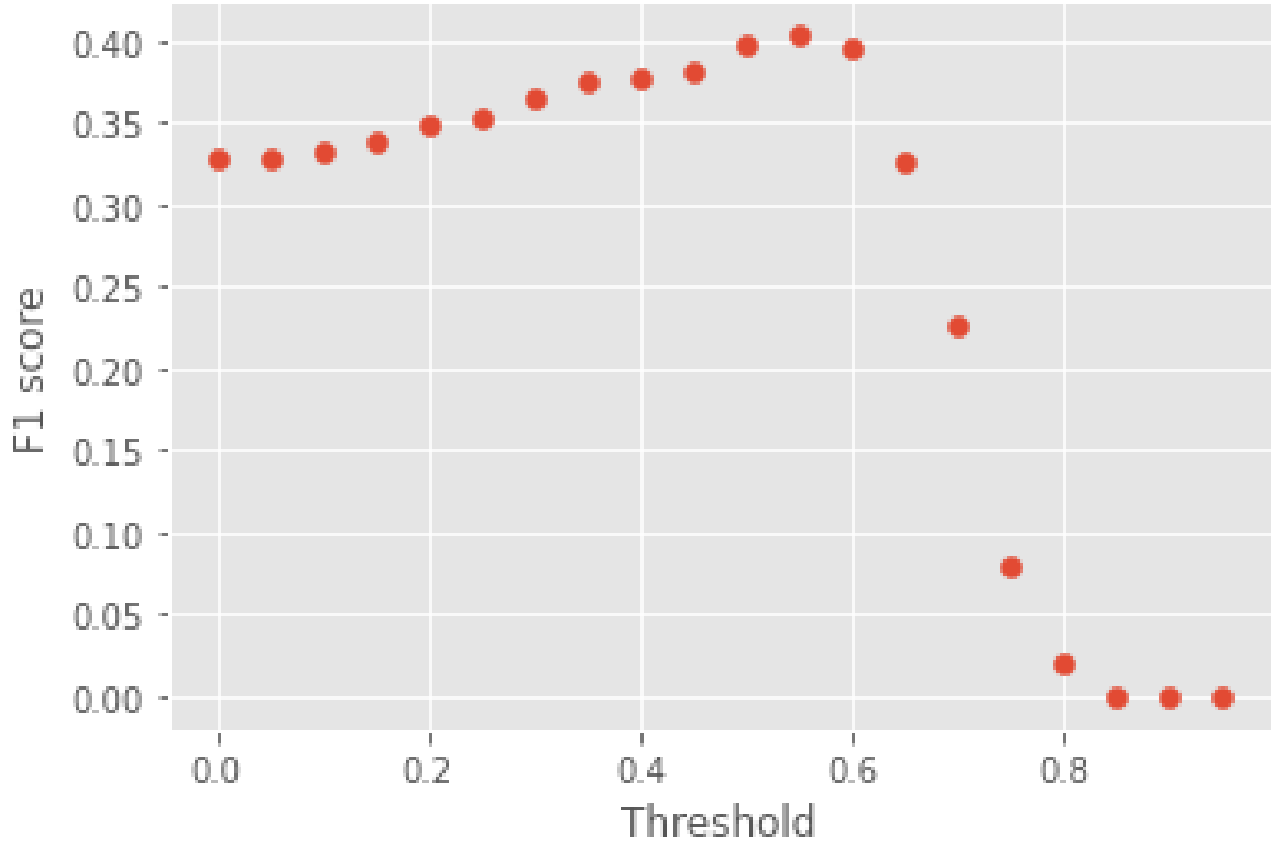
$$\textbf{Precision} = \frac{True\ Positives}{True\ Positives + False\ Positives}$$

$$\textbf{Recall} = \frac{True\ Positives}{True\ Positives + False\ Negatives}$$



Evaluation metric (F1 score)

$$F1 = 2 * \frac{precision * recall}{precision + recall}$$



The model achieved an F1 score of 0.4, this is higher than the mean radiologist F1 score =0.387 [1]

[1] Rajpurkar, P., Irvin, J., Zhu, K., Yang, B., Mehta, H., Duan, T., … Ng, A. Y. (2017). CheXNet: Radiologist-Level Pneumonia Detection on Chest X-Rays with Deep Learning. Retrieved from http://arxiv.org/abs/1711.05225

Summary

- The model can assist radiologists in prioritizing which x-ray scans require more immediate attention.
- Already performing at the level of radiologists.