TEAM #1

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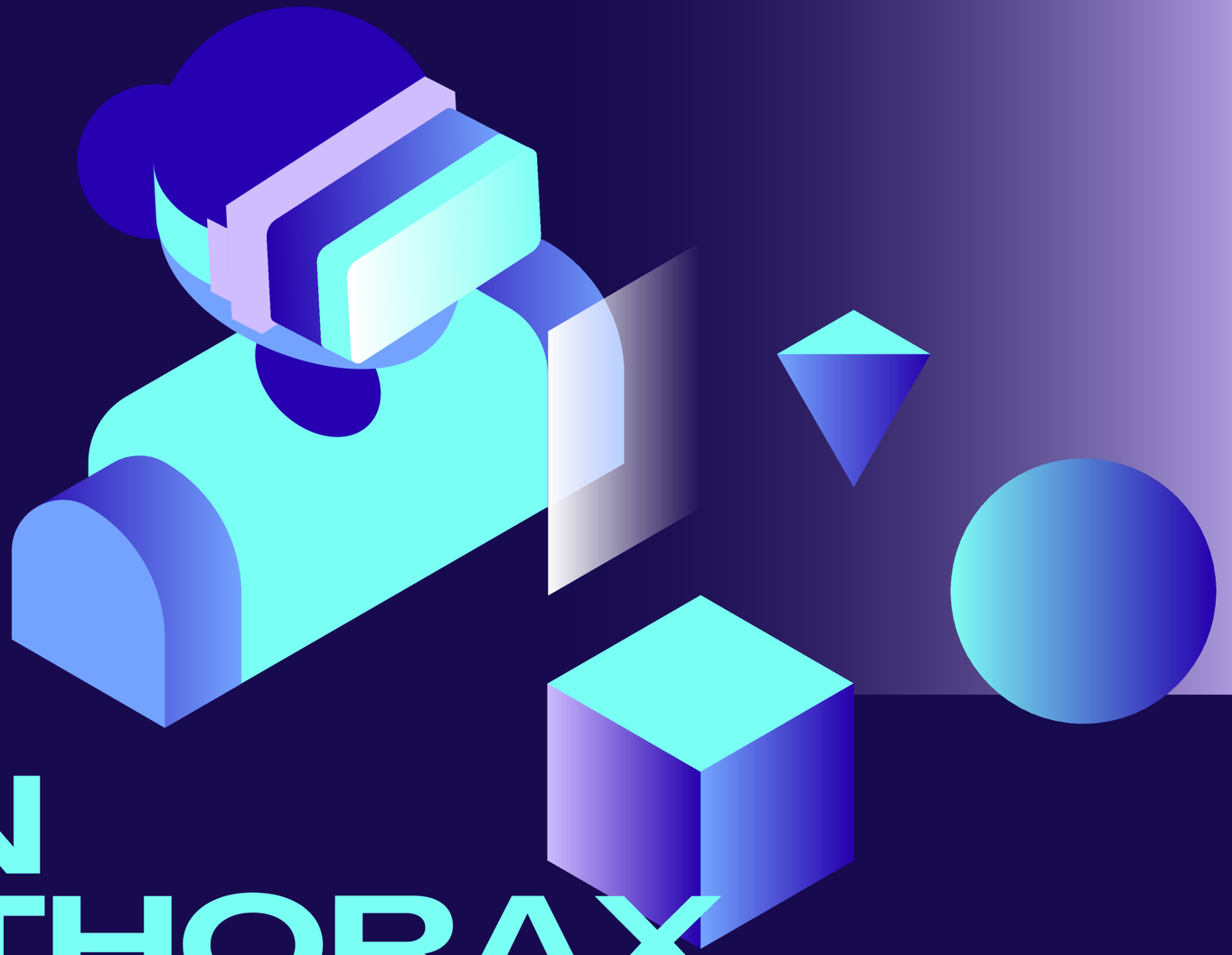


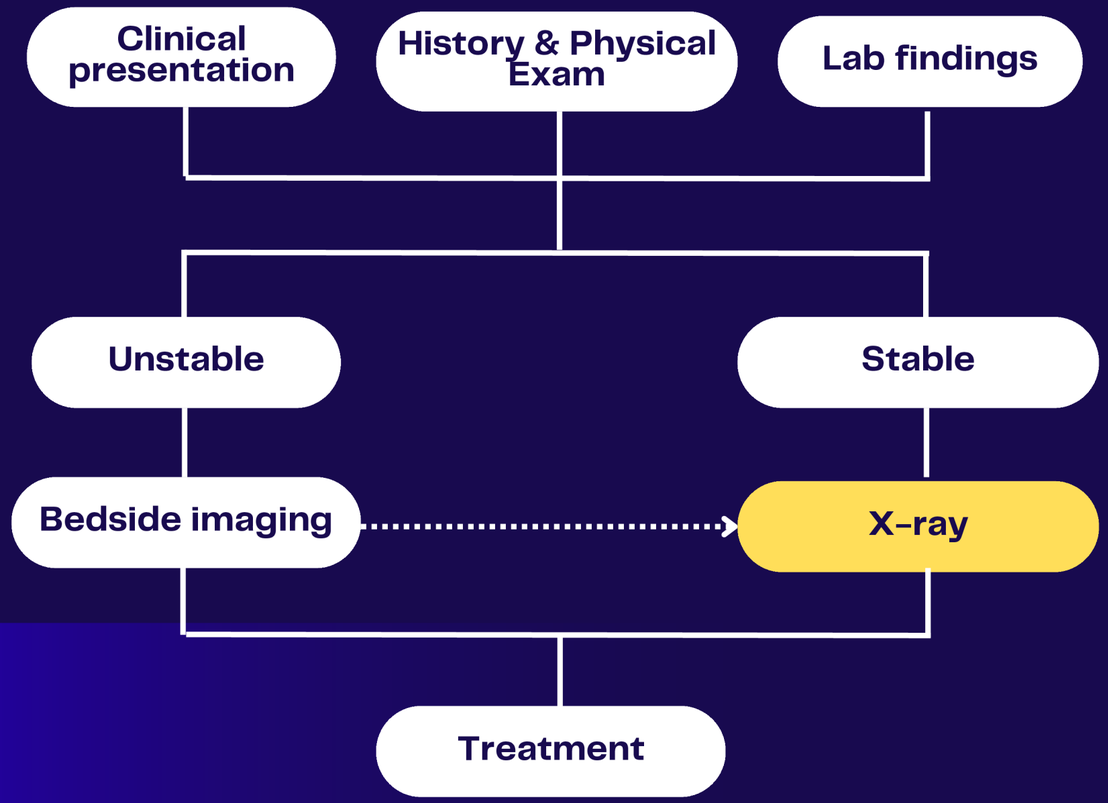
AI-DRIVEN PNEUMOTHORAX DETECTION

WHAT IS PNEUMOTHORAX

- The accumulation of air in the pleural space, leading to lung collapse, shock, and death.
- Common and critical
- If untreated, tension pneumothorax can be fatal very quickly, approaching 100% mortality if intervention is delayed [1].
- **EARLY DETECTION IS CRITICAL**

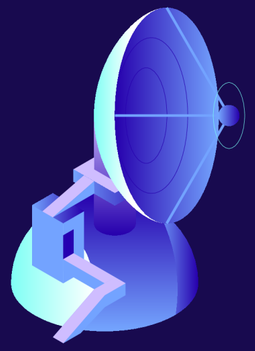
Disease burden
17 to 24 per 100,000 in men
1 to 6 per 100,000 in women
annually [2]

DIAGNOSTIC FLOWCHART

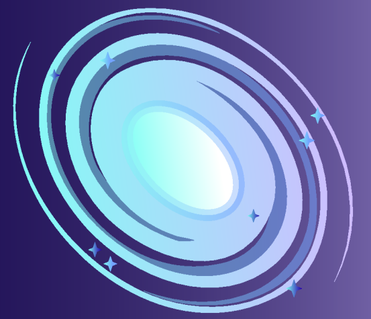


So what's the issue?

- 72% of Canadian radiologists scored high in the emotional exhaustion domain of burnout [4]
- 59% of Canadian emergency physicians reported high emotional exhaustion [5]



STUDY SIGNIFICANCE



Efficient Triaging and Diagnosis

- automating image analysis → provide rapid results
- healthcare providers to make quicker decisions, particularly in emergency settings

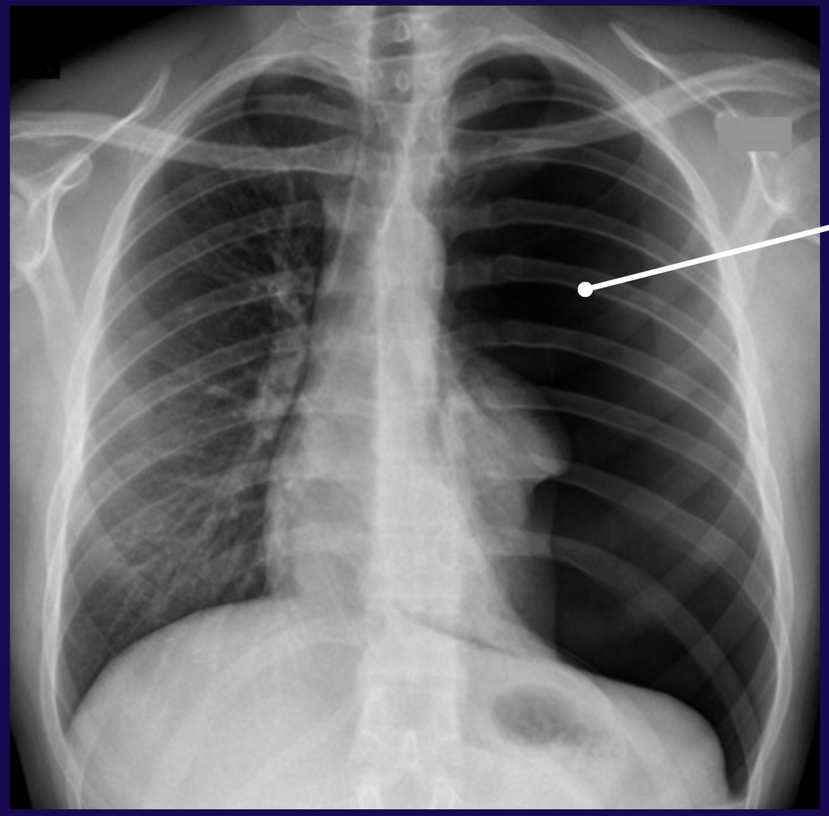
Address Radiologist Shortages

- reliable tool for timely diagnoses, especially in rural or under-resourced areas (e.g. few radiologists)

Scalability and Accessibility

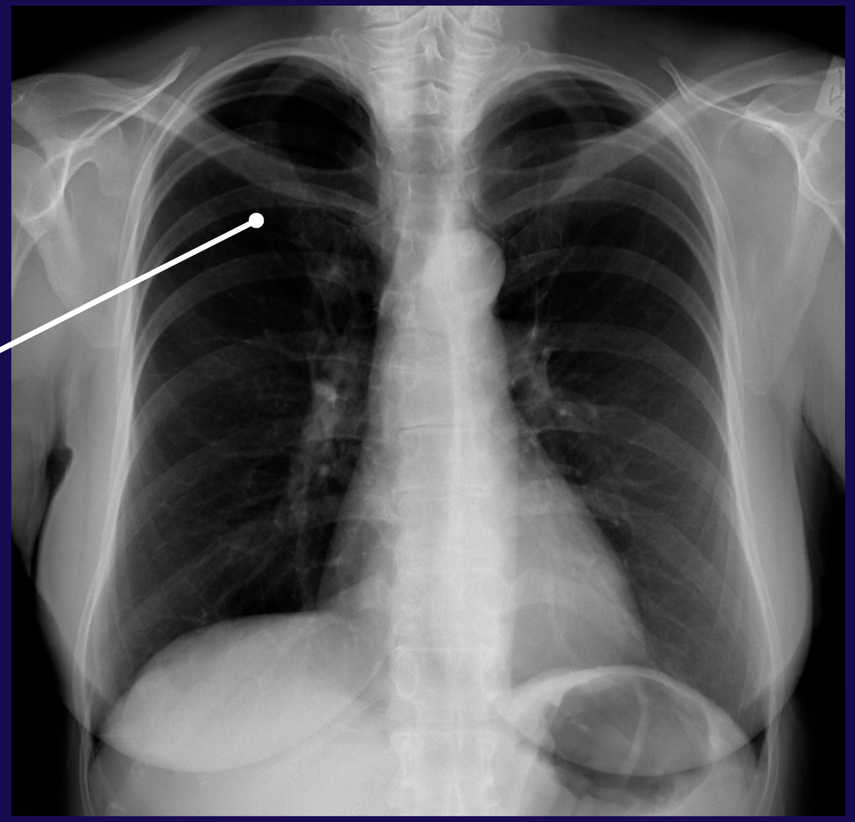
- AI systems can be widely implemented
- can improve access to high-quality diagnostics in low-resource settings globally

WHAT DOES IT LOOK LIKE?



Left lung is completely compressed

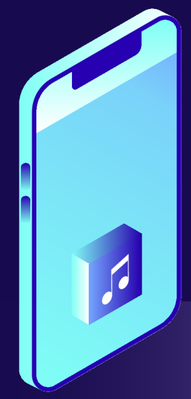
Lack of lung markings indicating lung collapse



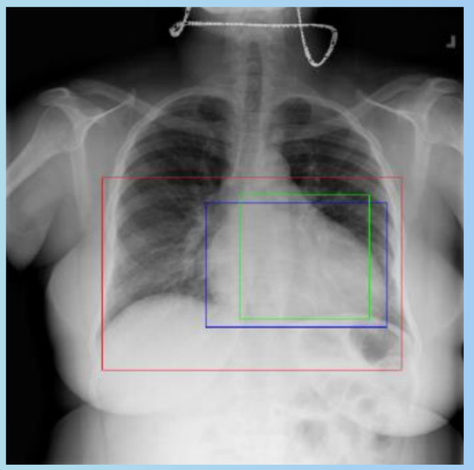
Tension Pneumothorax [3]

Patient 71: Pneumothorax

NIH CHEST X-RAYS

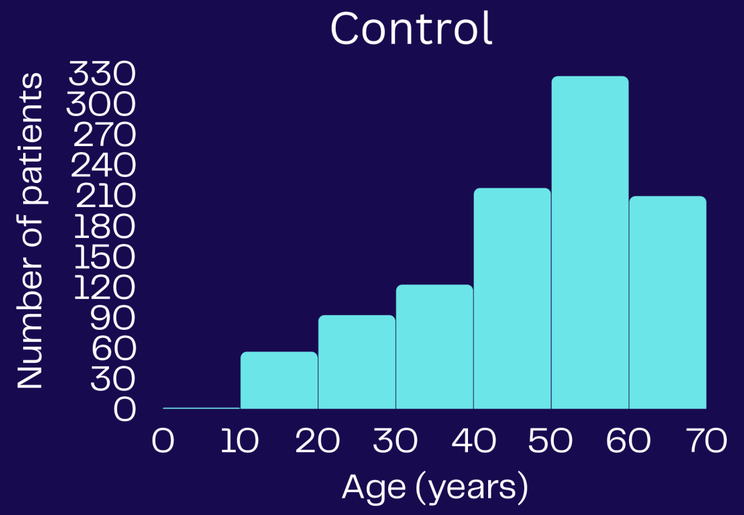


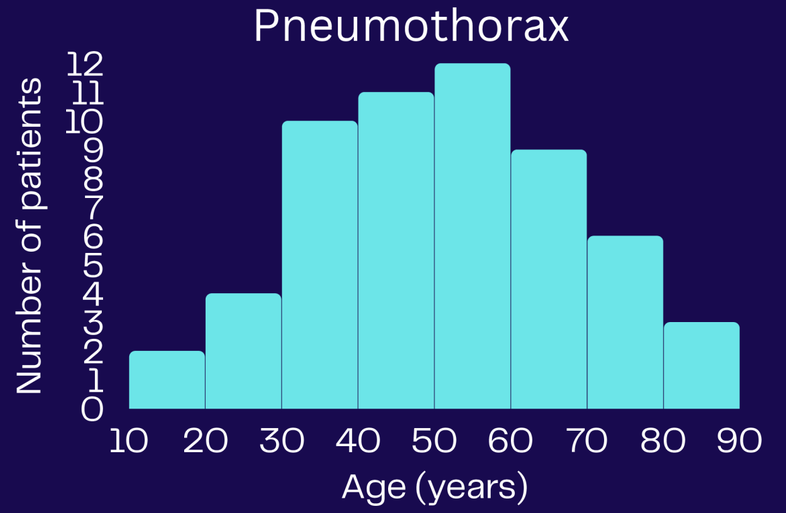
- Natural language processing was used to text-mine disease classifications from radiology reports
- Disease labels are expected to be >90% accurate and suitable for machine learning

Radiology report	Keyword	Localization result
Findings include: 1. cardiomegaly (ct ratio of 17/30). 2. otherwise normal lungs and mediastinal contours. 3. no evidence of focal bone lesion.	Cardiomegaly	 Blue: ground truth Green: correct Red: false positives

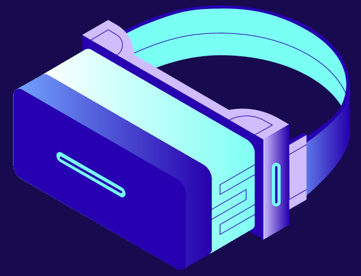
STUDY DEMOGRAPHICS

Characteristic	Control n=1332	Pneumothorax n=57
Male, n (%)	703 (53%)	34 (60%)
Age (years), mean (SD), range	53.1 (16.9), 84	50.4 (17.1), 71
X-rays, n	4800	199





DENSE NET



What is DenseNet[6]

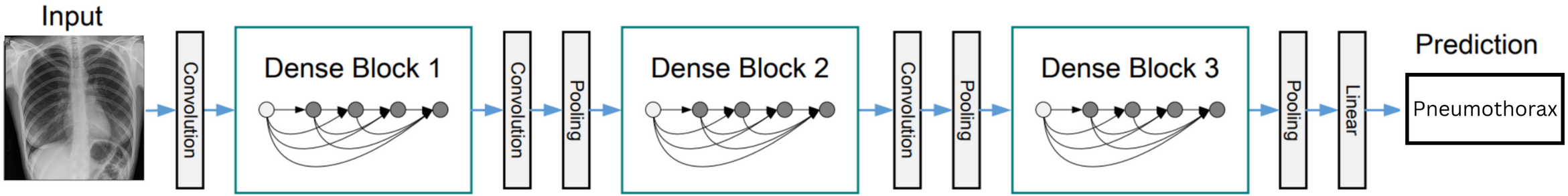
- **Open-source pre-trained** neural network commonly used for **medical images**
- **Densely connected layers** allow for efficiency in learning
- **High accuracy** with **few layers**

Why a pre-trained model?

- DenseNet was trained on **1.2 million images** of **1000 different categories**
- We changed the last layer to output our two classes (Pneumothorax and Not-Pneumothorax)

How does it work?

- **Dense Connectivity:** Each layer gets inputs from all previous layers
- **Efficiency**: Fewer parameters than traditional CNNs by avoiding redundant feature learning

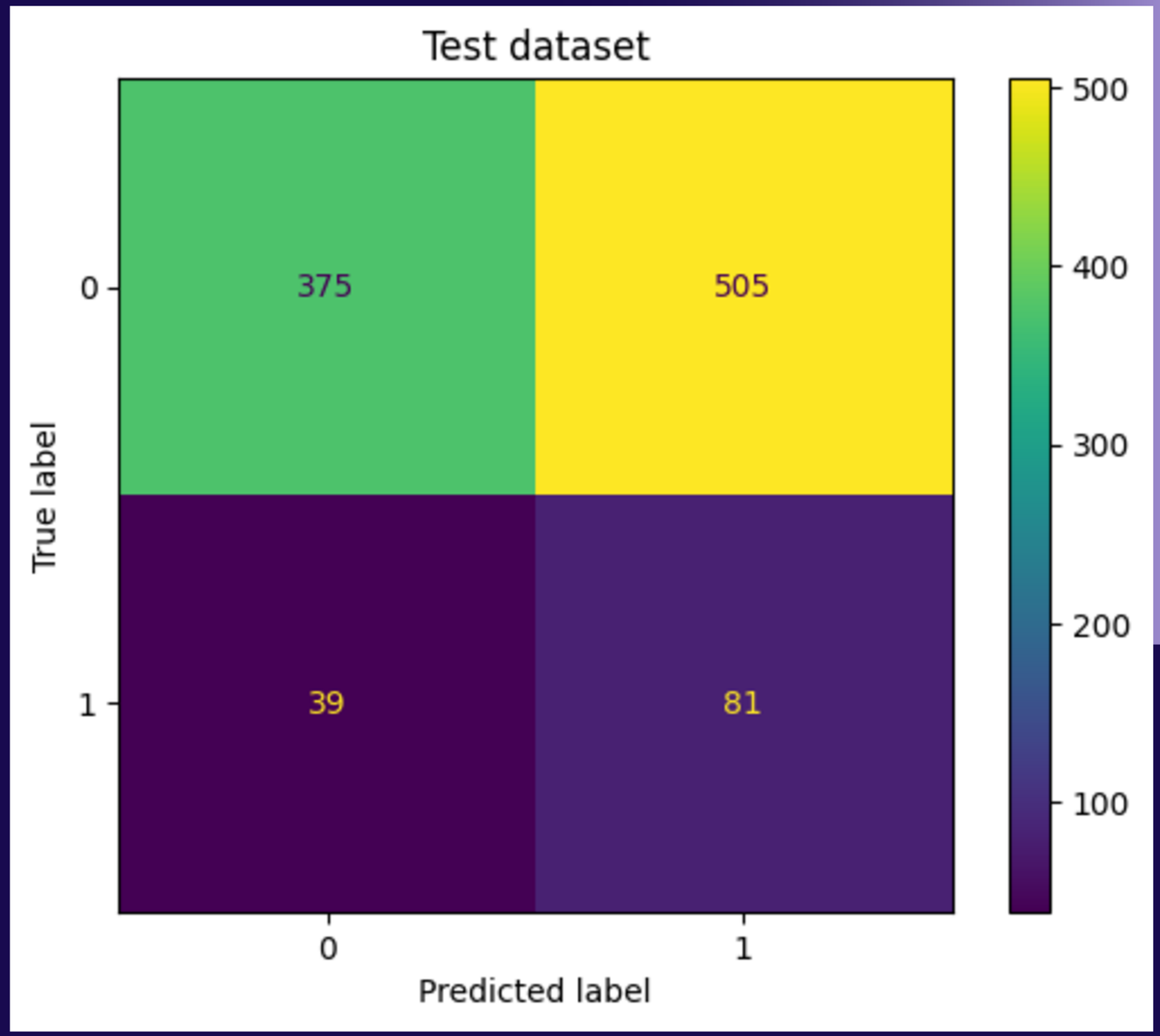


RESULTS

Training Set
- Accuracy: 0.644
- Recall: 0.571
- F2 Score: 0.588

Validation Set
- Accuracy: 0.646
- Recall: 0.573
- F2 Score: 0.589

Test Set
- Accuracy: 0.456
- Recall: 0.138
- F2 Score: 0.379



DEMO!

CONCLUSION

- We attempted to demonstrate the potential of machine learning in detecting the presence of pneumothorax on chest X-rays.
- By leveraging a well-validated dataset and a longer training duration, our model shows promise for integration into clinical workflows, particularly in settings with limited radiology expertise.

Limitations

- **NLP-extracted image labels,** although accuracy is estimated to be >90%
- DenseNet captures global features effectively, but **may struggle to detect subtle, localized abnormalities** such as small fractures or microcalcifications
- **High class imbalance** (pneumothorax cases comprise **4.8%** of images in the entire dataset)

Future directions

- Employ **image pre-processing** techniques
- Integrate pertinent **clinical parameters**, such as vital signs, age, and sex
- Conduct **subset model training** based on age and sex to evaluate potential improvements in predictive performance
- **Multi-center validation** to ensure generalizability

REFERENCES

[1] Hoechter, D. J., et al. (2022). Tension pneumothorax during one-lung ventilation – An underestimated complication? Journal of Cardiothoracic and Vascular Anesthesia, 32(3), 1398-1402.

[2] McKnight, C. L., & Burns, B. (2023, February 15). Pneumothorax. In StatPearls [Internet]. StatPearls Publishing. Available from https://www.ncbi.nlm.nih.gov/books/NBK441885/

[3] Lloyd-Jones, G. (2019, October). Chest X-ray - Pneumothorax gallery - Tension pneumothorax. Radiology Masterclass. Available from https://www.radiologymasterclass.co.uk/gallery/chest/pneumothorax/pneumothorax_b

[4] Cao, D. J., Hurrell, C., & Patlas, M. N. (2022). Current status of burnout in Canadian radiology. Canadian Association of Radiologists Journal, 74(1), 37-43. https://doi.org/10.1177/08465371221117282

[5] de Wit, K., et al. (2024). A longitudinal survey on Canadian emergency physician burnout. Annals of Emergency Medicine, 83(6), 576-584.

[6] Huang, G., et al. (2017). Densely connected convolutional networks. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (pp. 4700-4708).