Disease Classification on Chest X-Rays

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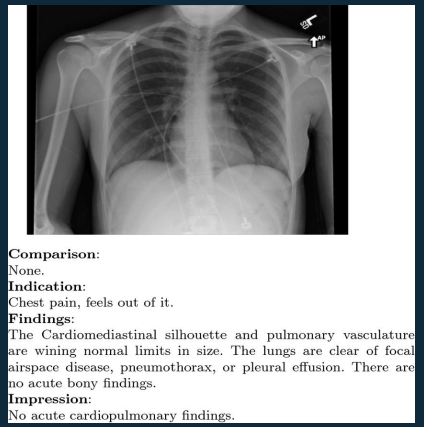
PROBLEM + MOTIVATION

- IMPROVE AND EXPEDITE PATIENT CARE
- UNDERSTANDING BIASES IN AI
- 1. CNN TO CLASSIFY DISEASE BASED ON X-RAY IMAGE
  2. STRATIFY EVALUATION BY CLINICAL + DEMOGRAPHIC FACTORS

DATA
EXISTING RESEARCH
PREPROCESSING

MIMIC-IV DATABASE

- 370k X-ray Images with corresponding labels
- Clinical Reports (Unstructured)
- Demographic, Hospital Records
- **Target Variable: Disease Class**



Comparison:
None.
Indication:
Chest pain, feels out of it.
Findings:
The Cardiomediastinal silhouette and pulmonary vasculature are wining normal limits in size. The lungs are clear of focal airspace disease, pneumothorax, or pleural effusion. There are no acute bony findings.
Impression:
No acute cardiopulmonary findings.

EXISTING RESEARCH

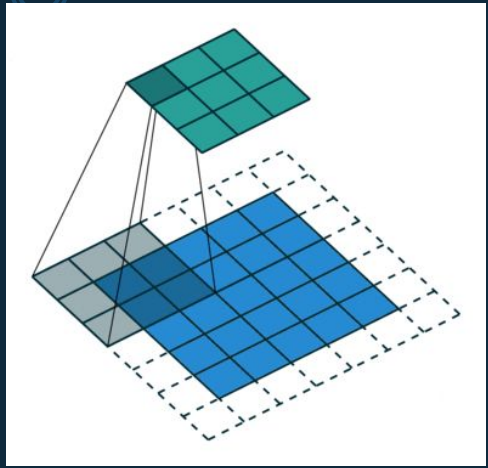
- Similar models have been produced for x-ray images

PREPROCESSING

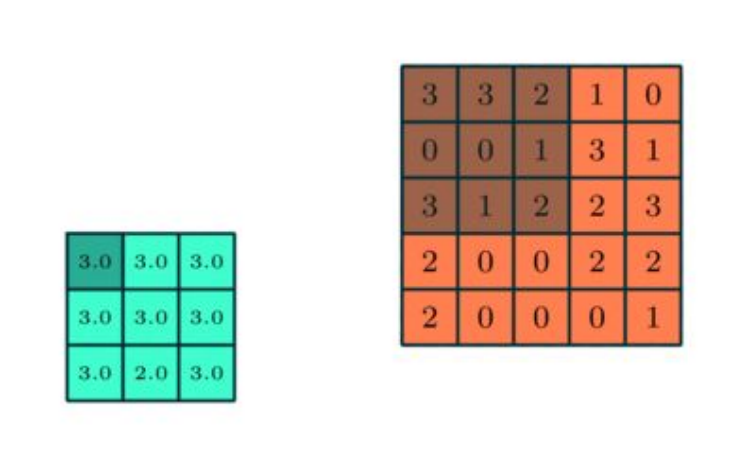
- Pixel intensity normalization
- Image augmentation (horizontal flipping, random rotation, random scaling)
- resizing

CONVOLUTIONAL NEURAL NETWORKS (CNN)

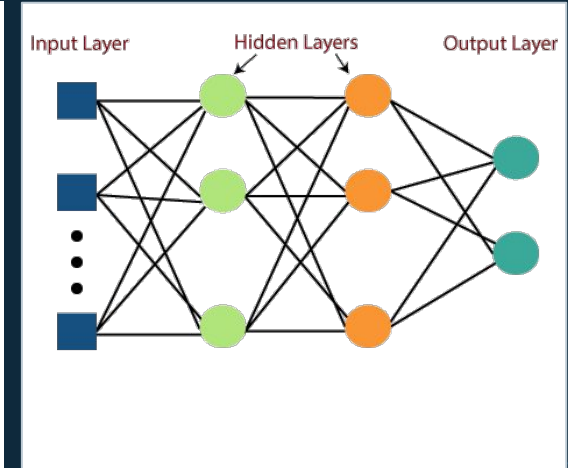
Convolution



(Max) Pooling



Fully Connected Classification Layer

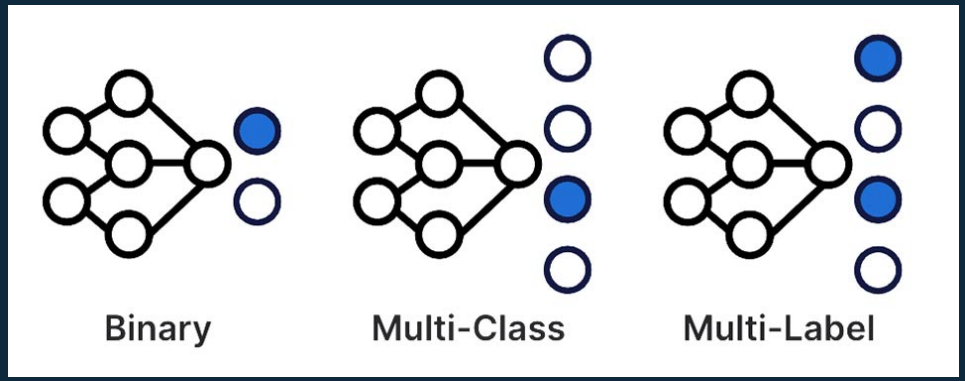


Tools Used

pandas

scikit learn

slurm workload manager



Multi-Label Classification

	Baseline	Model 1	Model 2
Architecture	Densenet121	Densenet121	Densenet121
Loss	Binary Cross Entropy	**Focal** ***(with class weights)***	Focal (with class weights)
Batch Size	64	64	64
Initial Learning Rate	0.0001	0.0001	Cyclical LR Scheduler
Optimizer	Adam	Adam	Adam

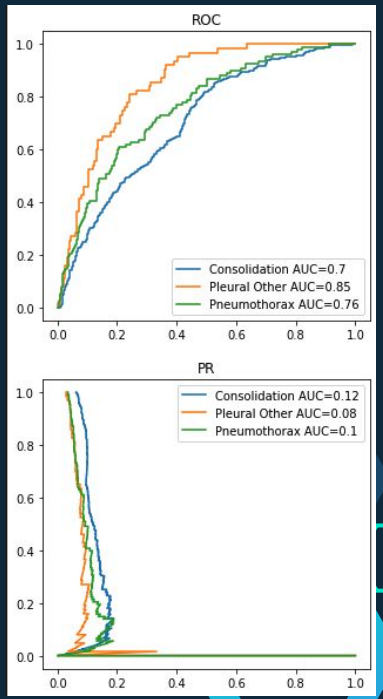
Model Details

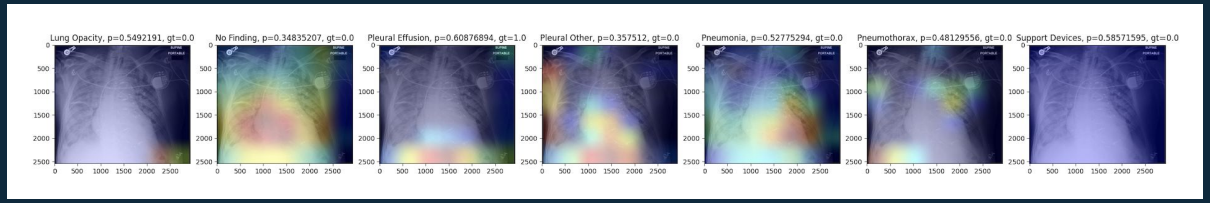
EVALUATION METRICS

AUROC VS AUPRC

	rocauc_baseline	rocauc_focal	auprc_baseline	auprc_focal
Atelectasis	0.743140	0.700140	0.358765	0.389755
Cardiomegaly	0.754633	0.698755	0.474693	0.404593
Consolidation	0.680509	0.703928	0.092124	0.121996
Edema	0.811594	0.788511	0.538378	0.474672
Enlarged Cardiomediastinum	0.698938	0.643836	0.060693	0.069028
Fracture	0.665450	0.659770	0.028644	0.053882
Lung Lesion	0.710903	0.677230	0.070730	0.064194
Lung Opacity	0.632638	0.656952	0.429424	0.452477
No Finding	0.783655	0.770607	0.530393	0.484493
Pleural Effusion	0.869156	0.813536	0.719472	0.627116
Pleural Other	0.778278	0.847400	0.027356	0.079380
Pneumonia	0.640391	0.624123	0.176493	0.161715
Pneumothorax	0.673110	0.759181	0.035135	0.095061
Support Devices	0.839021	0.791981	0.705847	0.661052

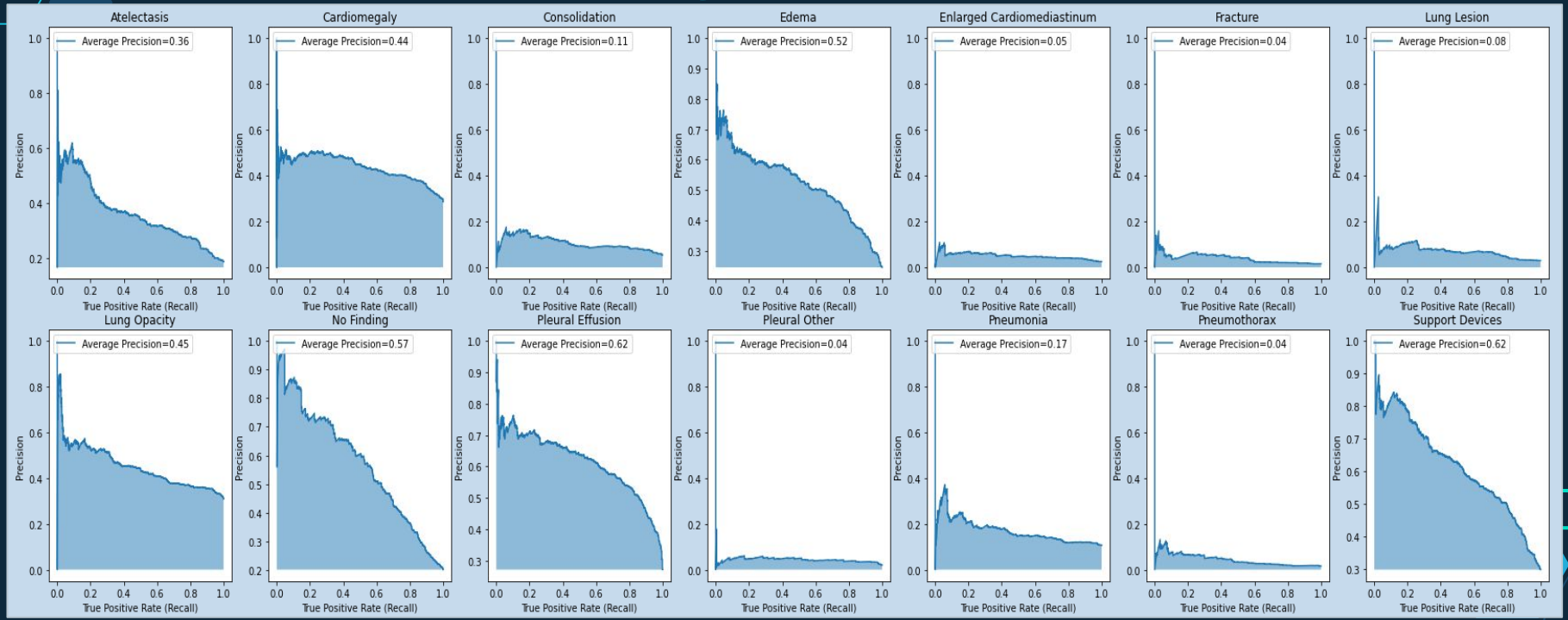

```
{'Atelectasis': 0.225,
 'Cardiomegaly': 0.39,
 'Consolidation': 0.056,
 'Edema': 0.302,
 'Enlarged Cardiomediastinum': 0.025,
 'Fracture': 0.016,
 'Lung Lesion': 0.029,
 'Lung Opacity': 0.444,
 'No Finding': 0.255,
 'Pleural Effusion': 0.36,
 'Pleural Other': 0.012,
 'Pneumonia': 0.116,
 'Pneumothorax': 0.014,
 'Support Devices': 0.414}
```



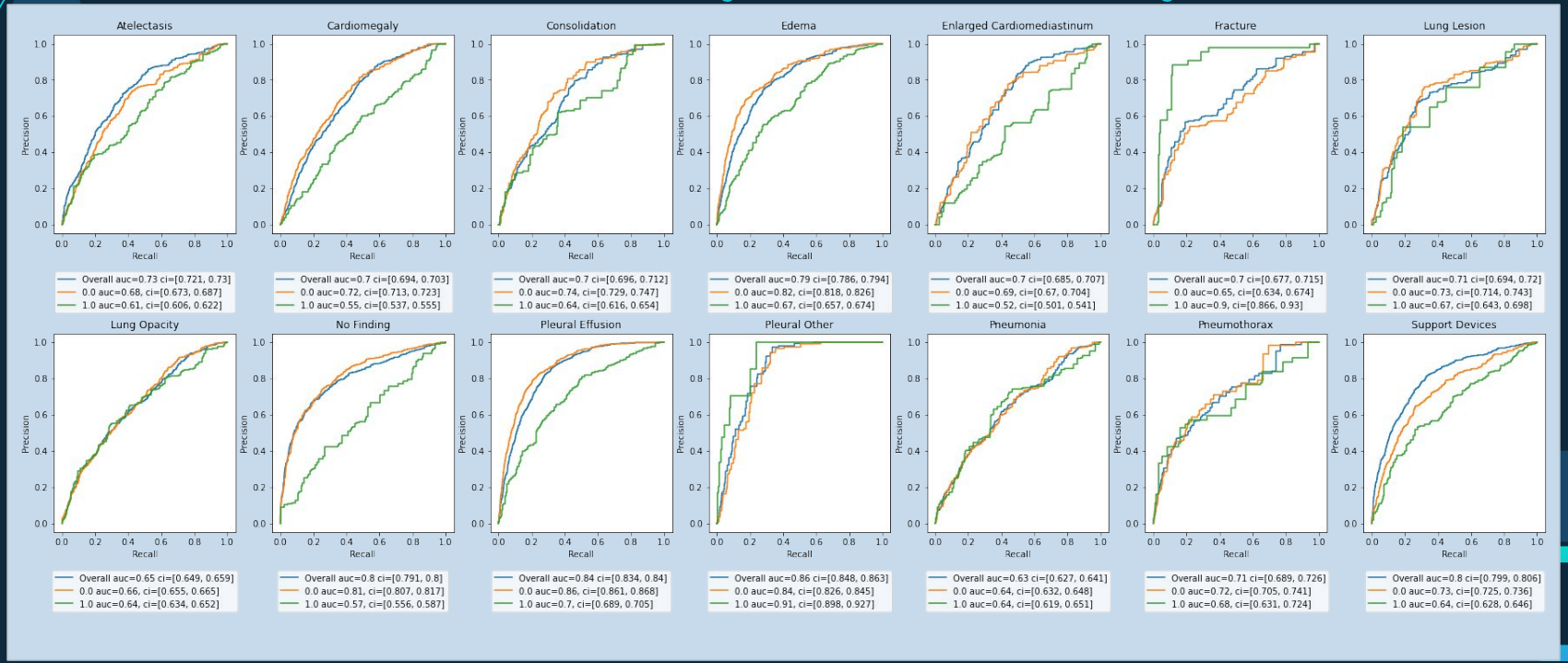
PRELIMINARY RESULTS

PRC Curves for each Diagnosis (with Focal Loss):

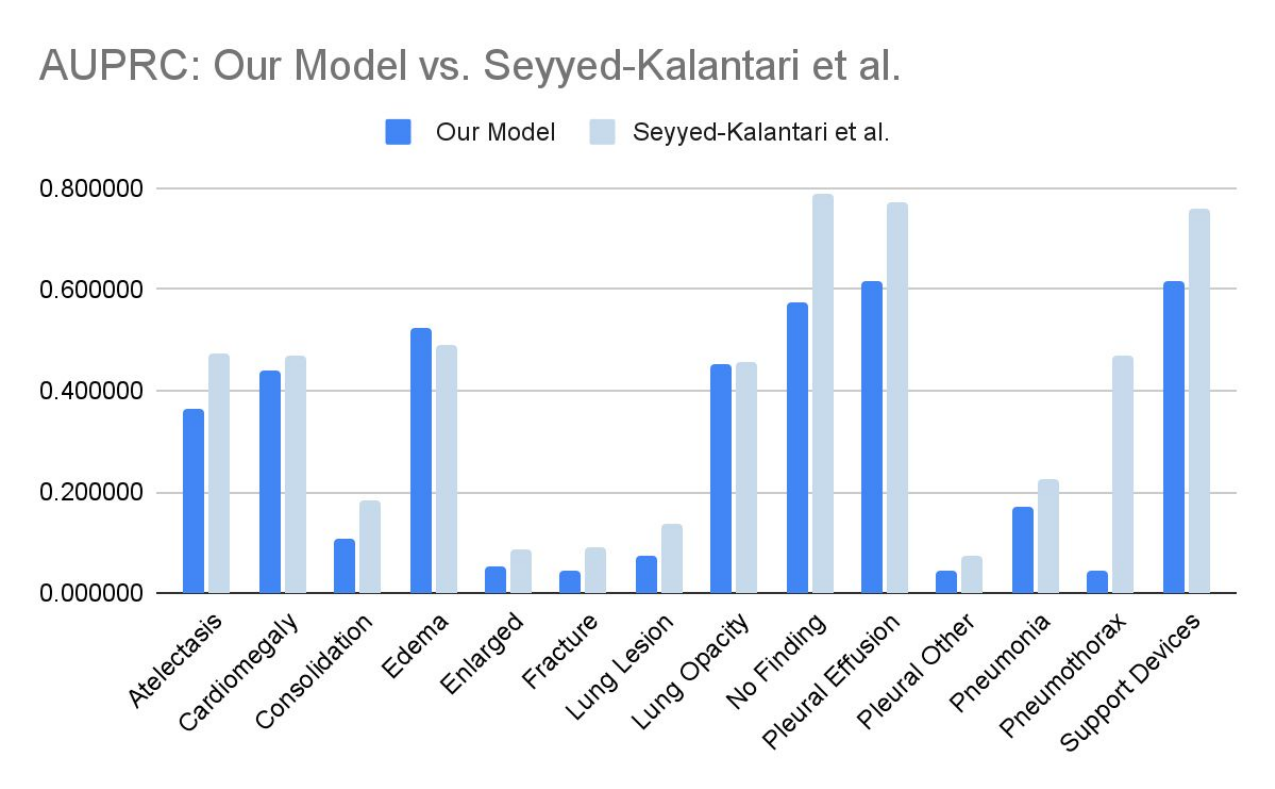


PRELIMINARY RESULTS

ROC Curves Stratified by ICU Status (Binary)



PRELIMINARY RESULTS



NEXT STEPS

Complete stratification analysis

- **“Is model performance the same across different groups?”**
- **“Are findings correlated with any category?”**
- **Categories for stratification:**
  a. **Age**
  b. **Sex**
  c. **Race**
  d. **Insurance Provider**
  e. **ICU status**
- **Tools:**
  - **Chi-squared test**
  - **Pearson correlation**
  - **TPR Disparity**