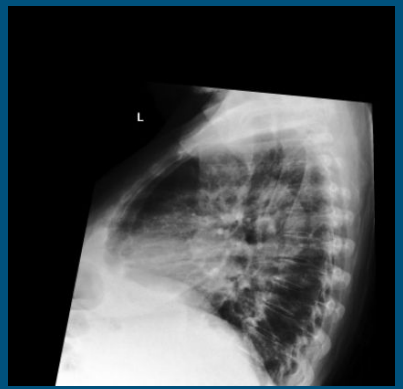
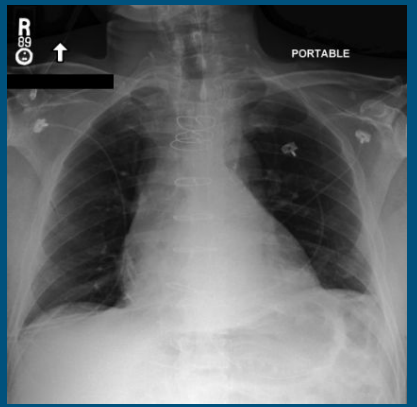
AOS Symposium

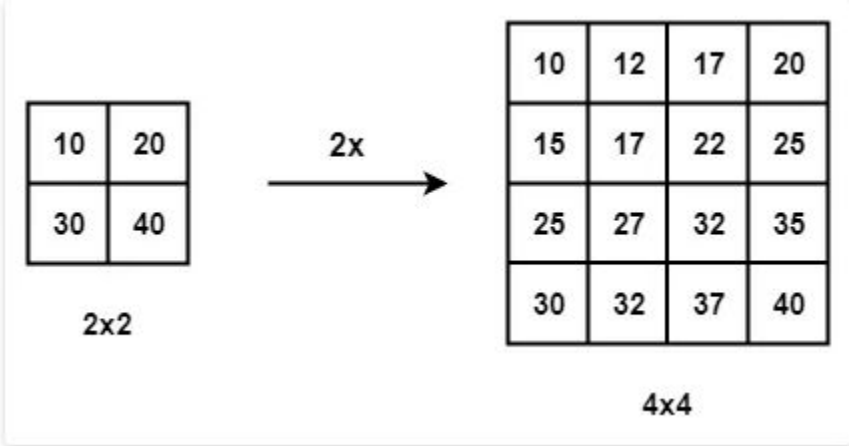
Rohan Bhansali
Avi Komarlingam

Data Processing

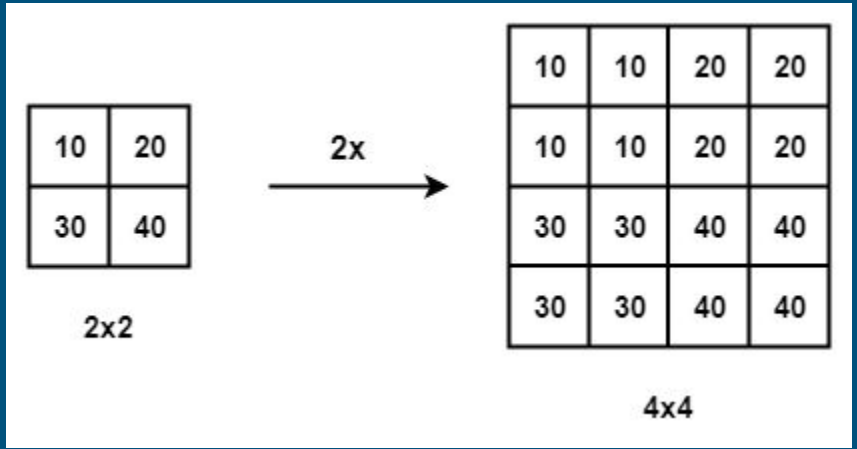




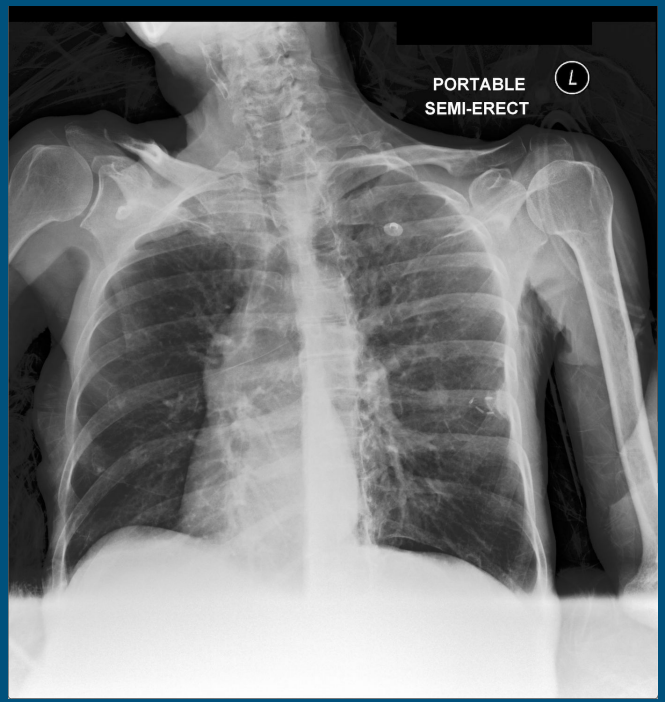
Bilinear Interpolation



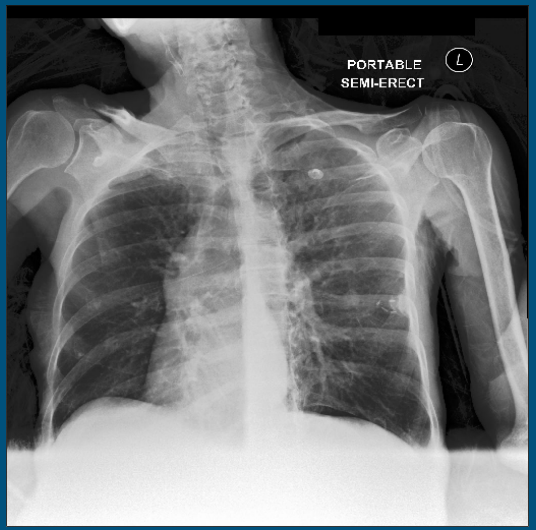
Nearest Neighbor Interpolation



Bilinear Interpolation

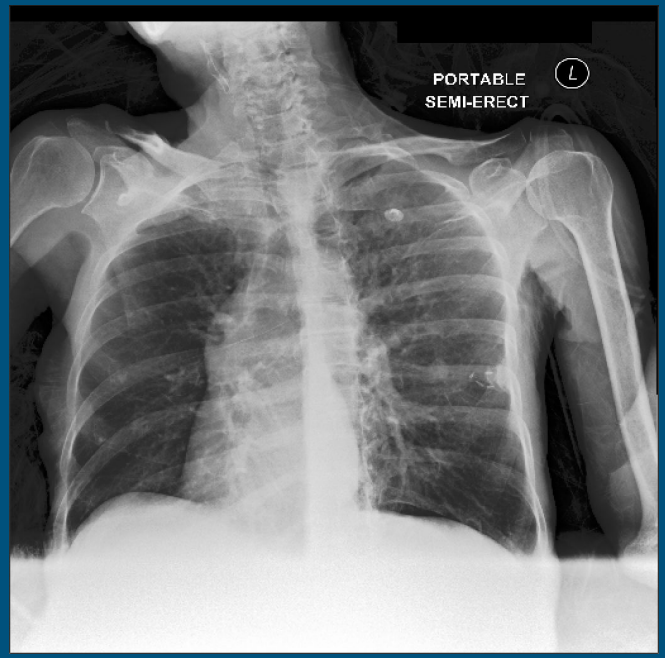


(2539, 2705)



(512, 512)

Pixel Normalization



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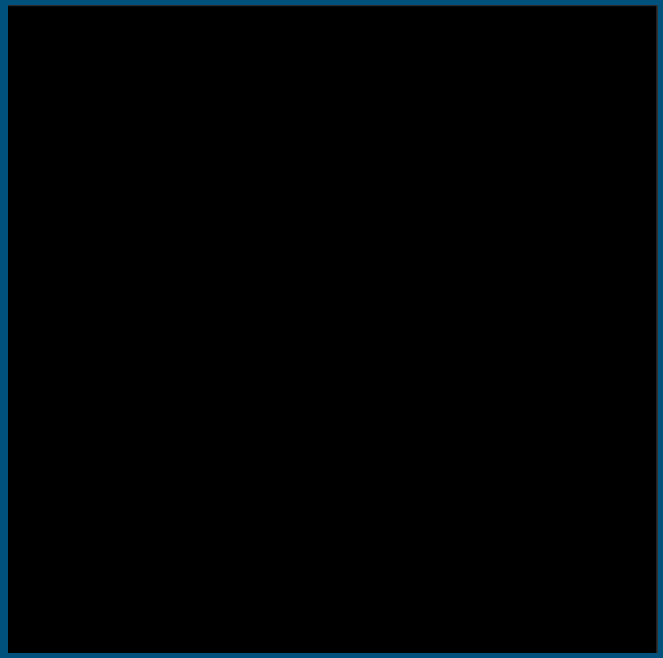
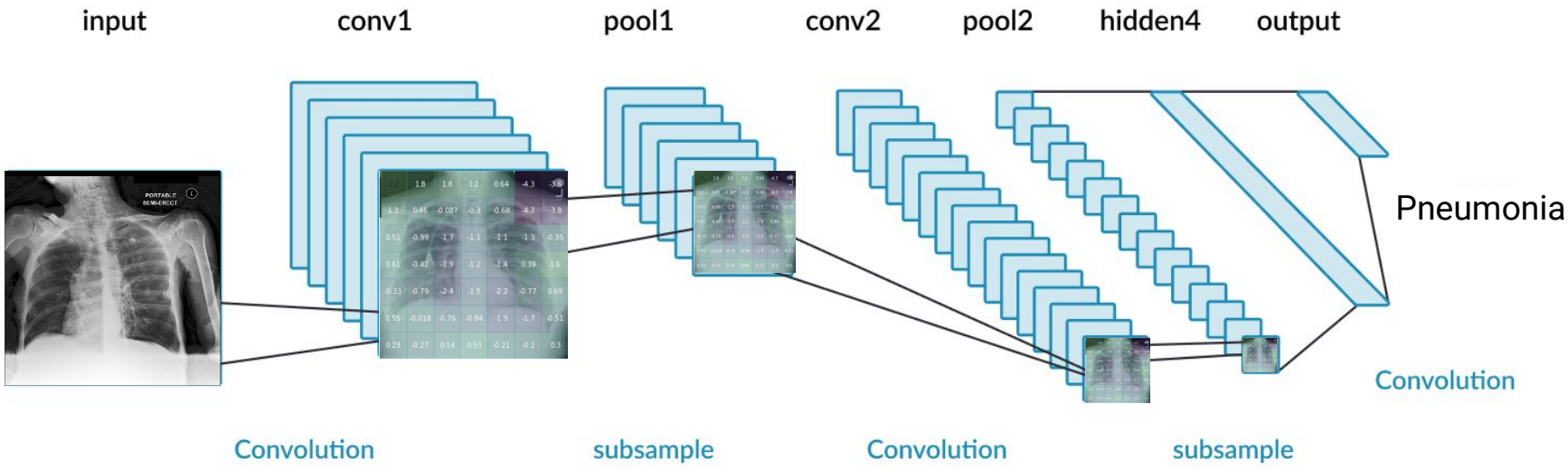


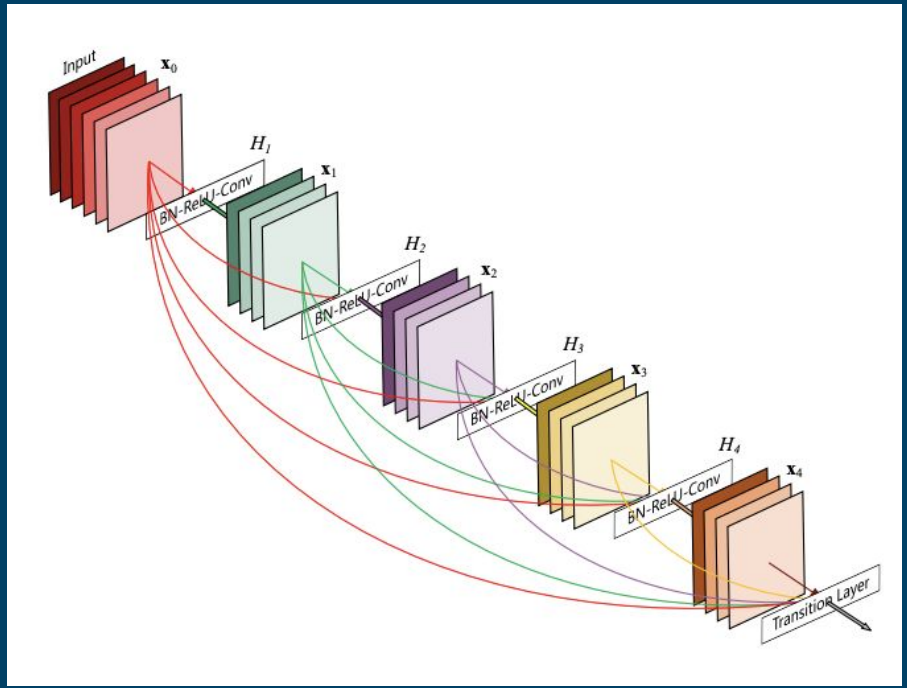
Min: 0.000, Max: 1.000

AP CNNs


input
conv1
pool1
conv2
pool2
hidden4
output
Pneumonia
Convolution
subsample
Convolution
subsample
Convolution

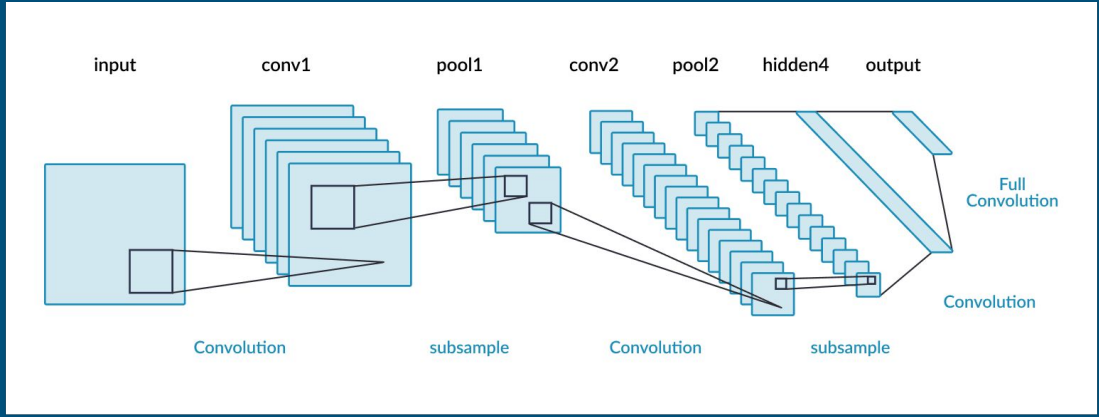
DenseNet

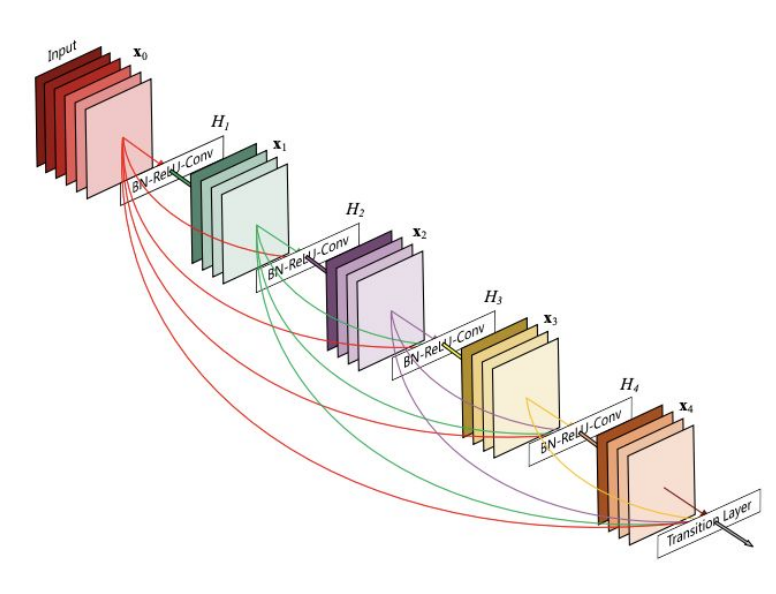
DenseNet Fast
DenseNet-121
DenseNet-161
DenseNet-169
DenseNet-201



DenseNet

- Alleviates the vanishing-gradient problem
- Strengthens feature propagation and reuse
- Substantially reduces the number of parameters





Model Summaries

DenseNet-121

Layers: 121

Epochs: 3

Batch size: 8

Loss function: categorical cross entropy

Accuracy: 92.30%

Time: 2321s/epoch

DenseNet-161

Layers: 161

Epochs: 3

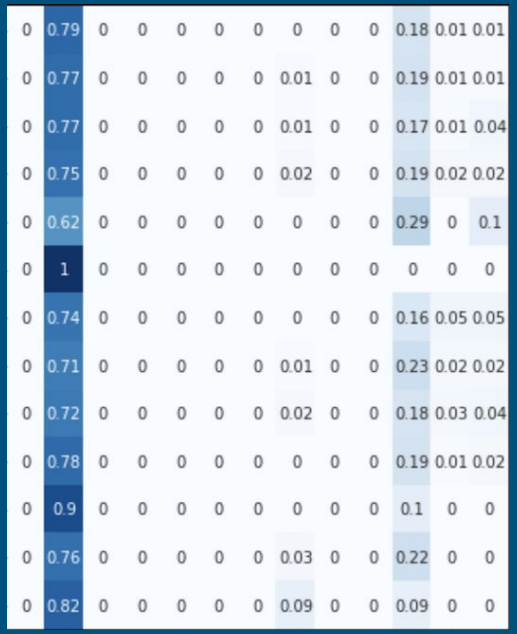
Batch size: 5

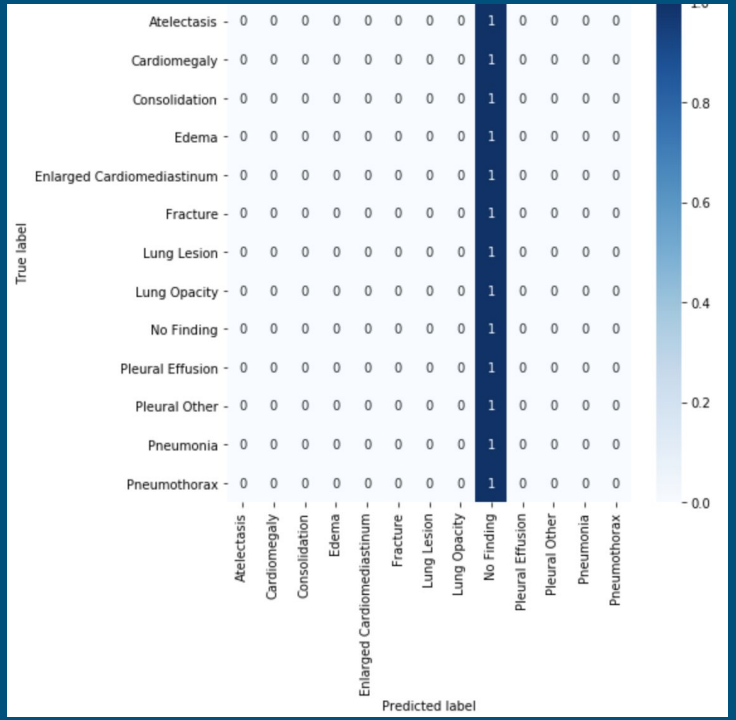
Loss function: categorical cross entropy

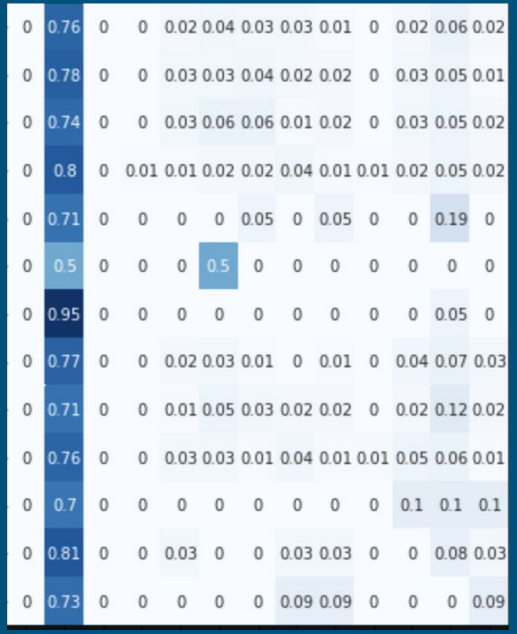
Accuracy: 92.15%

Time: 3393s/epoch

“Results”


0 0.79 0 0 0 0 0 0 0 0 0.18 0.01 0.01
0 0.77 0 0 0 0 0 0.01 0 0 0.19 0.01 0.01
0 0.77 0 0 0 0 0 0.01 0 0 0.17 0.01 0.04
0 0.75 0 0 0 0 0 0.02 0 0 0.19 0.02 0.02
0 0.62 0 0 0 0 0 0 0 0 0.29 0 0.1
0 1 0 0 0 0 0 0 0 0 0 0 0
0 0.74 0 0 0 0 0 0 0 0 0.16 0.05 0.05
0 0.71 0 0 0 0 0 0.01 0 0 0.23 0.02 0.02
0 0.72 0 0 0 0 0 0.02 0 0 0.18 0.03 0.04
0 0.78 0 0 0 0 0 0 0 0 0.19 0.01 0.02
0 0.9 0 0 0 0 0 0 0 0 0.1 0 0
0 0.76 0 0 0 0 0 0.03 0 0 0.22 0 0
0 0.82 0 0 0 0 0 0.09 0 0 0.09 0 0

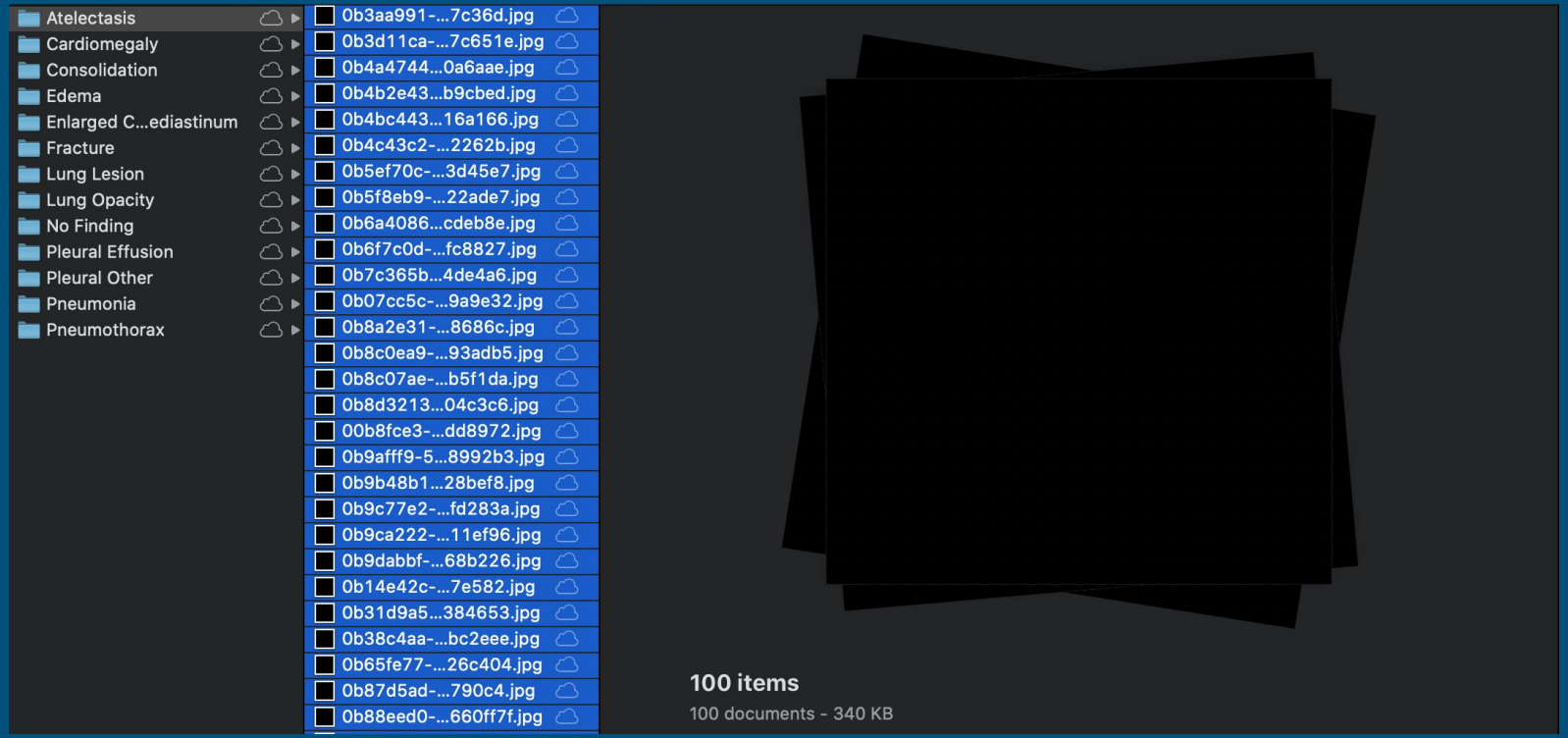

Atelectasis 0 0 0 0 0 0 0 1 0 0 0 0
Cardiomegaly 0 0 0 0 0 0 0 1 0 0 0 0
Consolidation 0 0 0 0 0 0 0 1 0 0 0 0
Edema 0 0 0 0 0 0 0 1 0 0 0 0
Enlarged Cardiomediastinum 0 0 0 0 0 0 0 1 0 0 0 0
Fracture 0 0 0 0 0 0 0 1 0 0 0 0
Lung Lesion 0 0 0 0 0 0 0 1 0 0 0 0
Lung Opacity 0 0 0 0 0 0 0 1 0 0 0 0
No Finding 0 0 0 0 0 0 0 1 0 0 0 0
Pleural Effusion 0 0 0 0 0 0 0 1 0 0 0 0
Pleural Other 0 0 0 0 0 0 0 1 0 0 0 0
Pneumonia 0 0 0 0 0 0 0 1 0 0 0 0
Pneumothorax 0 0 0 0 0 0 0 1 0 0 0 0
True label
Atelectasis
Cardiomegaly
Consolidation
Edema
Enlarged Cardiomediastinum
Fracture
Lung Lesion
Lung Opacity
No Finding
Pleural Effusion
Pleural Other
Pneumonia
Pneumothorax
Predicted label
0.8
0.6
0.4
0.2
0.0


0 0.76 0 0 0.02 0.04 0.03 0.03 0.01 0 0.02 0.06 0.02
0 0.78 0 0 0.03 0.03 0.04 0.02 0.02 0 0.03 0.05 0.01
0 0.74 0 0 0.03 0.06 0.06 0.01 0.02 0 0.03 0.05 0.02
0 0.8 0 0.01 0.01 0.02 0.02 0.04 0.01 0.01 0.02 0.05 0.02
0 0.71 0 0 0 0 0.05 0 0.05 0 0 0.19 0
0 0.5 0 0 0 0.5 0 0 0 0 0 0 0
0 0.95 0 0 0 0 0 0 0 0 0 0.05 0
0 0.77 0 0 0.02 0.03 0.01 0 0.01 0 0.04 0.07 0.03
0 0.71 0 0 0.01 0.05 0.03 0.02 0.02 0 0.02 0.12 0.02
0 0.76 0 0 0.03 0.03 0.01 0.04 0.01 0.01 0.05 0.06 0.01
0 0.7 0 0 0 0 0 0 0 0 0.1 0.1 0.1
0 0.81 0 0 0.03 0 0 0.03 0.03 0 0 0.08 0.03
0 0.73 0 0 0 0 0 0.09 0.09 0 0 0 0.09

Possible Causes

1. Domination of one class over the others due to overrepresentation

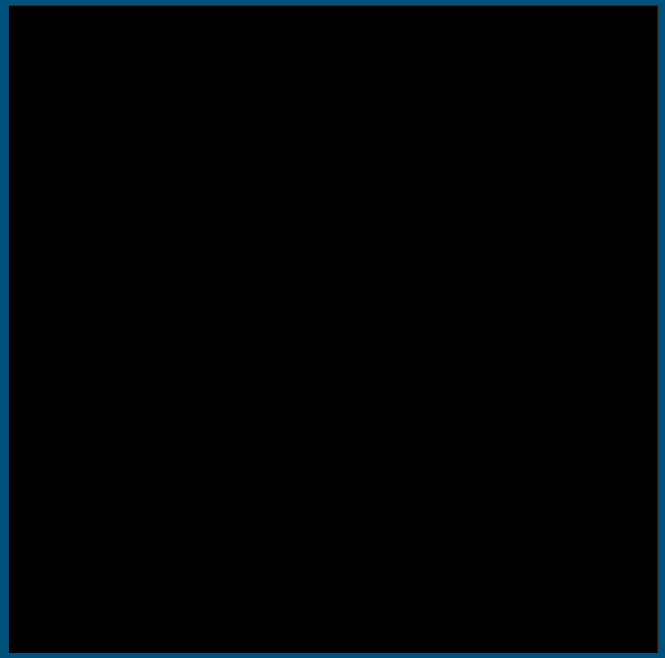
Equalizing Class Sizes



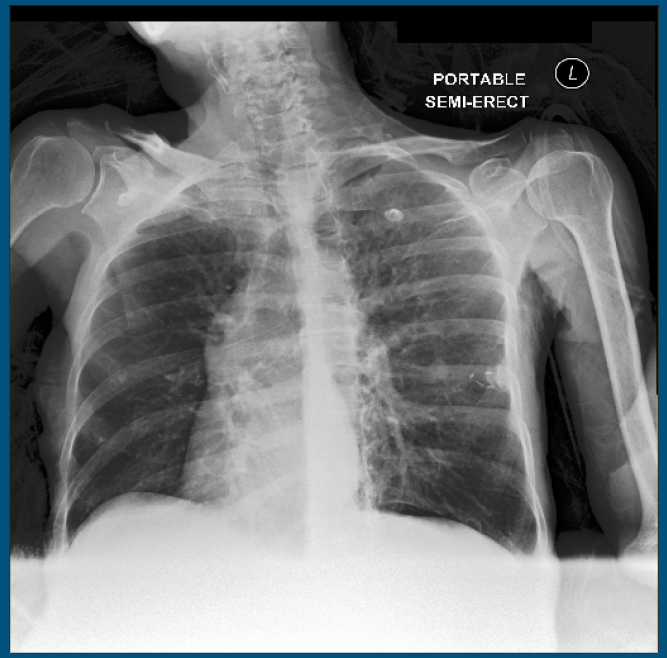
Possible Causes

1. Domination of one class over the others due to overrepresentation
2. Errors in preprocessing images

Pixel Denormalization



Min: 0.000, Max: 1.000



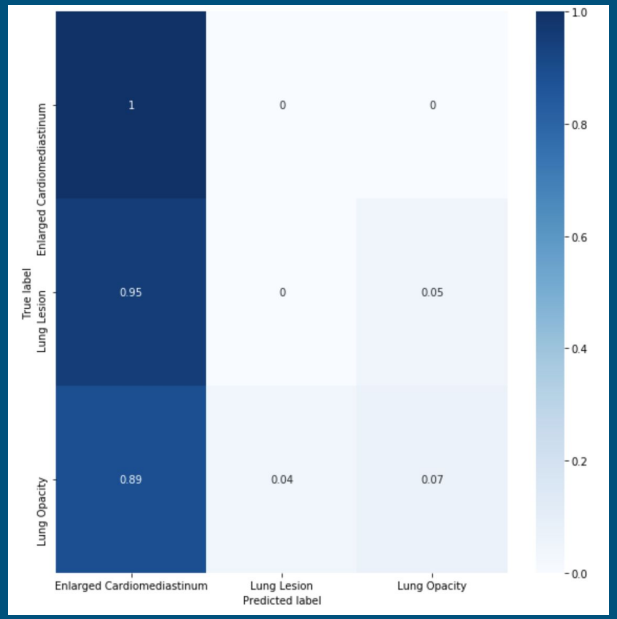
Min: 0.000, Max: 255.000

Possible Causes

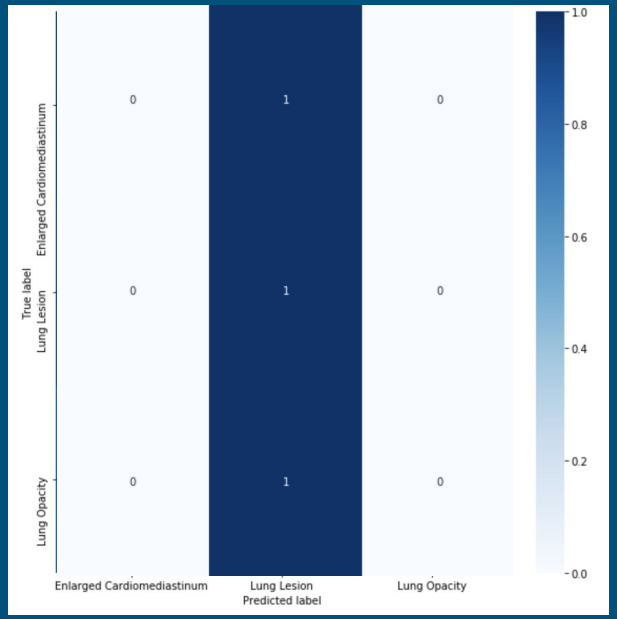
1. Domination of one class over the others due to overrepresentation
2. Errors in preprocessing images
3. Issues with model architecture

Different Model Architectures

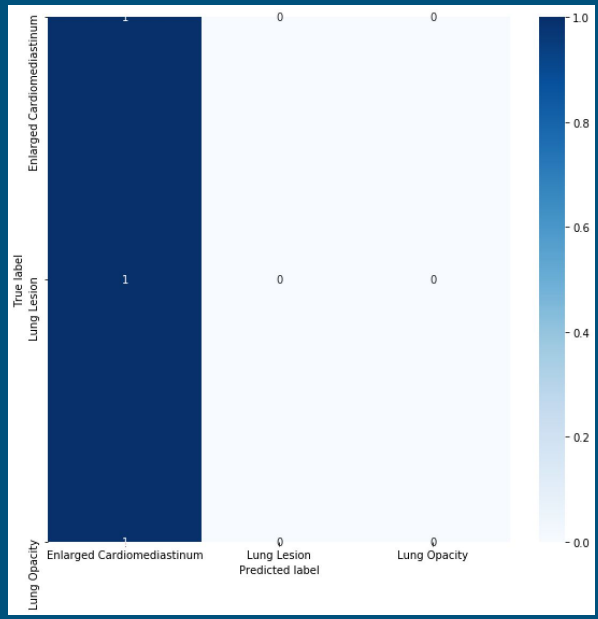
DenseNet-121



ResNet-50



CNN-7

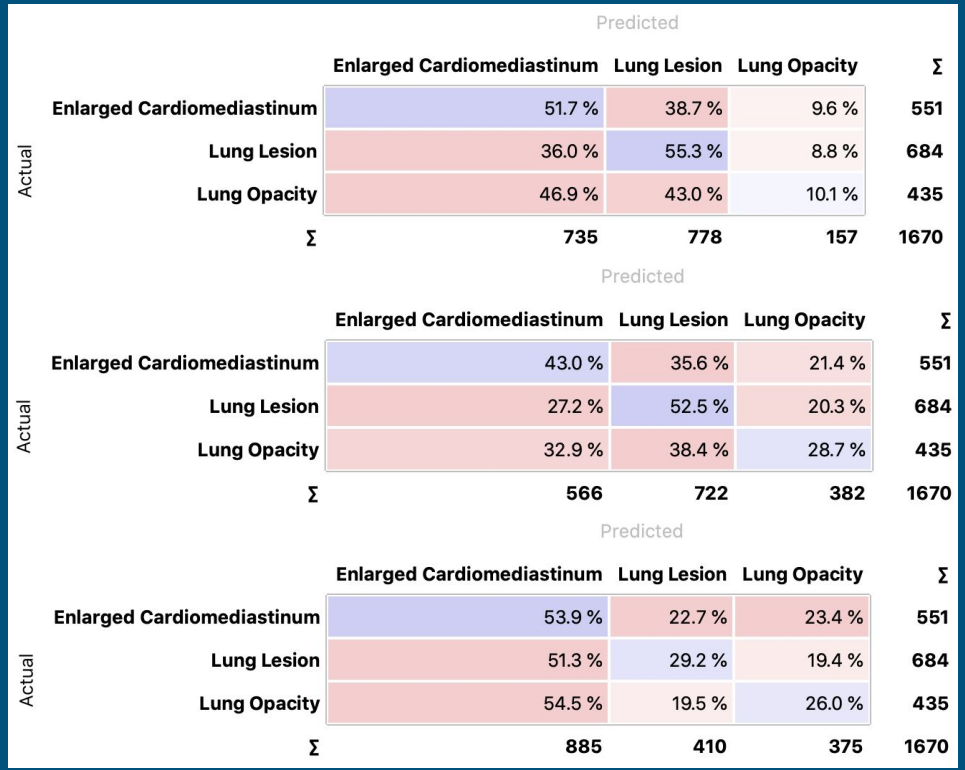


Even More Different Model Architectures

kNN

Logistic Regression

SVM



kNN

Predicted

Actual	Enlarged Cardiomediastinum	Lung Lesion	Lung Opacity	Σ
Enlarged Cardiomediastinum	51.7 %	38.7 %	9.6 %	551
Lung Lesion	36.0 %	55.3 %	8.8 %	684
Lung Opacity	46.9 %	43.0 %	10.1 %	435
Σ	735	778	157	1670

Logistic Regression

Predicted

Actual	Enlarged Cardiomediastinum	Lung Lesion	Lung Opacity	Σ
Enlarged Cardiomediastinum	43.0 %	35.6 %	21.4 %	551
Lung Lesion	27.2 %	52.5 %	20.3 %	684
Lung Opacity	32.9 %	38.4 %	28.7 %	435
Σ	566	722	382	1670

SVM

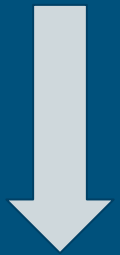
Predicted

Actual	Enlarged Cardiomediastinum	Lung Lesion	Lung Opacity	Σ
Enlarged Cardiomediastinum	53.9 %	22.7 %	23.4 %	551
Lung Lesion	51.3 %	29.2 %	19.4 %	684
Lung Opacity	54.5 %	19.5 %	26.0 %	435
Σ	885	410	375	1670

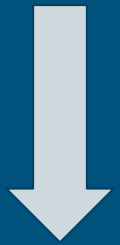
Scientist Outreach

Future Work

Train and optimize AP, PA, and lateral CNNs



Fuse networks via DualNet architecture



Incorporate patient information (syndromes, history, etc.) into diagnosis