Disease Detection using Chest X-rays

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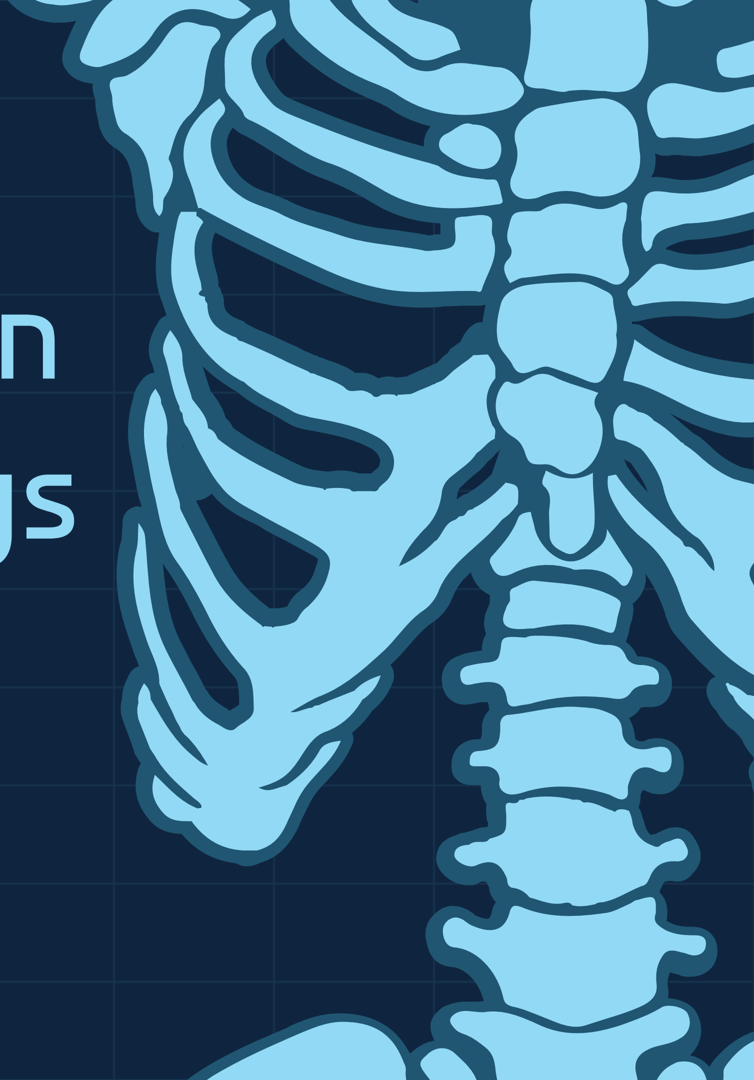
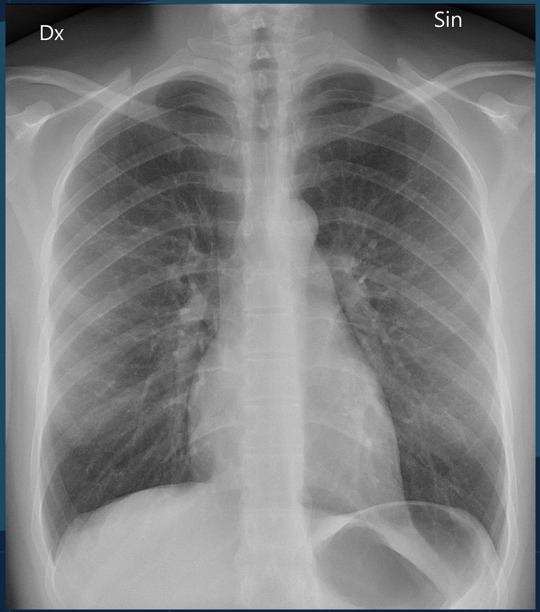


Introduction

Motivation behind disease detection using chest X-rays

Goal: Use deep learning algorithms to detect diseases using chest x-ray images using CNN architectures.

- Chest X-ray's are the most common used film in medicine to detect lung conditions and were used as a source for detecting Covid-19
- Highly trained radiologists are required to interpret these films
- Image classification techniques can be used to detect anything abnormal and disease progression over time



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Data Sources/EDA

Mendeley Data

Large Dataset of Labeled Optical Coherence Tomography (OCT) and Chest X-Ray Images

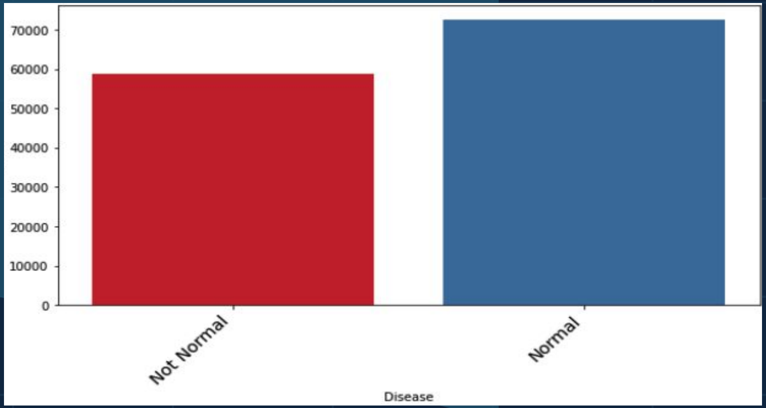
Kaggle

COVID-19 chest X-ray

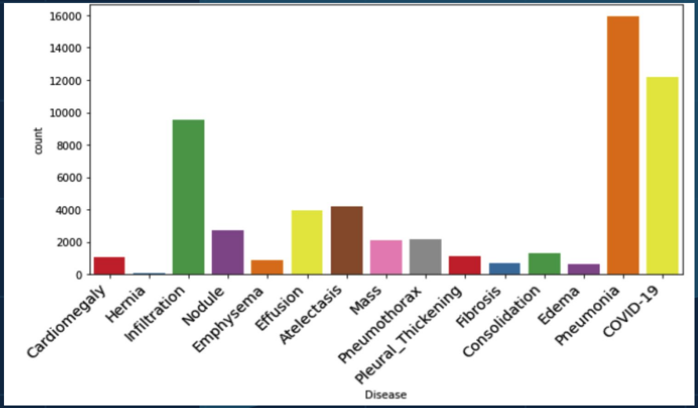
COVID-QU-Ex Dataset

NIH

ChestX-ray8 Database



Distribution of image type



Distribution of not normal images

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Methods - Transfer Learning

- Explored various transfer learning methods to identify the optimal model binary (normal vs. abnormal) classification multiclass for specific disease (COVID-19, Pneumonia, and Other)

- Adjust hyperparameters further to optimize results

MultiClass Model Hyperparameters								Results
Transfer Learning Model	Data Augmentation	Early Stopping	Optimizer	Learning Rate	Steps per Epoch	Number of Epochs	Etc.	Accuracy
VGG-16								
Model 1	N	N	RMSprop	0.0001	50	5		80%
Model 2	Y	N	RMSprop	0.0001	50	5		87%
VGG-19								
Model 1	Y	Y - Patience: 5	RMSprop	0.0001	50	5		71%
Model 2	Y	Y - Patience: 5	RMSprop	0.0001	50	5		85%
Model 3	N	N	RMSprop	0.0001	50	5		89%
InceptionResNetV2								
Model 1	N	N	RMSprop	0.001			Dropout = 0.7	54%
Model 2	N	N	RMSprop	0.0001			Dropout = 0.5	89%
Inception V3								
Model 1	N	N	RMSprop	0.0001	50	7	Dropout = 0.55	79%
Model 2	N	N	RMSprop	0.0001	50	7	Dropout = 0.7	89%
ResNet-50								
Model 1	N	N	SGD	0.001	50	5		89%
Model 2	Y	N	SGD	0.001	50	5		66%
ResNet-152V2								
Model 1	Y	N	SGD	0.001	50	5		70%
DenseNet-121								
Model 1	N	N	Adam	0.001	50	7	Dropout	31%
Model 2	N	N	Adam	0.001	50	7	Dropout	28%
Model 3	N	N	RMSprop	0.001	50	5	Dropout = 0.5	56%
Model 4	N	N	RMSprop	0.0001	50	5	Dropout = 0.7	95%
Model 5	Y	N	RMSprop	0.0001	50	5	Dropout = 0.7	65%
Model 6	Y	N	RMSprop	0.0001	50	5	Dropout = 0.7	88%
DenseNet-201								
Model 1	Y	N	RMSprop	0.0001	50	5	Dropout = 0.7	68%
Model 2	Y	N	RMSprop	0.0001	50	7	Dropout = 0.8	55%
Model 3	Y	N	RMSprop	0.0001	50	7	Dropout = 0.7	59%
Model 4	Y	N	RMSprop	0.0001	50	5	Dropout = 0.7	81%
Model 5	N	N	RMSprop	0.0001	50	5	Dropout = 0.7	76%
Xception								
Model 1	Y	N	RMSprop	0.0001	50	5		56%
Model 2	Y	N	RMSprop	0.0001	50	5	Dropout = 0.7; Momentum 0.9; Decay 0.01	63%
Model 3	Y	N	RMSprop	0.0001	50	5	Dropout = 0.5; Momentum 0.7; Decay 0.001	65%
Model 4	Y	N	RMSprop	0.001	50	5	Dropout = 0.7; Momentum 0.7; Decay 0.001	53%
Model 5	Y	N	RMSprop	0.0001	50	5	Dropout = 0.5; Momentum 0.7; Decay 0.001	60%

Multiclass Model Hyperparameters

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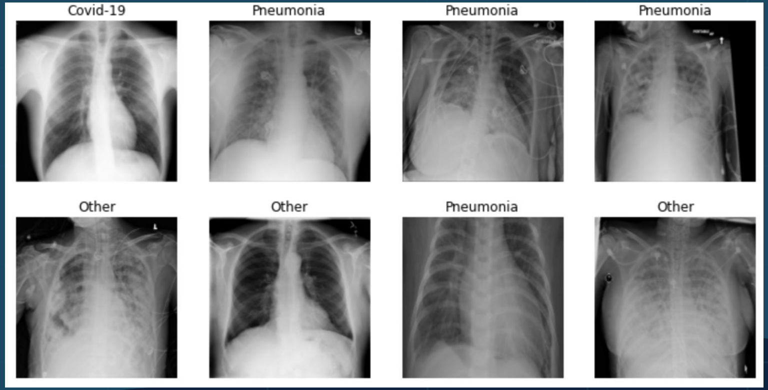
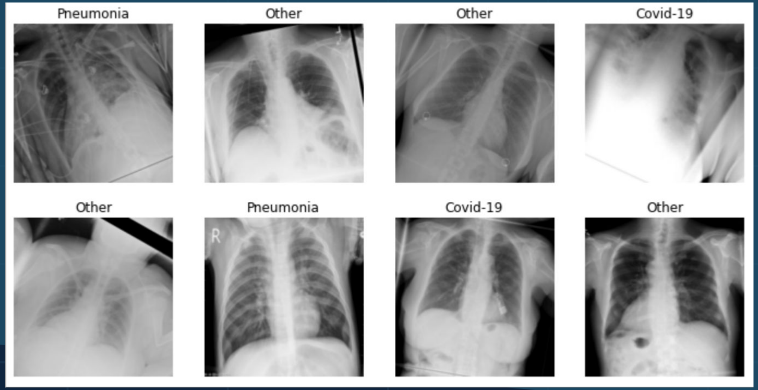
Methods - Data Augmentation

- Augmented data with horizontal flip and rotation transformations
- Increase the volume and diversity of the data during the training process
- Minimize overfitting





Results

Type	Multiclass	Binary
DenseNet-121	95%	67%
DenseNet-201	81%	58%
Inception-V3	89%	63%
Inception ResNet-V2	89%	71%
ResNet-50	89%	55%
ResNet-152V2	70%	53%
VGG-16	87%	68%
VGG-19	89%	57%
Xception	65%	56%

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Binary - Additional Metrics

Type	Accuracy	AUC	Precision	Recall
DenseNet-121	67	0.78	0.64	0.84
DenseNet-201	58	0.71	0.56	0.97
Inception V3	63	0.67	0.66	0.75
Inception ResNet V2	71	0.78	0.75	0.67
ResNet-50	55	0.55	0.62	0.91
ResNet-152V2	53	0.5	0.53	0.9975
VGG-16	68	0.76	0.77	0.57
VGG-19	57	0.66	0.55	0.92
Xception	56	0.6	0.8	0.22

- Inception ResNet V2 top performer
- No Data Augmentation
- Adam optimizer with a learning rate = 0.0001

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Conclusions

Binary vs. Multiclass

As expected from previous research, the multi-classification performed better than binary classification.

Trends are more easily identified for specific diseases rather than generalized for all types of anomalies.

Data Augmentation

Horizontal transformations generated better results than other augmentation strategies.

Overall Performance

DenseNet-121 classified the chest X-rays of COVID-19, Pneumonia, and Other with 95% accuracy.

Inception ResNet-V2 classified chest X-rays as normal and abnormal with 71% accuracy.

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Questions

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Appendix

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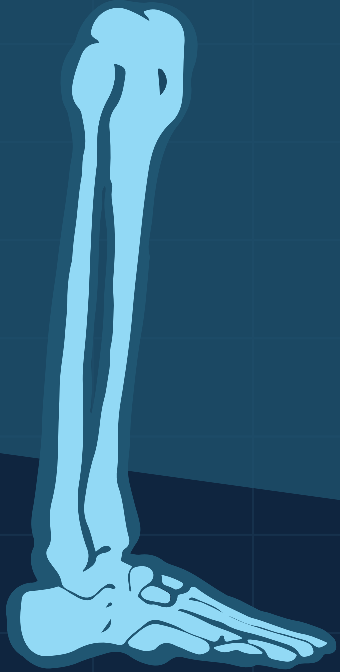
Literature Review



- X-ray detection via deep learning can provide high accuracy over multiple illness
    - Many existing algorithms that leverage deep learning methods on chest X-ray images were for specific clinical conditions such as cancer, pneumonia, tuberculosis, etc.
- In one study, multiple CNN architectures were evaluated that included GoogleNet, SqueezeNet, DenseNet, SuffleNet and MobileNetV2 to classify lung tumors into malignant and benign categories.
- Generally, radiologists can improve their performance by reviewing results from a deep-learning model

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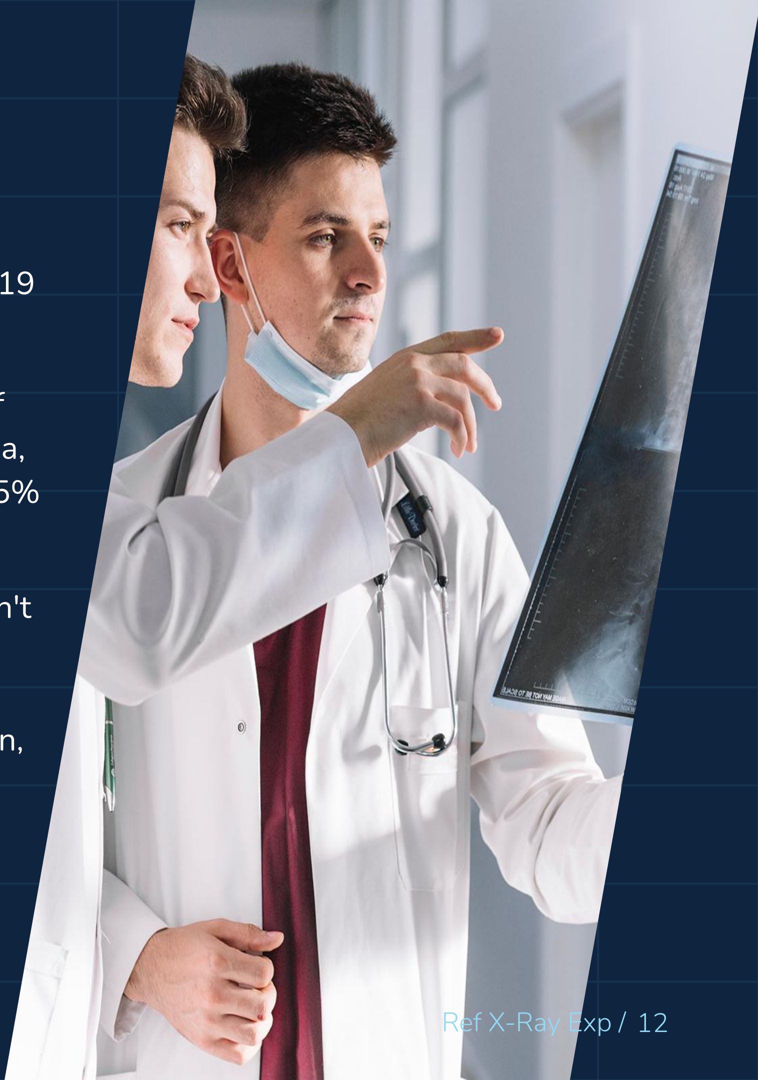
Literature Review

- There have been many research papers published related to Covid-19 that utilize deep learning techniques using chest x-rays
- In one study, chest x-ray images were classified into a similar set of three classes as compared to previous articles: Covid-19 pneumonia, no-Covid-19 pneumonia, and non-pneumonia and resulted in a 94.5% overall accuracy
    - This improves upon a previously mentioned study that couldn't as accurately classify Covid-19 pneumonia and no-Covid-19 pneumonia because this experiment uses two image pre-processing steps to remove most of the diaphragm region, remove image noise and improve image contrast as well as creates a pseudo color image to feed into an existing deep learning model that is already a strong performer for color images in a transfer learning strategy



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Contributions

Manpreet Dhindsa

- Multi-Class Classification
- Supported Binary Classification
- Wrote Report/Slides

Gretchen Larrick

- Data Preparation and Handling
- Binary Classification
- Wrote Report/Slides

Sarah Rodgers

- Data Augmentation
- Supported classifications
- Wrote Report/Slides

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