Chest X-Rays Pathology Detection Using Augmented Datasets with GAN and Radiology Reports

Viveak Ravichandiran (SUNet ID: vravicha)
Aditya Srivastava(SUNet ID: adityaks)
Ying Chen (SUNet ID: smileyc)

Stanford University

CS 230

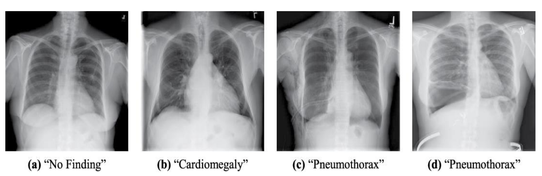
Abstract

X-Rays are the most common and best available medical imaging technique used to diagnose lungs, heart and chest related diseases. The number of radiologists is decreasing in the US , which is even worse in the underdeveloped countries. This motivated us to develop an AI solution by building a hybrid deep Neural Network architecture using augmented datasets with GAN and Radiology Reports to detect and recognize cardiopulmonary diseases to help radiologists to maximize their effort in diagnosing the problems.

DataSets

Two datasets are used for our work.

1. NIH – 112, 000 images
2. MIMIX-CXR – 9568 images with radiology reports

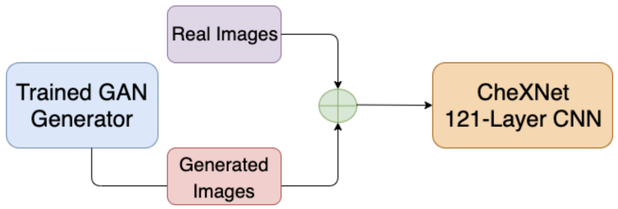


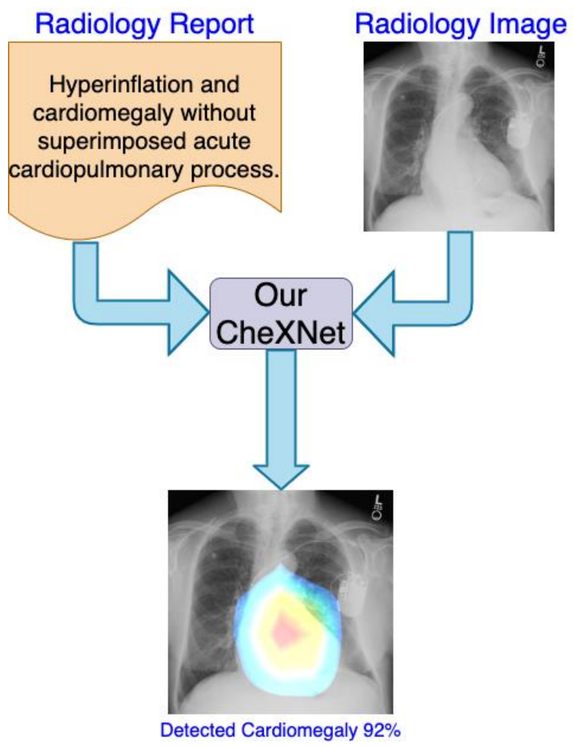
(a) "No Finding" **(b)** "Cardiomegaly" **(c)** "Pneumothorax" **(d)** "Pneumothorax"

Models and Result

Three models are mainly used for our work.

1. DenseNet-121 CNN model based on CheXNet algorithm.
2. CheXPert NLP Model to generate class labels for MIMIC-CXR dataset.
3. GAN Model to generate synthetic chest X-Ray images.



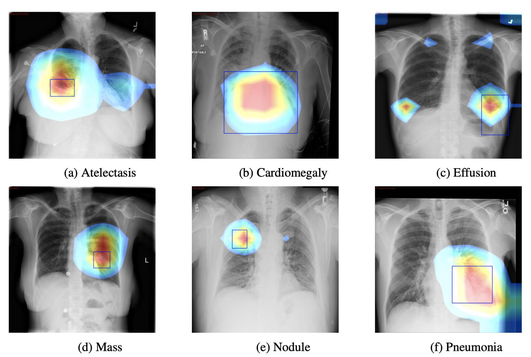


Evaluation Metrics

Pathology	CheXNet (Rajpurkar et al. 2017)	Pre-trained Weights	CheXNet (ours) - NIH dataset	CheXNet (ours) - MIMIC dataset	CheX-GAN (ours) - Synthetic
Atelectasis	0.809	0.821	0.784	0.834	-
Cardiomegaly	0.925	0.500	0.890	0.824	-
Effusion	0.864	0.889	0.852	0.883	-
Infiltration	0.735	0.722	0.713	-	-
Mass	0.868	0.841	0.844	-	-
Nodule	0.780	0.744	0.780	-	-
Pneumonia	0.768	0.661	0.657	0.594	-
Pneumothorax	0.888	0.884	0.767	0.621	-
Consolidation	0.790	0.747	0.797	0.749	-
Edema	0.888	0.668	0.865	0.760	-
Emphysema	0.938	0.578	0.974	-	-
Fibrosis	0.805	0.543	0.724	-	0.623
Pleural Thickening	0.806	0.792	0.739	-	0.564
Hernia	0.916	0.500	0.733	-	-

- The model is initially trained with pre-trained weights which produced less accuracy. The hyper parameters were fine tuned by freezing the conv layers and retrained with fully connect layers to improve performance.
- Subset of MIMIC-CXR dataset is used to test the model and it produced promising result.
- Synthetic images are generated for 2 classes using GAN but the performance is low with generated images.

HeatMap



(a) Atelectasis (b) Cardiomegaly (c) Effusion
(d) Mass (e) Nodule (f) Pneumonia

Conclusion

By addressing the class imbalance problem in medical imaging or chest X-ray in general, using similar datasets and generating augmented/synthetic images using GAN, helped to improve the performance of some of the pathology classes.

Future work

More time is required to process more images and radiology reports from the new MIMIC-CXR dataset to improve the predications of all the classes. Radiology reports, the model can also be trained to predict secondary diseases.

Source Code

All the code is located at https://github.com/vivekravi/cs230-project

References

[1] Rajpurkar Pranav, Irvin Jeremy, Zhu Kaylie,et al, CheXNet: Radiologist-Level Pneumonia Detection on Chest X-Rays with Deep Learning. arXiv:1711.05225v3, 25 Dec 2017.

[2] Irvin Jeremy, Rajpurkar Pranav, Ko Michael, et al. CheXpert: A Large Chest Radiograph Dataset with Uncertainty Labels and Expert Comparison. arXiv:1901.07031 [cs.CV] 21 Jan 2019.