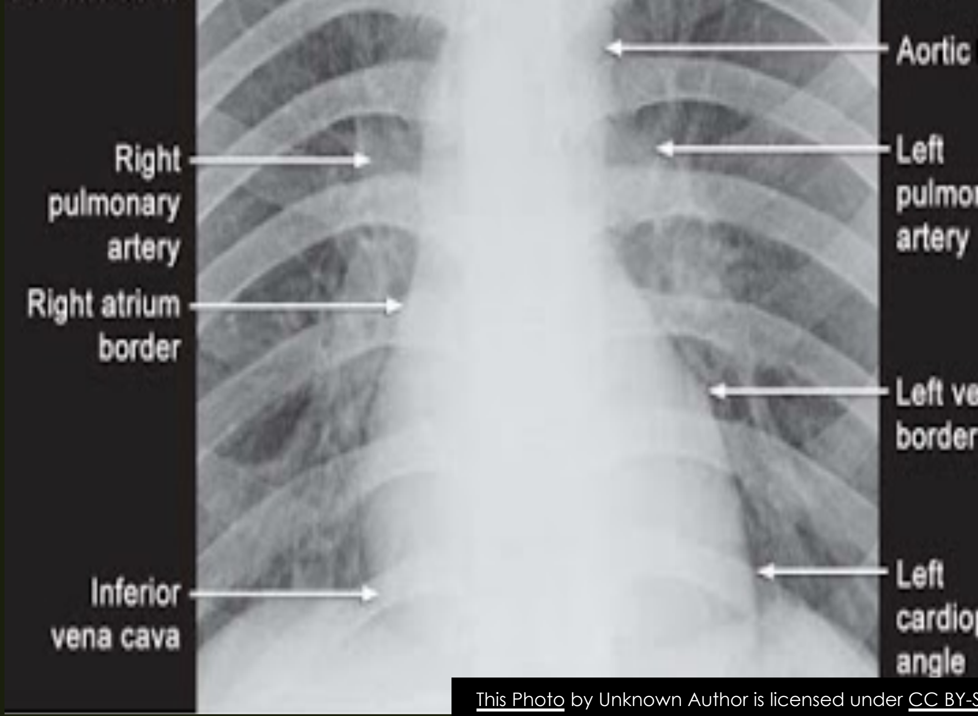
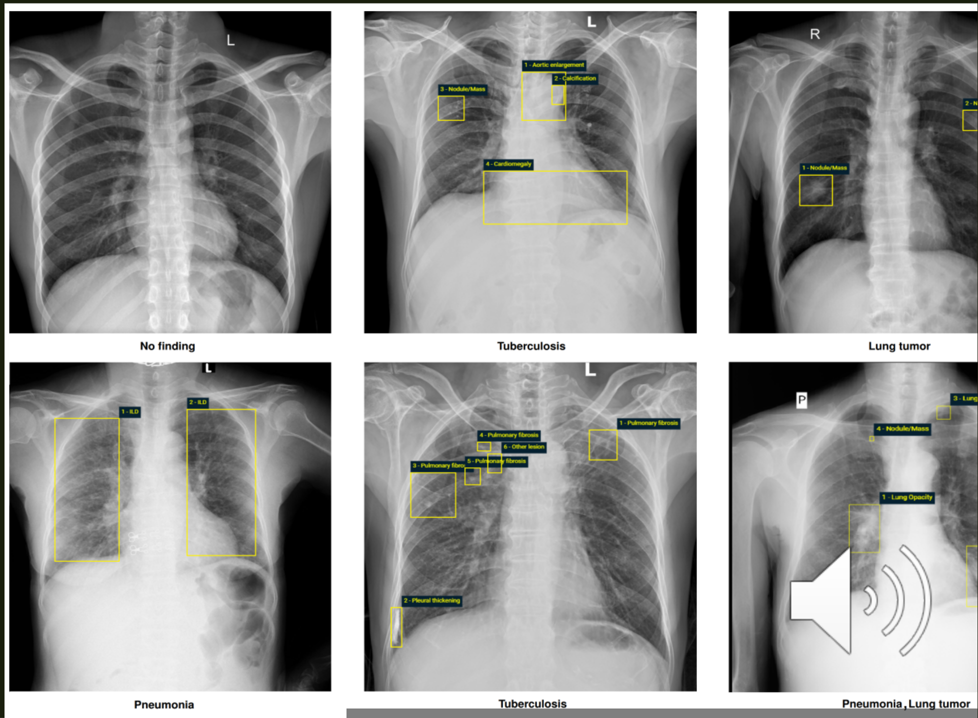
Source: https://www.futuretimeline.net/blog/2019/01/25-2.htm



Classification and Localization of Chest X-Ray Images using CNN

- Syrus Mathew
- MSDS692_X41
- Data Science Practicum

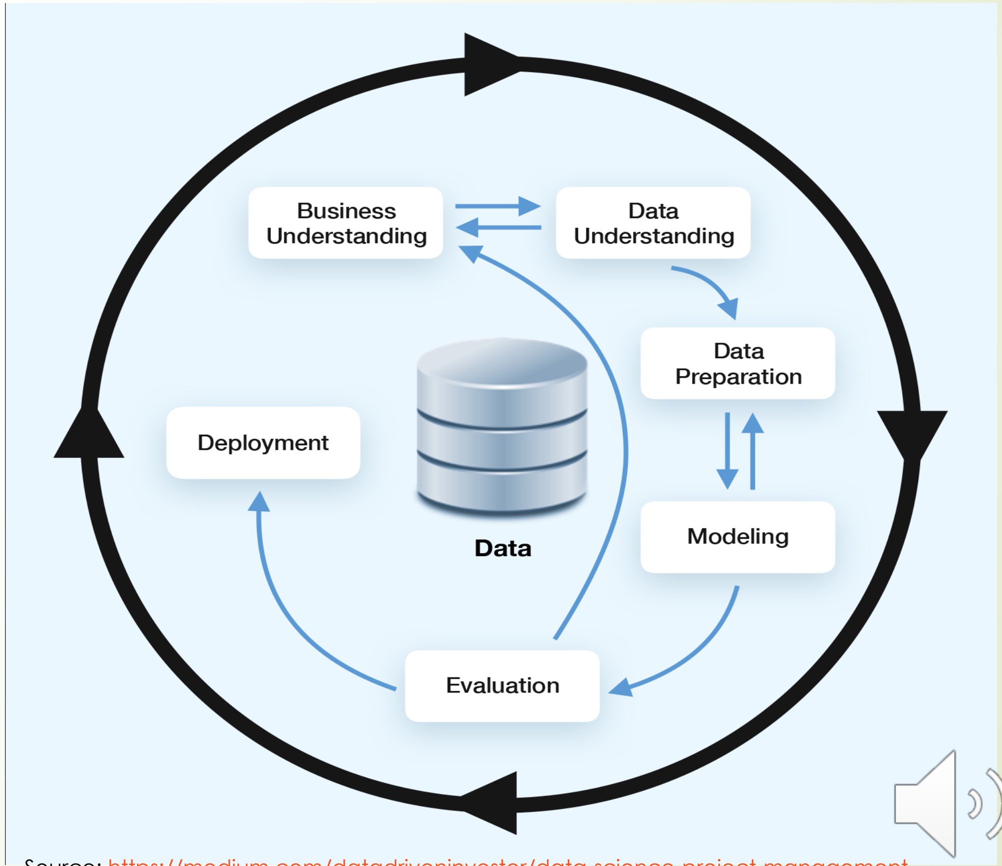


Problem Background

- Medical professionals still face challenges on the interpretation of X-Ray images/radiographs, especially chest radiograph.
- Misinterpretation of chest x-rays can lead to medical misdiagnosis even for most experienced doctors and radiologists.
- Existing methods of reading and interpreting these images classify them into a list of findings; no specifications of their locations on the images, leading to difficulties in correlating images and their specific locations.
- We need a solution for localization of findings on the chest x-ray images to provide meaningful diagnostic assistance to doctors and radiologists.
- This study is geared towards providing a solution to the above contemporary challenge.

Project Methodology: CRISP-DM

- I will be following the CRISP-DM methodology introduced by IBM in working on this project.
- My focus will be on the 6 processes shown in the figure on my right-hand side.
- Understanding the problem of my research is the most important aspect of my project



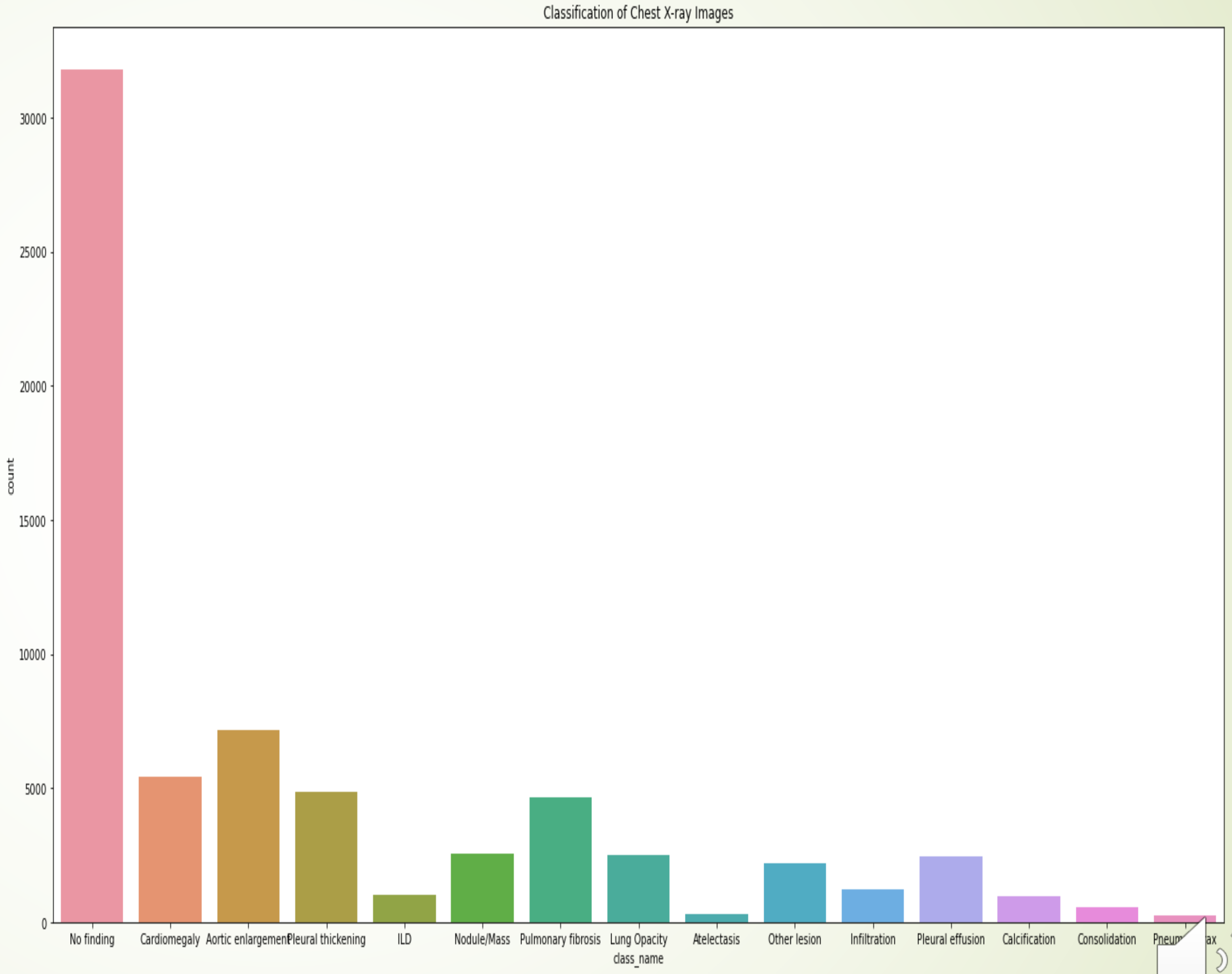
Source: https://medium.com/datadriveninvestor/data-science-project-management-methodologies-f6913c6b29eb

Data Understanding

- Collection and exploration of data is one of the second most important aspect of any research.
- I collected my data from Kaggle Competition 2021;
- Source: https://www.Kaggle.com/awsaf49/vinbigdata-original-image-dataset.
- My dataset comprised 191 Gigabits of scanned X-Ray images. I had two options of collecting the data. I down-loaded the data to my local disk and had the option of down-loading my data to my Kaggle API account.
- My main goal was to classify 14 common thoracic lung abnormalities from chest radiographs and localizing critical findings through object detection and classification.
- My dataset consisted of 18,000 scans of which 15,000 were independently labeled images for training my model.
- I used 3,000 test images to evaluate the accuracy of my model

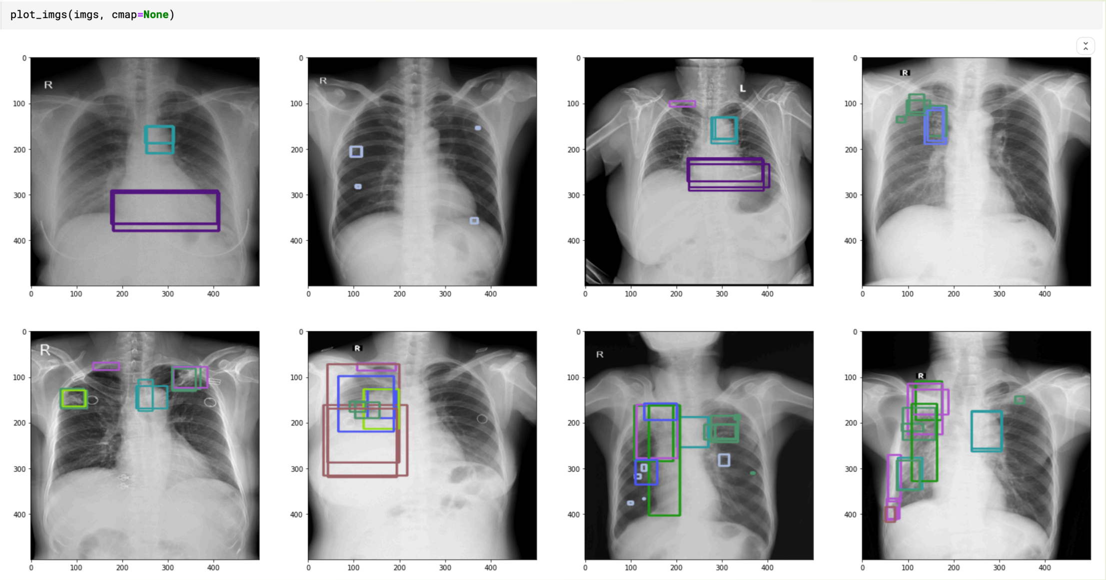
Exploratory Data Analysis

- The histogram demonstrates how various abnormalities are distributed.
- It shows that there's more images with no findings compared to other disease detections.



Localization of Chest X-Ray Images

- My goal was to classify and localize Chest Xray images to make it easy for health care professionals to not only identify abnormalities in the images, but, point to the exact location and area where there is anomaly.
- I was able to achieve my goal as seen in the right hand side of this slide.



Data Preparation

Garbage in is directly equivalent to garbage out. This is very important to avoid major mistakes which shall eventually affect our output.

Data cleaning

I replaced ‘na’ and ‘nan’ with ‘0’-The rationale was derived from the fact that these ‘na’ and ‘nan’ are in areas where there’s no finding.

I tried to format images from dicom to jpeg, but I realized it does not do any good.

Integrate Data;

- Merged Data by using groupby functions

d3637a1935a905b3c326af31389cb846	Aortic enlargement	0	R10	1329.0	743.0	1521.0	958.0
afb6230703512afc370f236e8fe98806	Pulmonary fibrosis	13	R9	1857.0	1607.0	2126.0	2036.0
7c1add6833d5f0102b0d3619a1682a64	Lung Opacity	7	R10	600.0	1332.0	903.0	1523.0
18a61a07e6f5f13ebfee57fa36cd8b6f	Pulmonary fibrosis	13	R9	393.0	283.0	822.0	643.0
5550a493b1c4554da469a072fdfab974	No finding	14	R9	NaN	NaN	NaN	NaN
869f39afbdd8783b531530942eda8bad	No finding	14	R3	NaN	NaN	NaN	NaN
321c111713c3ee5385db0effb54ff568	Aortic enlargement	0	R8	1292.0	554.0	1477.0	805.0
f55460fccf2d3c591f57f9c0de2c37c2	No finding	14	R6	NaN	NaN	NaN	NaN
cdbacab6bf30170ef0ba9fd1d195d270	No finding	14	R9	NaN	NaN	NaN	NaN
80caa435b6ab5edaff4a0a758ffaec6e	Atelectasis	1	R9	331.0	462.0	1384.0	2365.0
5da264775732004f1b724b660138854a	Aortic enlargement	0	R9	1635.0	673.0	1978.0	1151.0
fb8e11c6b2886b2d41b379e0598669b9	Aortic enlargement	0	R10	1390.0	878.0	1616.0	1163.0

+ Code + Markdown

```
## lets clean the data and replace zeros  for 'na' and 'nan'
train_df.fillna(0)
train_df.replace(np.nan,0)
```

	class_name	class_id	rad_id	x_min	y_min	x_max	y_max
image_id							
50a418190bc3fb1ef1633bf9678929b3	No finding	14	R11	0.0	0.0	0.0	0.0
21a10246a5ec7af151081d0cd6d65dc9	No finding	14	R7	0.0	0.0	0.0	0.0
9a5094b2563a1ef3ff50dc5c7ff71345	Cardiomegaly	3	R10	691.0	1375.0	1653.0	1831.0
051132a778e61a86eb147c7c6f564dfe	Aortic enlargement	0	R10	1264.0	743.0	1611.0	1019.0
063319de25ce7edb9b1c6b8881290140	No finding	14	R10	0.0	0.0	0.0	0.0
...	...	...	...	...	...	...	...
936fd5cff1c058d39817a08f58b72cae	No finding	14	R1	0.0	0.0	0.0	0.0
ca7e72954550eeb610fe22bf0244b7fa	No finding	14	R1	0.0	0.0	0.0	0.0
aa17d5312a0fb4a2939436abca7f9579	No finding	14	R8	0.0	0.0	0.0	0.0
4b56bc6d22b192f075f13231419dfcc8	Cardiomegaly	3	R8	771.0	979.0	1680.0	1311.0
5e272e3adbdaafb07a7e84a9e62b1a4c	No finding	14	R16	0.0	0.0	0.0	0.0

Modeling

- ✓ I used the CNN model to run my training data and tested the model with my test data
- ✓ My model contains several building blocks ;
- ✓ Input layer
- ✓ Hidden layers; contain convolution with RELU layer and pooling layer
- ✓ Output layer
- ✓ Relu- is performed with non-linear activation function that sets negative input values to zero.
- ✓ After completion; the pooling layer executes sampling operation

Evaluation

- The testing pipeline is similar to the training pipeline with small differences then caching follows between the epoch
- Iteration and creating of model by changing parameters; Using Sigmoid activation instead of 'relu'
- Reduce and Increase layers to test
- With reduction of layers, accuracy drops significantly from 97.4% to 94.37% Let me see what happens with increase of number of layers.

Deployment

- The model can be deployed in most of the PACs server platforms for most hospitals and can be used to classify images in real-time.
- It may be deployed in the cloud on AWS or GCP or Azure streaming platforms using kinesis
- The model requires a lot of memory(RAM), it works best when deployed in cloud platforms which can leverage the power of shared memory.
- Future review of the images may be made possible by archiving the images in some cheaper storage areas in the cloud and easily whenever needed.

Inferences and Summary

- The model was able to give a 74% prediction with consistent accurate results
- Chest x-Ray classification and localization was successful and comparable to Radiologist classification.
- The prediction/classification is faster compared to human classification by radiologists
- There's promising outcome from the use of this model in Chest X-Ray prediction and classification
- With increase of layers like the previous model. Accuracy improved , though not as much as when using the 'relu' activation. Our accuracy improved to 96.32 , but still its less than the previous 97.59%

Conclusion

- TensorFlow deep learning platform has helped us accomplish significant roles in training our dataset. We were able to build several utility layers and nodes within each layer. The number of activation layers and the type of activation node were identified to influence the performance of the model significantly.
- One way to enhance the performance of the model is experiment with different numbers of this elements/parameters .
- Other Machine learning algorithms have employed optimization techniques like hyperparameter tuning, feature selections and enhanced feature transformations which can equally be used for CNN with tensor flow or h2o and other improved deep learning and artificial intelligence tools.
- From this model; 'relu' activation was found to perform better compared to the sigmoid activation. But, this does not mean that it's better than 'sigmoid'; there are variations on different activation nodes depending on the model under study.

Future Directions and lessons learnt

- A lot of research and collaboration with Clinical professionals and radiologists is required.
- There shall be rigorous testing of the model to ensure consistency and success of this model
- The model may be improved to become an AI Model and deployment needs continuous evaluation and monitoring
- HIPPA and Privacy protocols must be taken into consideration before any release or use of patient data.

References

- https://www.kaggle.com/c/vinbigdata-chest-xray-abnormalities-detection/data
- https://github.com/naitik2314/Chest-X-Ray-Medical-Diagnosis-with-Deep-Learning/blob/master/X-Ray.ipynb
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- https://mjoc.uitm.edu.my/main/images/journal/vol4-1-2019/MJOC_vol41_seq5.pdf