Rajiv Gandhi Institute of Technology
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Technical Seminar on
"Deep learning Enables Accurate Diagnosis of Novel Coronavirus (COVID-19) with CT images"

Under The Guidance Of:

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Some facts about COVID-19

- Late December 2019
- WHO named it as “COVID-19”
- COVID-19 is a beta-CoV of group 2B with at least 70% similarity in genetic sequence to SARS-CoV
- And it’s the seventh member of the family of enveloped RNA coronavirus that infect humans

The Problem

- From the last 14 days the number of new covid cases in india are 43,96,614
- The approximate number of doctors in india is 11,56,000
- The ratio is **1:4**
- There are few tests out there in the market
  - RT-PCR(24 to 48 hours)
  - Rapid Antigen Test(2 hours)
- They tell whether covid is there in patient or not
- Will they assist doctors?

Solution

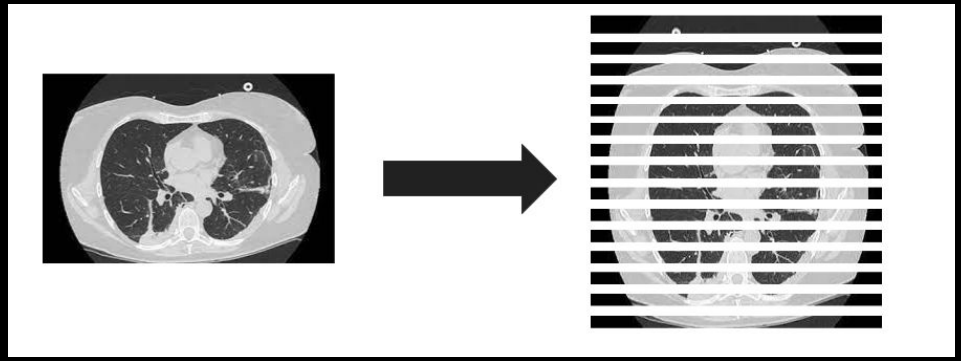
- WHO has approved CT(Computed tomography) has one of the major factor to be considered while treating covid patient
- With the use of deep learning that is computer vision they have build an entire server which helps doctors to diagnose covid patients with just CT scans
- Ground-Glass Opacity (GGO) from radiographs.
- http://biomed.nscc-gz.cn/server/Ncov2019

Data acquisition

- Renmin Hospital of Wuhan University and two affiliated hospitals of the Sun Yat-sen University in Guangzhou.
- Total of 88 patients CT scans
- nasopharyngeal swabs were collected performed RT-PCR and compared to the novel coronavirus nucleocapsid protein gene (nCoV-NP) and the novel coronavirus open reading coding frame lab (nCoV ORFlab) sequence.
- For still more data they have collected 86 healthy people and 100 covid patients (bacterial pneumonia patients) CT scans

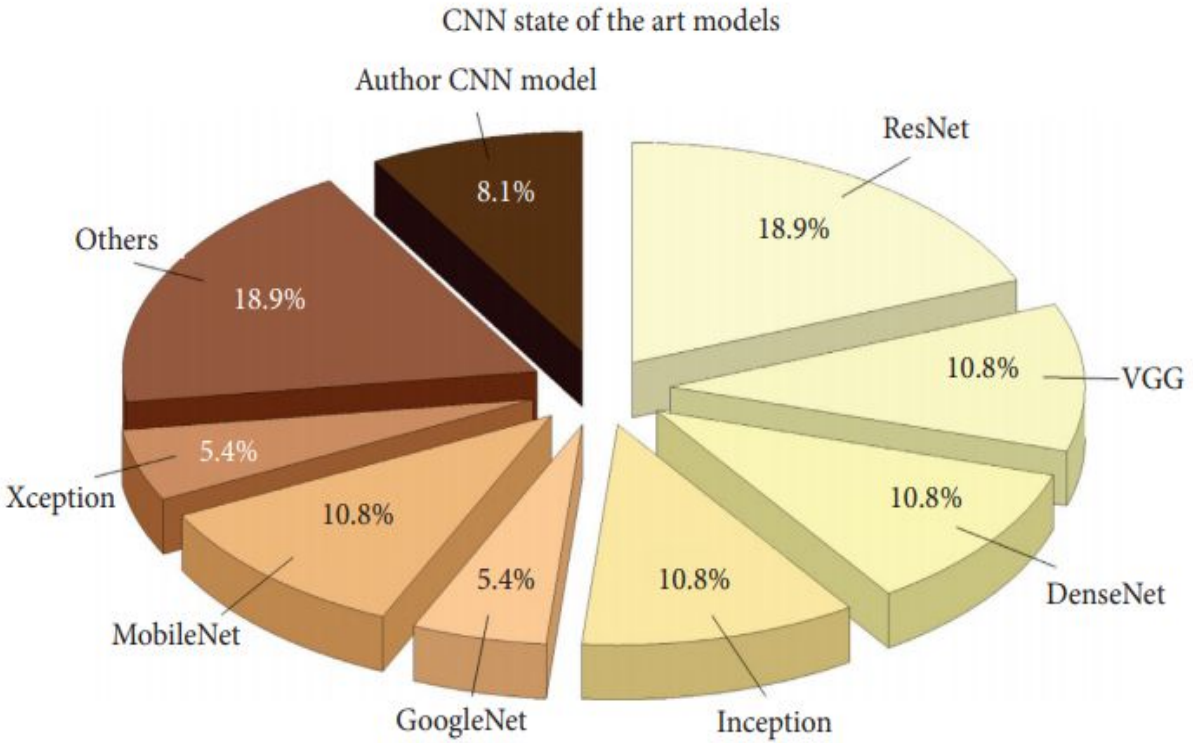
Data PreProcessing

- The entire Pre Processing is done using OpenCV



- As the lung contours are of large differences between humans, the images were filled with an background composed of 10 translational and rotational lungs.
- 88 Covid patients with 777 CT images and 100 bacterial pneumonia patients with 505 slices, and 86 healthy people with 708 slices

Distribution of Models related to Covid-19



DRE-Net

- The models were concretely constructed on the pretrained ResNet-50 with Feature Pyramid Network (FPN) which extracts the top-K details from each image
- An attention module is coupled to learn the importance of each detail.
- The model can not only detect the most important part of images, but also interpret the outputs by the neural network.
- The image-level scored results of slices were aggregated for each patient using mean pooling for human level results

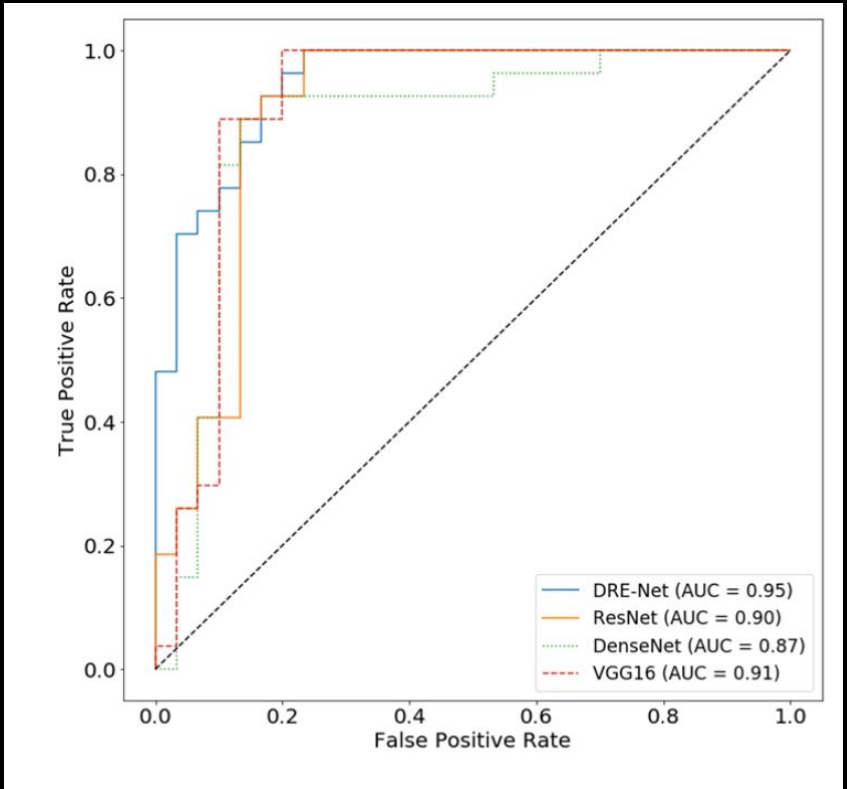
Evaluation

- The patient level split strategy following the LUNA16 competition by using random splits of 60% / 10% / 30% for training, validation, and test sets, respectively.
- There are two tasks on which models were build on that are for classification and diagnosis.
- Evaluation Metrics used to hypertune and find the optimal models
    - AUC(Area Under the Curve)
    - Recall
    - Precision
    - F1-score
    - Accuracy

Results for classification task

Table 1. Performance comparisons on pneumonia classification dataset.

Model	AUC	Recall	Precision	F1-score	Accuracy
VGG16	0.91	0.89	0.80	0.84	0.84
DenseNet	0.87	0.93	0.76	0.83	0.82
ResNet	0.90	0.93	**0.81**	0.86	0.86
DRE-Net	**0.95**	**0.96**	0.79	**0.87**	**0.86**

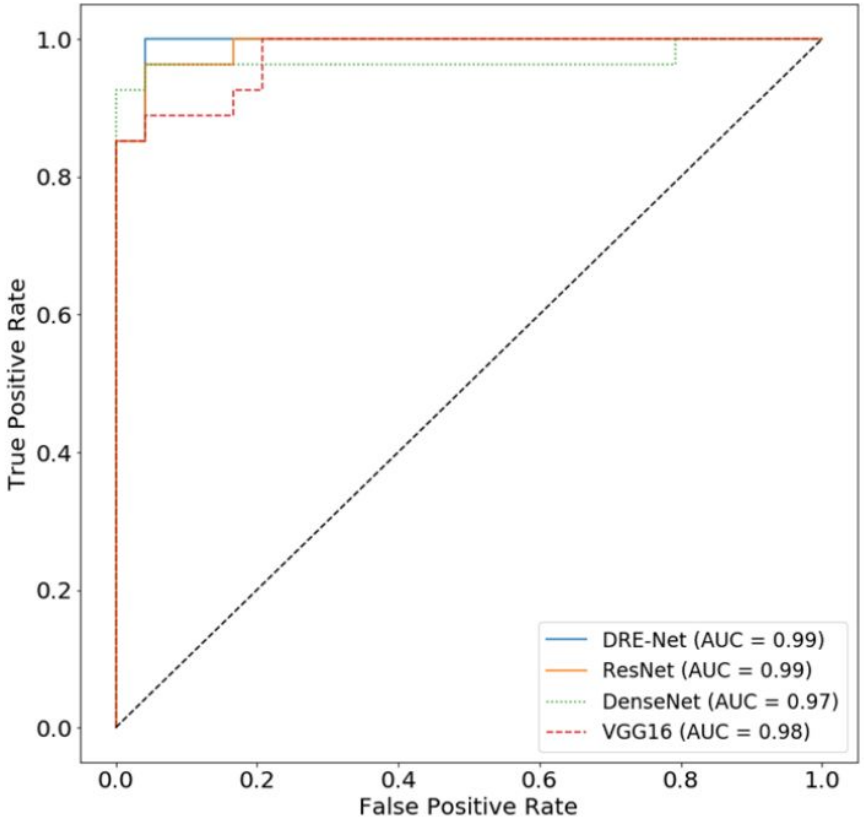


Test set= 57	Predicted: NO	Predicted: YES
Actual: NO	TN = 23	FP = 7
Actual: Yes	FN = 1	TP = 26

Results for diagnosis task

Table 2. Performance comparisons on pneumonia diagnosis dataset.

Model	AUC	Recall	Precision	F1-score	Accuracy
VGG16	0.98	0.89	0.92	0.91	0.90
DenseNet	0.97	0.92	0.85	0.92	0.92
ResNet	0.99	0.89	0.96	0.92	0.92
DRE-Net	**0.99**	**0.93**	**0.96**	**0.94**	**0.94**



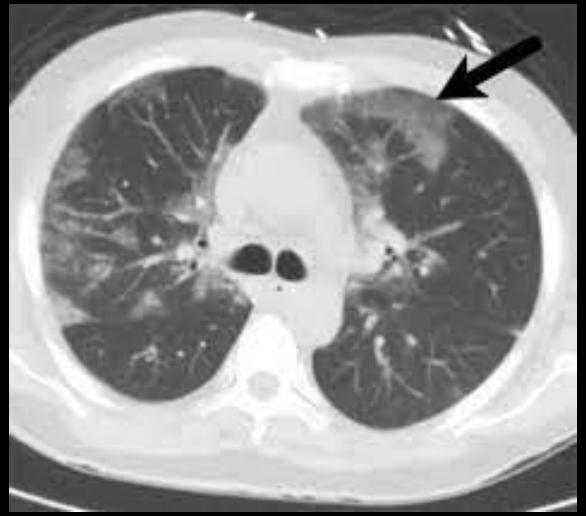
Test set= 51	Predicted: NO	Predicted: YES
Actual: NO	TN = 23	FP = 1
Actual: Yes	FN = 2	TP = 25

Model Interpretation

- Ground - Glass Opacification/Opacity (GGO) is a descriptive term referring to an area of increased attenuation in the lung on computed tomography (CT)

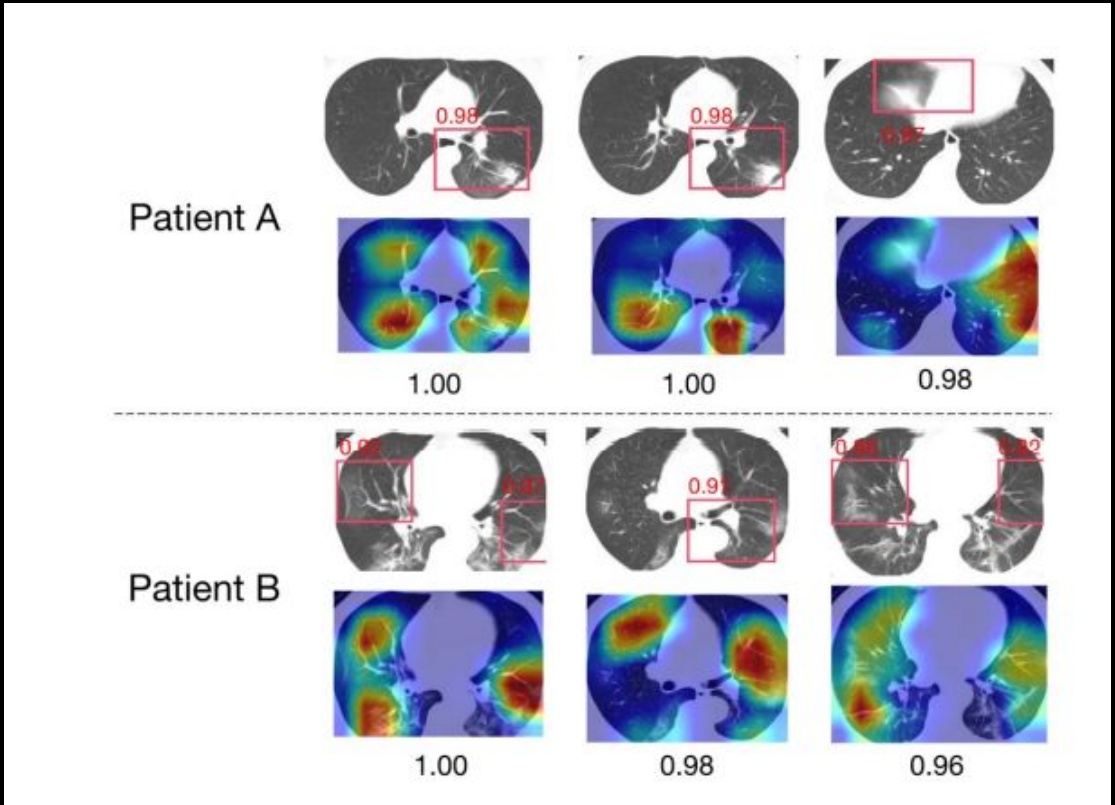
Healthy Person CT lung scan

Person with some lung related disease CT lung scan

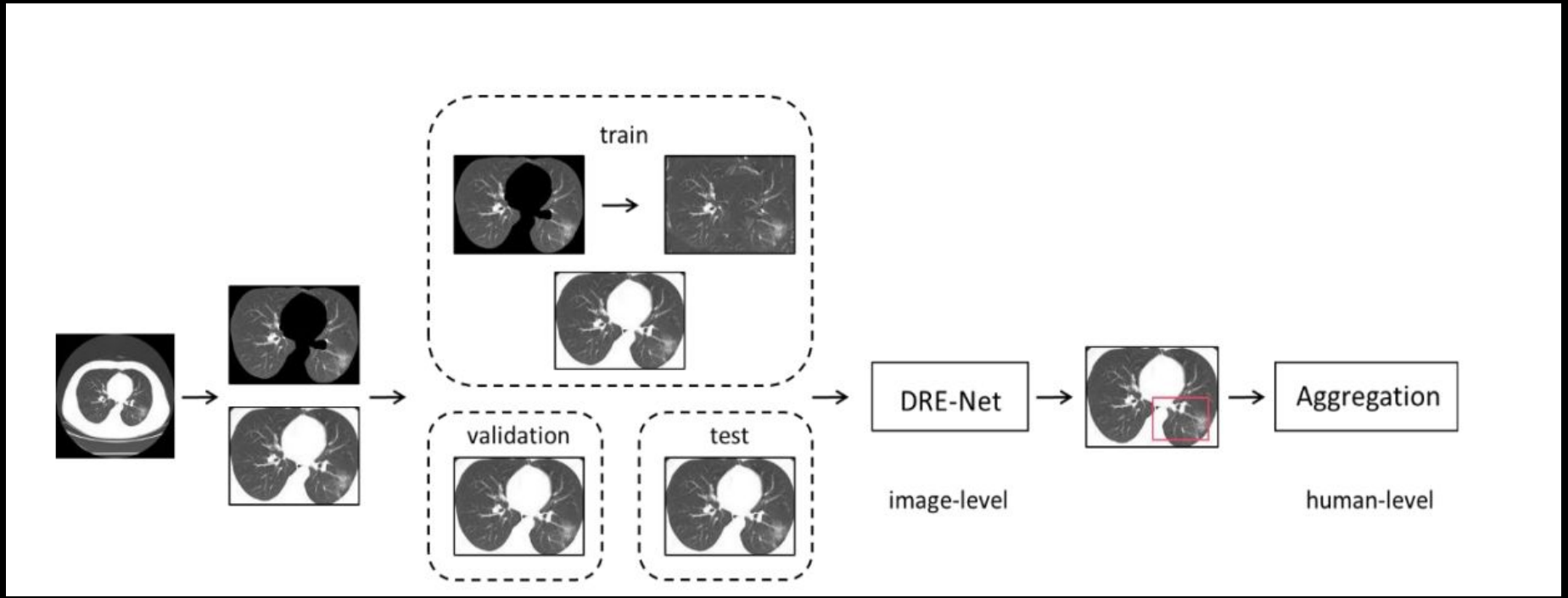


- For each patient, the top 3 predicted slices and the extracted details were indicated with predicted scores above 0.8 (range from 0 to 1).
- DRNet mainly focused on the region of the GGO abnormality.
- These findings indicate that DRNet learned to assess the correct features instead of learning image correlations.
- The model provides reasonable clues on the factors for its judgements, which is of great help to assist doctors in diagnosis.

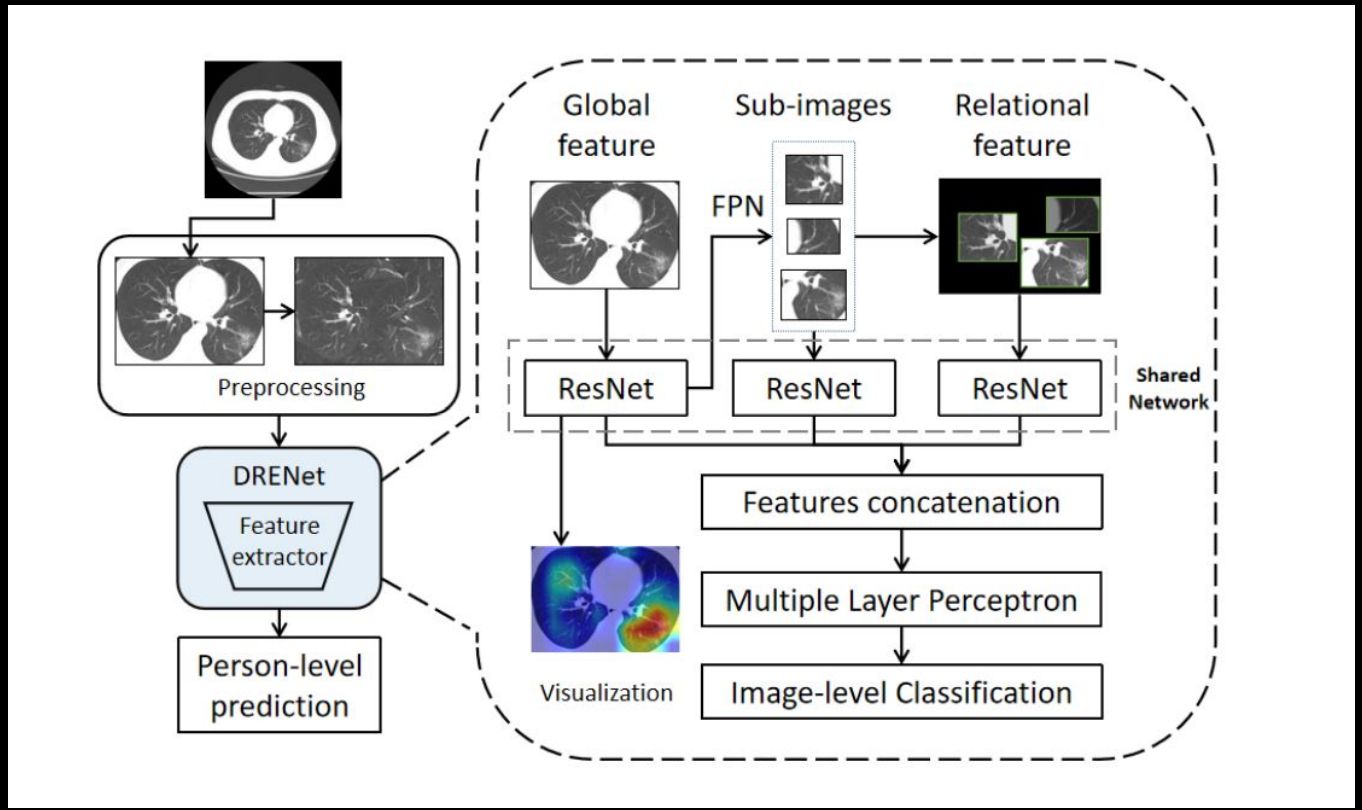
Visualized Results



Architecture



DRE-Net Architecture



Conclusion

The study demonstrated the feasibility of a deep learning approach to assist doctors to detect the patients with COVID-19 and automatically to identify the lesions from CT images. By achieving a high performance on both the pneumonia detection and classification tasks, the proposed system has enable a rapid identification of patients.

References

- Deep learning Enables Accurate Diagnosis of Novel Coronavirus
- Review Article Deep Learning in the Detection and Diagnosis of COVID-19 Using Radiology Modalities: A Systematic Review
- medRxiv.org
- Andrew Ng Article on Data Centric Models
- Stanford HAI(Stanford human centered artificial intelligence)

Thank You