Rapid and Robust COVID-19 Identification from Chest X-rays

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Radiology

CV/AI team

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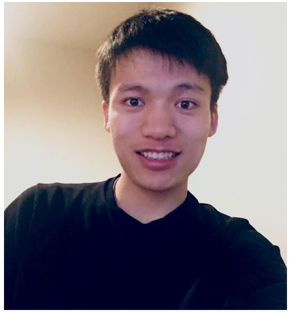
Taihui Li (CS&E)



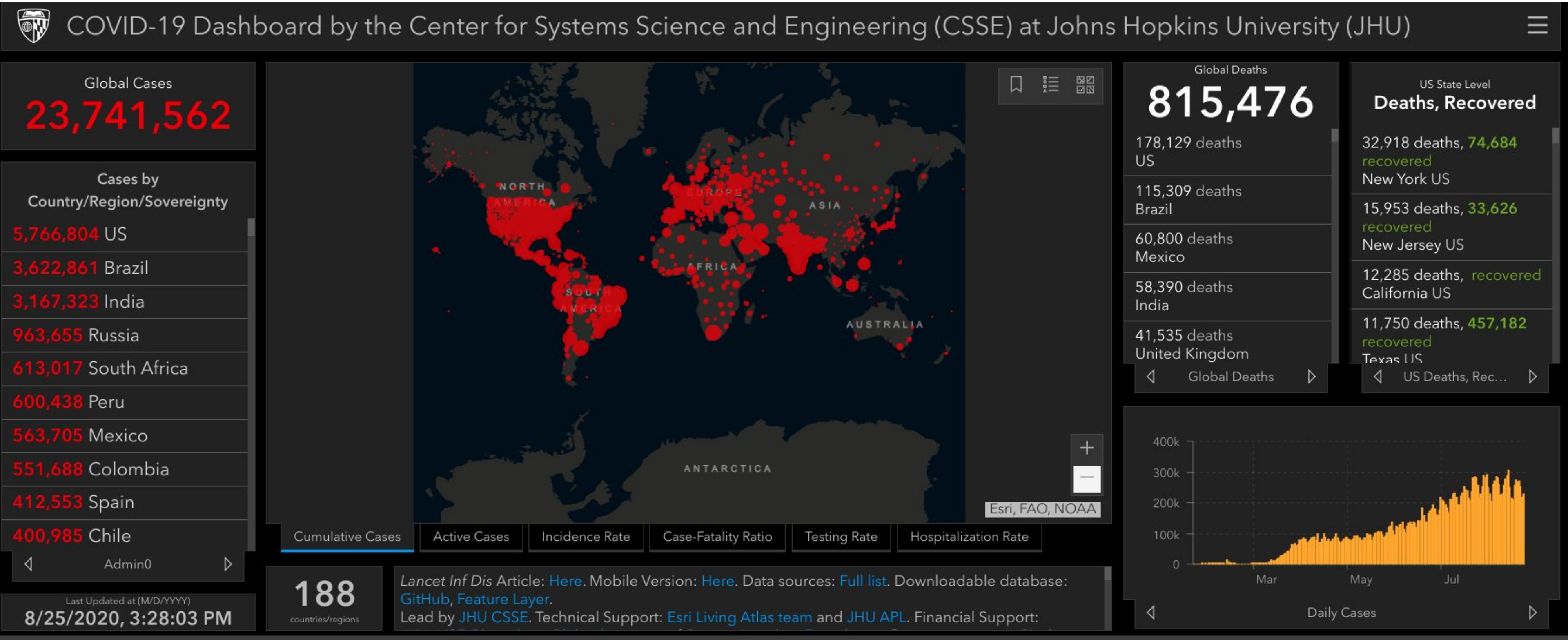
Le Peng (CS&E)

Dyah Adila (CS&E)

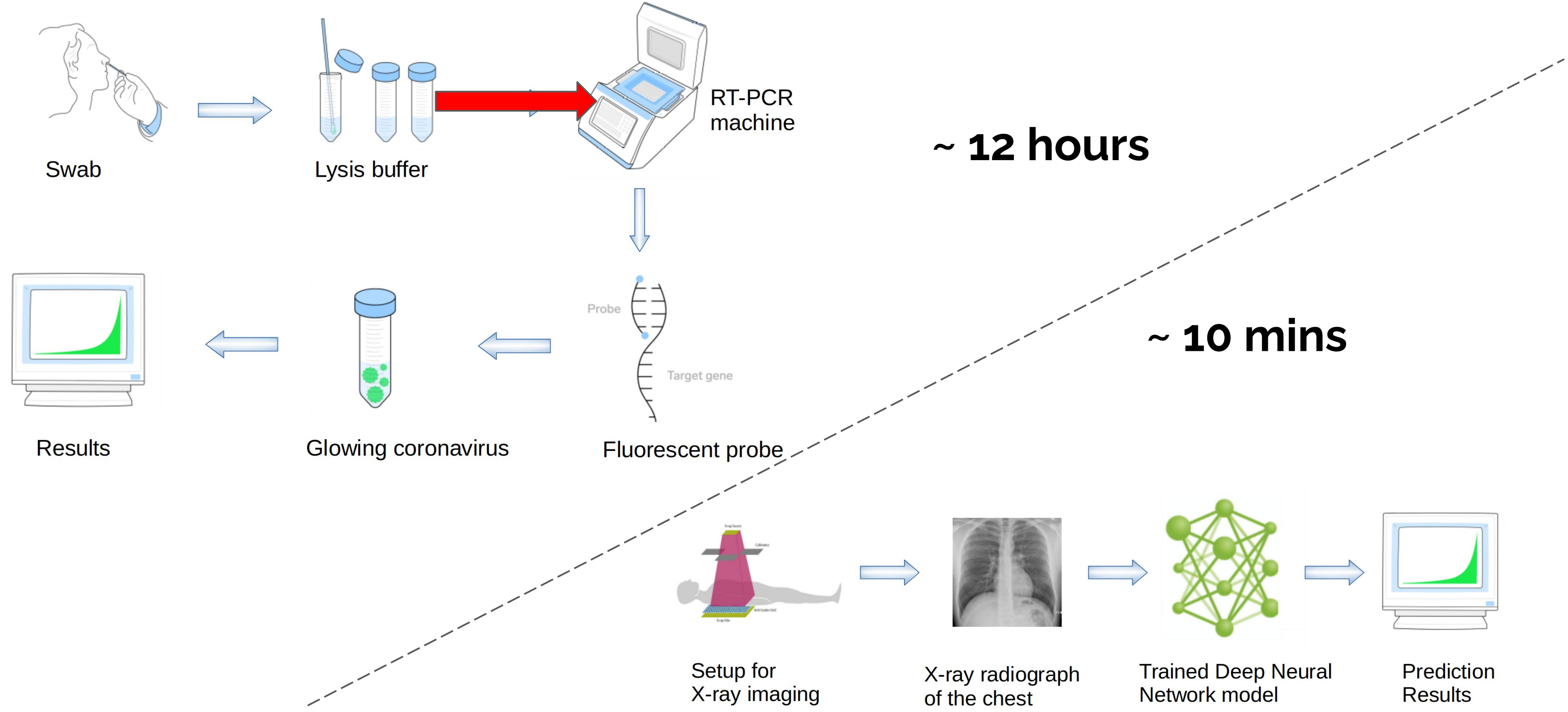
Deployment

Overview

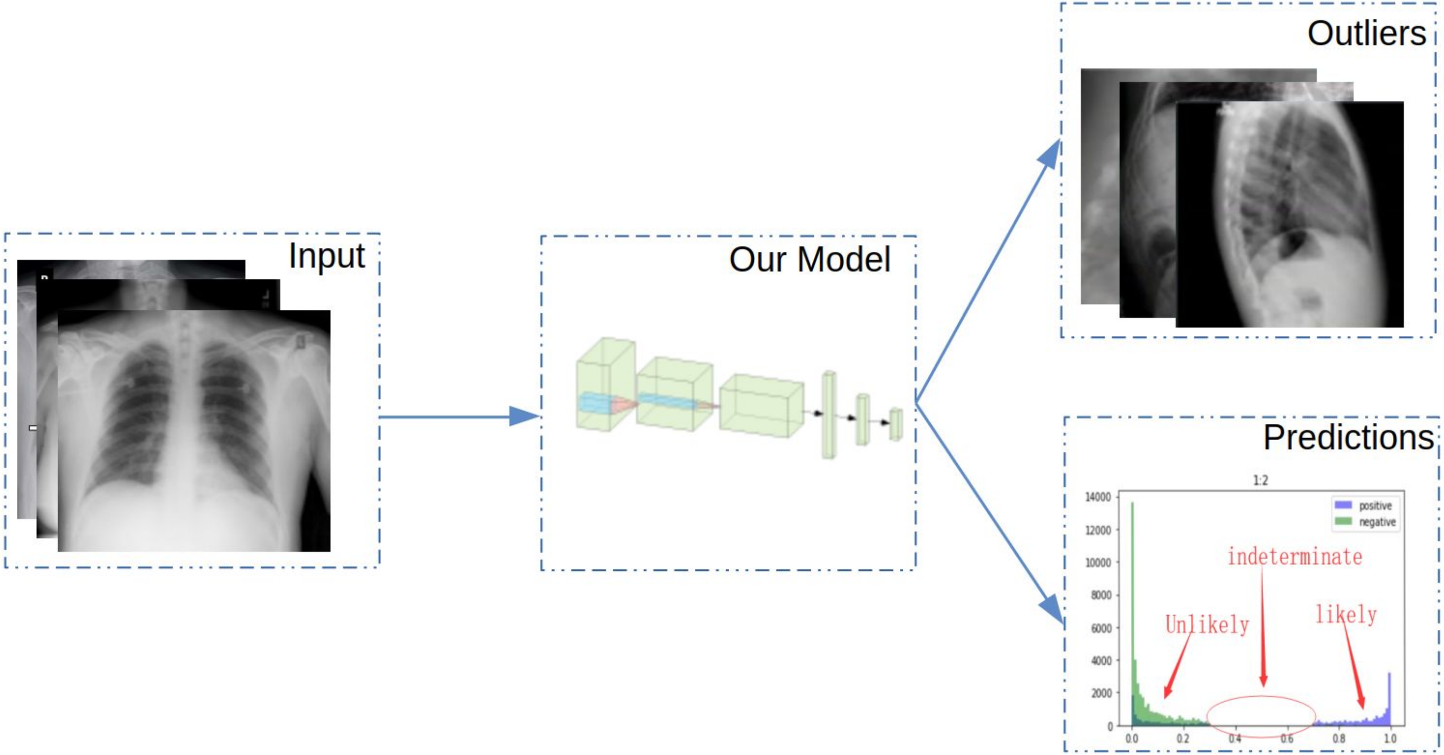
COVID-19 is killing people



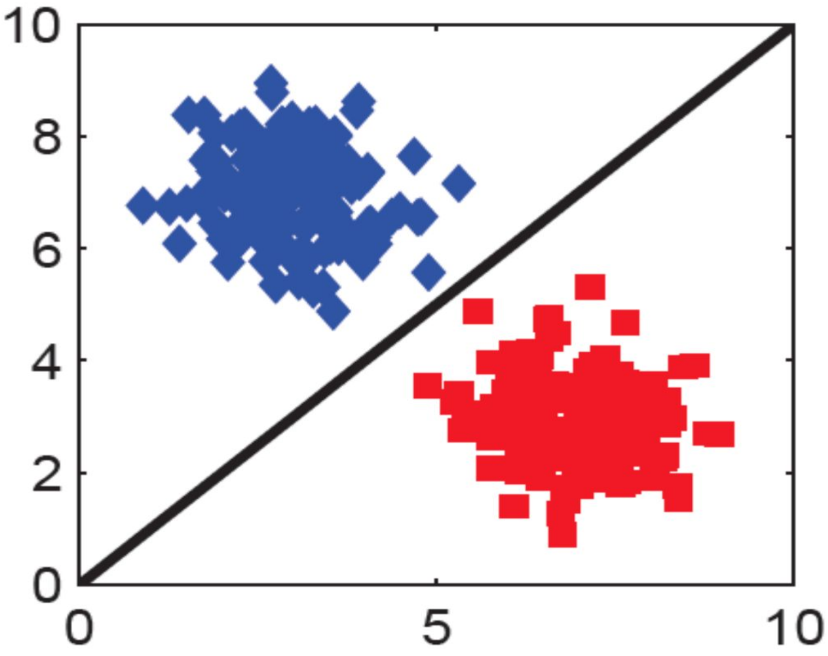
RT-PCR vs X-rays diagnosis



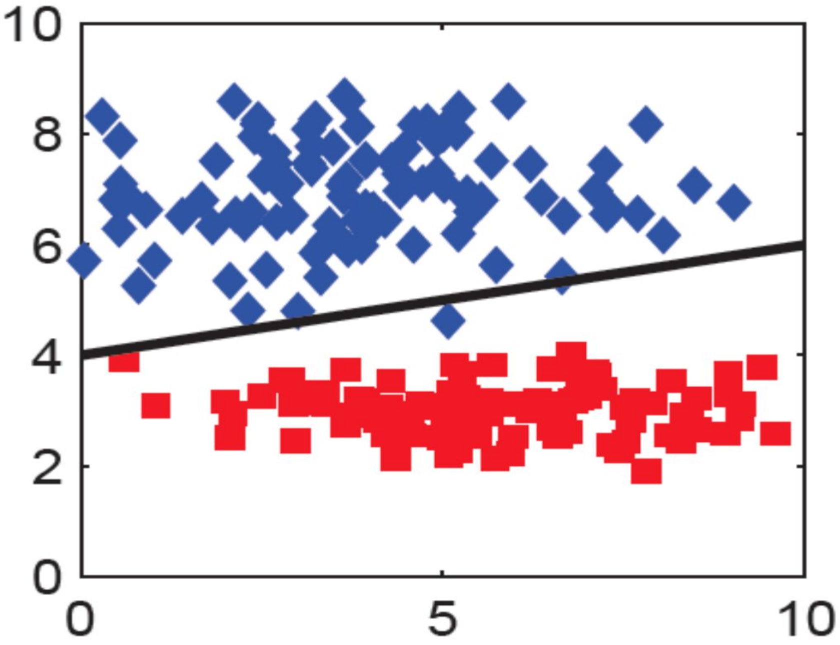
What our model offers.... In 10 mins



Transfer learning helps to generalize



(a) Fairview-COVID19



(b) BIMCV-COVID19

How our model performs

Results on M Health Fairview data

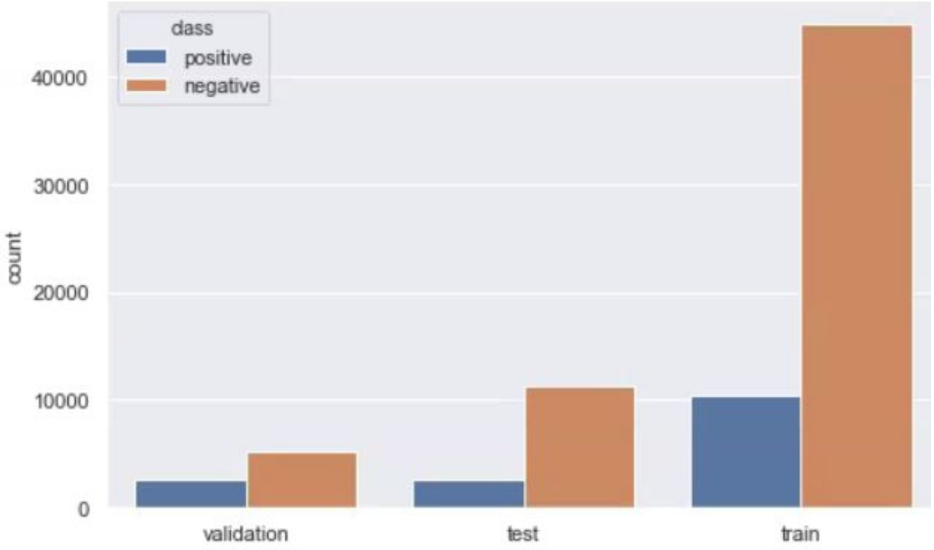


Table 1 test on **before** July 1st

ratio	specificity	sensitivity	ppv	npv
1	0.957	0.82	0.95	0.841
2	0.959	0.82	0.909	0.914
5	0.959	0.818	0.798	0.964

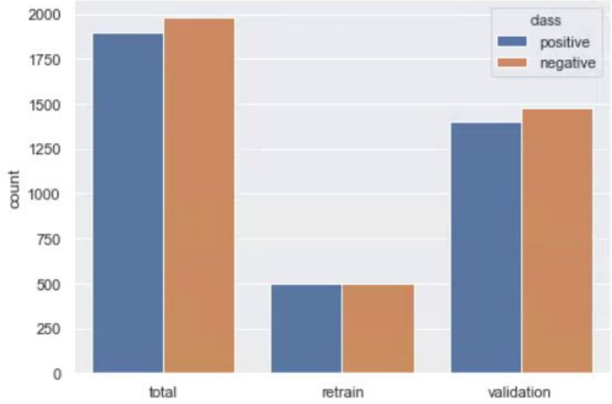
Uncertain=14.80%

Table 2 validation on **after** July 1st

ratio	specificity	sensitivity	ppv	npv
1	0.906	0.764	0.89	0.794
2	0.906	0.764	0.803	0.885
5	0.906	0.767	0.621	0.951

Uncertain=16.48%

Results on external



Transfer learning

ratio	specificity	sensitivity	ppv	npv
1	0.646	0.926	0.724	0.898
2	0.646	0.928	0.567	0.947
5	0.646	0.923	0.343	0.977

Uncertain=14.44%

Direct learning

ratio	specificity	sensitivity	ppv	npv
1	0.544	0.88	0.658	0.819
2	0.544	0.878	0.49	0.899
5	0.544	0.878	0.277	0.957

Uncertain=12.84%

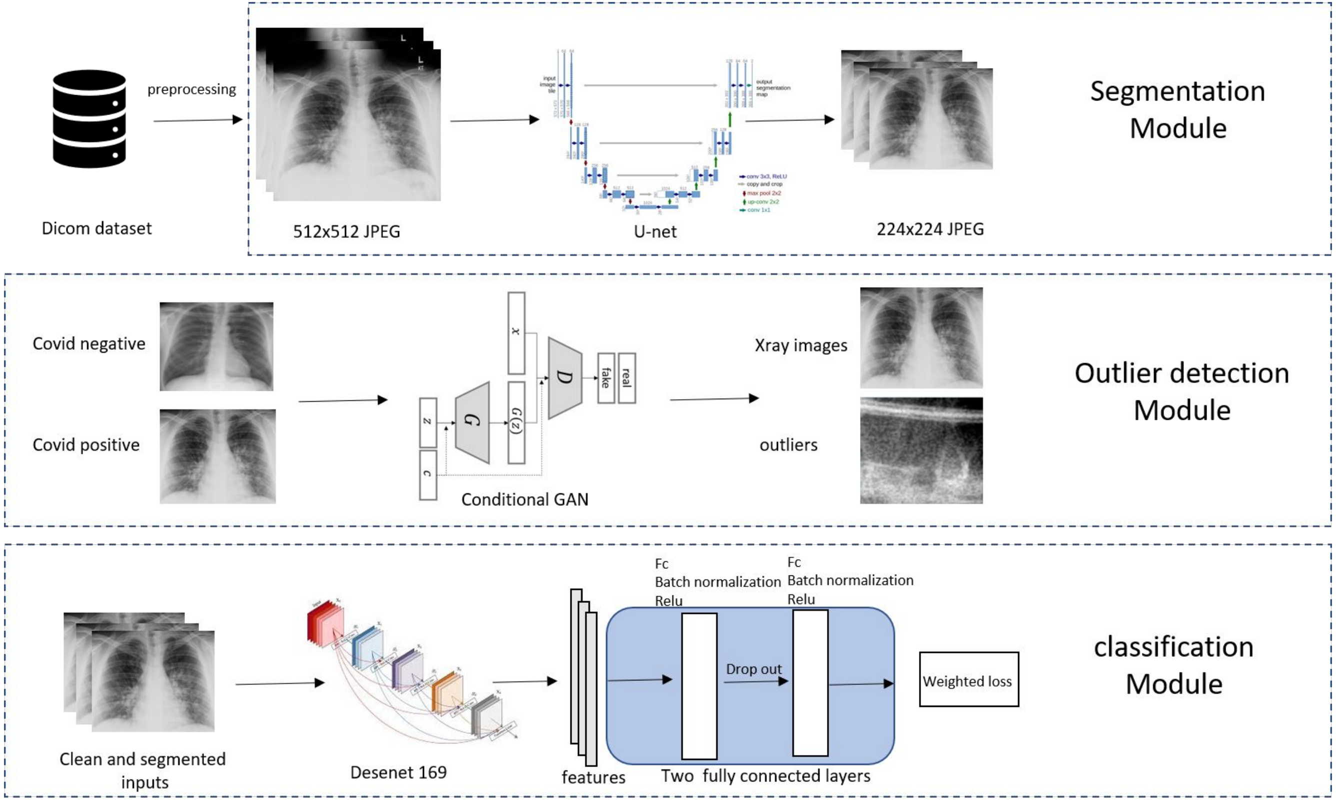
Direct generalization

ratio	specificity	sensitivity	ppv	npv
1	0.885	0.046	0.286	0.481
2	0.885	0.047	0.171	0.65
5	0.885	0.046	0.074	0.823

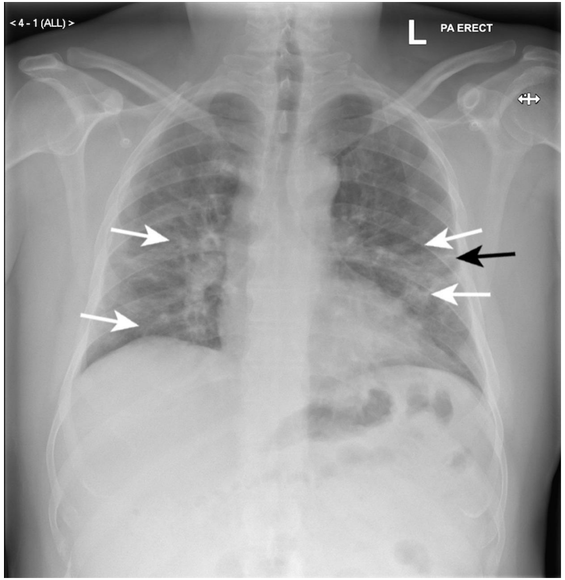
Uncertain=19.58%

Look into our model

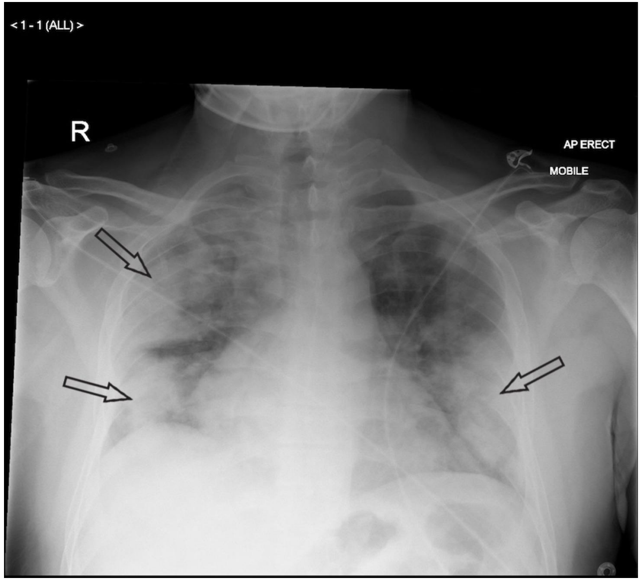
Look into our model



Domain (medical) knowledge - I



Ground glass opacity (mid, lower, peripheral)

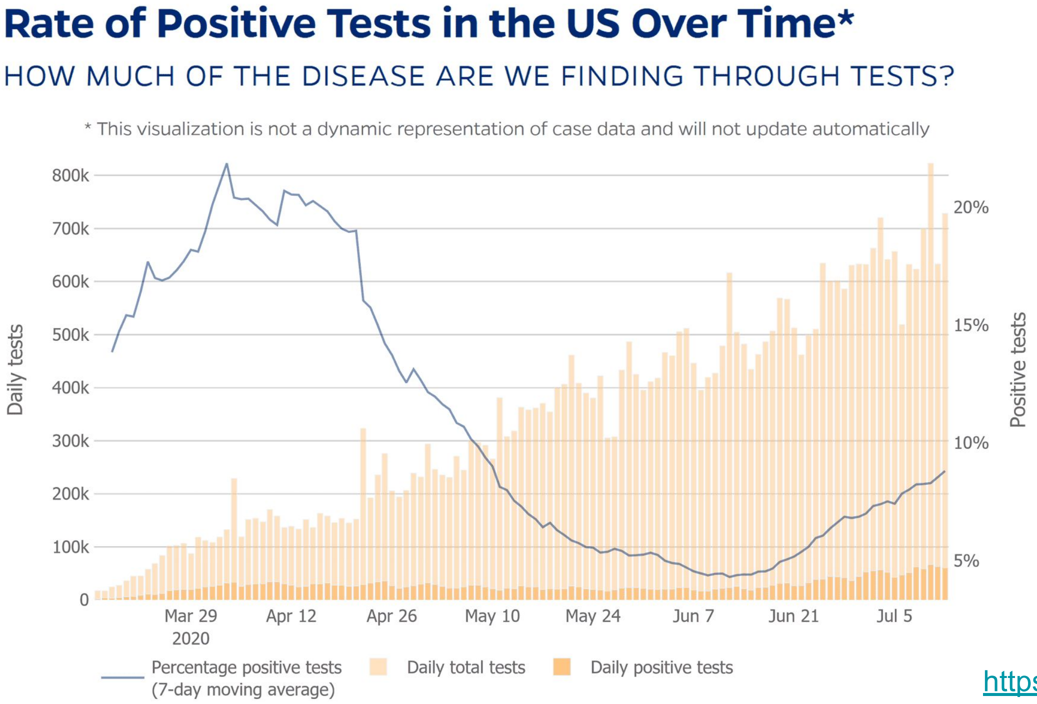


Consolidation (mid, lower, peripheral)

https://www.bmj.com/content/370/bmj.m2426

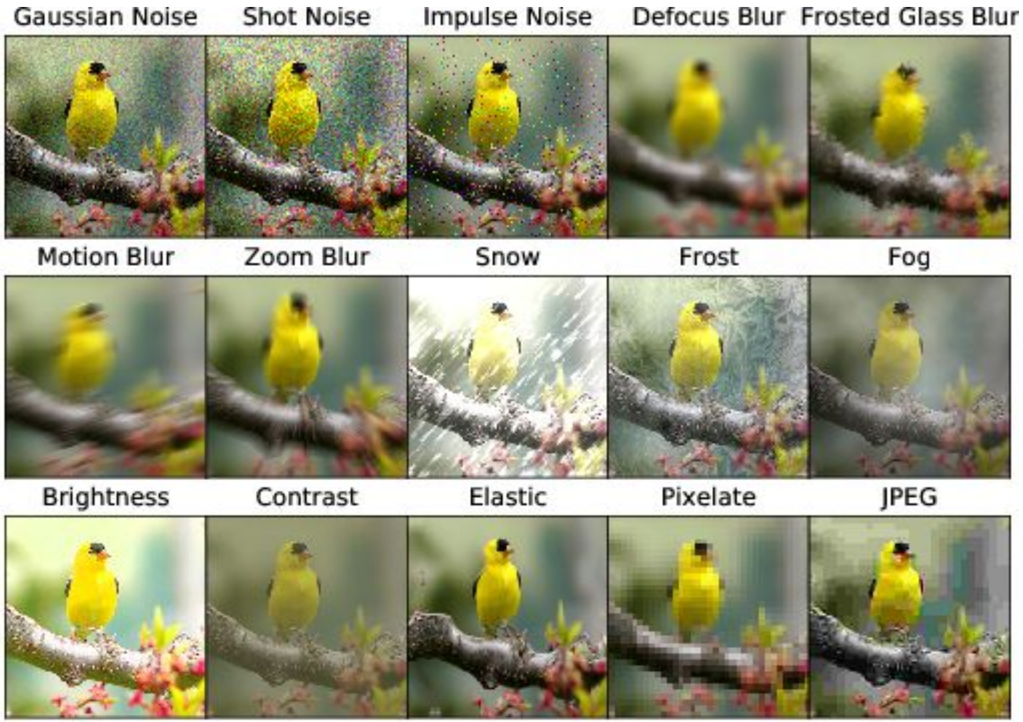
Domain (medical) knowledge - II

Case/Control imbalance



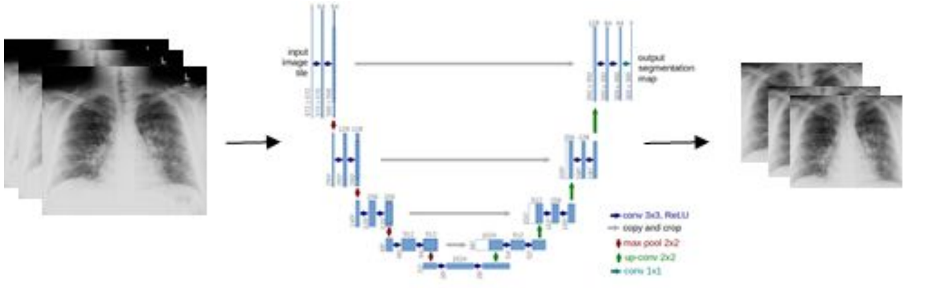
https://covidtracking.com/

Robustness of AI



https://github.com/hendrycks/robustness

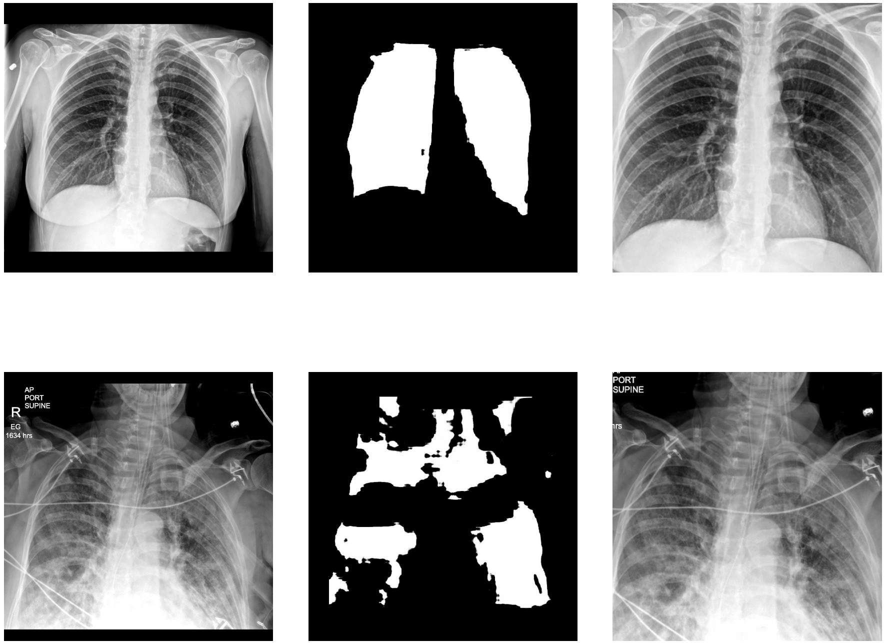
Step 1: Lung segmentation



512x512 JPEG

U-net

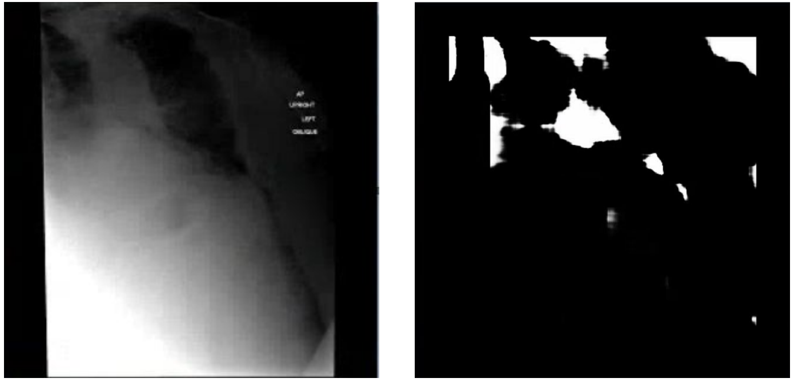
224x224 JPEG



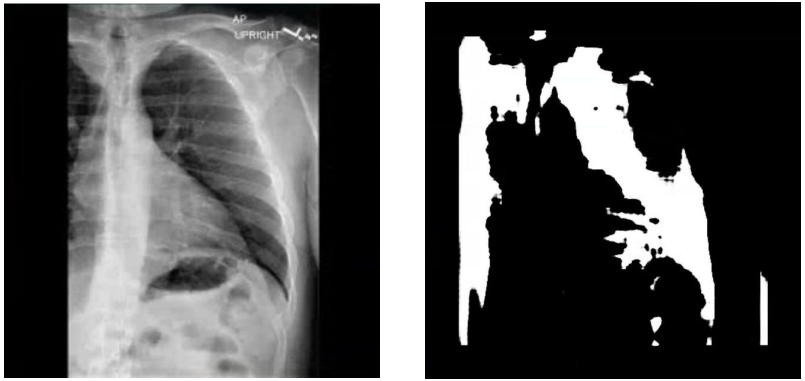
https://www.kaggle.com/nikhilpandey360/lung-segmentation-from-chest-x-ray-dataset

Step 2: Outlier detection - I

Lung area



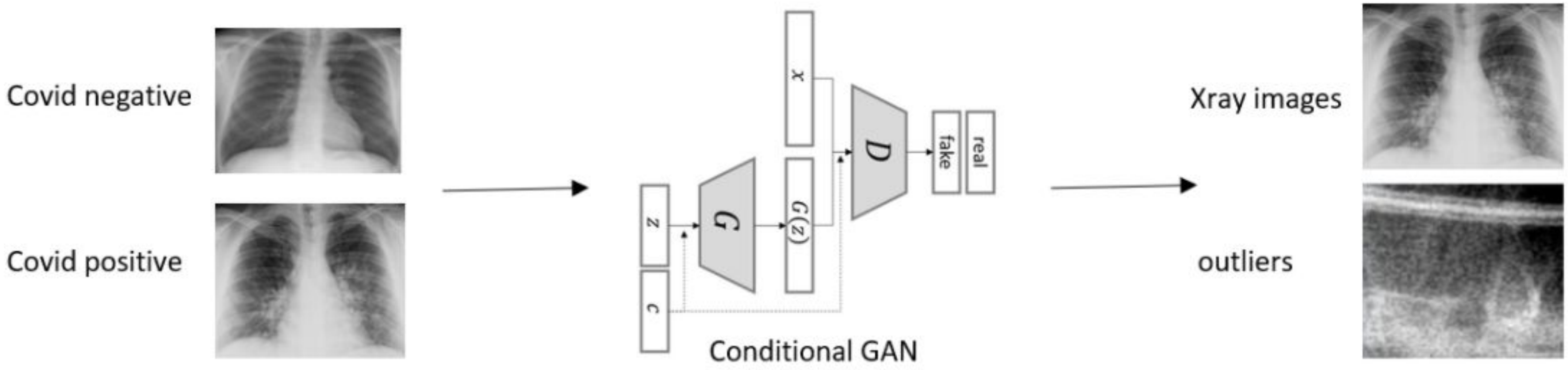
Outliers(True Positive)



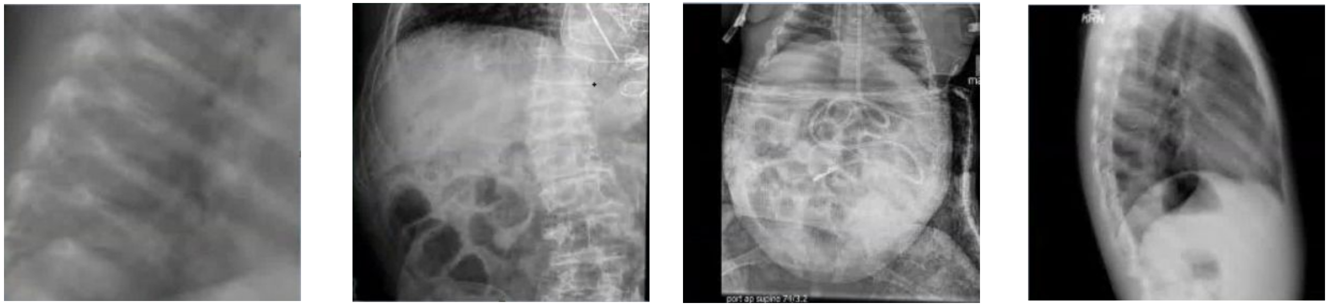
Outliers(False Negative)

Step 2: Outlier detection II

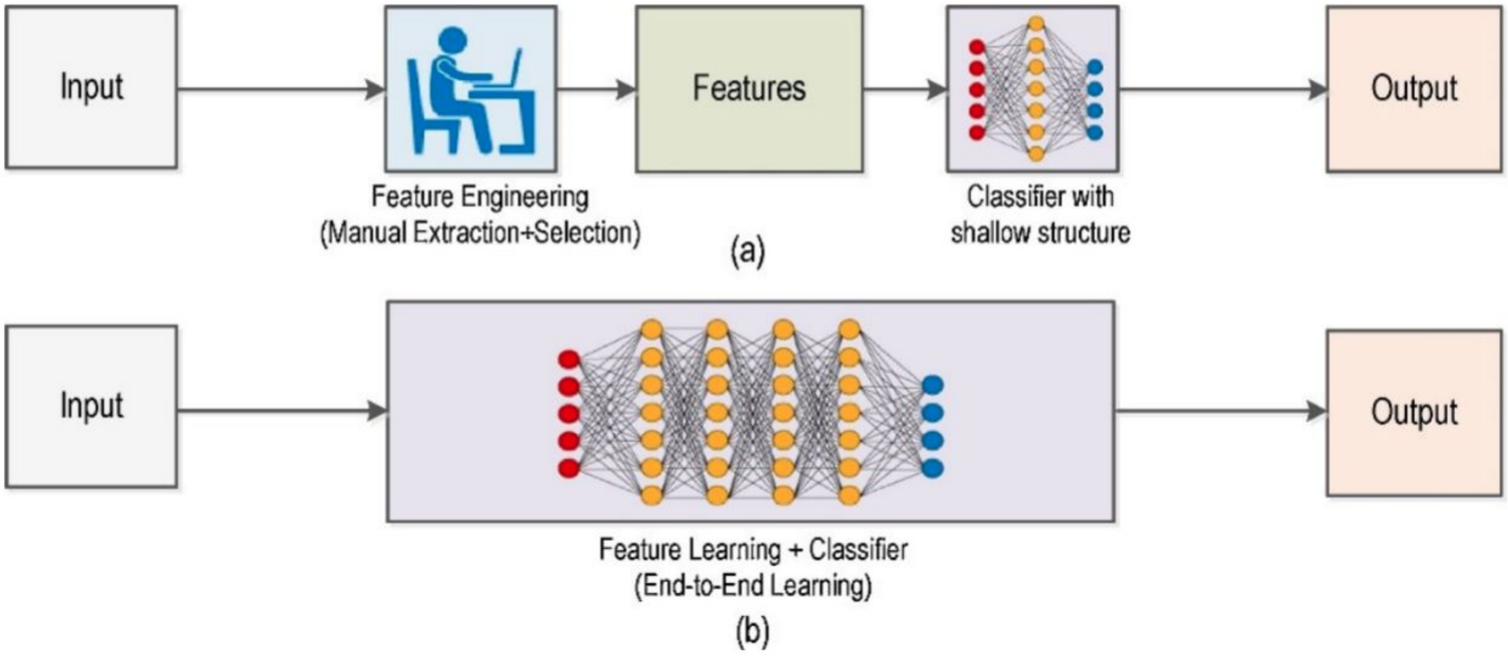
Conditional GAN



examples



Step 3: Feature extraction



Choose **pretrained DNN models** to counter **data imbalance** and maximize **generalization**

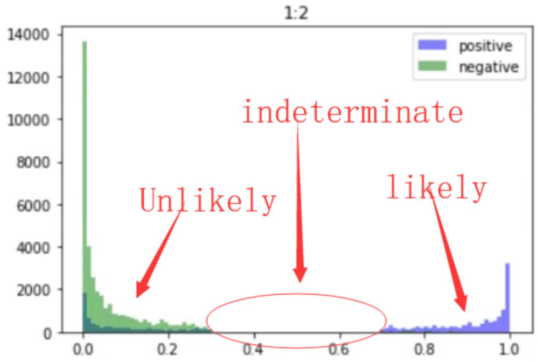
Step 4: Classification

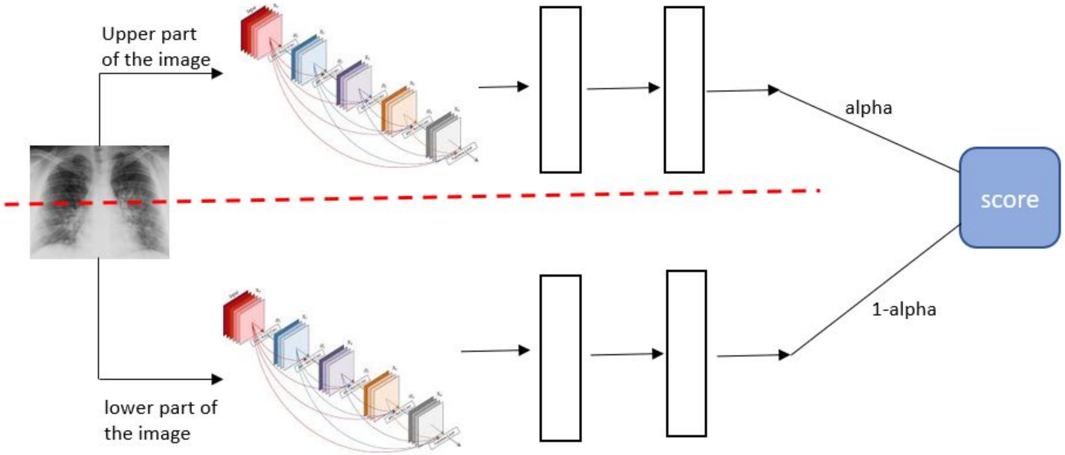
- **Imbalance problems**

$$L = \max(L_{\text{positive}}, L_{\text{negative}})$$

where L is BCE loss function.

- **Three decision values**

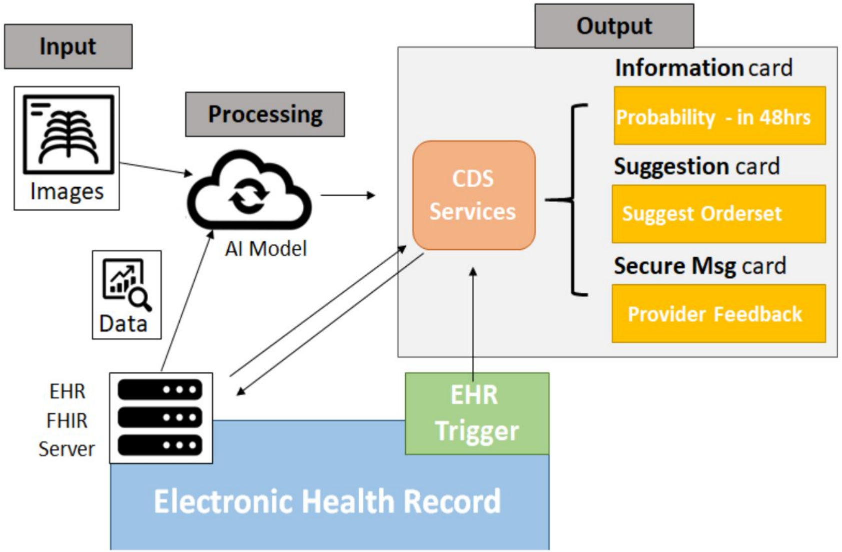




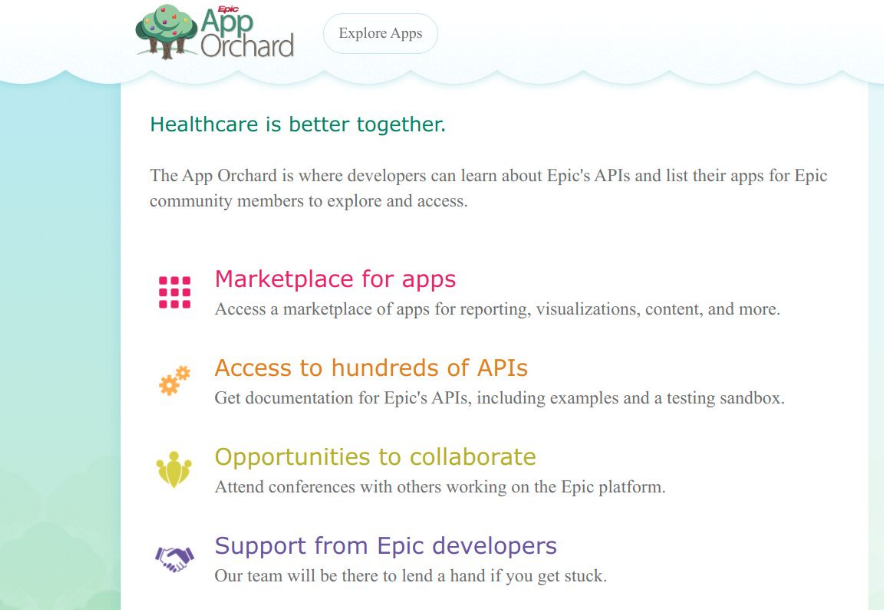
Deployment & Future Work

Deployment and public release

M Health Fairview CDS: 12 hospitals



Epic App Orchard: 450+ customers



Next

- Prognosis: adverse outcomes prediction