

2022 ANNUAL MEETING

OCTOBER 12 - 15 | SAN ANTONIO, TX



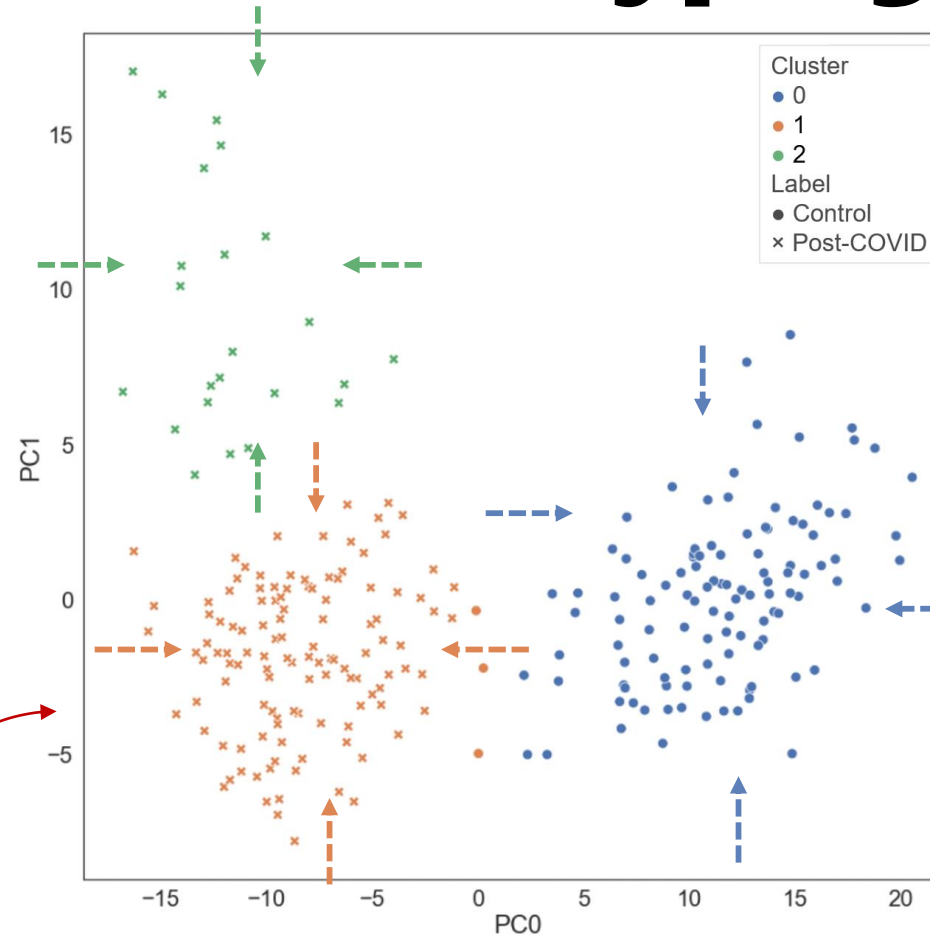
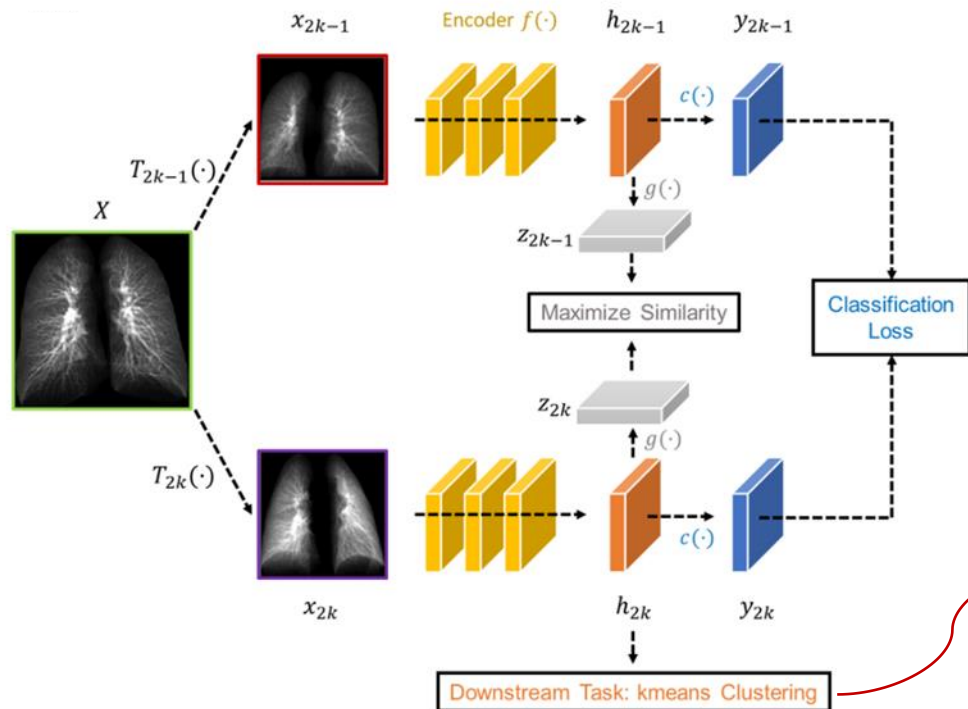
Removing the Foreground and Background of Chest X-rays using a Generative Adversarial Network (GAN)



Frank Li
Advisor: Dr. Ching-Long Lin
October 15, 2022

Rationale: Post-COVID Subtyping

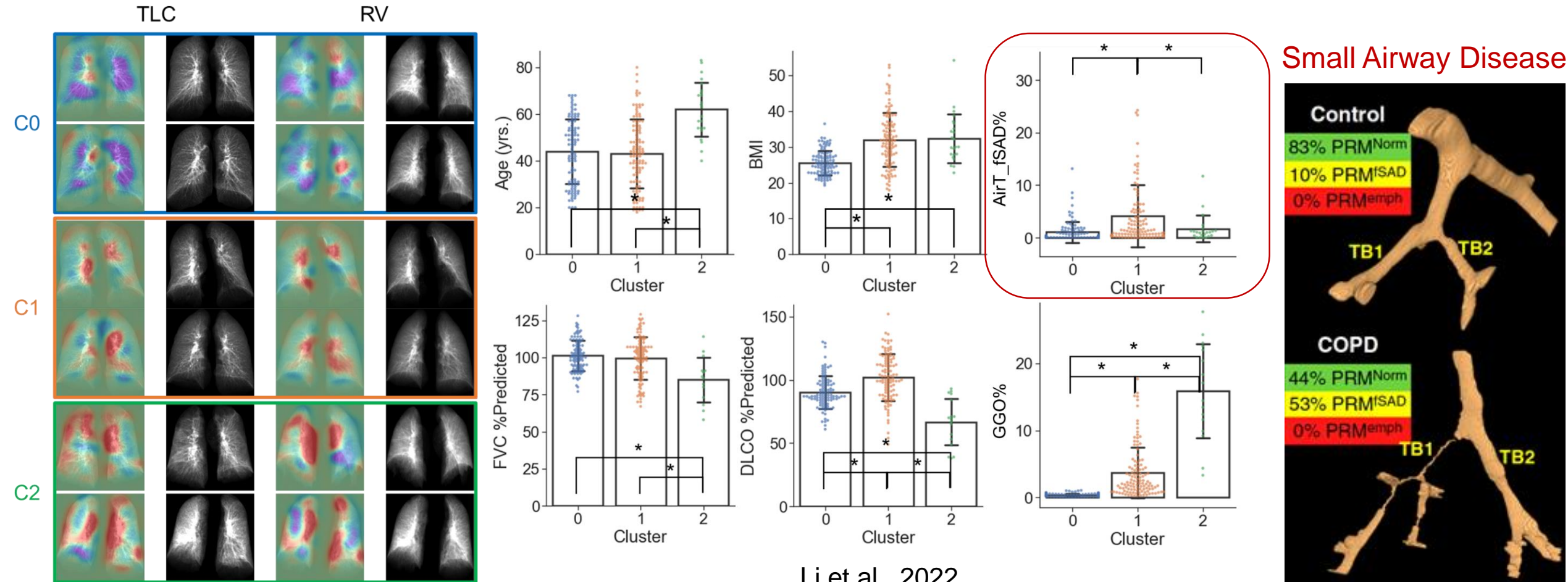
Contrastive Learning Model

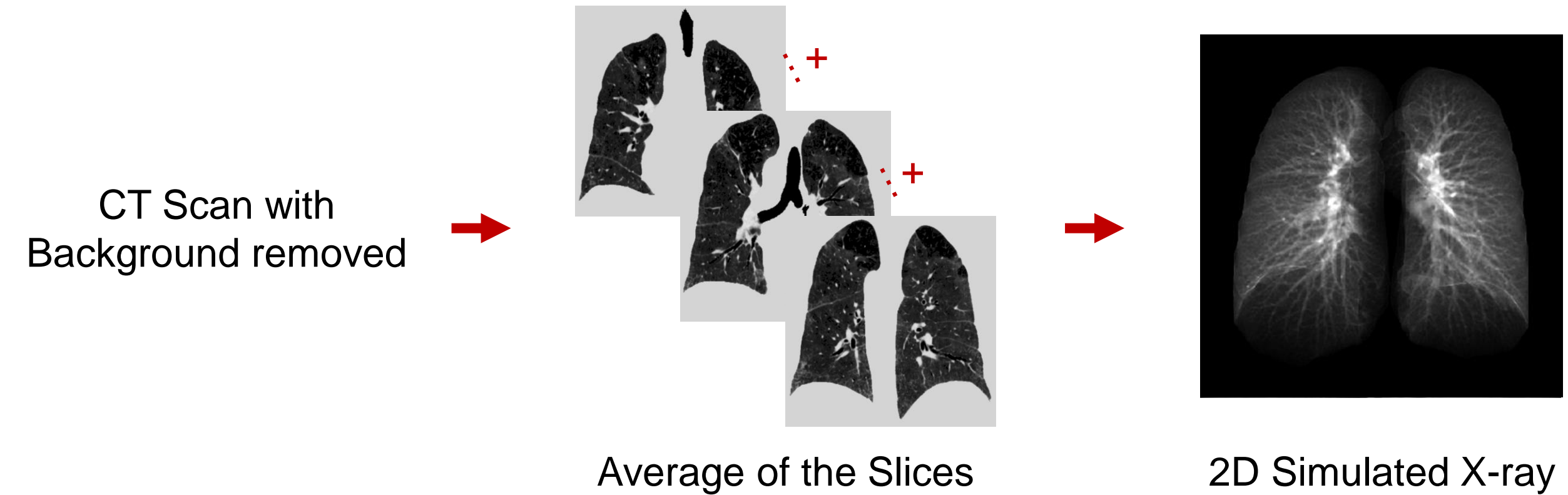


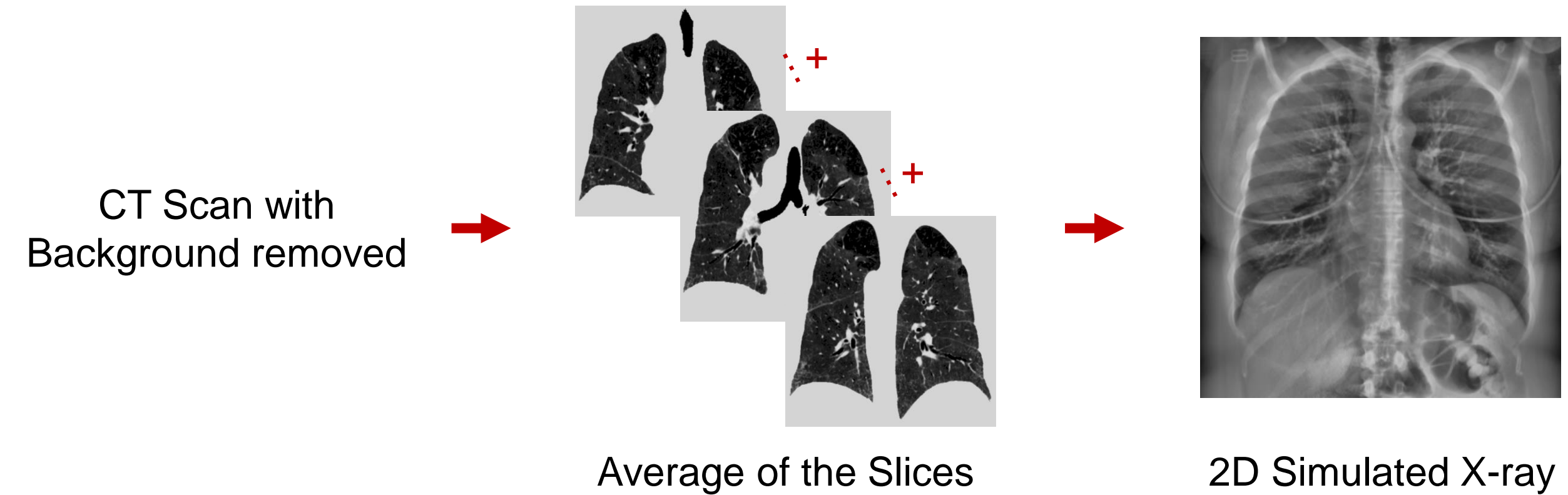
- 245 subjects
- Post-COVID:140
- Healthy:105
- 490 images: Inspiration and expiration images

Li F, Zhang X, Comellas AP, Hoffman EA, Yang T and Lin C-L (2022), Contrastive learning and subtyping of post-COVID-19 lung computed tomography images. Front. Physiol. 13:999263. doi: 10.3389/fphys.2022.999263

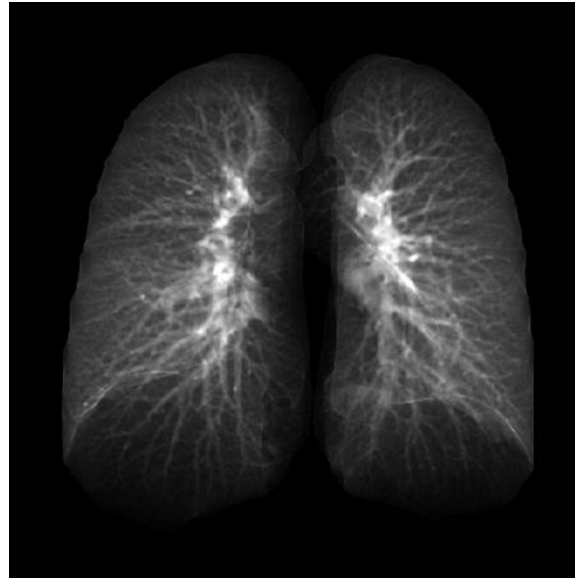
Two Post-COVID Clusters: C1 and C2



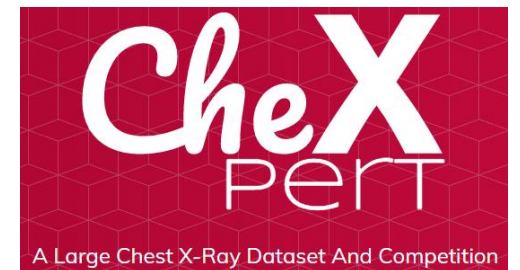




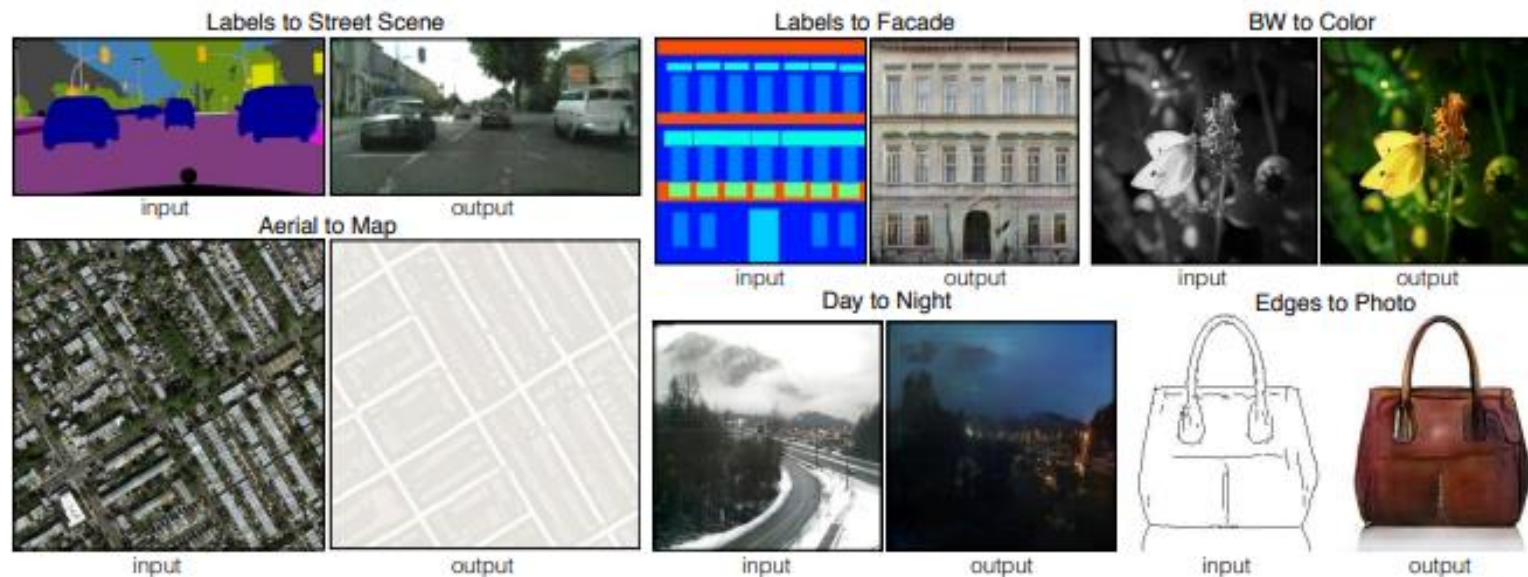
- Simulated X-rays provide more details than X-rays.
- CT scans are more expensive and the dose is higher.
- X-rays are easier to obtain, but more noisy.
- ***What if we can remove the backgrounds of the X-rays?***



Public Dataset Example



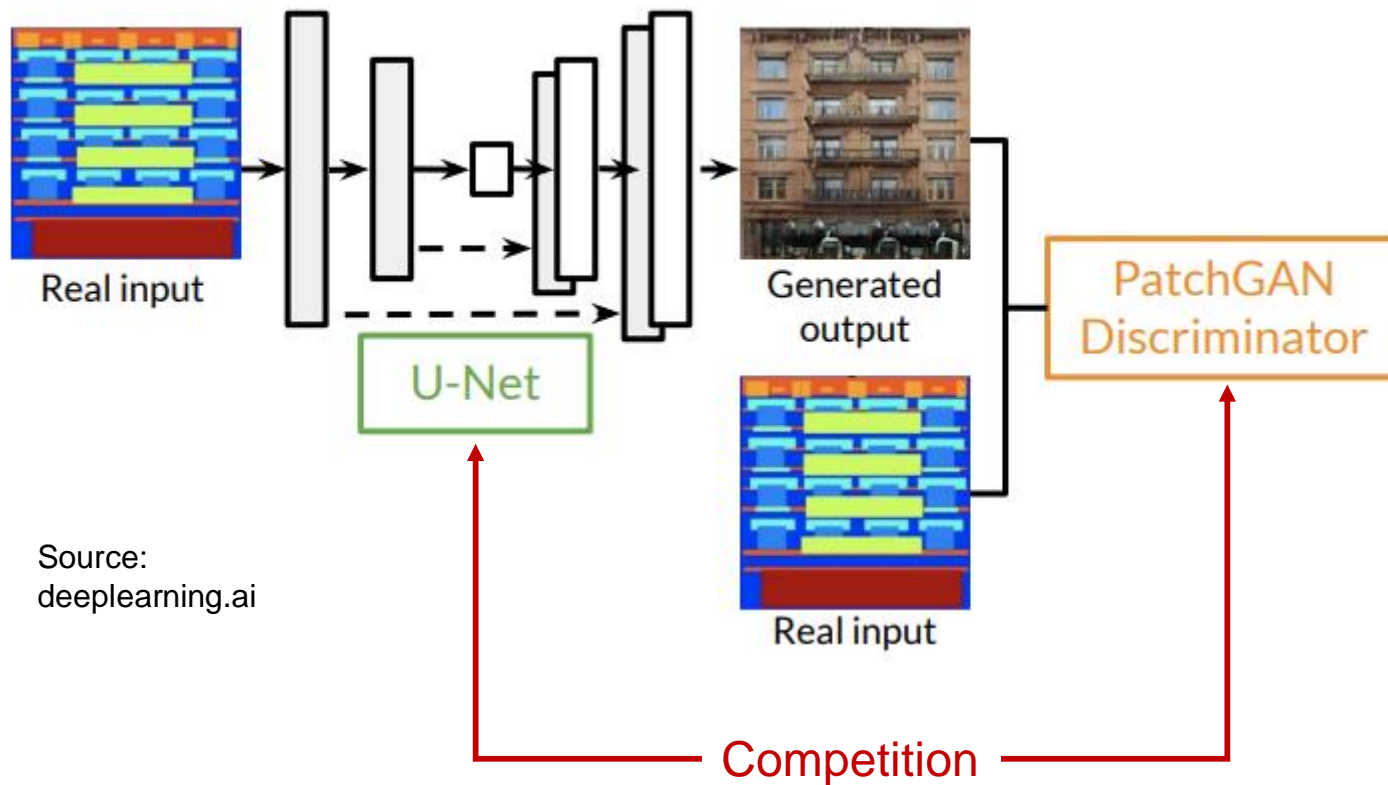
Pix2Pix: A Generative Adversarial Network (GAN)



Source:
<https://arxiv.org/abs/1611.07004>

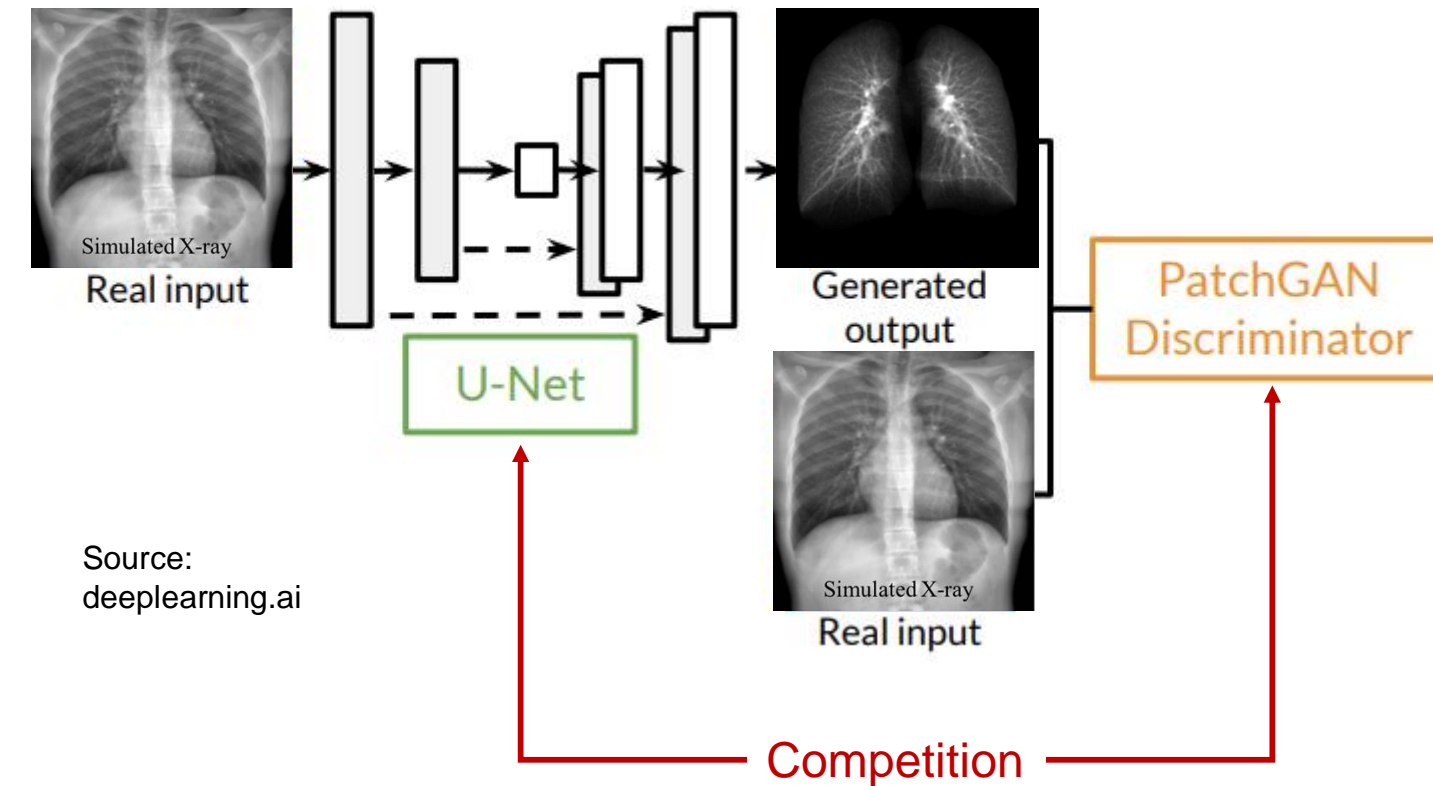
Isola, P., Zhu, J. Y., Zhou, T., & Efros, A. A. (2017). Image-to-image translation with conditional adversarial networks. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 1125-1134).

Pix2Pix



- **Generator: U-Net**
 - ✓ Fool the discriminator
- **Discriminator: PatchGAN**
 - ✓ Distinguish between real and fake

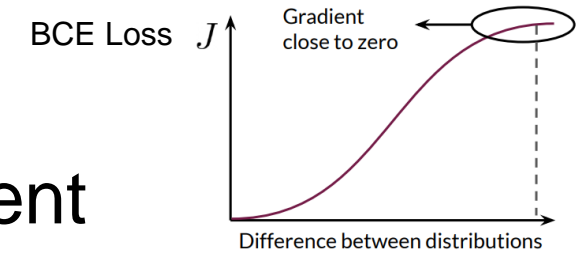
Pix2Pix



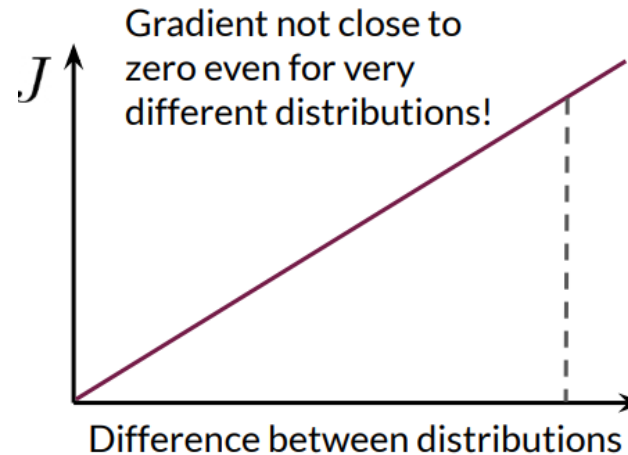
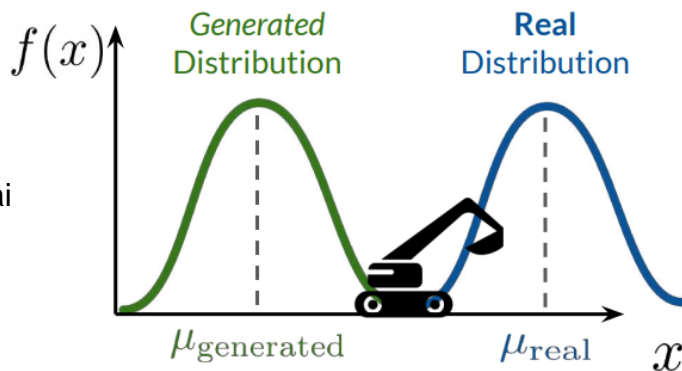
- **Generator: U-Net**
 - ✓ Fool the discriminator
- **Discriminator: PatchGAN**
 - ✓ Distinguish between real and fake

Wasserstein Loss (W-Loss)

- The discriminator gets too good → vanishing gradient
- Makes the GAN less prone to mode collapse and vanishing gradient



Earth Mover's Distance

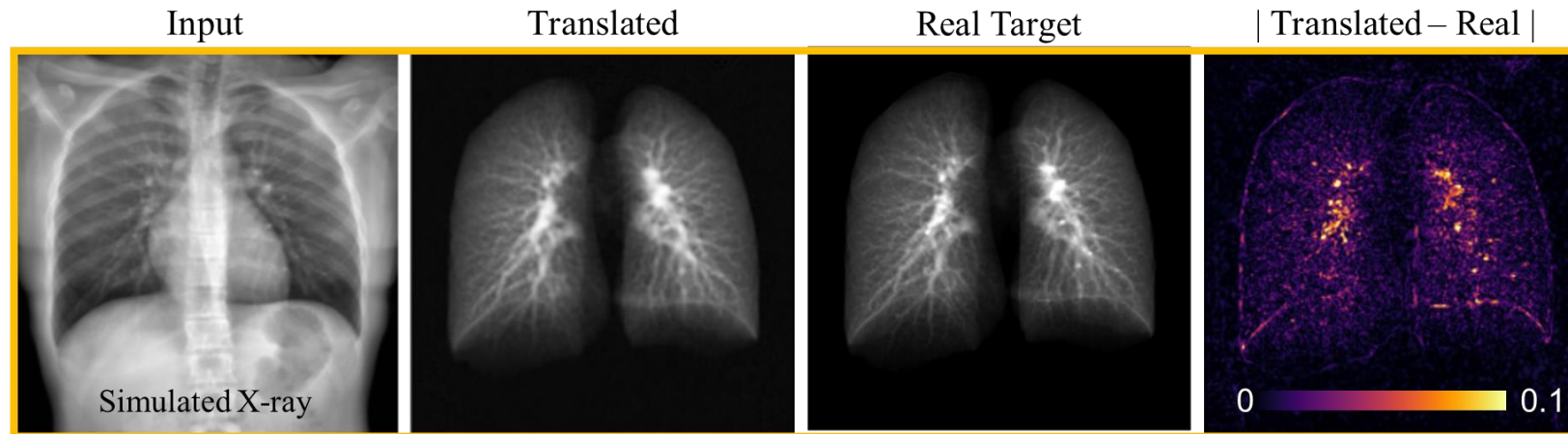


Arjovsky, M., Chintala, S., & Bottou, L. (2017, July). Wasserstein generative adversarial networks. In International conference on machine learning (pp. 214-223). PMLR.

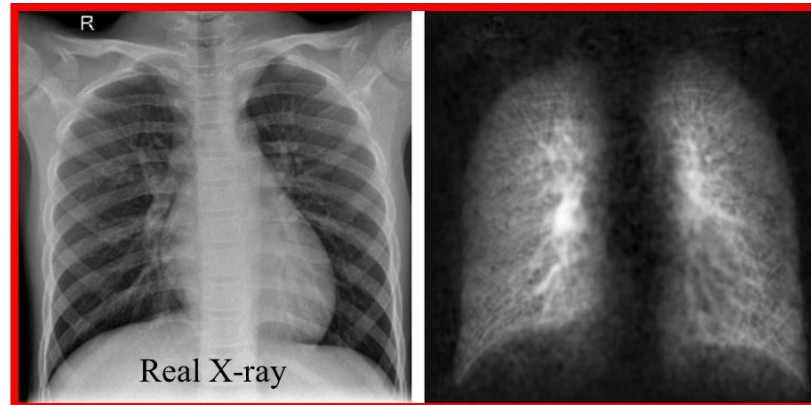
$$\min_g \max_d E(d(x)) - E(d(g(z))) + \text{Regularization}$$

Results

Simulated
X-ray



Real
X-ray



Conclusion

- The preliminary result seems promising.
- This technique may serve as a data augmentation to the CT images and help us to better understand Post-COVID subtypes.
- Larger sample size may help improving the performance.

Acknowledgement

- Dr. Ching-Long Lin
- Dr. Eric Hoffman
- Dr. Alejandro Comellas
- Mr. Xuan Zhang
- Roy J. Carver Department of Biomedical Engineering, The University of Iowa
- NIH grant: U01-HL114494, R01-HL130506, R01-HL112986, S10-RR022421, S10-OD018526, T32-HL-144461
- ED grant: P116S210005

2023 ANNUAL MEETING

OCTOBER 12 - 15 | SAN ANTONIO, TX

Thank you!

