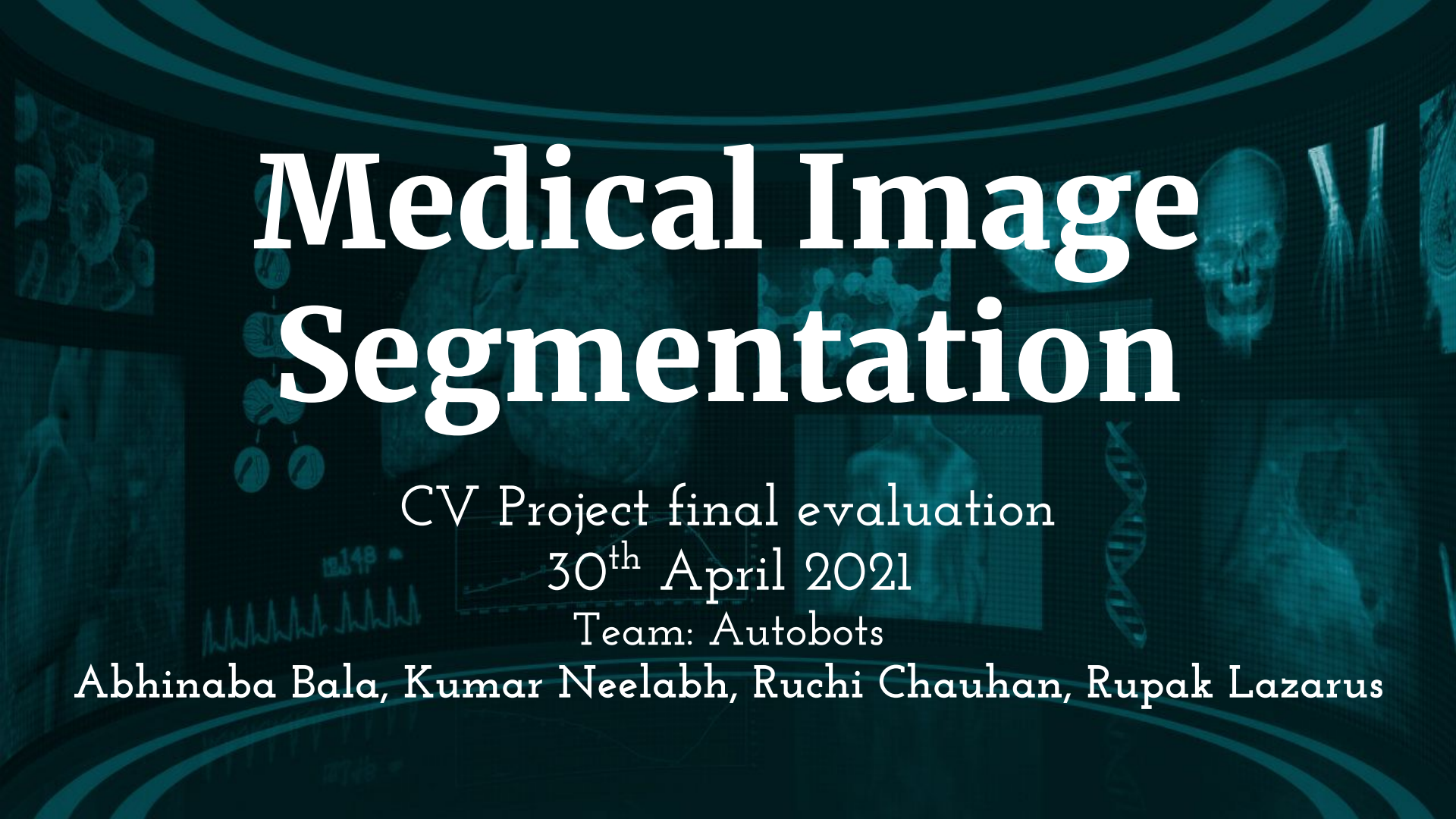


Medical Image Segmentation

CV Project final evaluation

30th April 2021

Team: Autobots

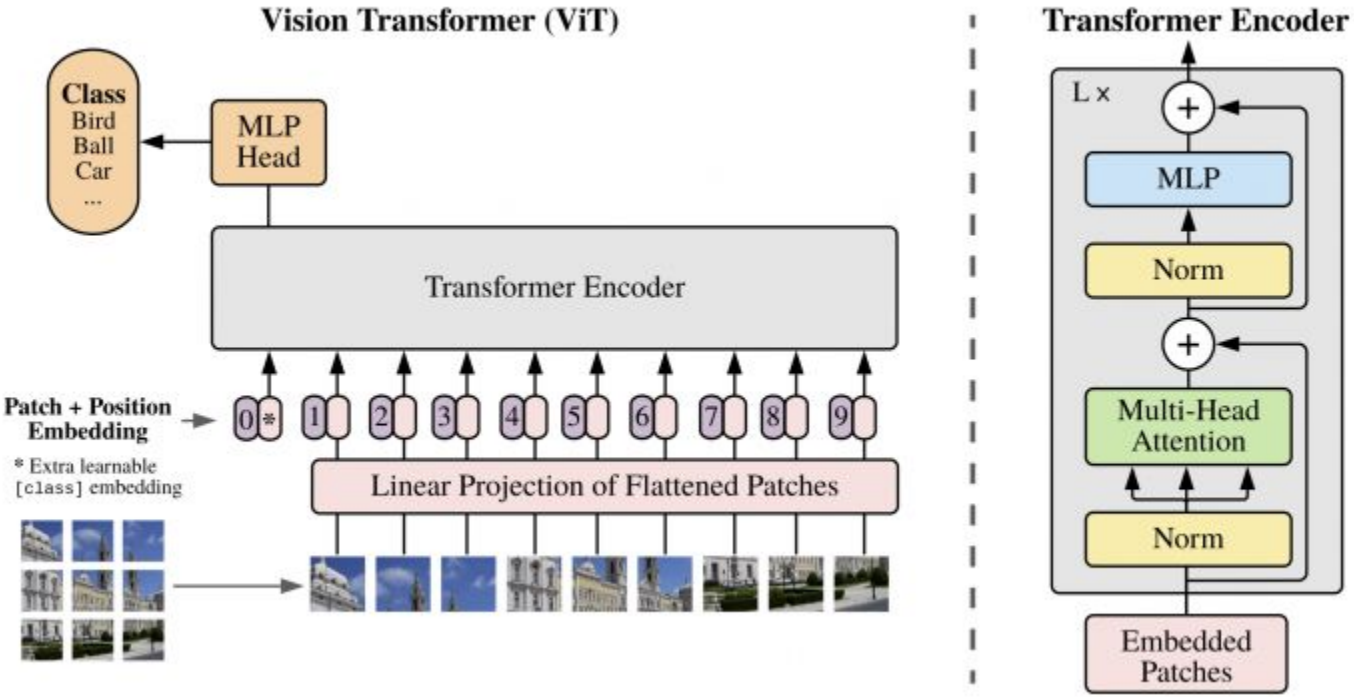
Abhinaba Bala, Kumar Neelabh, Ruchi Chauhan, Rupak Lazarus

Overview

- Medical Image Segmentation using Vision Transformer based U-Nets
- Modalities used : X-Ray, Ultrasound Images
- Tasks: Lung segmentation, Fetal Head Measurement
- Reference Paper: **[1]** Chen, Jieneng, et al. "TransUNet: Transformers Make Strong Encoders for Medical Image Segmentation." *arXiv preprint arXiv:2102.04306* (2021).
- Progress:
  - Result using vanilla U-Net on ultrasound dataset
  - Results using TransUNet on our XRay & Ultrasound datasets

Interactive version of this presentation can be viewed here

Vision Transformer (ViT)



Model

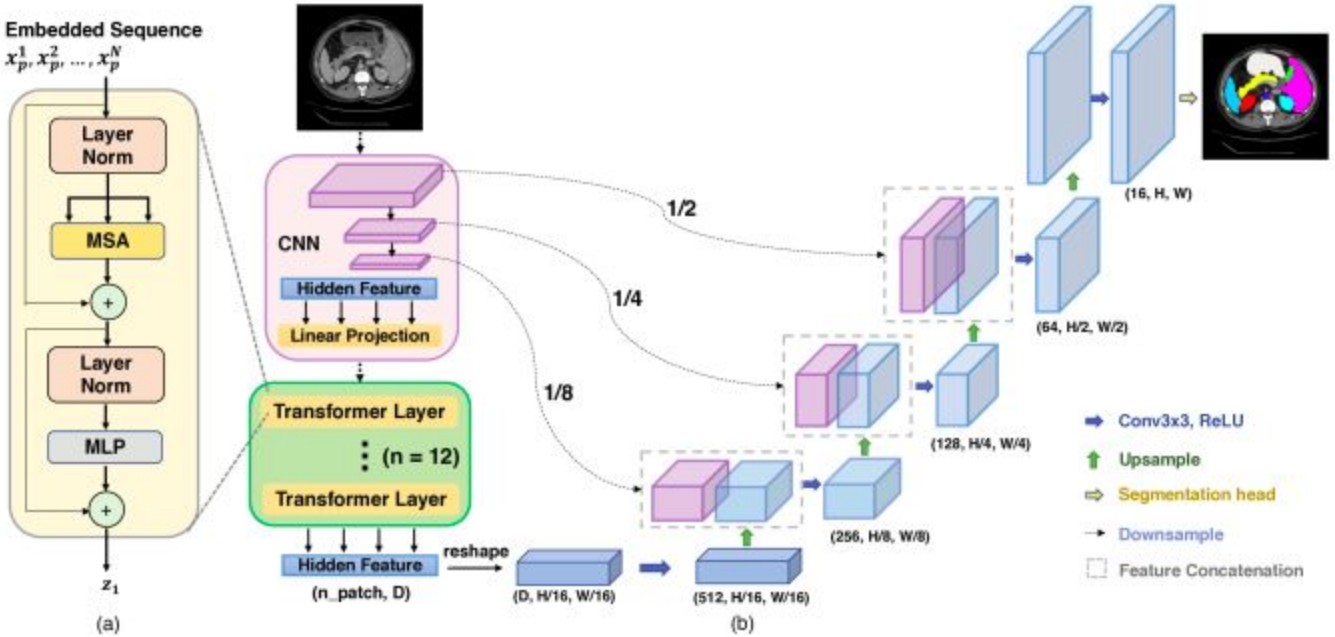
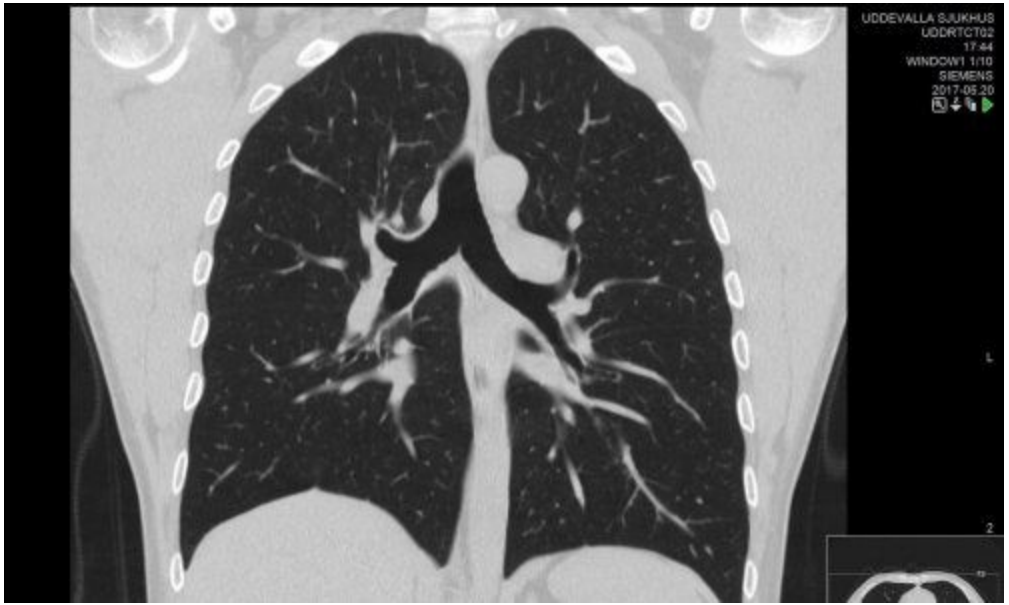
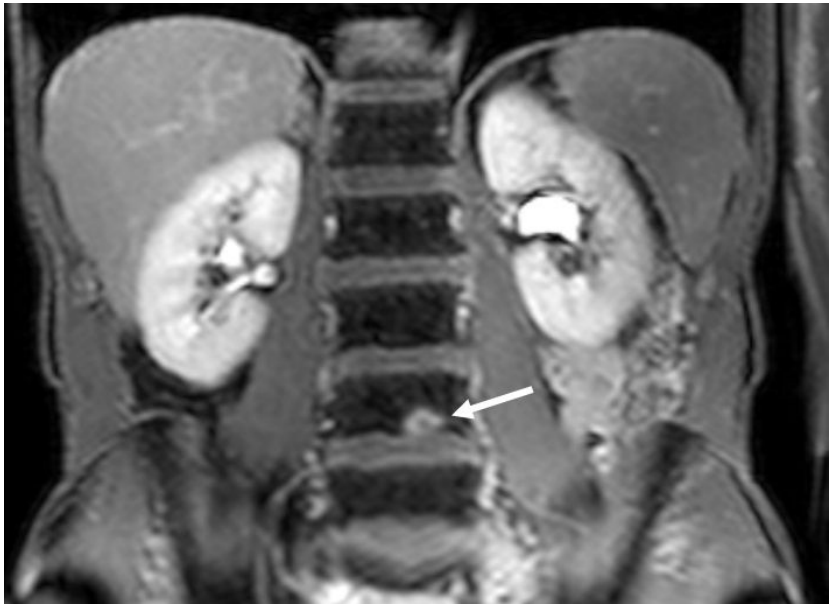


Figure 1: Overview of the framework. (a) schematic of the Transformer layer; (b) architecture of the proposed TransUNet.

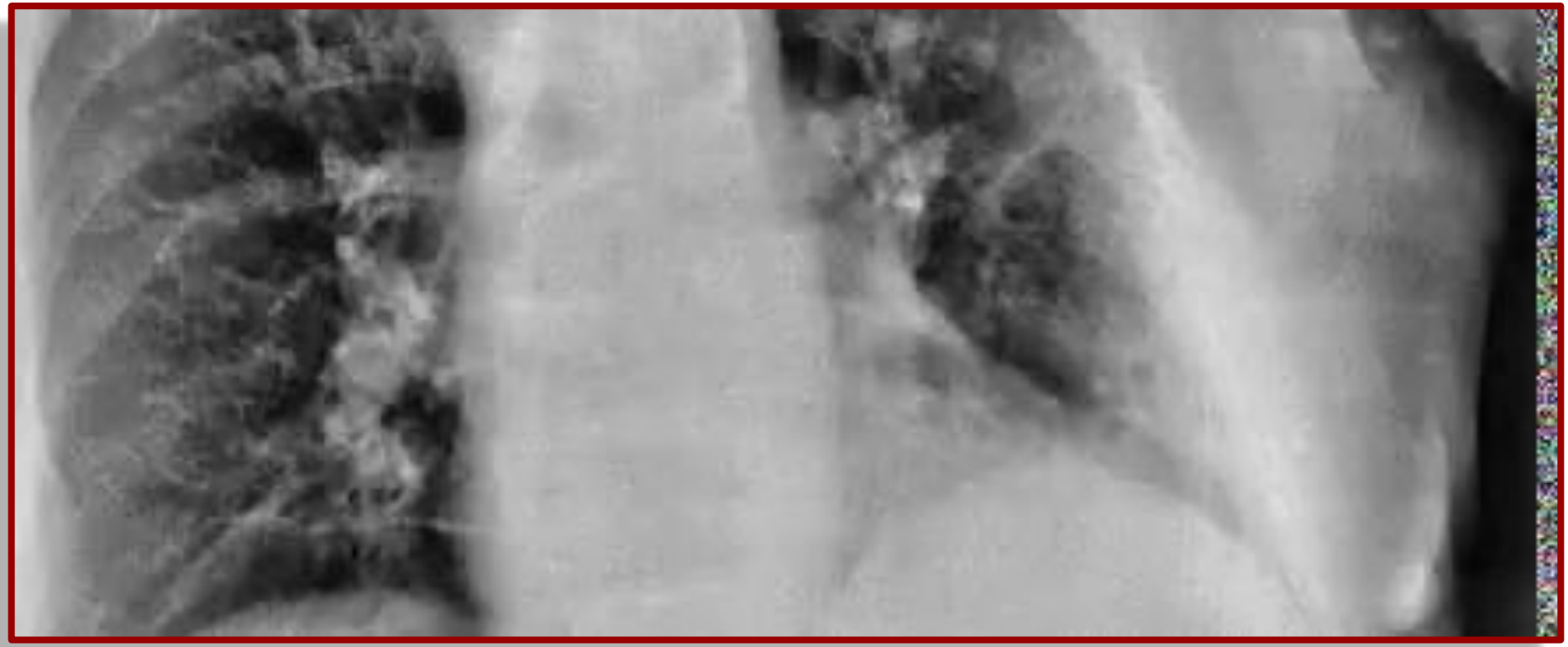


CT scan



MRI scan

Modality 1: X-Ray Images



Dataset Description

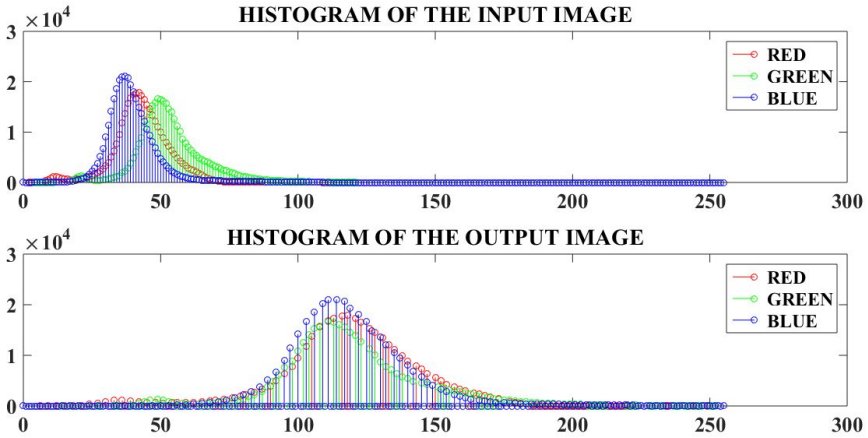
- Covid19-Xray Dataset by V7 Labs
- 6395 usable images of chest x-rays
- pixel-level polygonal lung segmentation labels
- Image resolutions, sources, and orientations vary across the dataset,
  - Max Size: 5600 x 4700 px
  - Min Size: 156 x 156 px
- Some Xrays are acquired using portable scanners, and have low quality
- License: CC4.0

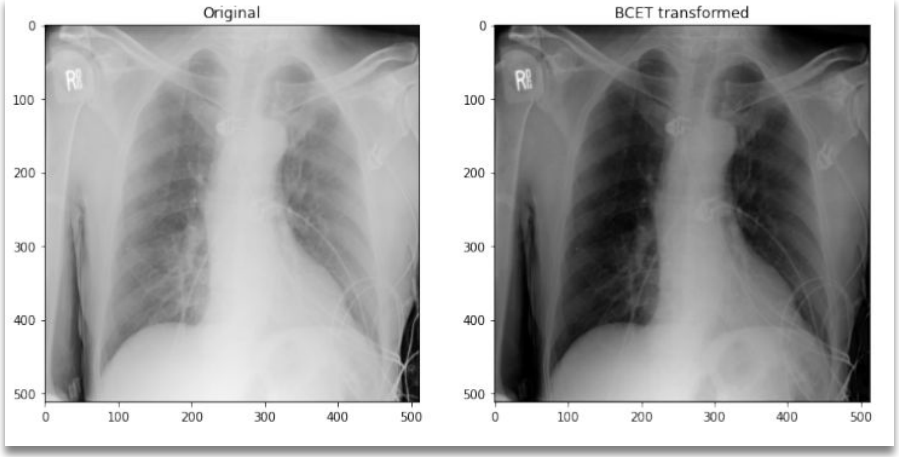
Kermany, Daniel; Zhang, Kang; Goldbaum, Michael (2018), "Labeled Optical Coherence Tomography (OCT) and Chest X-Ray Images for Classification", Mendeley Data, v2http://dx.doi.org/10.17632/rscbjbr9sj.2
Joseph Paul Cohen and Paul Morrison and Lan Dao COVID-19 image data collection, arXiv:2003.11597, 2020

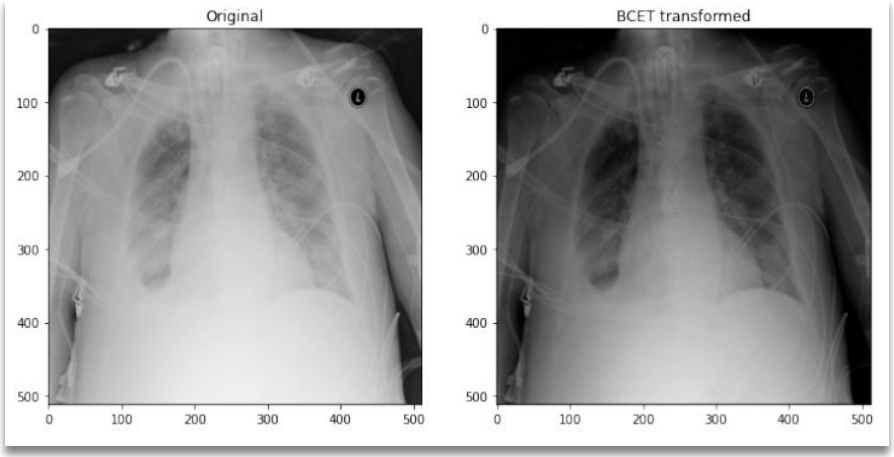
Preprocessing

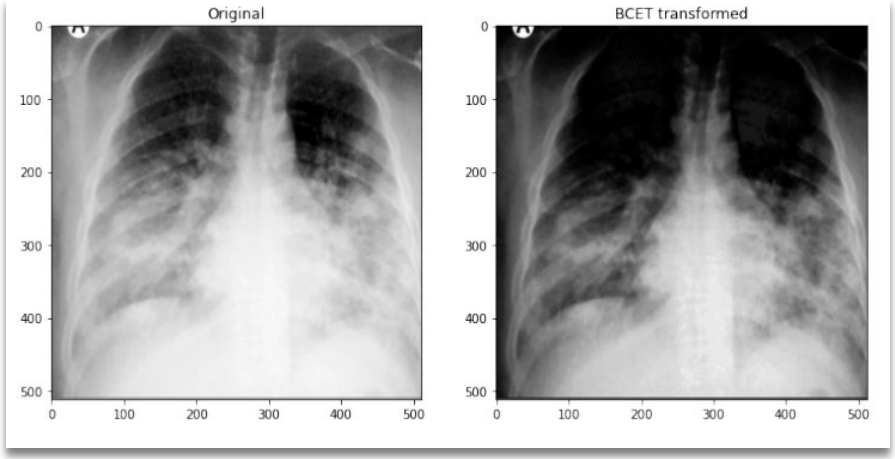
- Balance Contrast Enhancement Technique

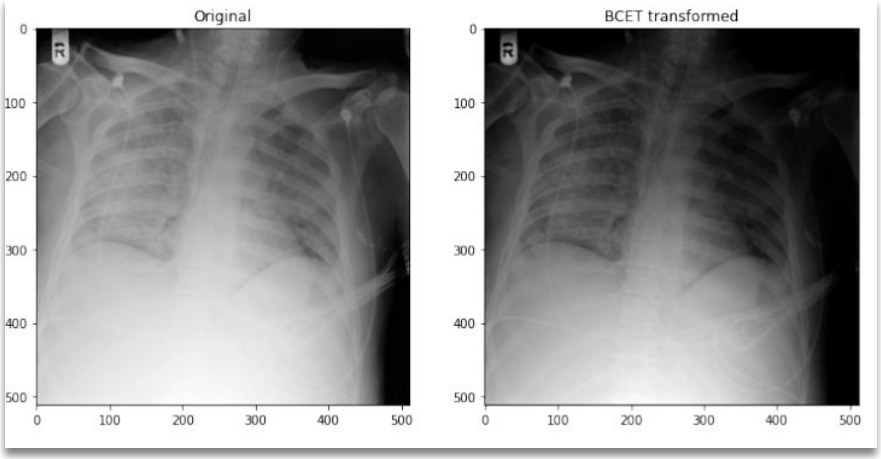
The contrast of the image stretched or compressed without changing the histogram pattern of the input image.



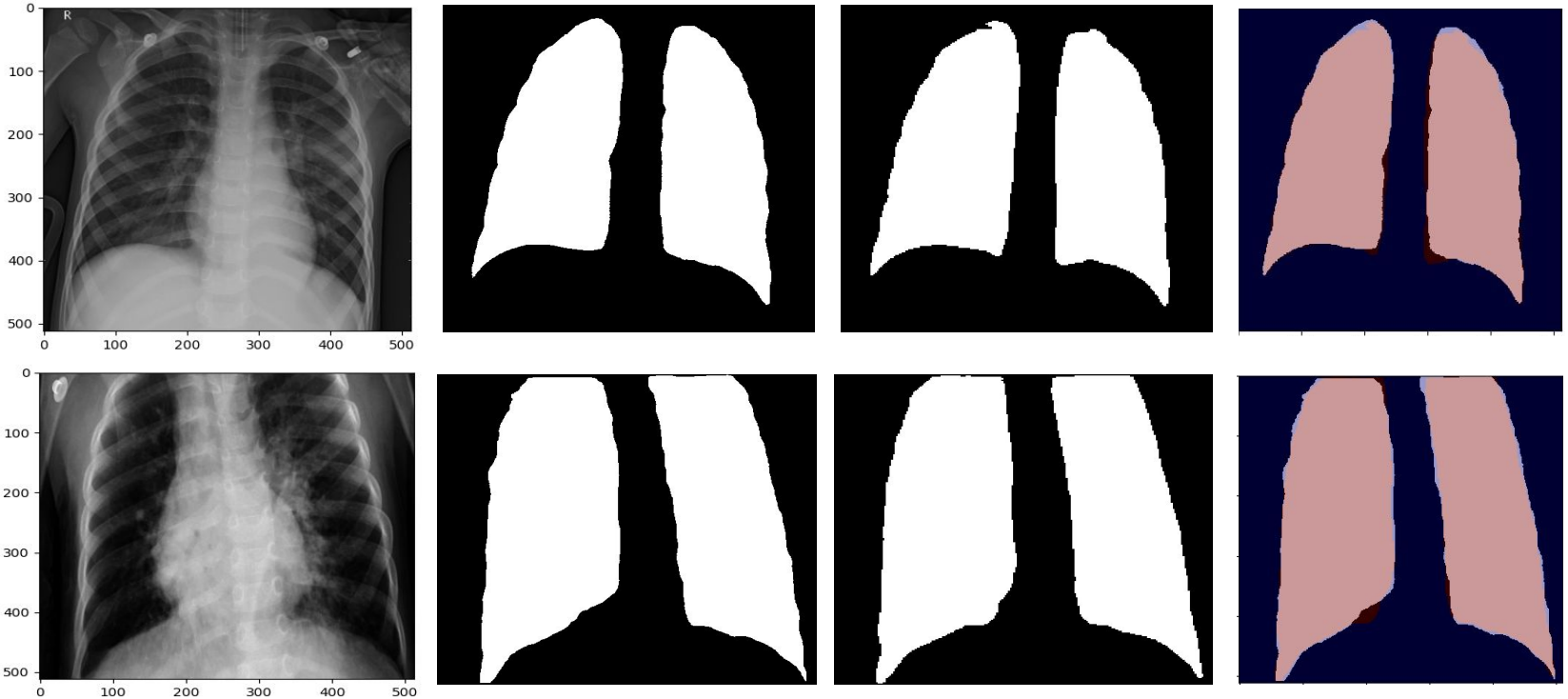

Original
BCET transformed


Original
BCET transformed


Original
BCET transformed


Original
BCET transformed

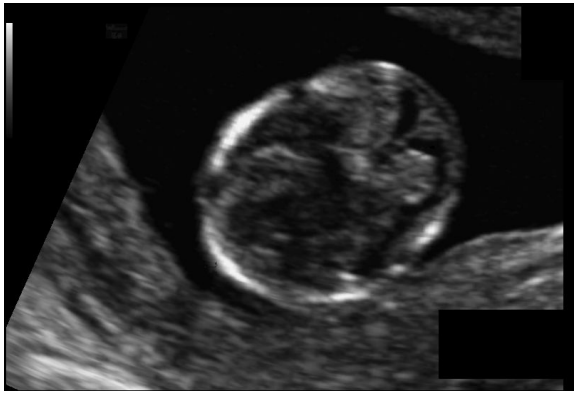
Qualitative Results



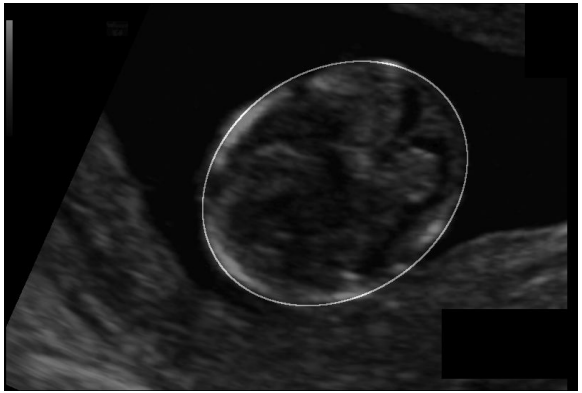
Modality 2: Ultrasound Images

Preprocessing

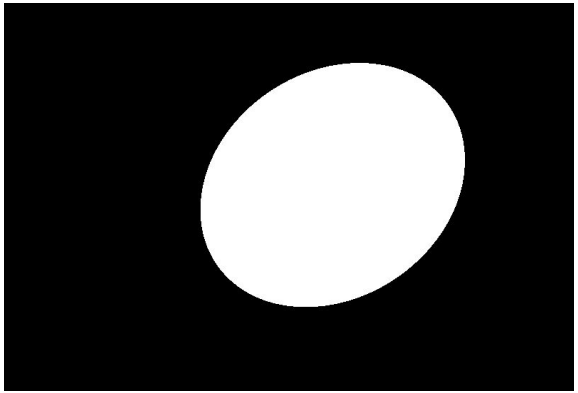
- The delineated outline of the fetal head creates extreme class imbalance calling for methods like dilated convolutions etc. To keep things simple, one neat trick is to convert the labels in the mask format



IMAGE



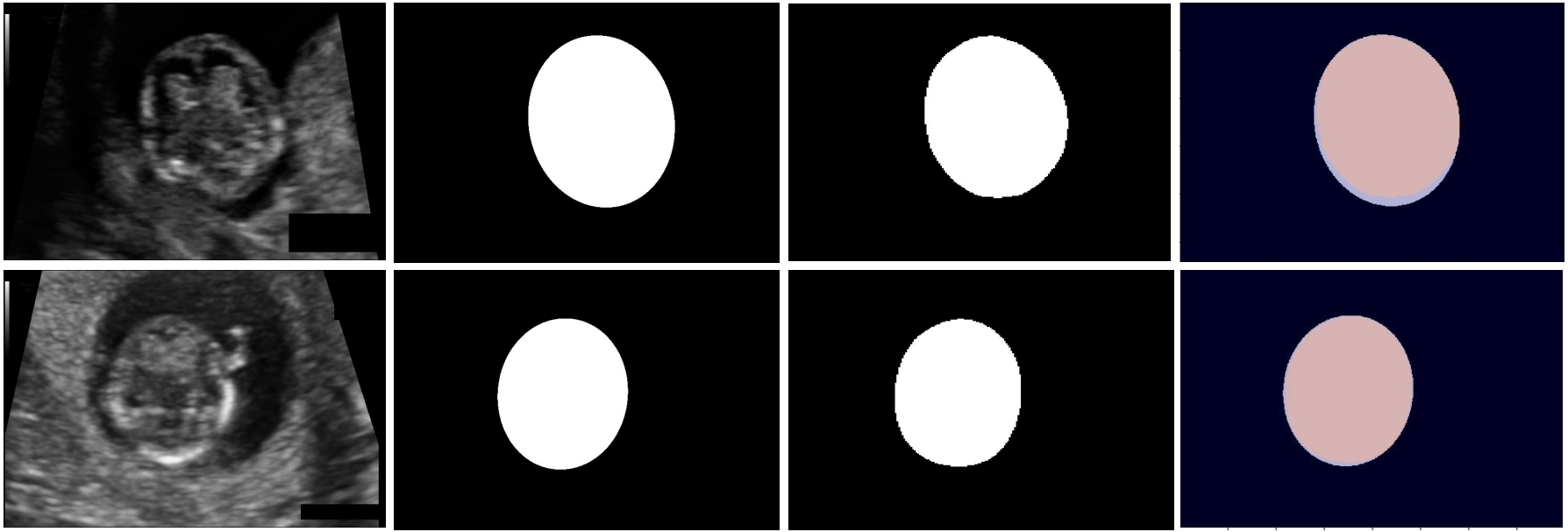
LABEL (OVERLAYED)



MASK

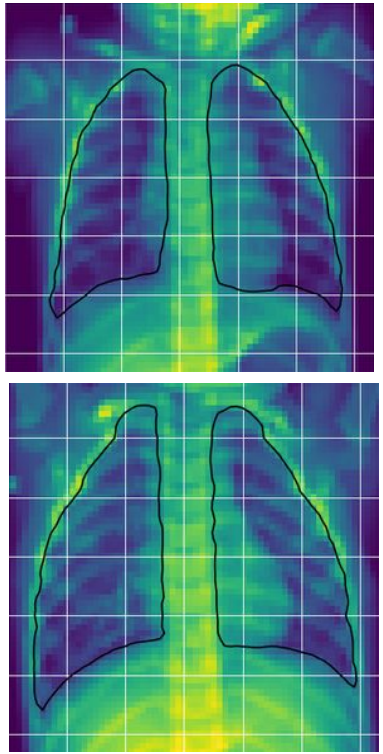
- Post processing would involve ellipse fitting over the mask & circumference measurement

Qualitative Results

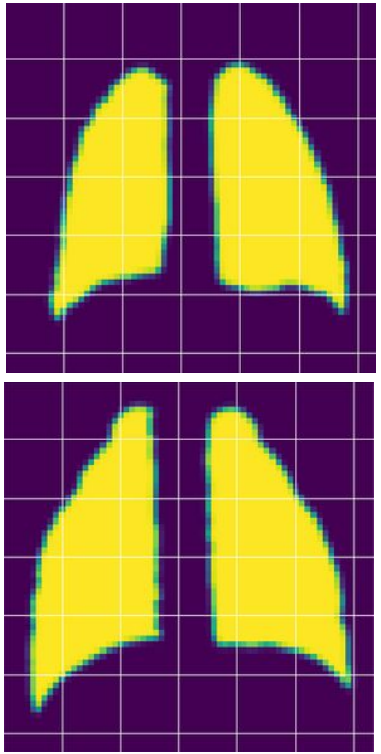


Input Image | label | prediction | Error

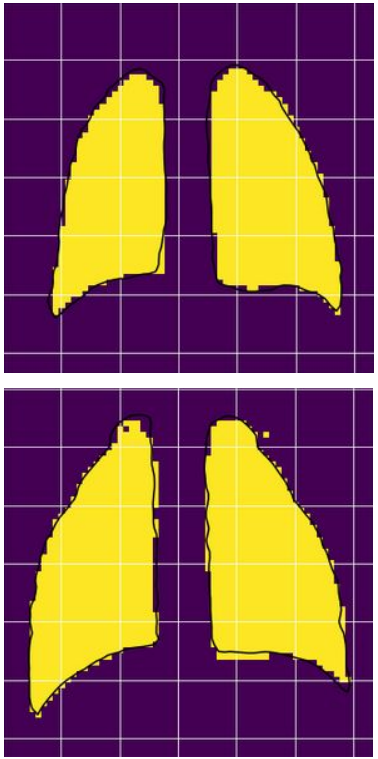
Unet Qualitative results



Original Image

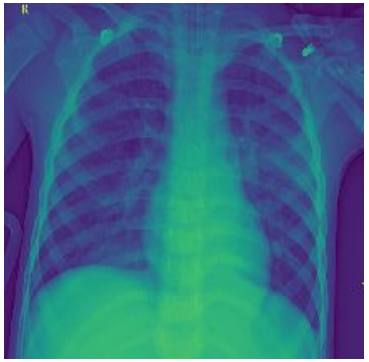
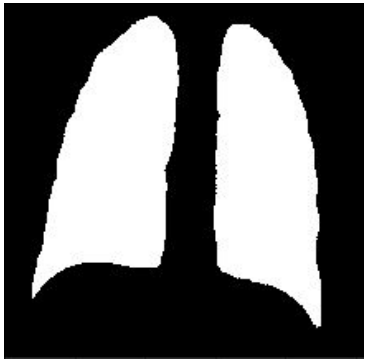
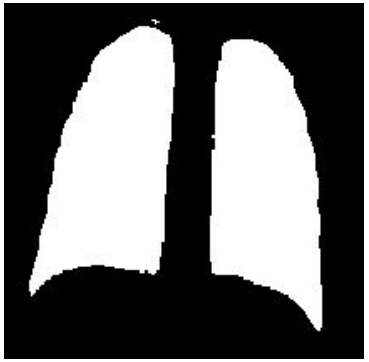
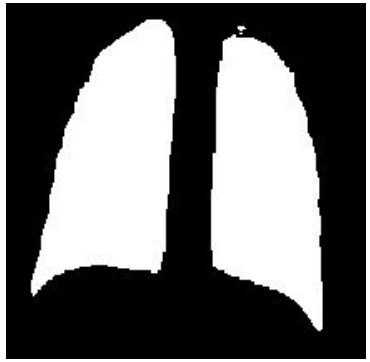


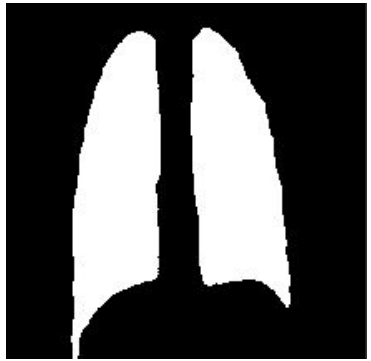
Ground Truth

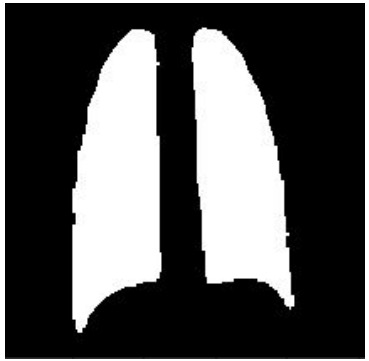


Unet Prediction

TransUNet Qualitative results: Lungs

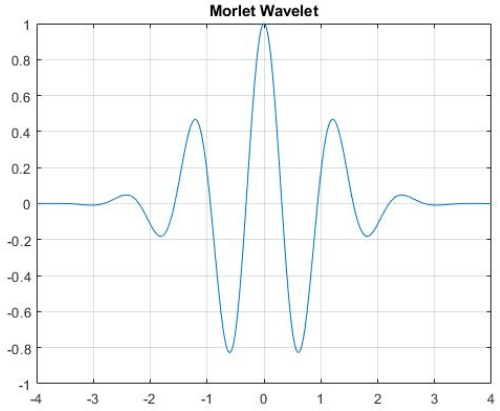









Original | Ground Truth | TransUnet | TransUnet + Scat

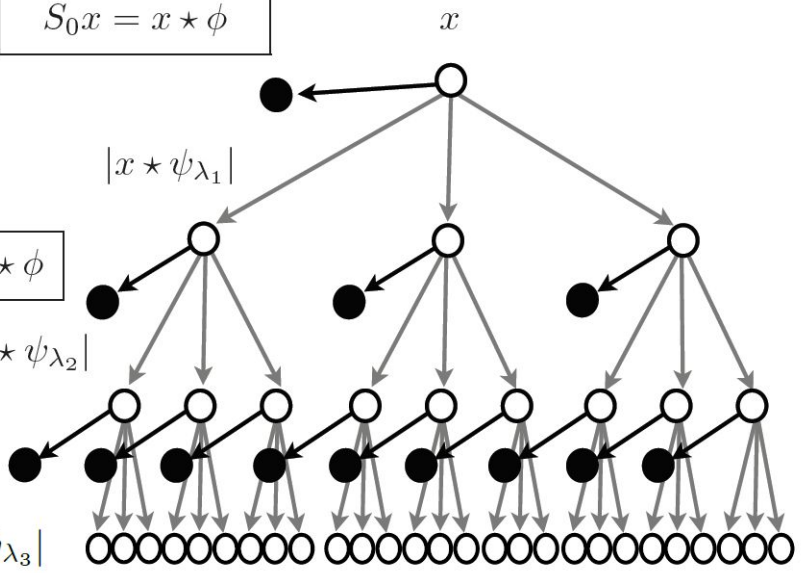
Scattering Coefficients



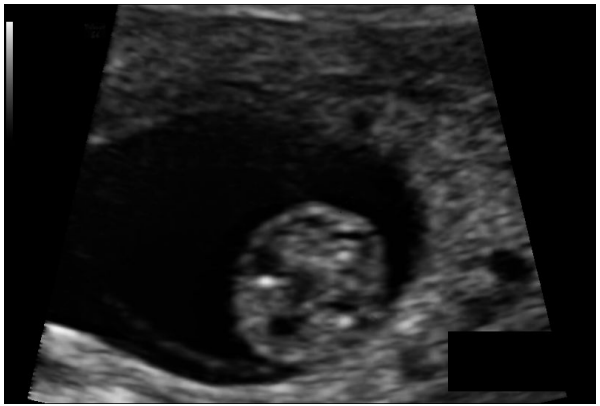
$$S_0 x = x \star \phi$$

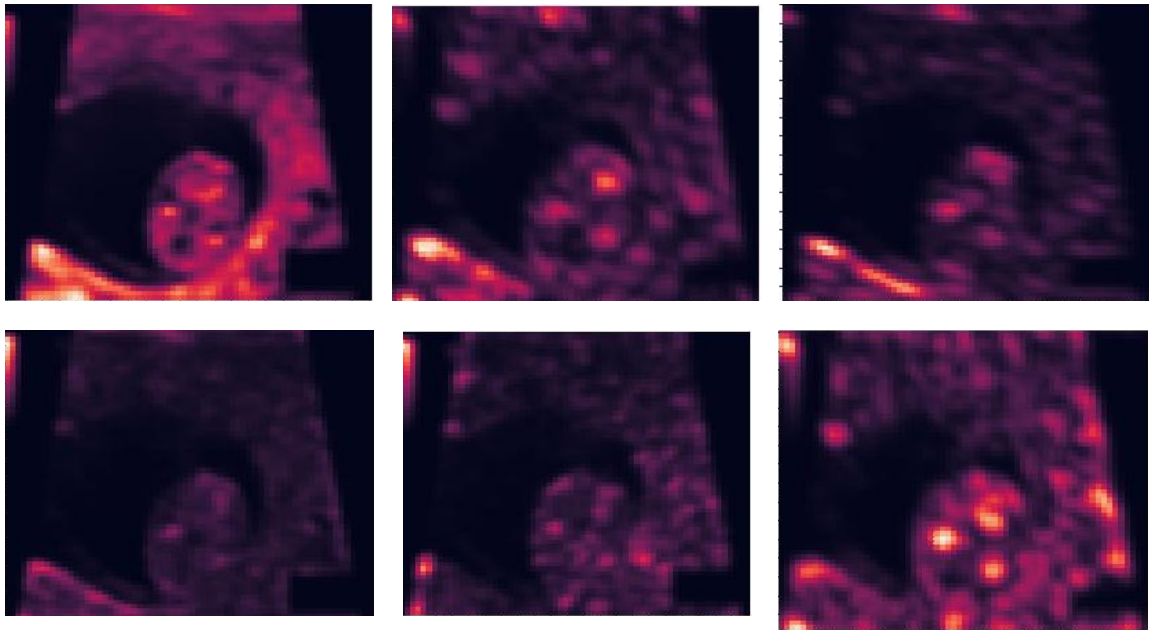
$$Sx(t, \lambda_1) = |x \star \psi_{\lambda_1}| \star \phi$$

$$Sx(t, \lambda_1, \lambda_2) = ||x \star \psi_{\lambda_1}| \star \psi_{\lambda_2}| \star \phi$$

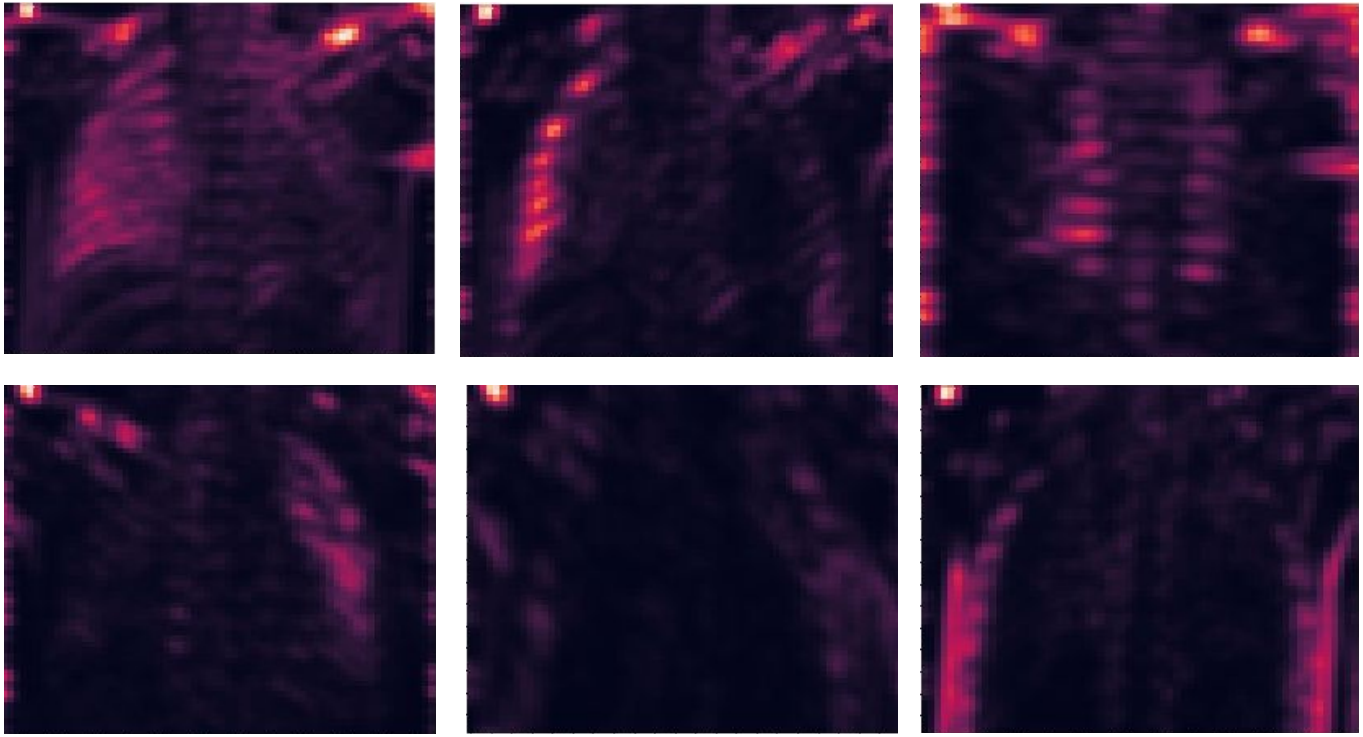


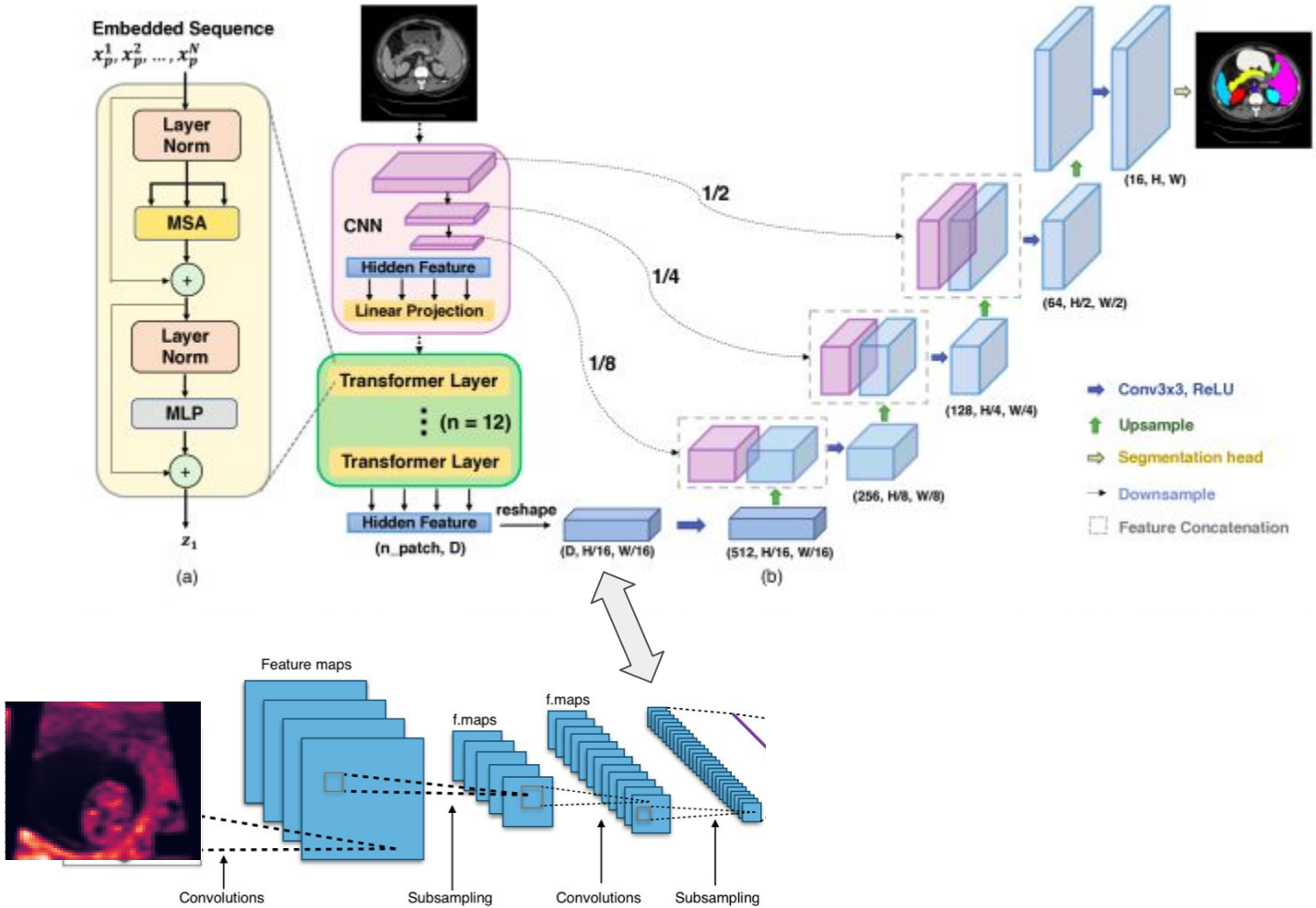
Scattering Coefficients Results: Ultrasound





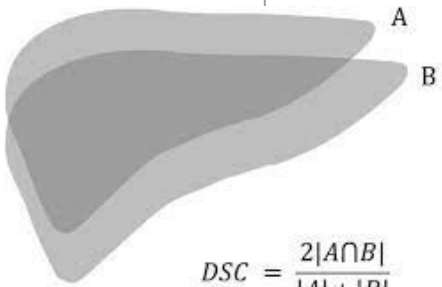
Scattering Coefficients Results: Xray




Embedded Sequence
$x_p^1, x_p^2, \ldots, x_p^N$
Layer Norm
MSA
Layer Norm
MLP
z_1
(a)
CNN
Hidden Feature
Linear Projection
Transformer Layer
(n = 12)
Transformer Layer
Hidden Feature
(n_patch, D)
reshape
(D, H/16, W/16)
(512, H/16, W/16)
(b)
1/2
1/4
1/8
(256, H/8, W/8)
(128, H/4, W/4)
(64, H/2, W/2)
(16, H, W)
Conv3x3, ReLU
Upsample
Segmentation head
Downsample
Feature Concatenation
Feature maps
f.maps
f.maps
Convolutions
Subsampling
Convolutions
Subsampling

Quantitative Results

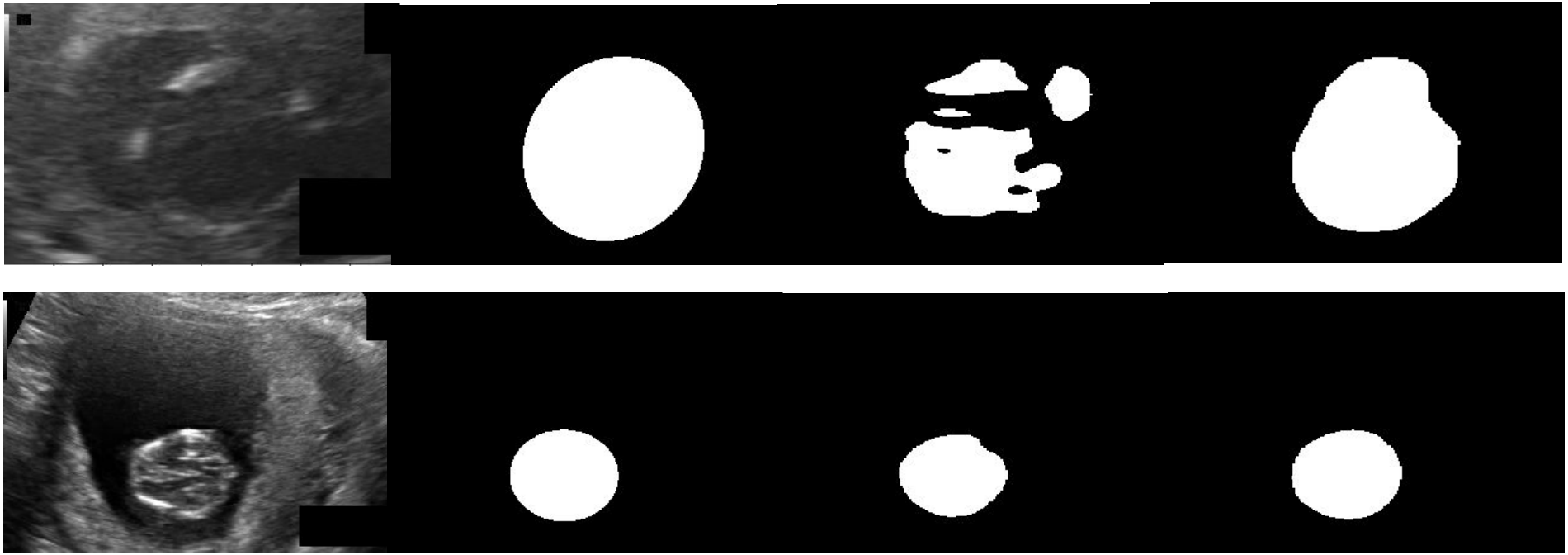
	Ultrasound	Xray
Unet *DICE*	0.961	0.956
TransUnet *DICE*	0.953469	0.956617
TransUnet-SC *DICE*	0.973595	0.956770
TransUnet with pretrained *DICE*	0.977352	95.5384



$$DSC = \frac{2|A \cap B|}{|A| + |B|}$$

DSC: Dice similarity coefficient

TransUNet Qualitative results: Ultrasound



Original Ground Truth TransUnet TransUnet + Scat

Next Steps - subjected to the available time

- Experiment with TransUnet architecture based on other upcoming works
- Experiment with scattering coefficients as additional inputs to improve performance
- Use the lung segmentation model as the first stage classifier for pneumothorax segmentation
- Extend the architecture for videos