

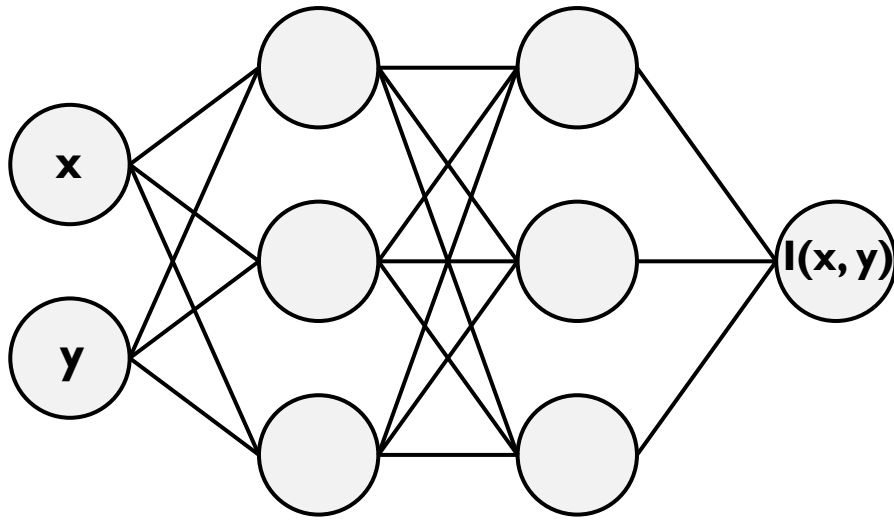
WIRE: Wavelet Implicit Neural Representations

Vishwanath Saragadam, Daniel Lejeune, Jasper Tan,
Guha Balakrishnan, Ashok Veeraraghavan, Richard G. Baraniuk

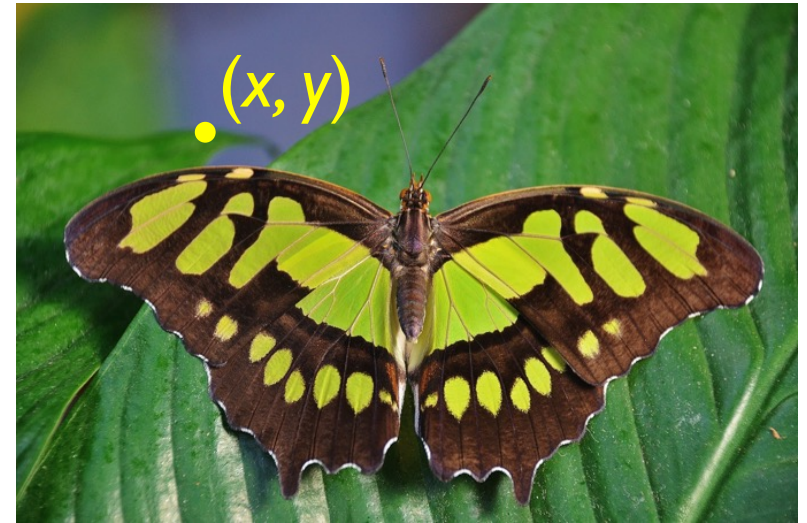
CVPR 2023 Paper tag: THU-AM-194

Implicit neural representation

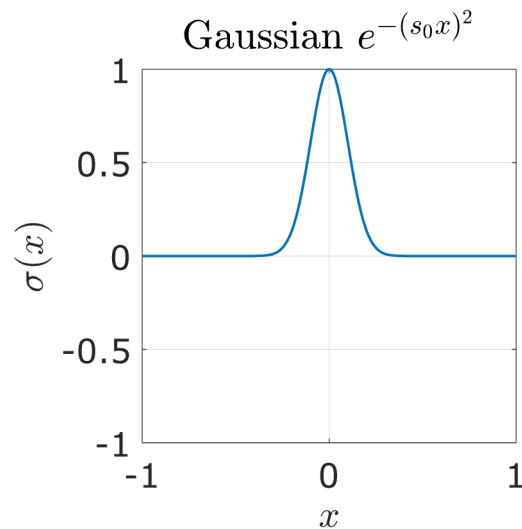
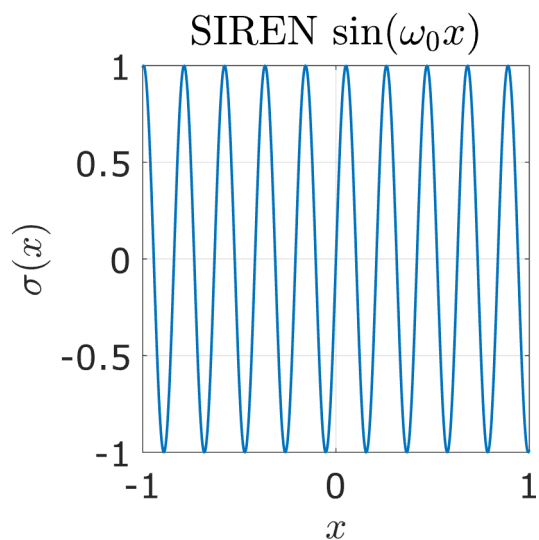
Input:
Spatial
coordinates



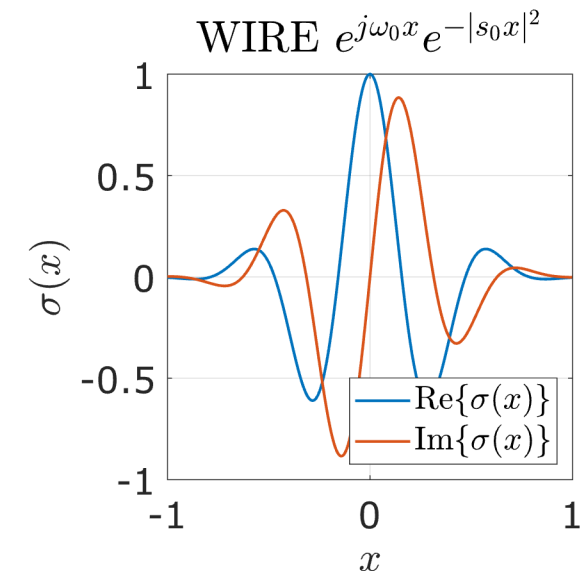
Output:
Pixel
intensity



Activation function choices:

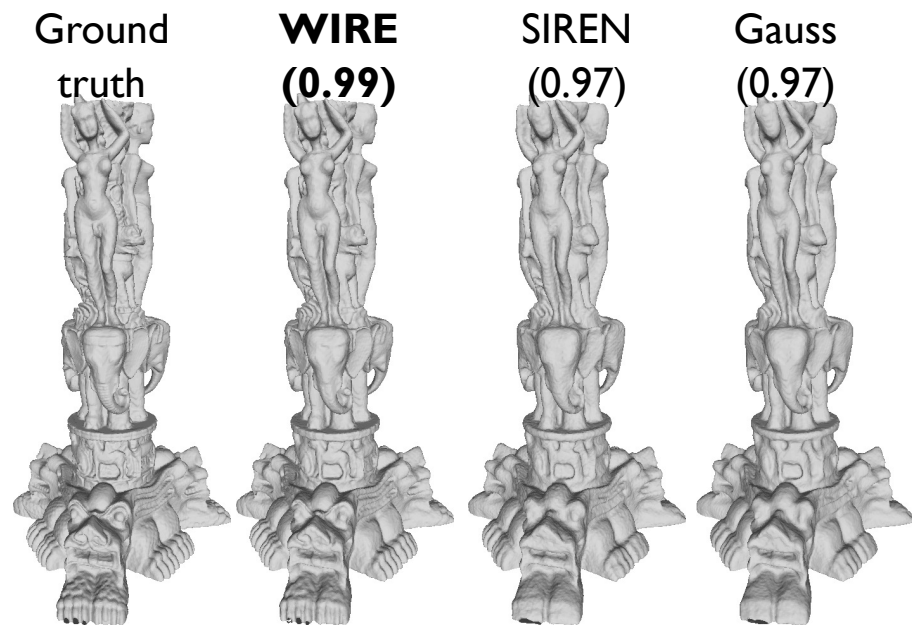


Wavelet implicit neural representation

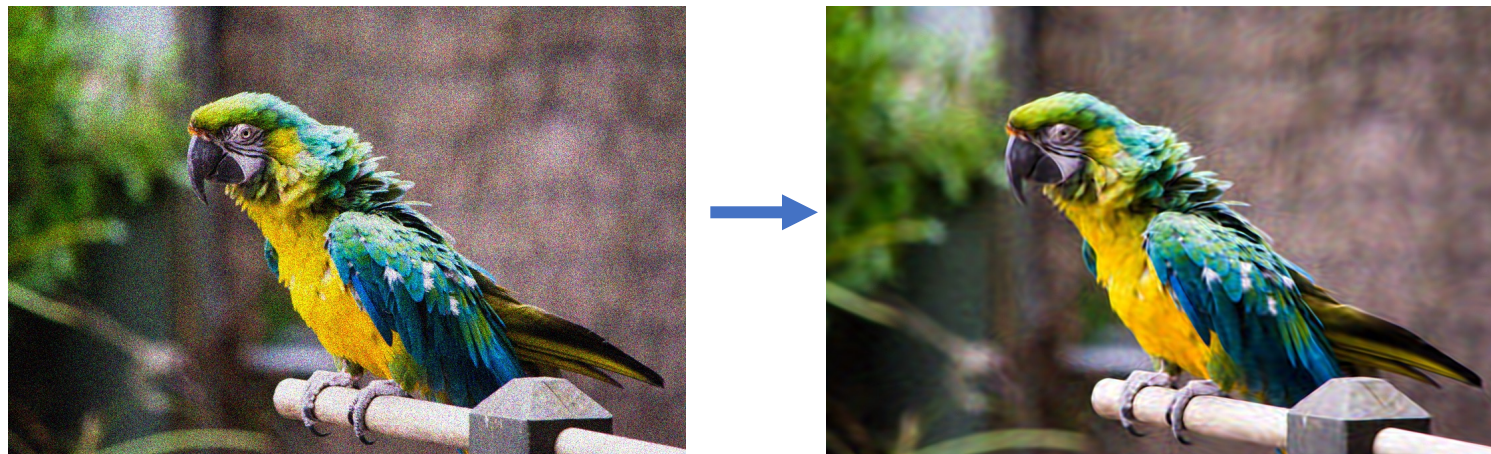


The numerous benefits of WIRE

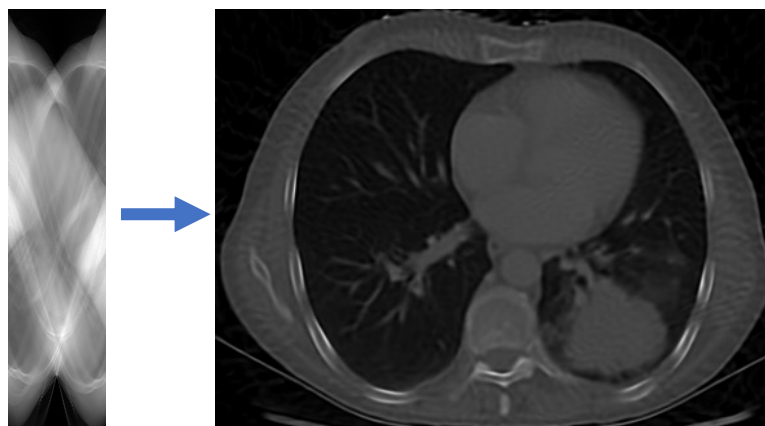
Higher accuracy



Robust image regularization



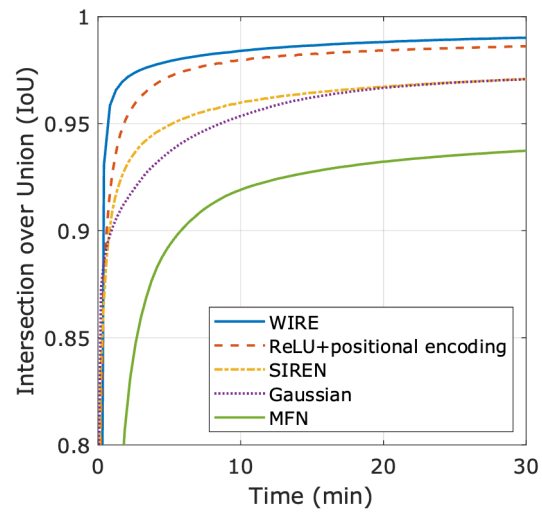
CT reconstruction



View synthesis

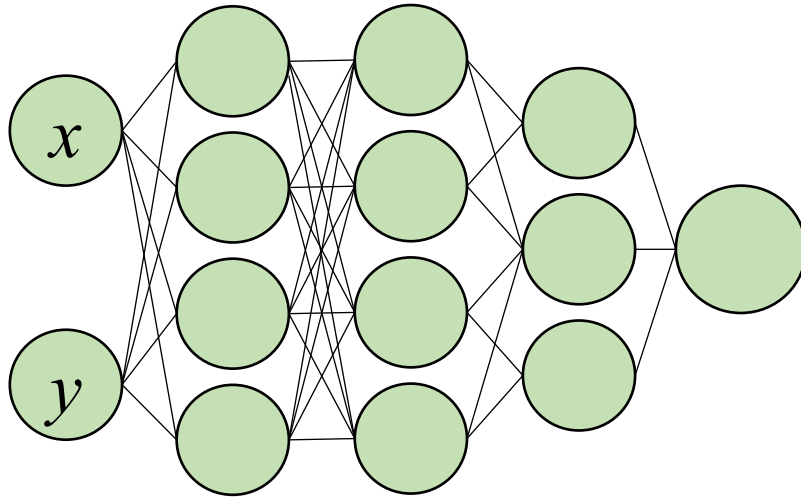


Faster training

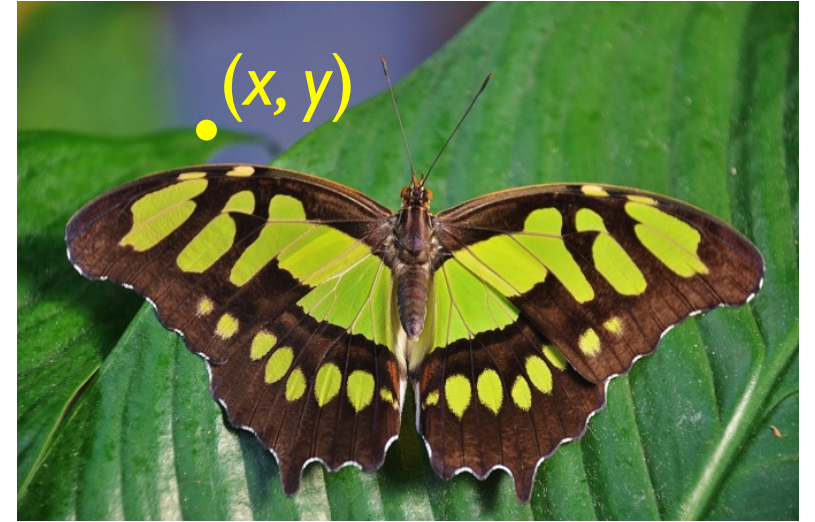


Implicit neural representation (INR)

Input:
Spatial
coordinates

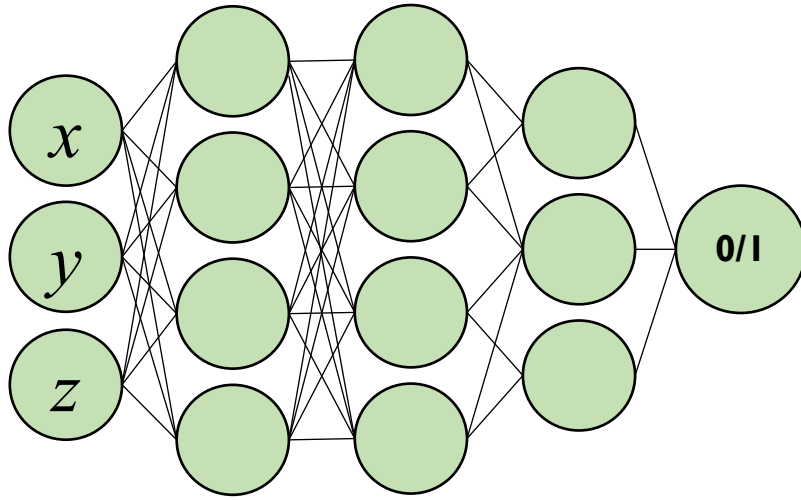


Output:
Pixel
intensity

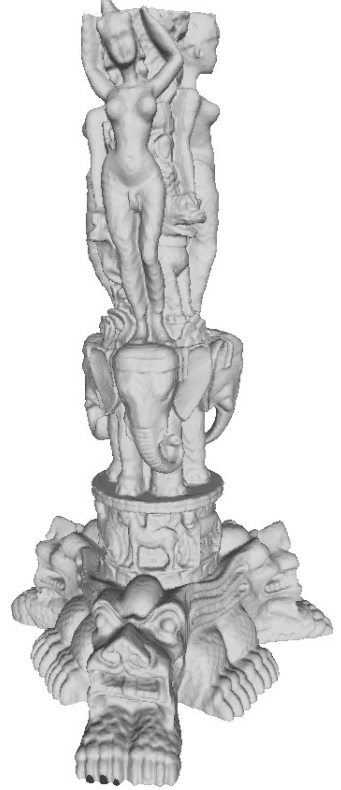
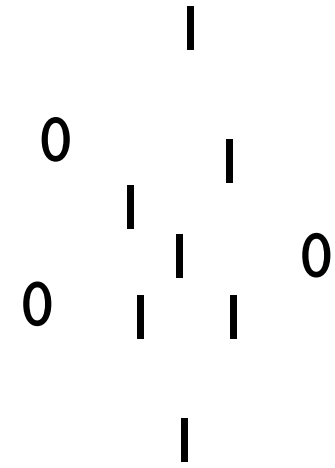


Implicit neural representation (INR)

Input:
Spatial
coordinates



Output:
Occupancy

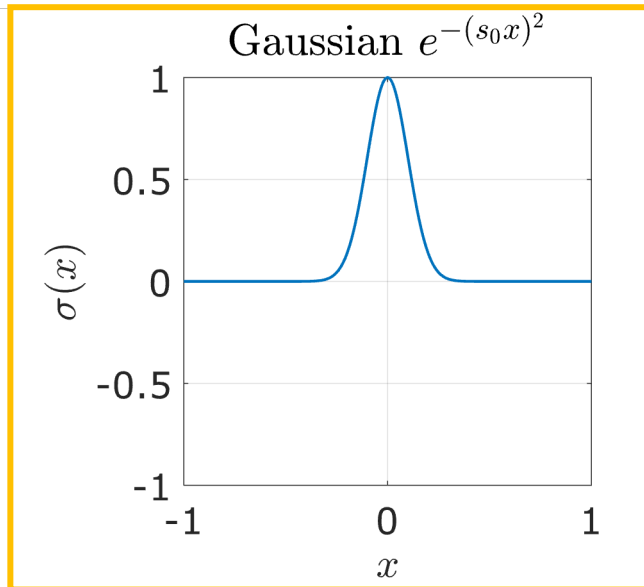
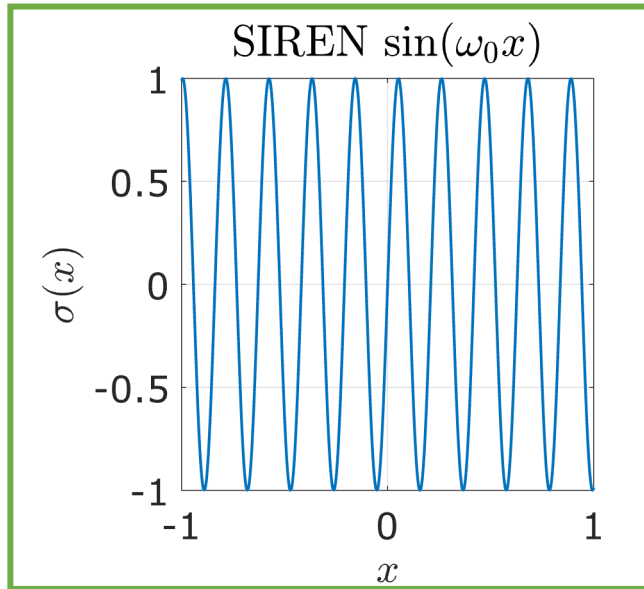


Neural network function (e.g. ID):

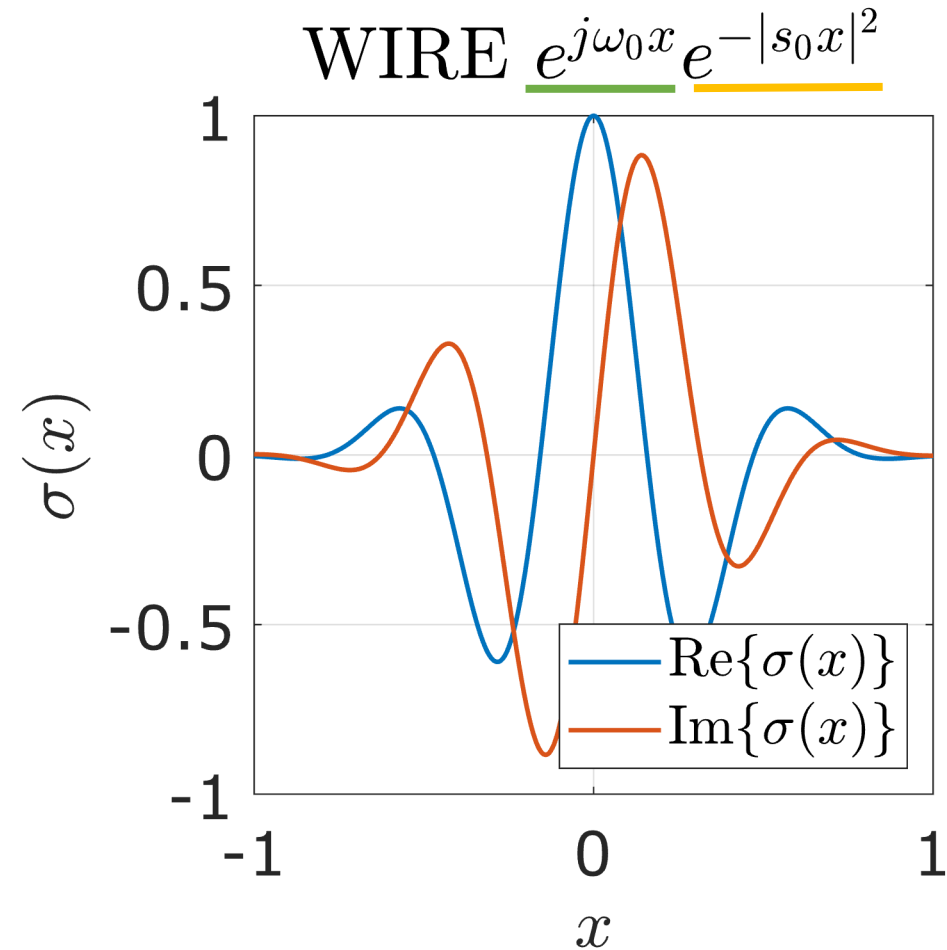
$$\sigma(W_3 \sigma(W_2 \sigma(W_1 u + b_1) + b_2) + b_3)$$

Nonlinear activation function

INR Activation Function



Gabor wavelet function:



Effect on Nonlinearity on Image Edges

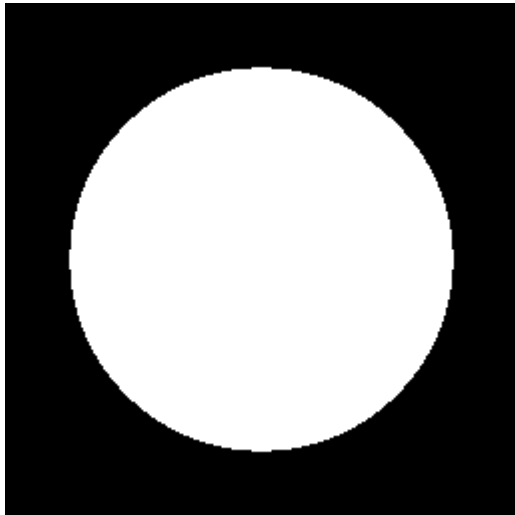
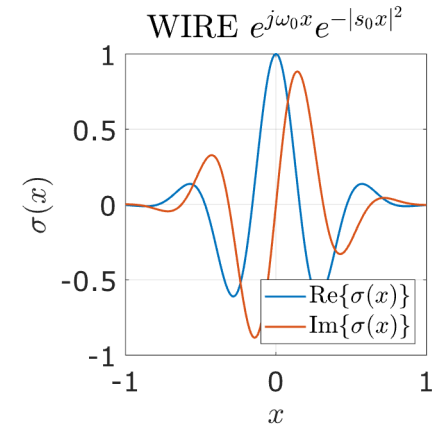
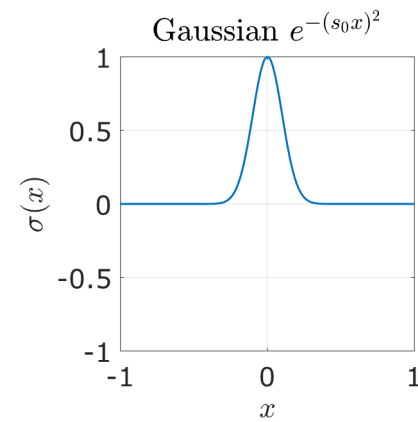
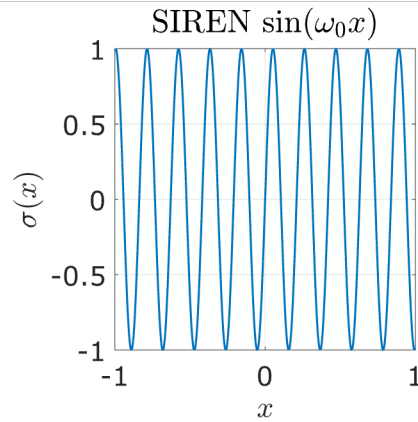
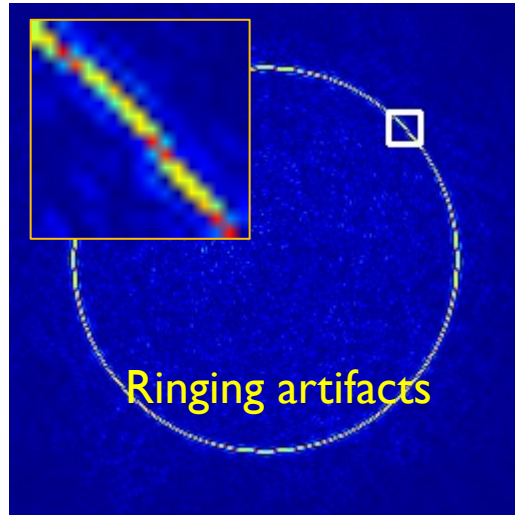
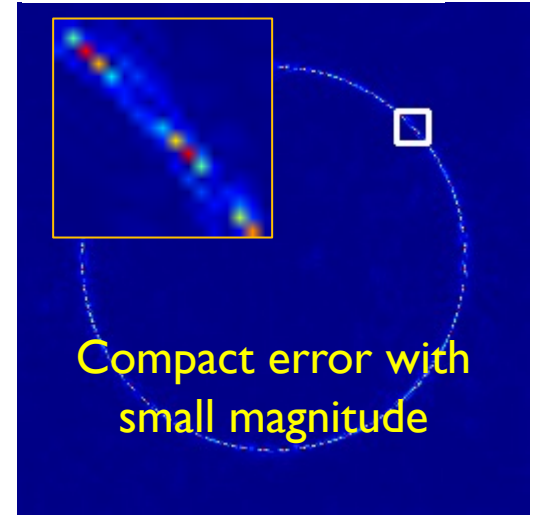
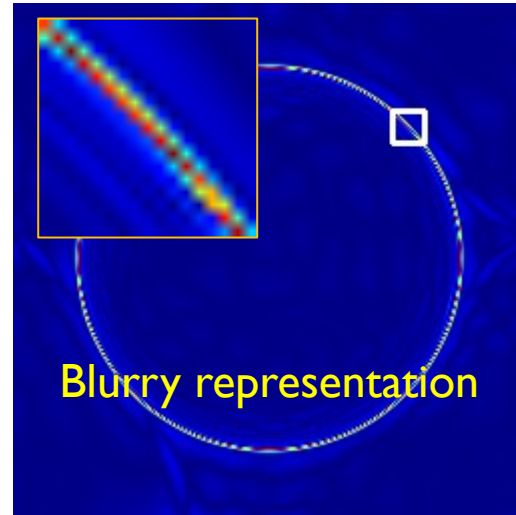


Image with sharp edges



Representation error
0.0  1.0



Compact error with small magnitude

Effect of Wavelet Frequency and Width

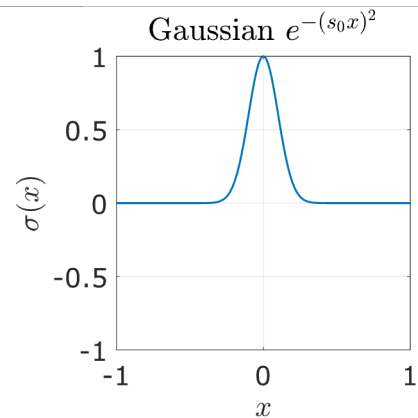
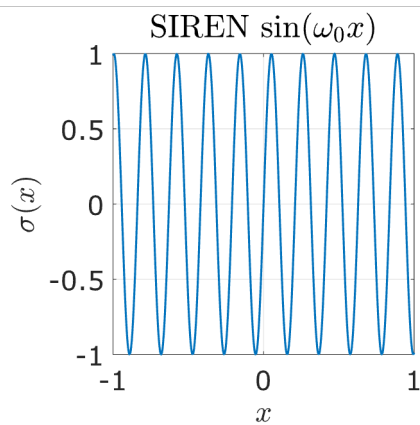
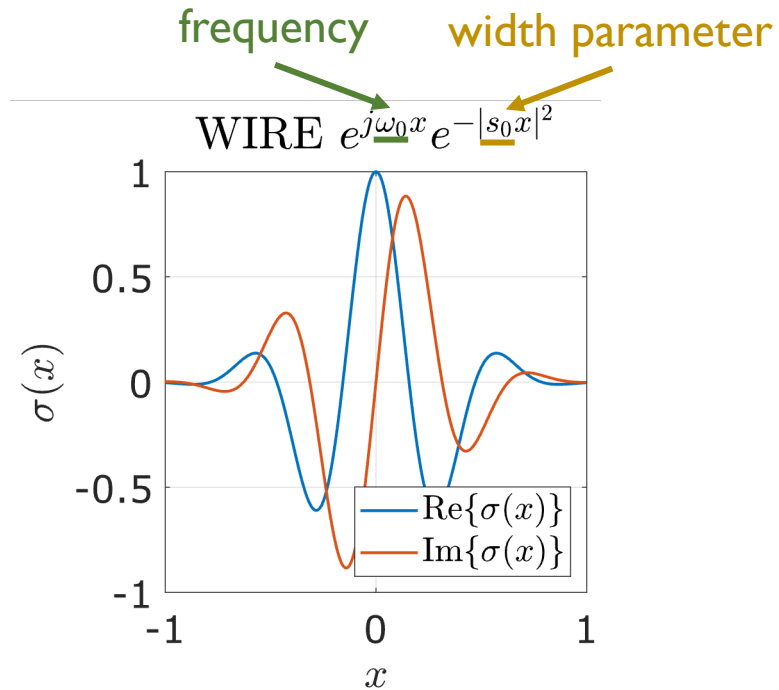
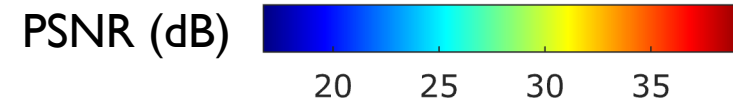
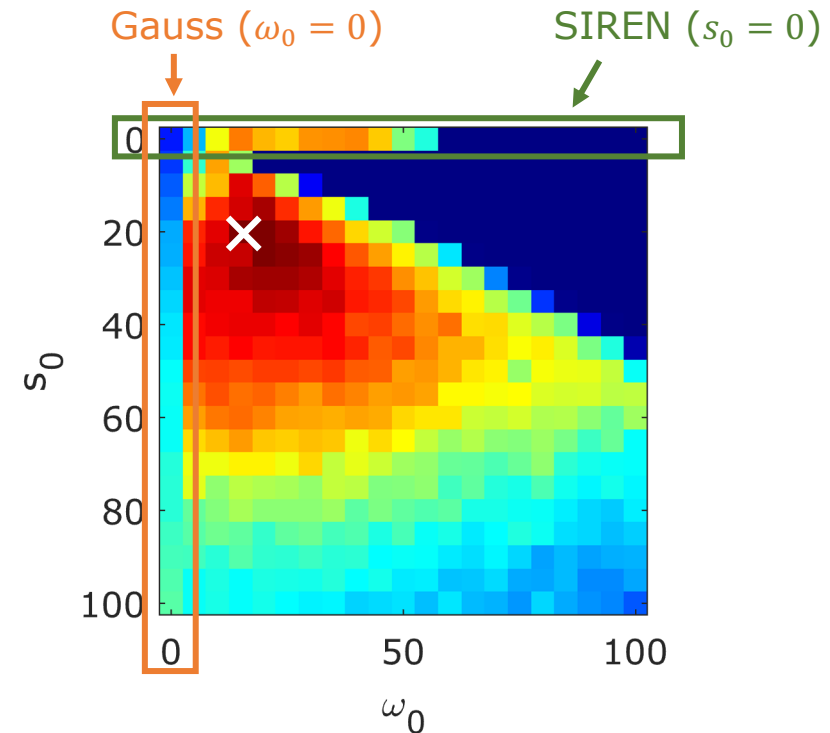
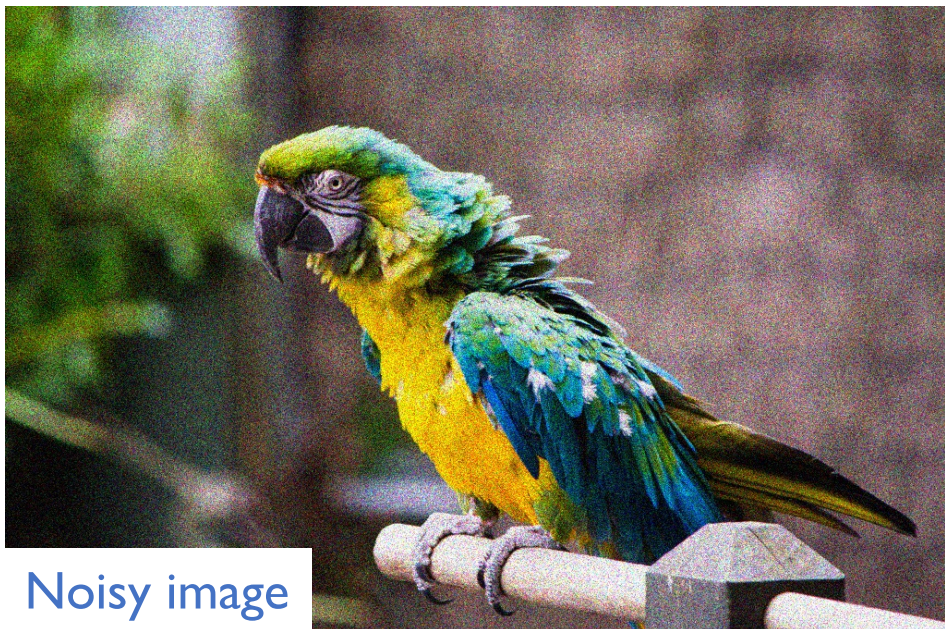


Image Representation



WIRE is robust to noise



WIRE is accurate and trains quickly

Ground truth



WIRE
(43.2dB)



ReLU + Pos. Enc
(32.1dB)



SIREN
(42.4dB)



Gauss
(40.0dB)



MFN
(32.1dB)



Ground truth



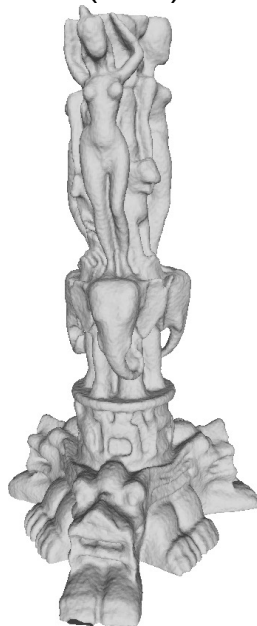
WIRE
(0.99)



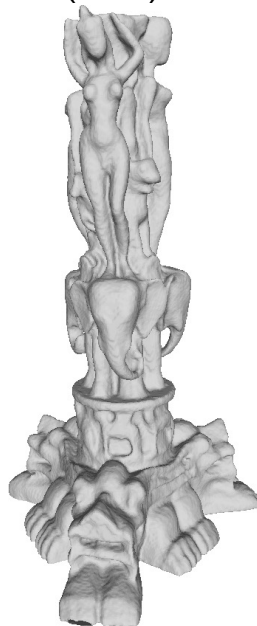
ReLU + Pos. Enc
(0.98)



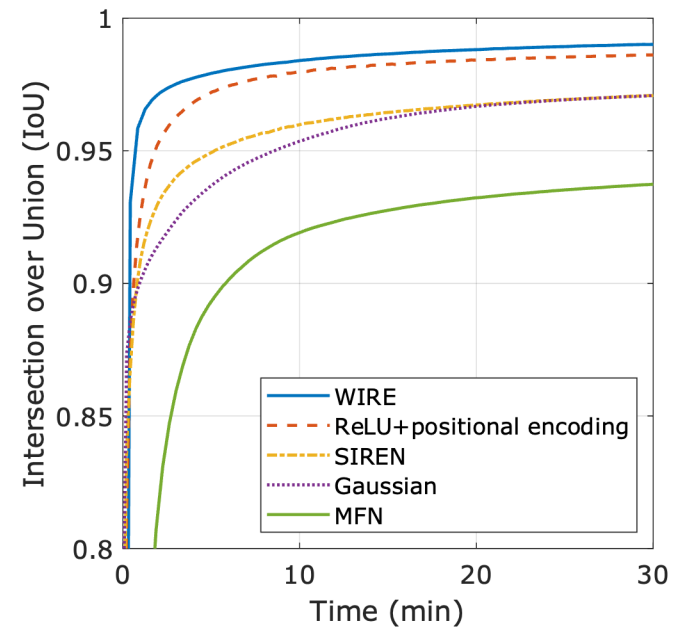
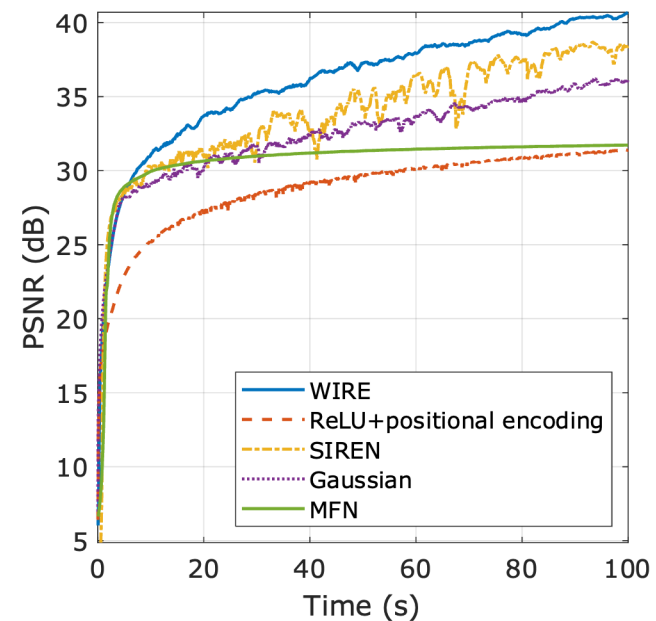
SIREN
(0.97)



Gauss
(0.97)



MFN
(0.94)

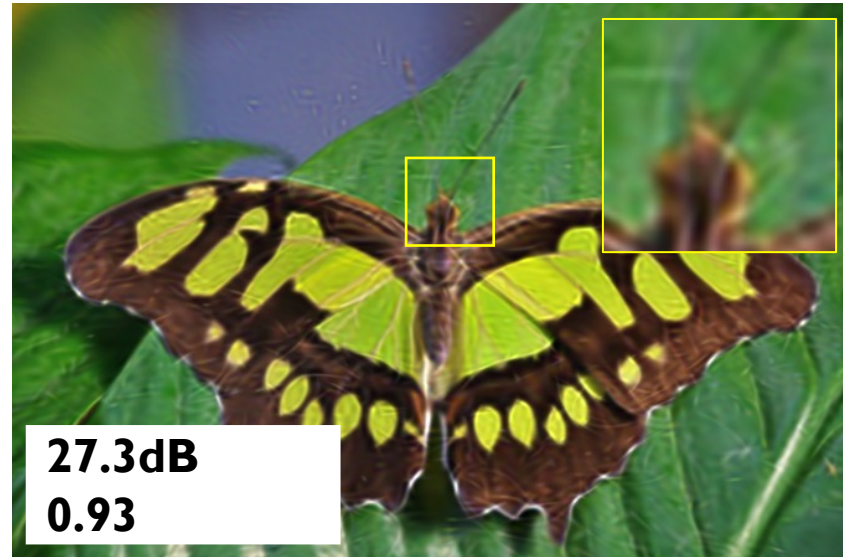


4x Super-Resolution

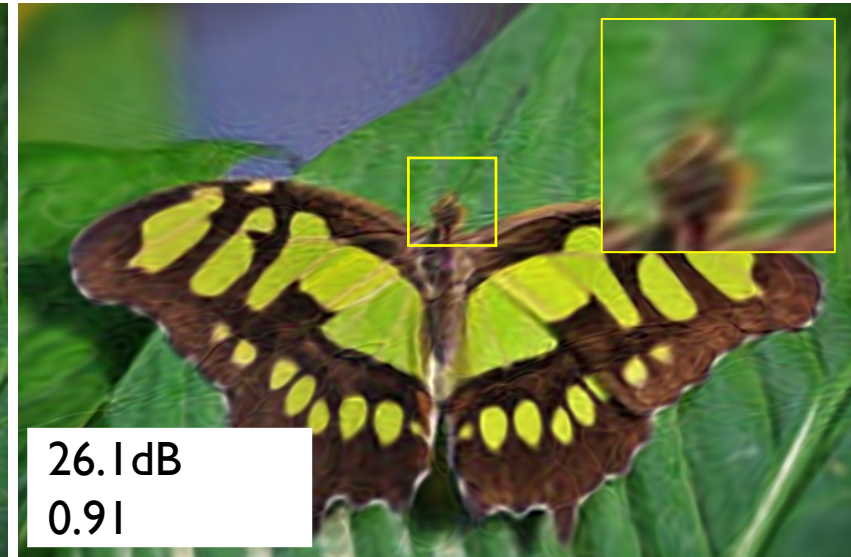
4x downsampled image



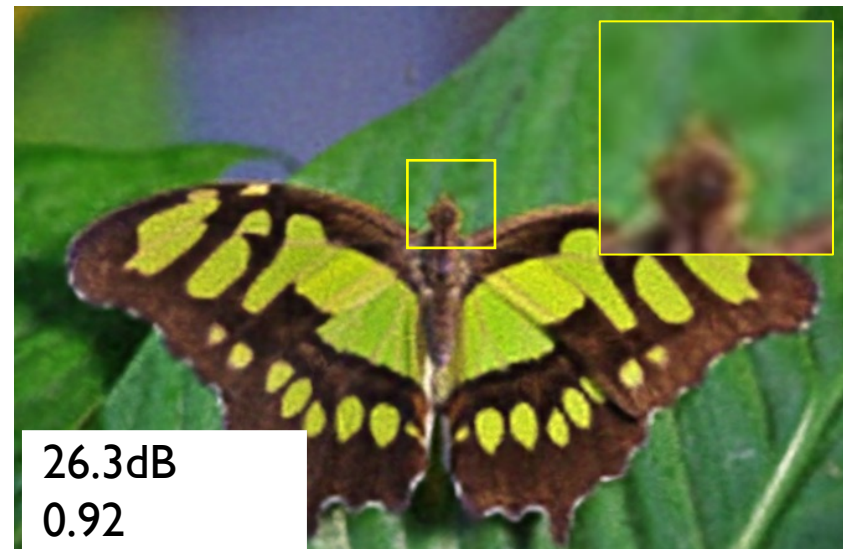
WIRE



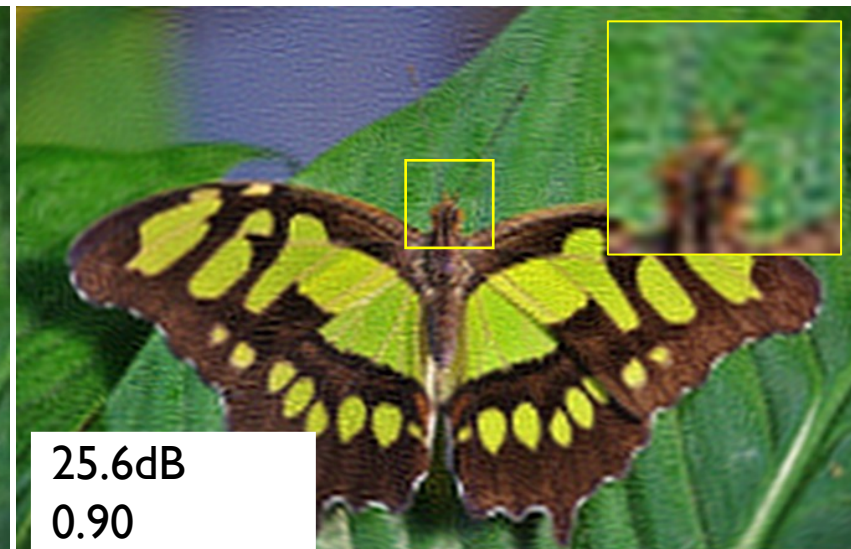
Gauss



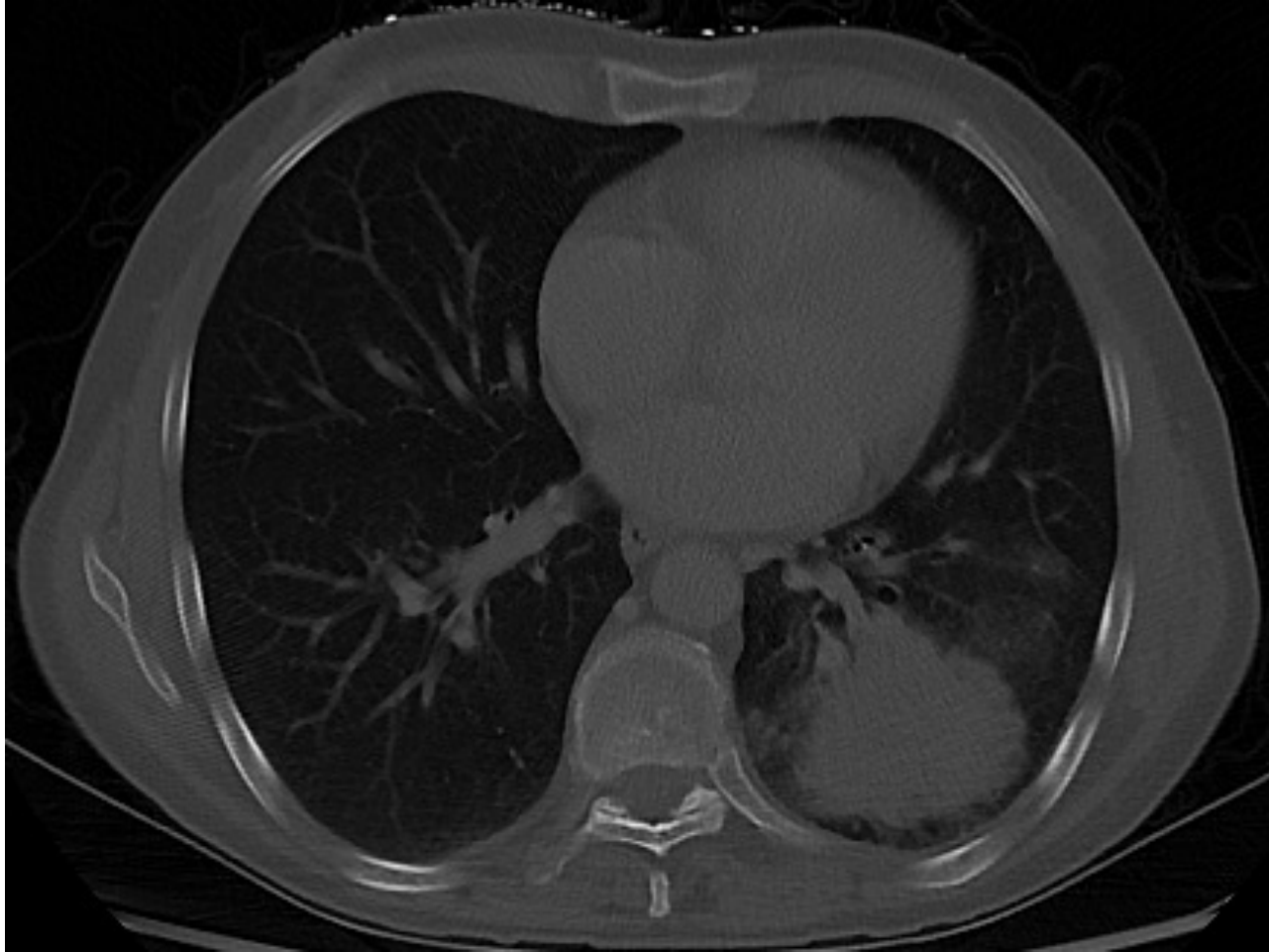
ReLU + Pos. Enc.



SIREN



WIRE for Computed Tomographic (CT) Reconstruction

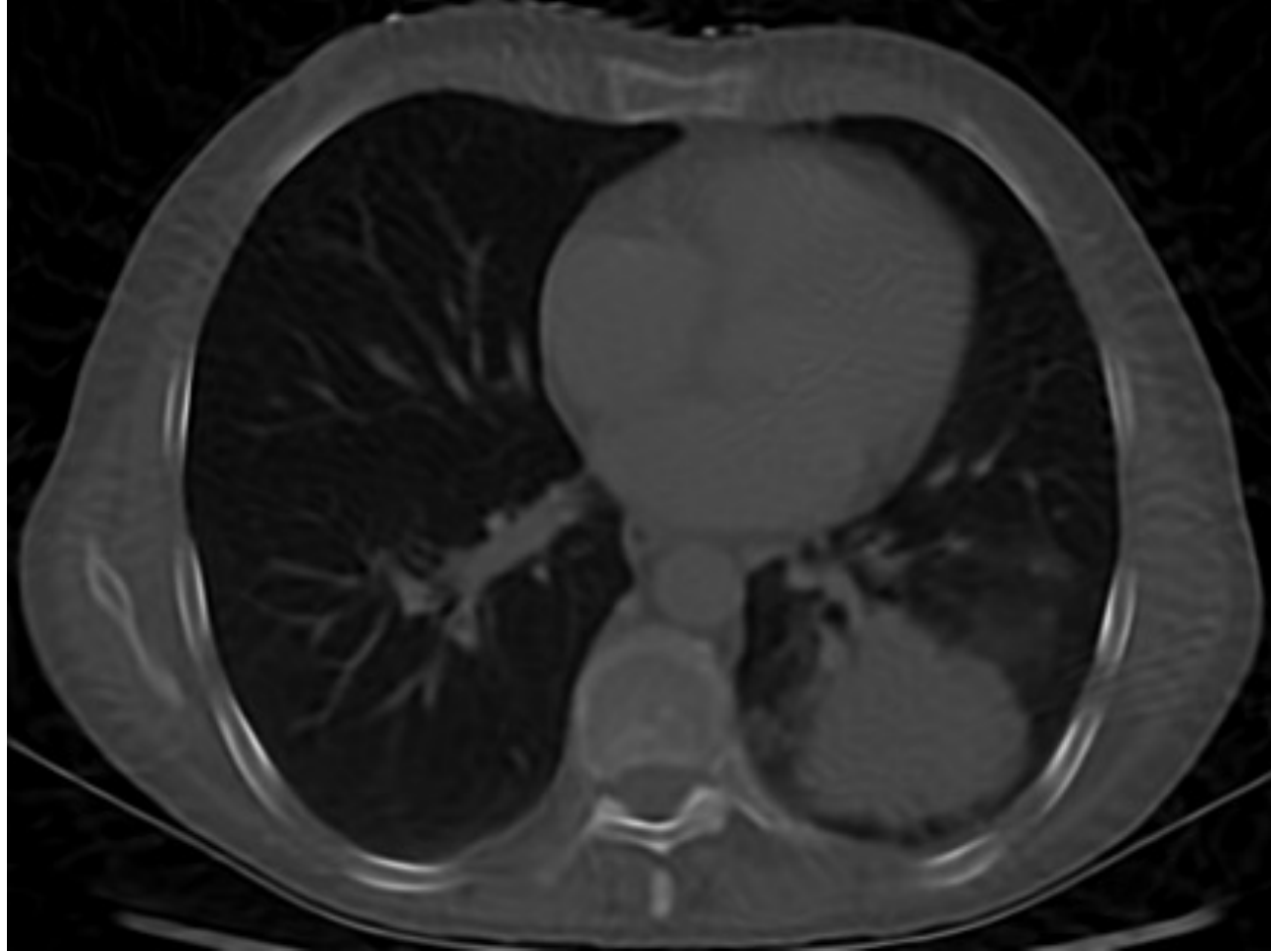


Ground truth image



Sinogram with 100 projections

WIRE for Computed Tomographic (CT) Reconstruction

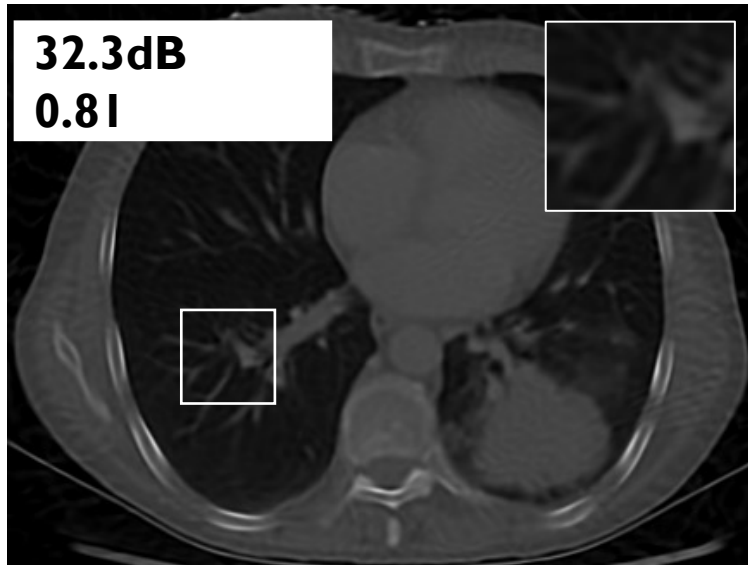


Sinogram with 100 projections

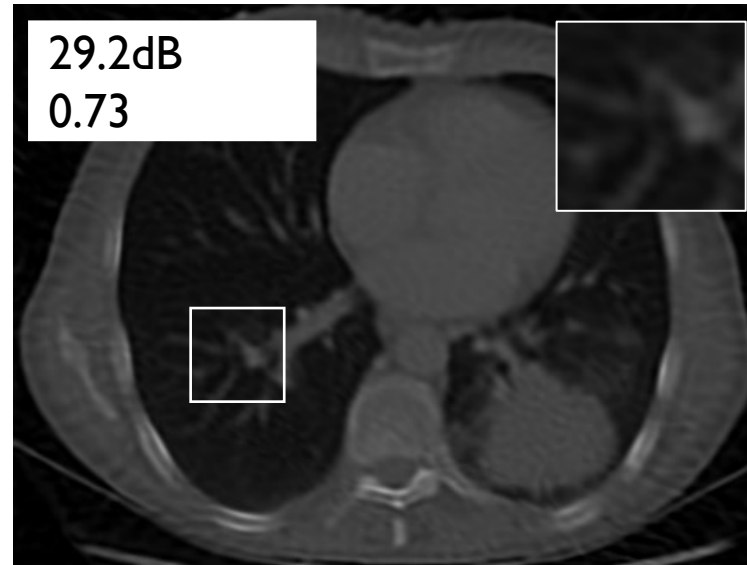
Solution with image represented with WIRE

CT Comparison

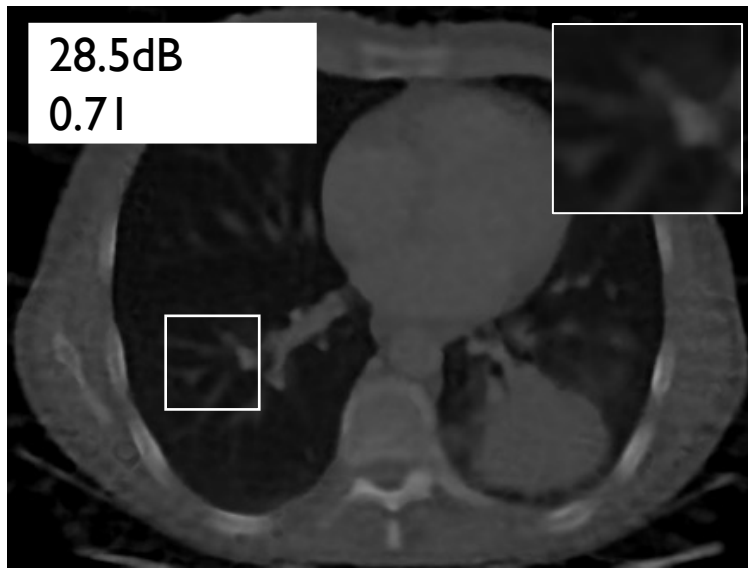
WIRE



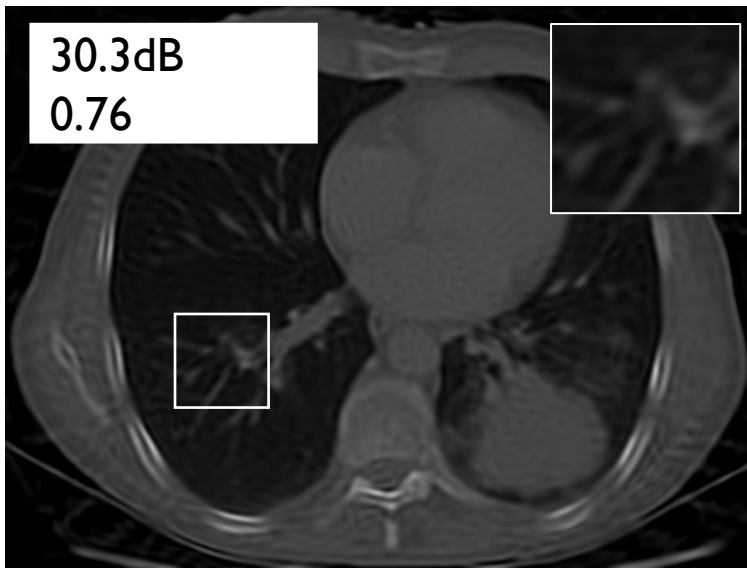
Gauss



ReLU + Pos. Enc.



SIREN



WIRE for Neural Radiance Fields

Trained with 25 out of 100 images

WIRE



SIREN



Gauss



ReLU + Positional Encoding



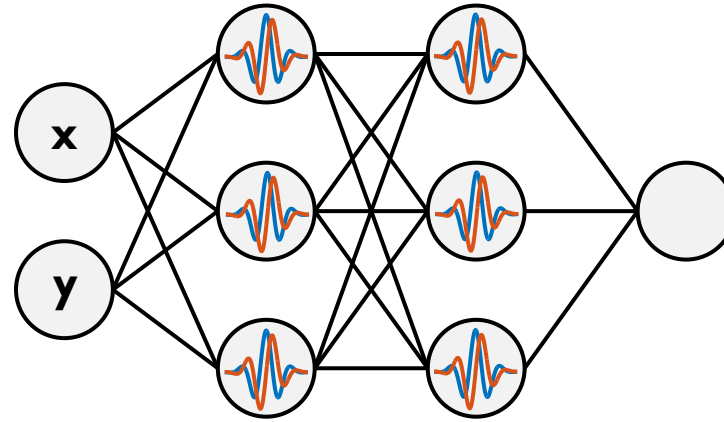
WIRE represents neural radiance fields accurately with significantly fewer images

WIRE Enables State-of-the-Art Performance

WIRE
(43.2dB)



Faster training



Complex Gabor wavelet
nonlinearity

High quality radiance
fields with fewer images



WIRE
(0.99)



Robust to noise



Regularizes Inverse problems

