Convolutional Neural Network for Inverse Problems in Imaging

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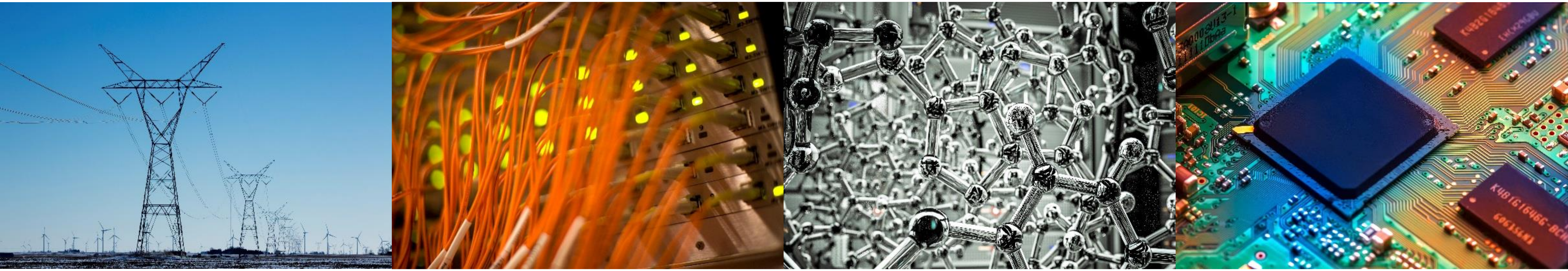


ECE 551 Course Project

ILLINOIS
Electrical & Computer Engineering
COLLEGE OF ENGINEERING

Inverse Problems in Imaging

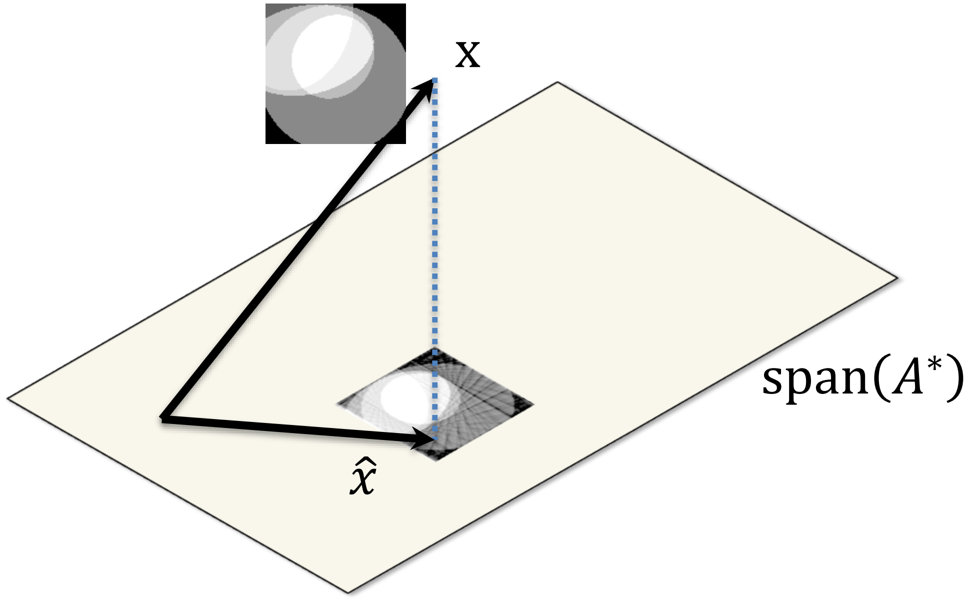
- " $y = blur(x) + noise$. *This is all of applied science.* "

  - Prof. Ivan Dokmanic

- Free space causes some blurring/low pass filtering that result in ill-posedness.

Linear Inverse Problems

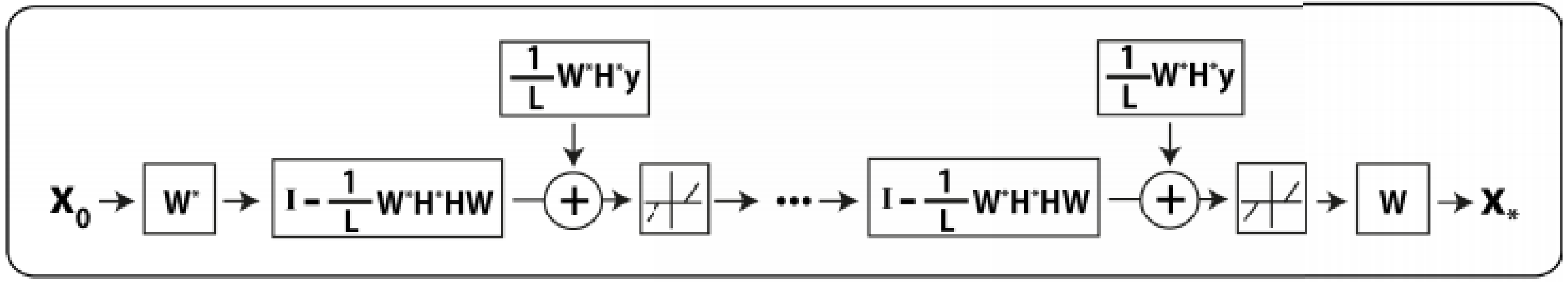
- $\mathrm{y} = A\mathrm{x} + \mathrm{n}$
- Direct inversion $\hat{x}$ (with a pseudoinverse) resides in $\mathrm{span}(A^*)$
- Using sparsity in the object as prior information



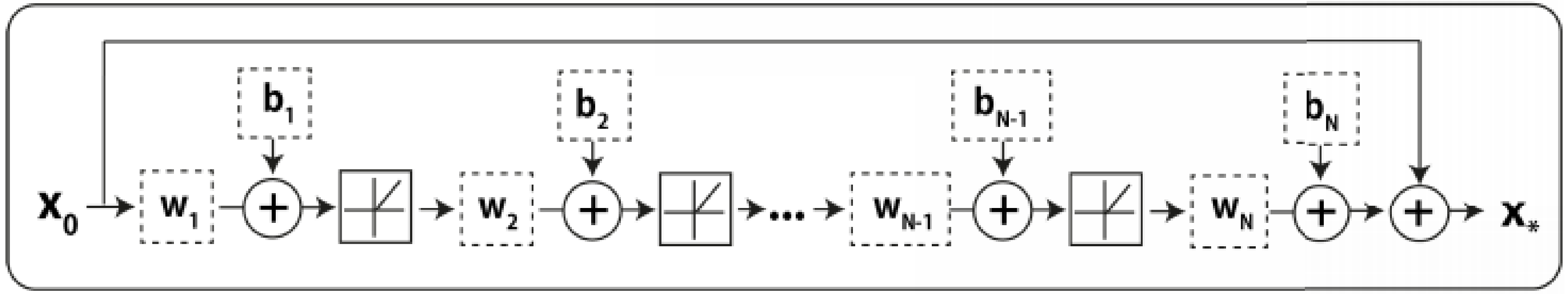
Motivation for using CNNs

- CNN structure similar to unrolled iterations

Iterative algorithm



CNN



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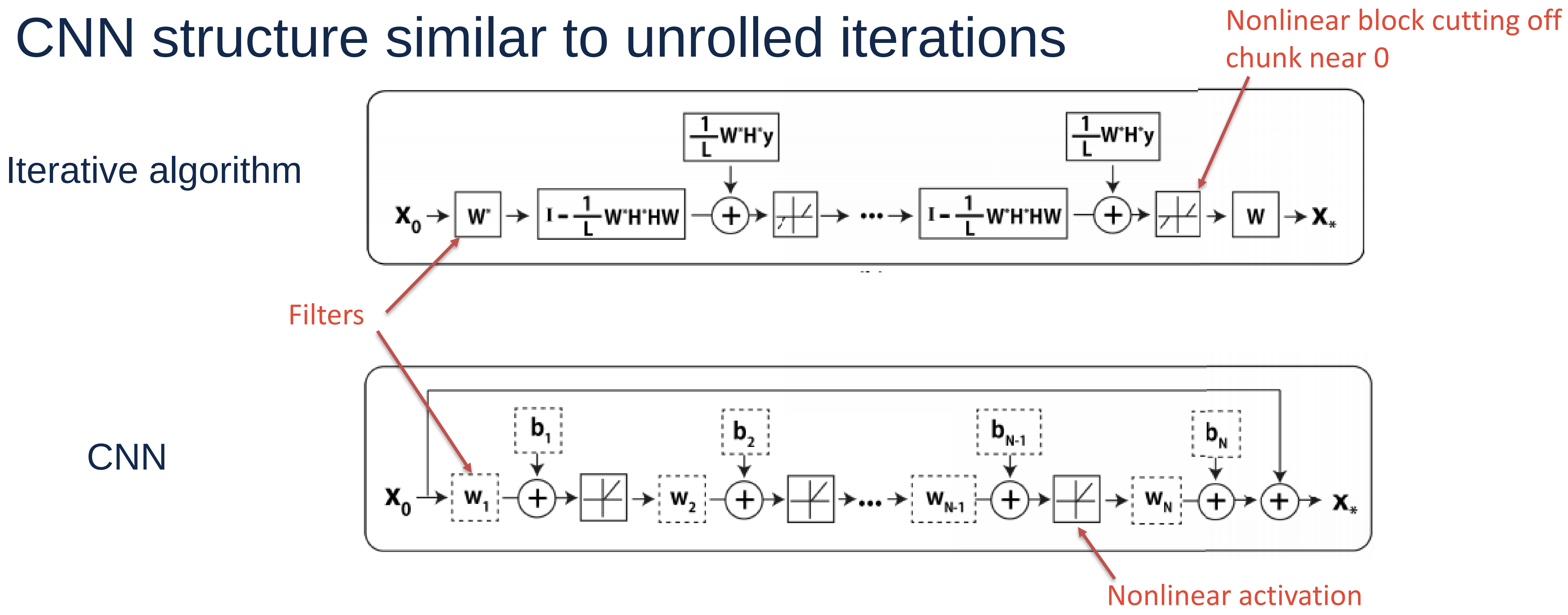
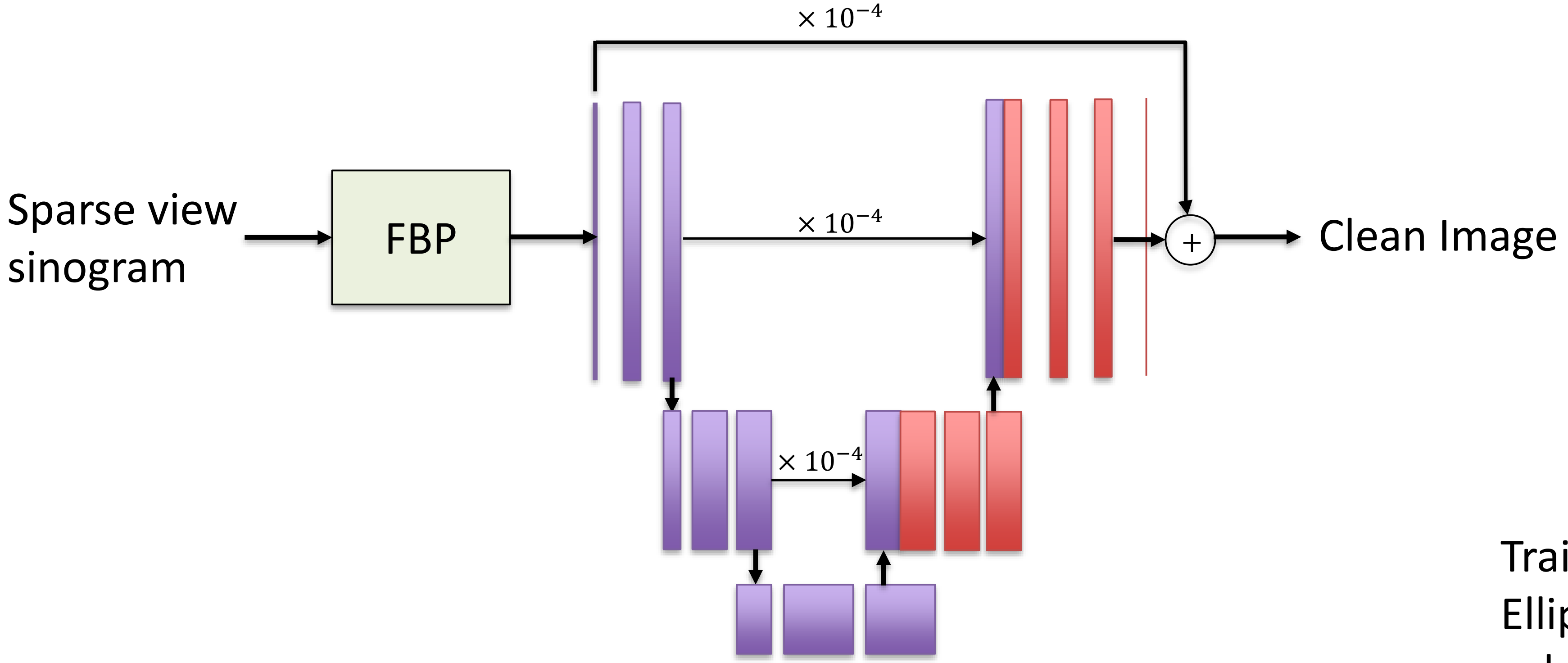
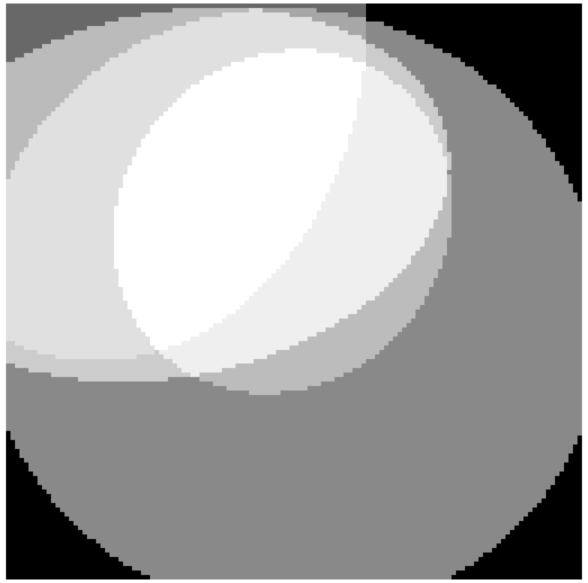


A specific implementation for CT - FBPConvnet

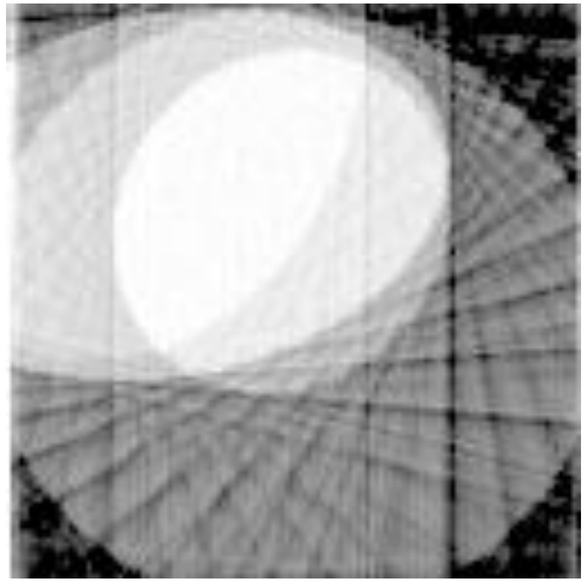


Trained on 700 ellipse images.
Ellipse dataset generated by a random selection of number of ellipses, strength, major/minor axes and tilts in each image.

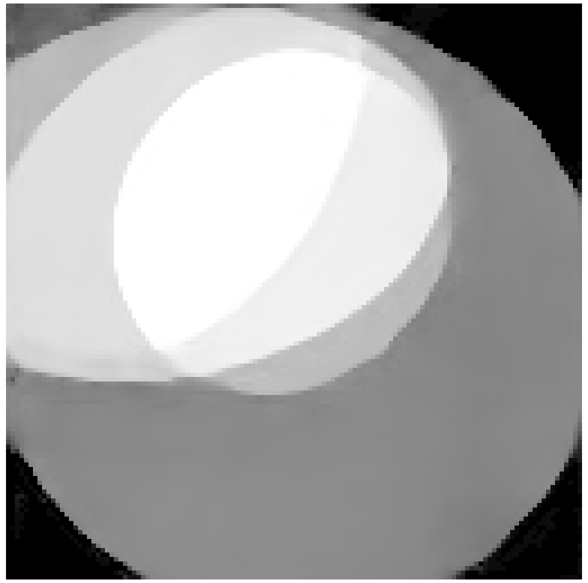
Results



Ground truth



Filtered Backprojection
MSE 8.7×10^{-4}



FBP-CNN
MSE 2.2×10^{-4}

Iterative
MSE 1.8×10^{-4}

Conclusions

- Iterative algorithms still better for highly sparse (piecewise constant) images like ellipses.
- CNN could perform better in cases where the sparse basis is not obvious.

References

- K. H. Jin, M. T. McCann, E. Froustey, and M. Unser, “Deep convolutional neural network for inverse problems in imaging,” IEEE Transactions on Image Processing, vol. 26, no. 9, pp. 4509–4522, 2017.
- M. T. McCann, K. H. Jin, and M. Unser, “Convolutional neural networks for inverse problems in imaging: A review,” IEEE Signal Processing Magazine, vol. 34, no. 6, pp. 85–95, 2017.