

# EE367 Project: Implementation of the weighted nuclear norm minimization for image denoising

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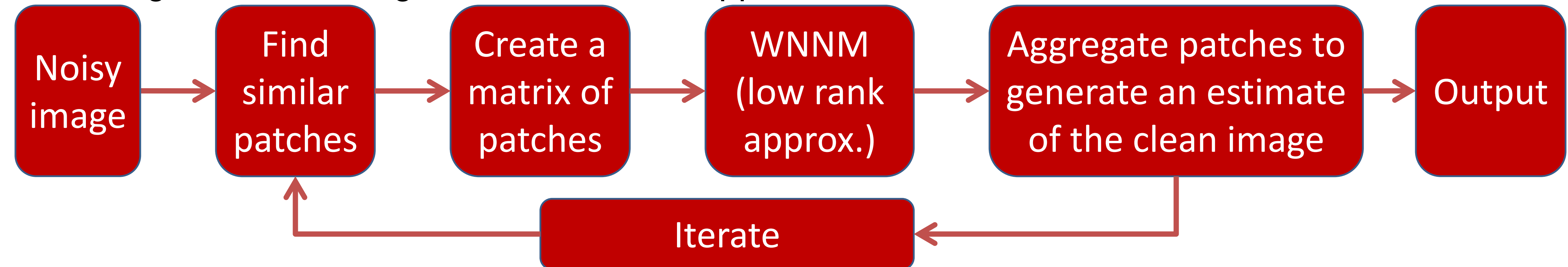
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## Motivation

- Image denoising is an important part of the image processing pipeline
- Foundational to other tools
- Gain insight by implementing a state of the art technique based on weighted nuclear norm minimization (WNNM)

## Method

- WNNM denoising relies on the assumption that the structure in the image can be identified among the noise using a matrix low rank approximation


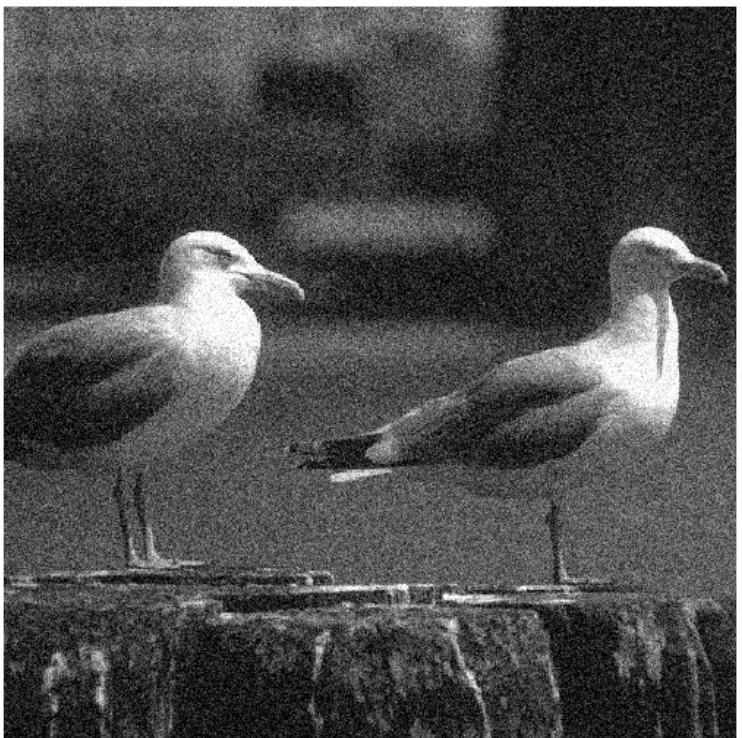
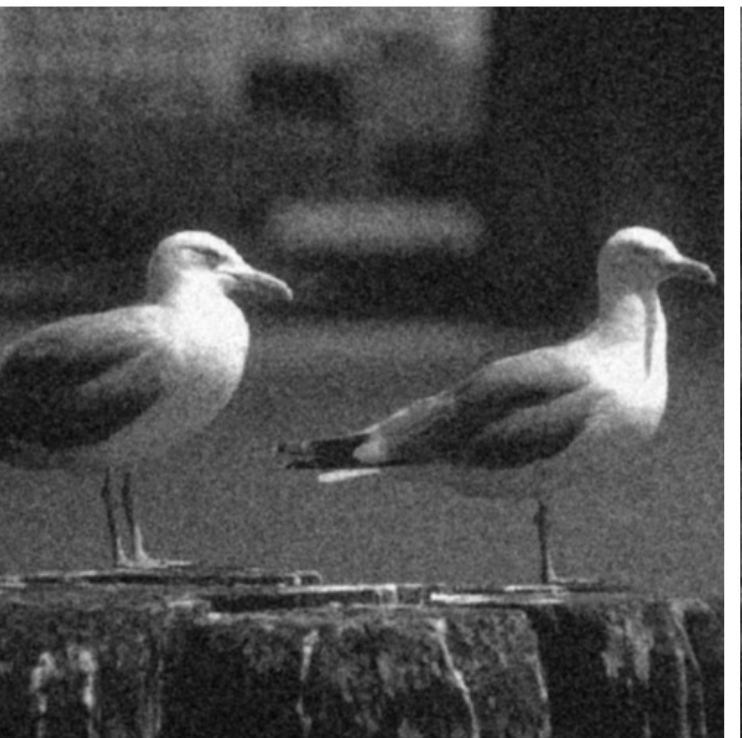
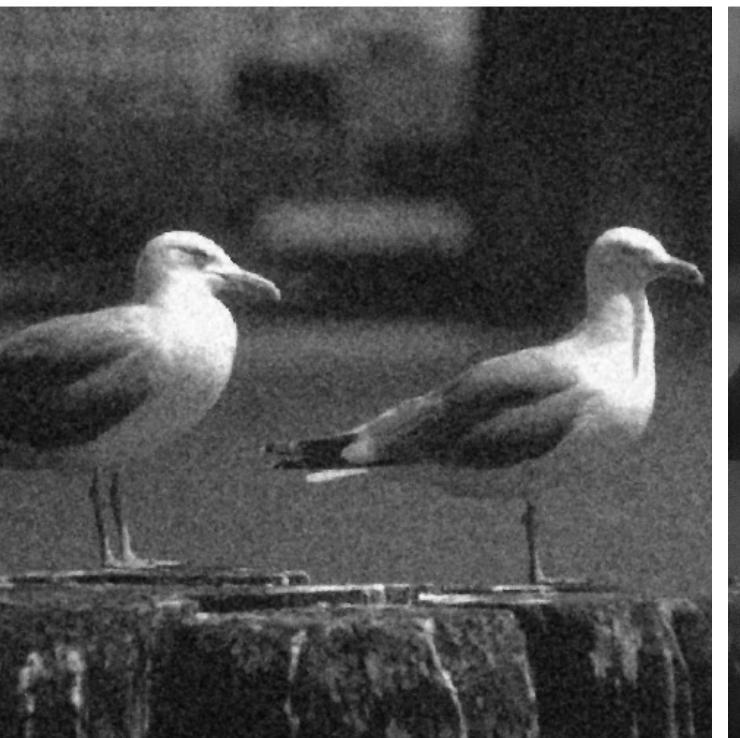




## Related Work

- Numerous techniques available from simple Gaussian and median filters to denoising convolutional neural networks (DnCNN)
- Non-local approaches have superior performance [1], especially Block matching and 3D filtering (BM3D) [2], WNNM [3], and DnCNN

## Experimental Results

- Compare to other denoising techniques

	Clean	Noisy	Gaussian	Bilateral	NLM	WNNM
						
PSNR	-	20.30	28.70	28.41	29.49	<b>31.72</b>
SSIM	-	0.39	0.83	0.81	0.88	<b>0.93</b>

- Averages across 15 grayscale images:

PSNR	-	20.22	26.36	26.60	26.97	<b>28.40</b>
SSIM	-	0.49	0.80	0.80	0.82	<b>0.86</b>

## References

- [1] L. Fan, F. Zhang, H. Fan, and C. Zhang. Brief review of image denoising techniques. *Visual Computing for Industry, Biomedicine, and Art*, 2(1):7, 2019.
- [2] K. Dabov, A. Foi, V. Katkovnik and K. Egiazarian, "Image Denoising by Sparse 3-D Transform-Domain Collaborative Filtering," in *IEEE Transactions on Image Processing*, vol. 16, no. 8, pp. 2080-2095, Aug. 2007, doi: 10.1109/TIP.2007.901238.
- [3] S. Gu, L. Zhang, W. Zuo, and X. Feng. Weighted nuclear norm minimization with application to image denoising. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, June 2014.