

Image Denoising by Data-driven Orthonormal Basis

**Mathematical Models and Methods for Image
Processing**

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Assignments

PCA-based denoising

Assignment 1

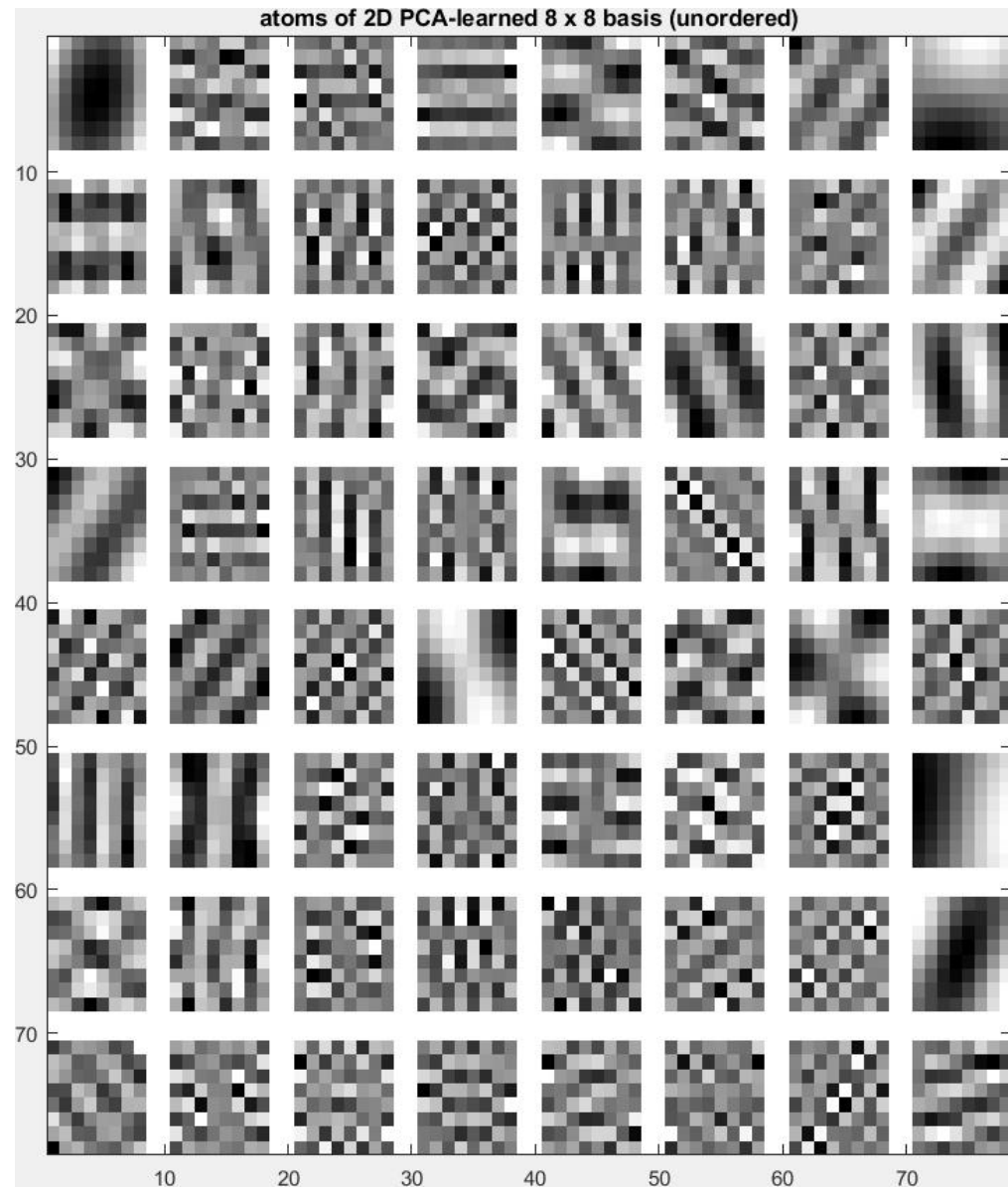
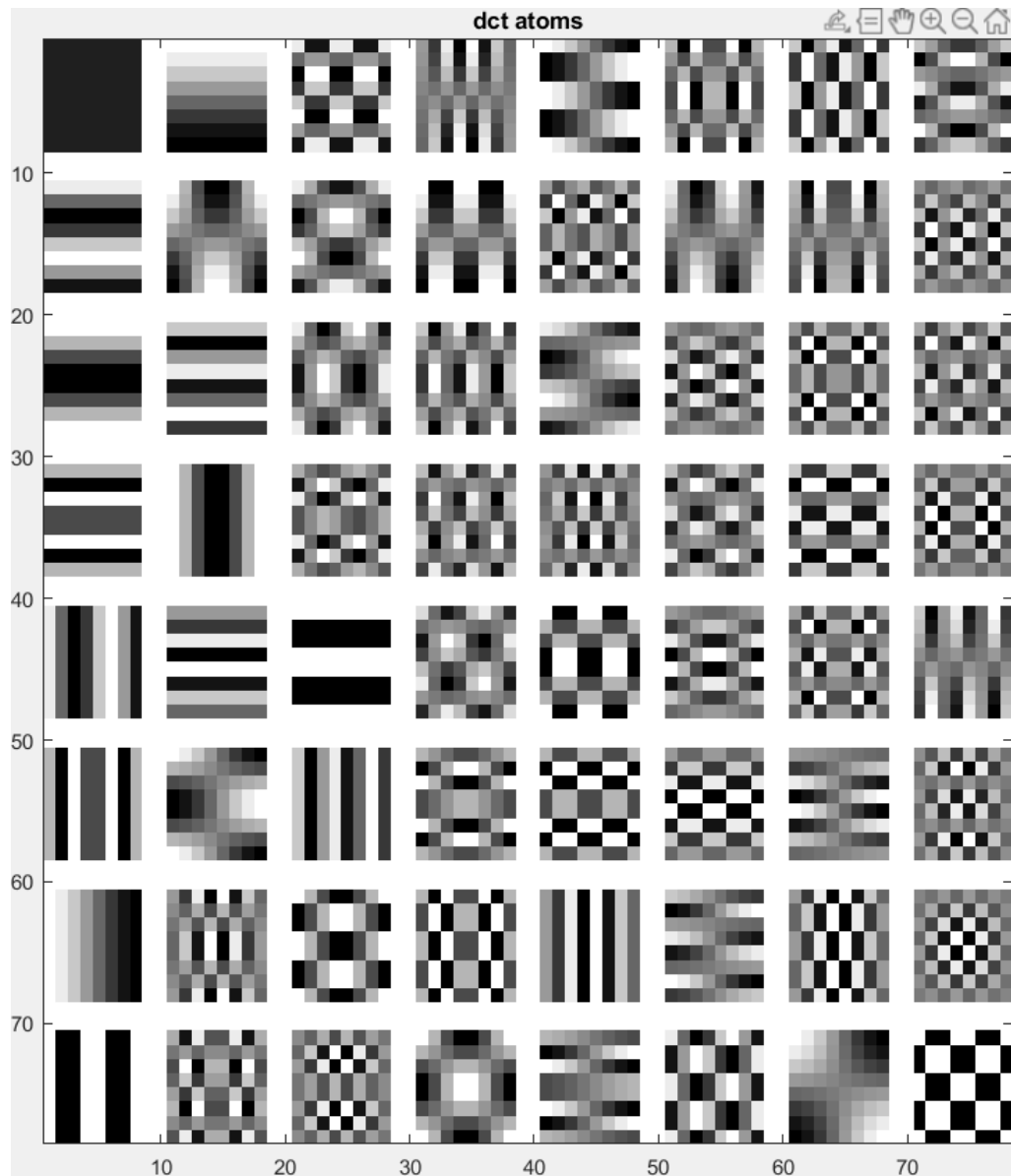
Implement Global PCA-based denoising.

- Define the orthonormal basis by PCA of all the image patches
- Visualize the atoms of the PC basis and compare these against DCT basis

DCT Atoms

vs

PC from Lena



Assignment 1

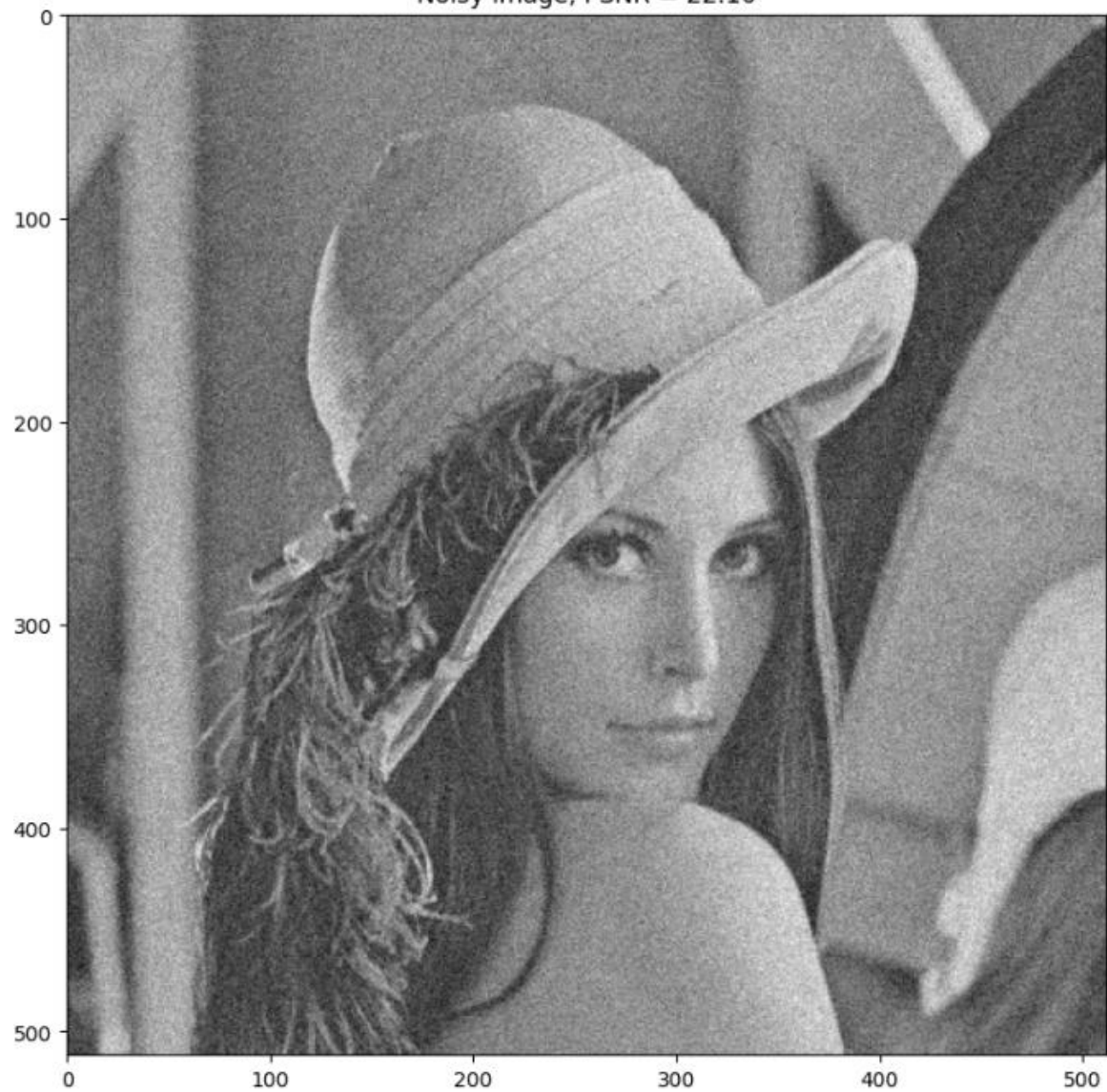
Implement Global PCA-based denoising.

- Define the orthonormal basis by PCA of all the image patches
- Visualize the atoms of the PC basis and compare these against DCT basis
- Compute projection and enforce sparsity w.r.t. this basis
- Implement the same aggregation scheme as for the DCT-based denoising

A reference paper

C.-A. Deledalle, J. Salmon, A. S. Dalalyan, *"Image denoising with patch based PCA: local versus global"* BMVC 2011, [PDF](#).

Noisy image, PSNR = 22.10

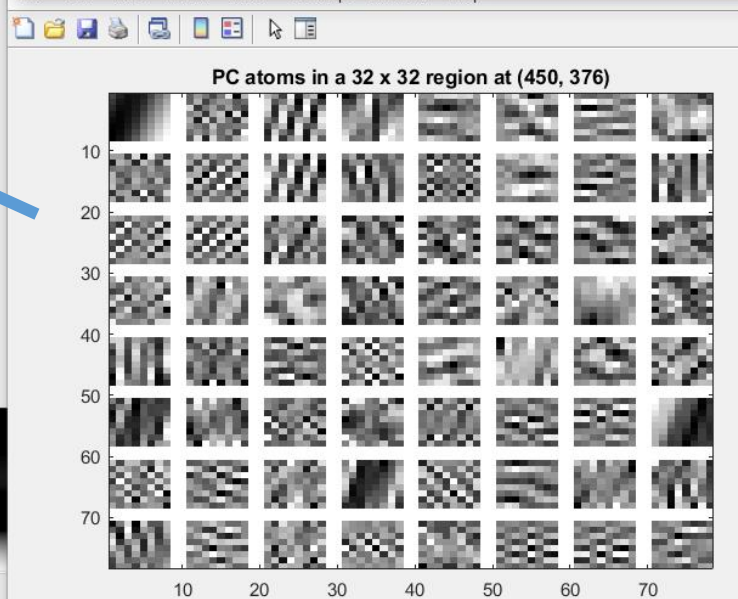
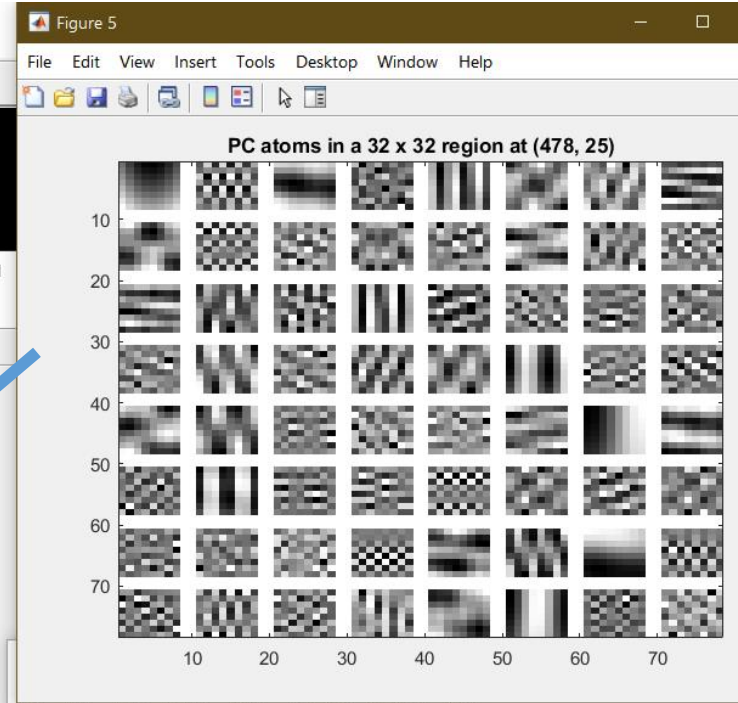
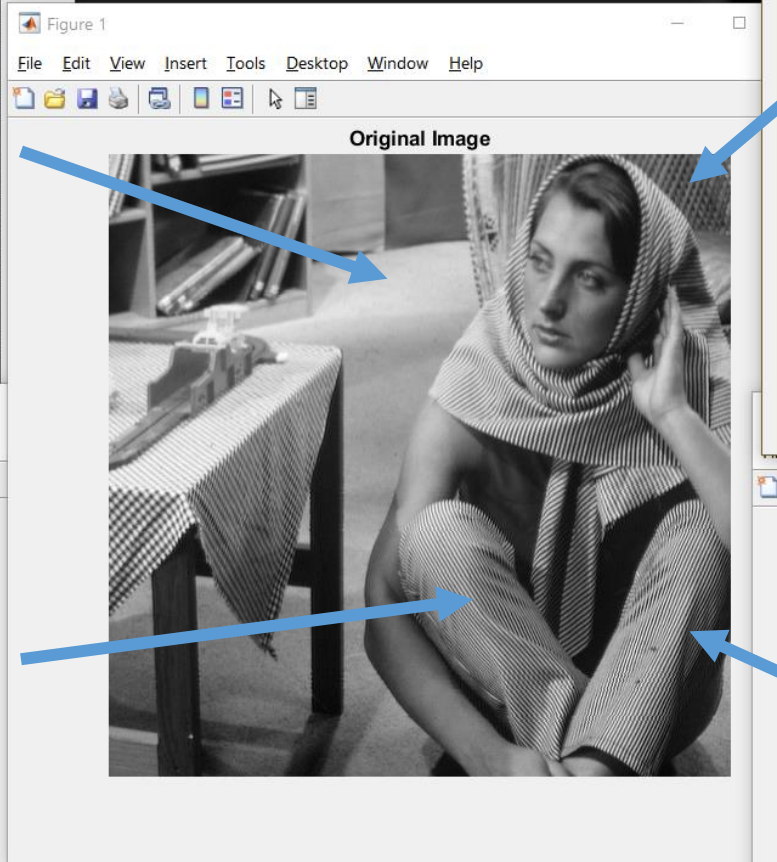
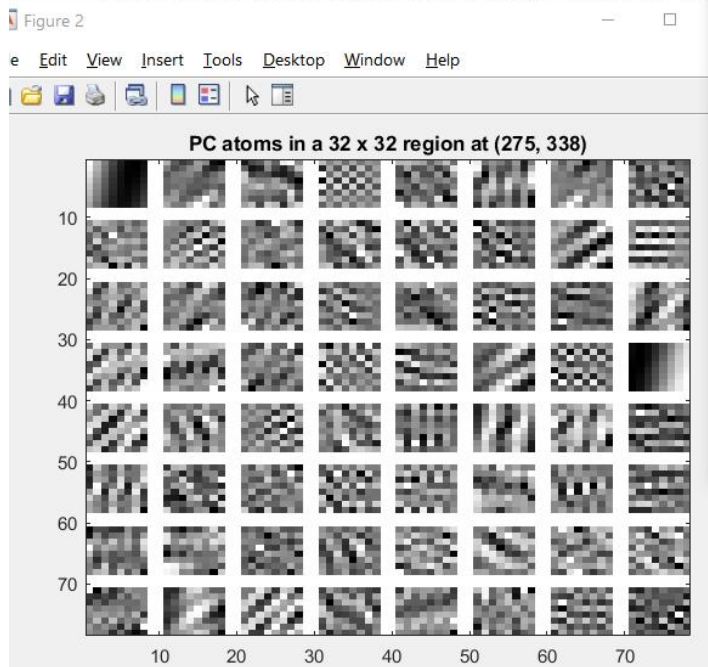
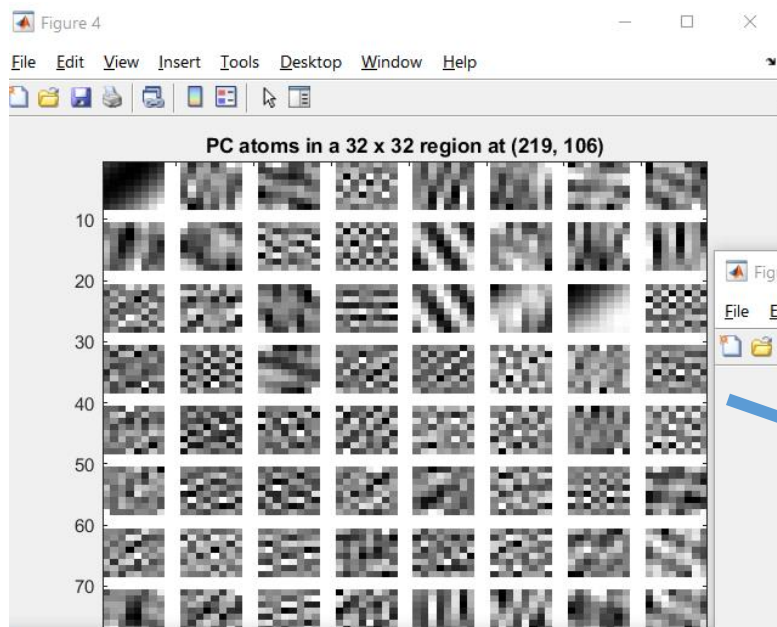


Estimated Image,
PSNR = 32.05



Assignment 2 (Optional)

- Implement a function to estimate the U matrix (and the preprocessing, the number of PC to preserve) within an image region



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Implement denoising by Local PCA basis

- First, define image regions where to compute PCA as tiles over an image (no overlap)
 - Hint: generate a collection of basis beforehand, then load the use the right basis in each pixel (depending on the location)
- Then define overlapping regions, to obtain for each patch, possibly estimates from different basis. Aggregate always by averaging
 - Hint: a simpler strategy than expanding the above approach is to define overlapping regions over an image. In each region extract PC and the perform denoising. Aggregate all the results at the end

Global PCA

PSNR = 29.54



Local PCA

PSNR = 31.12

