

Medical Image Analysis Exercises: Session 04

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- 15: noise level estimation by principal component analysis
- 16: smoothing with Wiener filter

15: noise level estimation by principal component analysis

a: sample generation

- reset the random number generator to the startup state
- generate 50 samples with a bivariate normal distribution with mean (1,5) and standard deviation (0.5, 0.5)
- generate 50 samples with a bivariate normal distribution with mean (3,1) and standard deviation (0.5, 0.5)

b: principal component analysis

- apply the principal component analysis of the 100 samples to get the estimated mean, the eigenvalues and eigenvectors of the covariance matrix (using `pca()`)
- estimate the noise standard deviation by the square root of the smallest eigenvalue

c: display

- display 1 axes in one figure, with a scatter plot of the samples
- overlay the principal components to the axes, with every component with the starting point at the estimated mean, the orientation as the eigenvector, and the length as the square root of the eigenvalue
- adjust the axes by using the same length for the data units along each axis
- show the estimated noise standard deviation in the title to the axes

Notes

- Pyatykh, S., J. Hesser, and L. Zheng. "Image Noise Level Estimation by Principal Component Analysis." IEEE Transactions on Image Processing 22, no. 2 (February 2013): 687-99.

16: smoothing with Wiener filter

input: `eight.tif` from MATLAB

a: add noises

- add Gaussian noise with 2 different variances separately
- add salt-and-pepper noise with 2 different levels separately

b: smoothing

- apply Wiener filter with 2 different neighborhood sizes separately, providing the real noise variances (only for Gaussian noise)
- apply Wiener filter with 2 different neighborhood sizes separately, without providing the real noise variances

c: compare the results

- display the results in 4 different figures, one figure for one noisy image
- display 6 or 4 axes in each figure, including the original image, the noisy image, the 4 or 2 outputs of the Wiener filter
- add titles to the axes