Exercises on

“Supervised and unsupervised learning in the visual system”

Part I: Groundwork

1) Did you finish the Part II of the exercises on “General Aspects of Vision”?

If not, make questions! Please solve at least II.3 before you continue.

Part II: Power Spectrum whitening of natural images

Consider the visual system that you have chosen in the last class.

1) Estimate and plot the power spectrum whitening filters considering the noise variance equal to 10^{-9},10^{-8},10^{-7},10^{-6} of the maximum value of the average power spectrum maximum value.

Hint 1: Do NOT use skimage.filters.wiener it is NOT appropriate to our case (the assumptions are different). Implement explicitly the wiener filter.

Hint 2: If you used numpy.fft.fftshift to visualize and save the average power spectrum do not forget to use numpy.fft.ifftshift before the inverse Fourier transform and numpy.fft.fftshift after the Fourier transform

Hint 3: By default, the result of numpy.fft.ifft2 is a numpy array of complex values. In our case, the imaginary part of the filter is zero. Convert

the array of complex to an array of doubles using numpy.real

2) Make the analysis in terms of filters shape in function of the noise.

3) Choose one of the filters and estimate and plot the average power spectrum of images whiten with that filter

Hint 1: use a similar procedure to estimate the power spectrum as the last class, but now each image sample has to be convolved with the whitening filter before estimating the power spectrum

Hint 2: to convolve the image samples with the whitening filter you can usescipy.ndimage.filters.convolve. Use the mode "wrap"

Part III : Independent components of natural images

Consider the visual system that you have chosen in the last class.

1) Estimate and plot the independent components of image samples of your dataset

Hint1: There is a tutorial on blind source separation using PCA and ICA in sckit learn that you can use to estimate the components of your data: http://scikit-learn.org/stable/auto_examples/decomposition/plot_ica_blind_source_separation.html

Hint1: Use the class sklearn.decomposition.FastICA

Hint2: The data should first be p reprocessed

Hint3: Theoretically, data should be first whiten, but in the class FastICA there is an option to whiten in the fly. Use it, because it is faster and more

efficient than the power spectrum whitening implemented above.

Hint4: To use the algorithm presented in the class you should set the option *algorithm='parallel'* in FastICA.

Hint5: Given the complexity of the algorithm, it is better to estimate the independent components of small image samples. Set the sample size to 12x12 pixels