In The Name of God

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Advanced Neuroscience HW9

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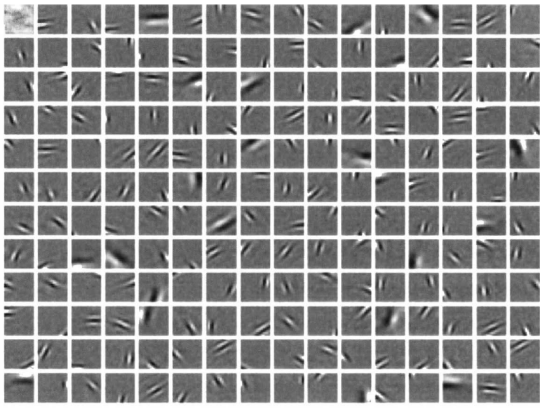
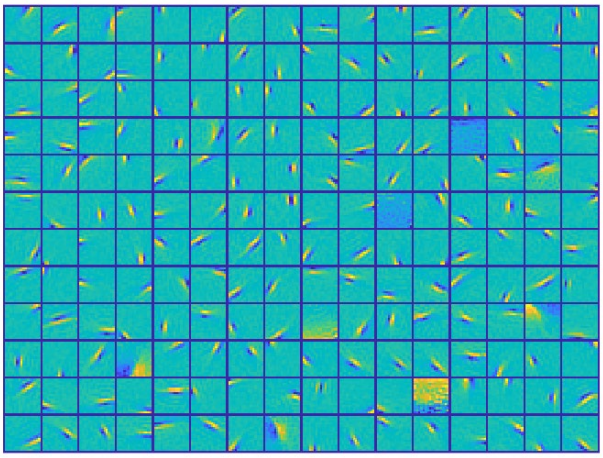
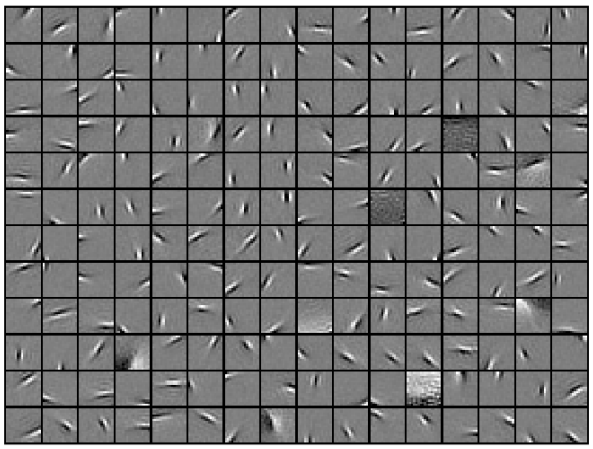
Part 1) In this part, we simulate sparse basis functions of the natural images using the IMAGES.mat file, which contains 10 natural images. All images' variances are set to 0.1. The results of 192 basis function with the size 16*16 are shown below which are almost like the paper figure:

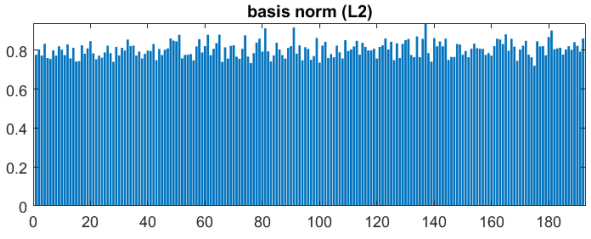
Paper result:

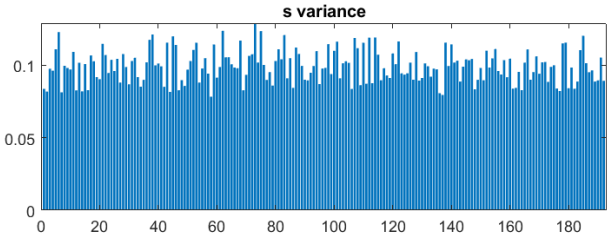


Our result:



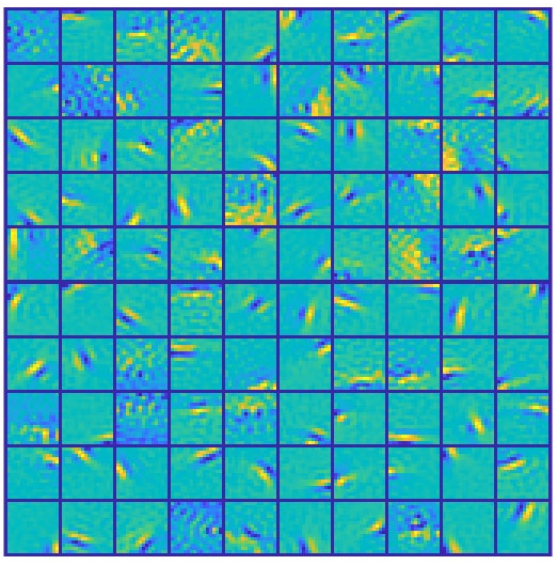


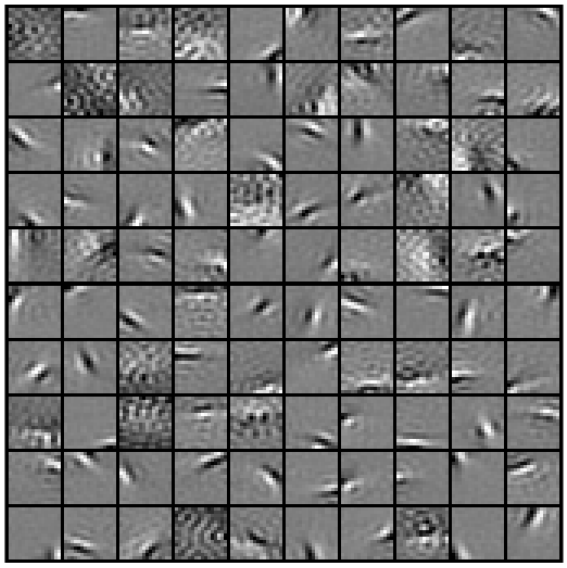


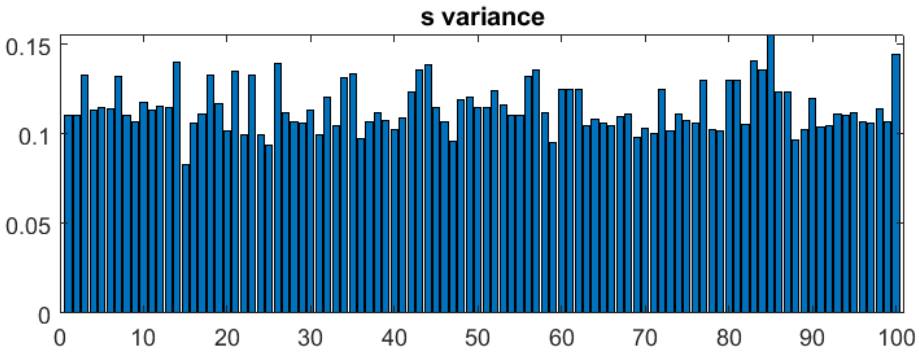


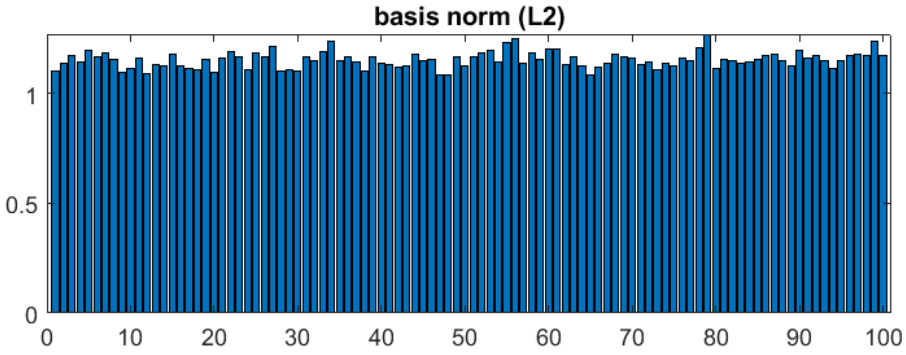
Part 2) In this part, we simulate sparse basis functions of the natural images using Other Data sets image files, picking 10 random images from each. In order to get images ready, firstly all images' means are omitted, and the images are scaled between 0 and 1. Then the images are whitened using the method written in the file "make-your-own-images" and the variances are set to 0.1. Here are the results for simulation of 100 basis functions with different sizes and from different datasets:

Yale (basis functions' sizes = 16*16):

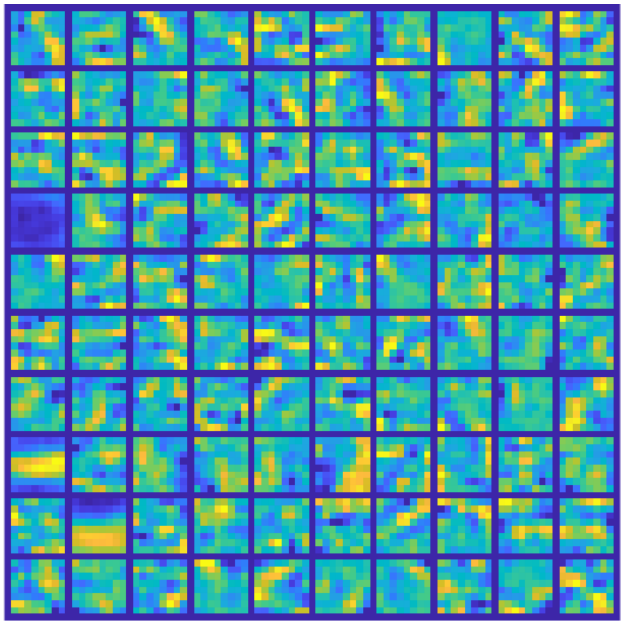


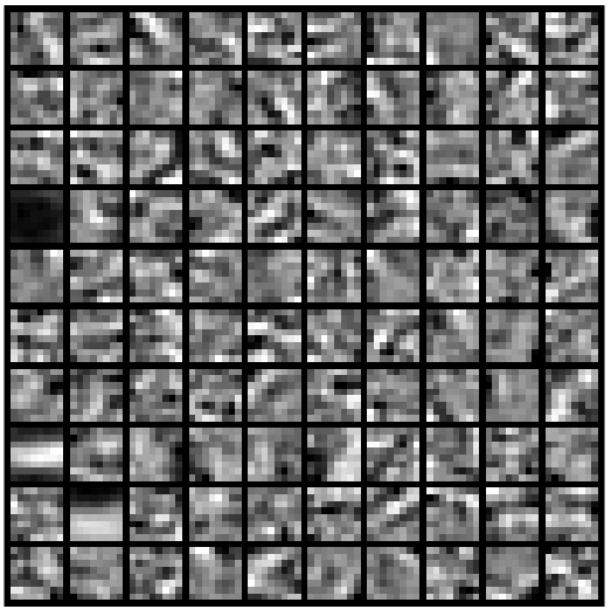


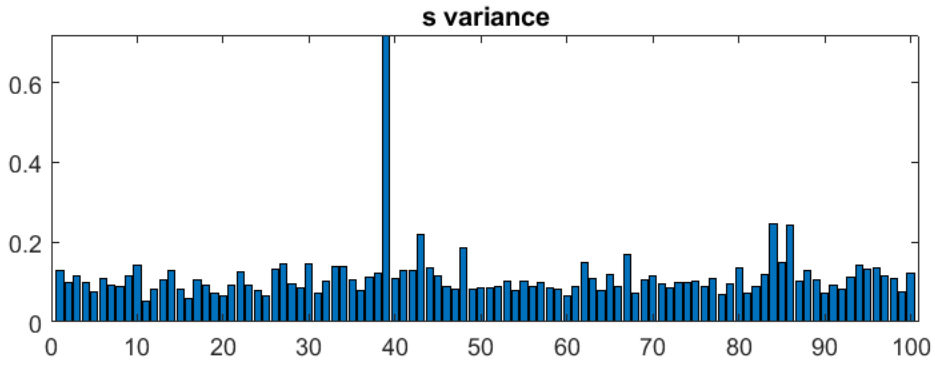


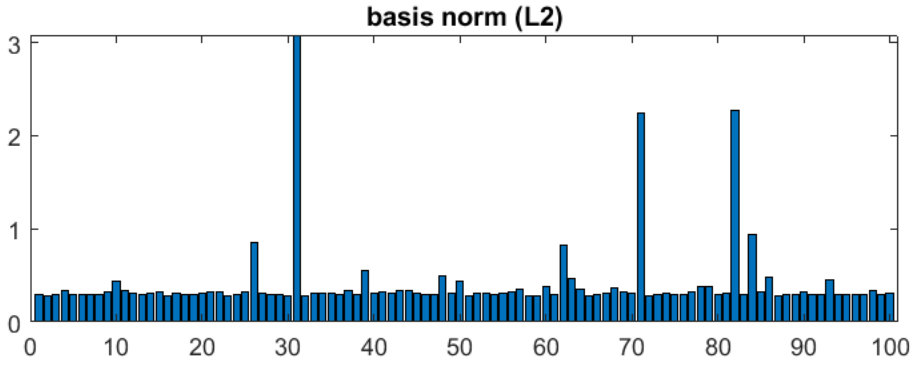


Yale (basis functions' sizes = 8*8):

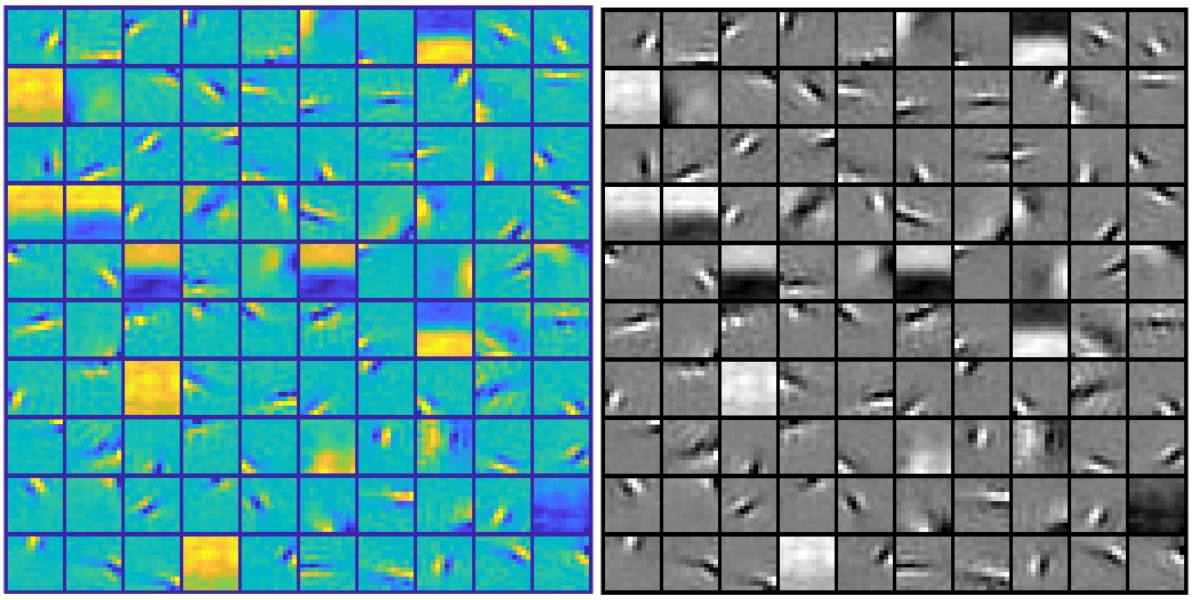


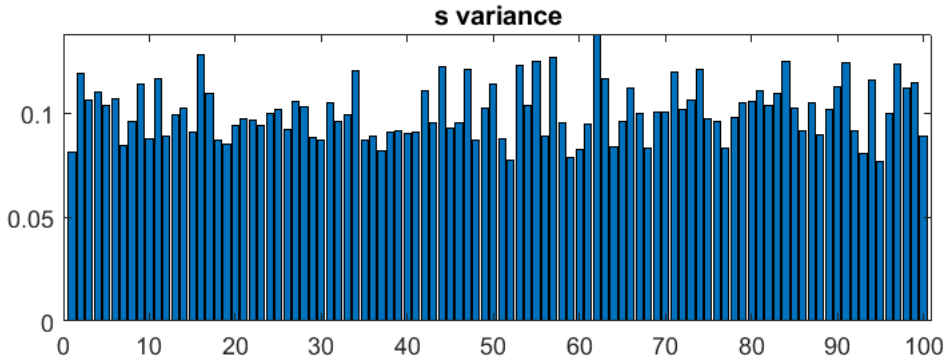


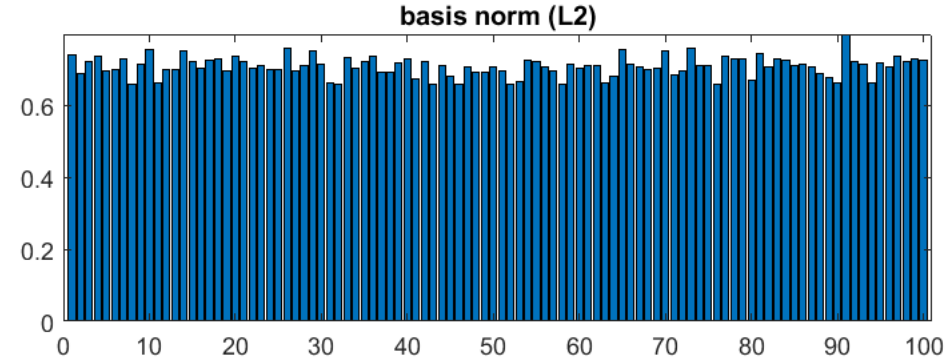




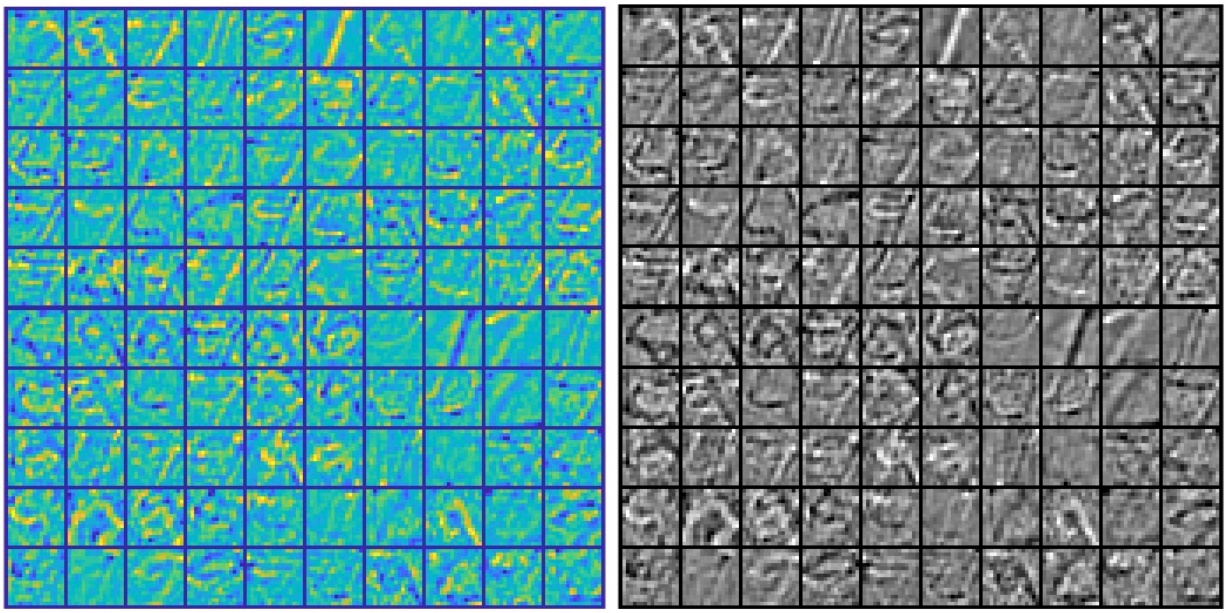
Yale (basis functions' sizes = 12*12):

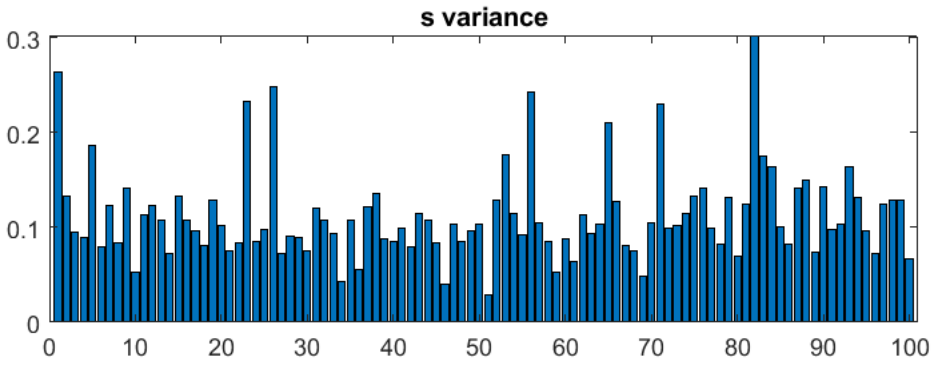


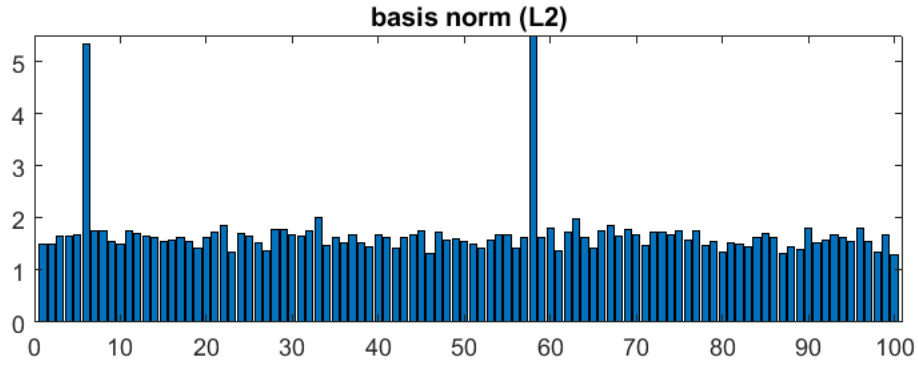




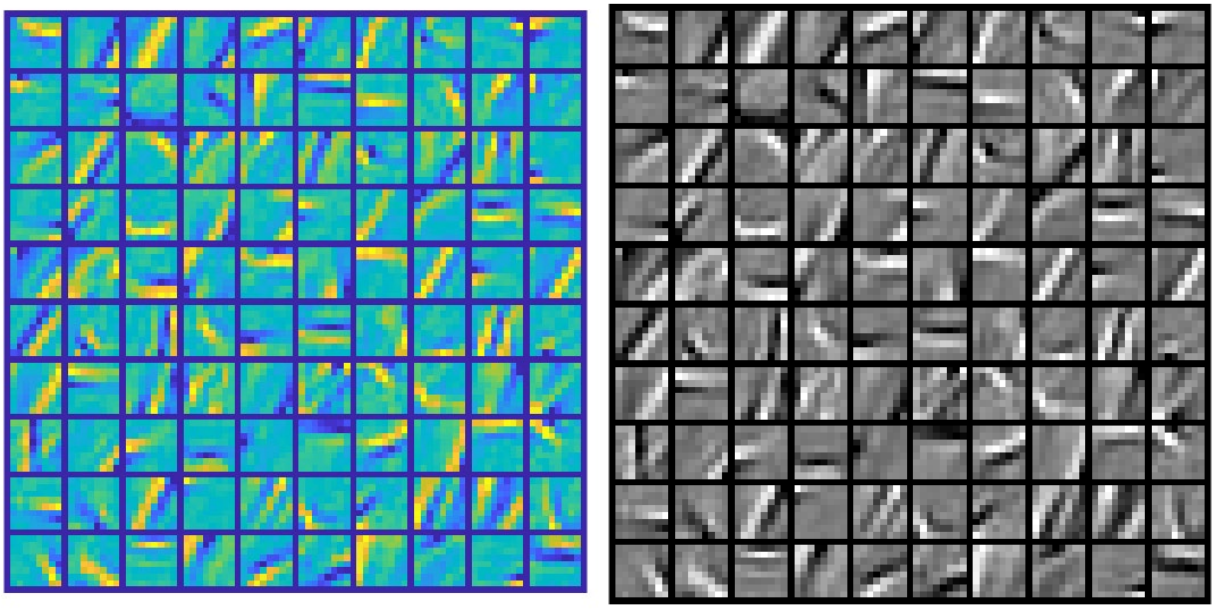
MNIST (basis functions' sizes = 16*16):

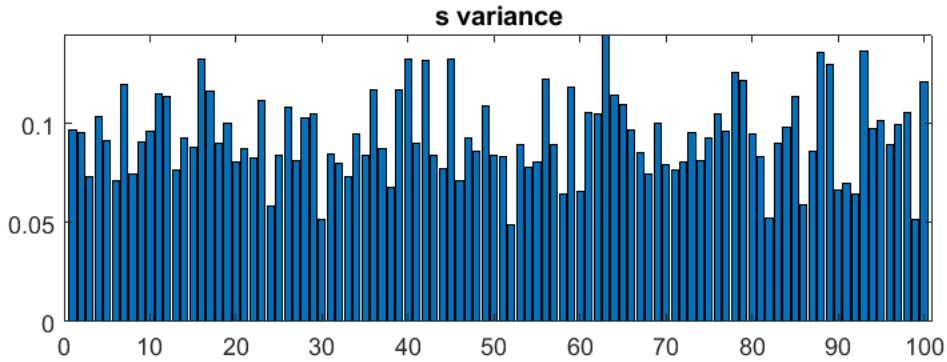


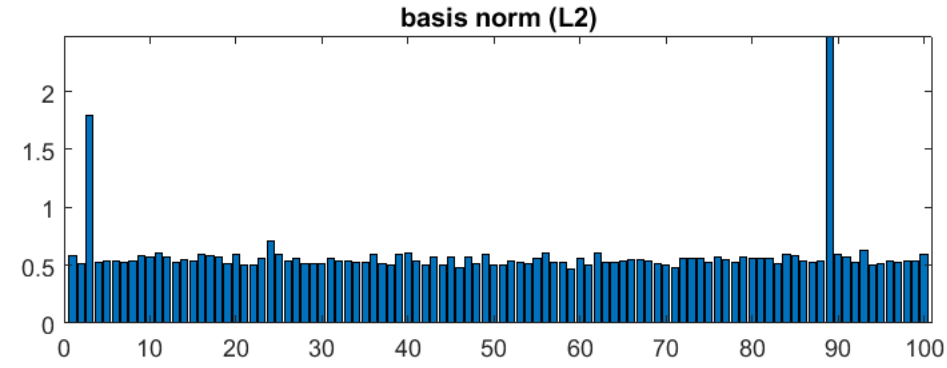




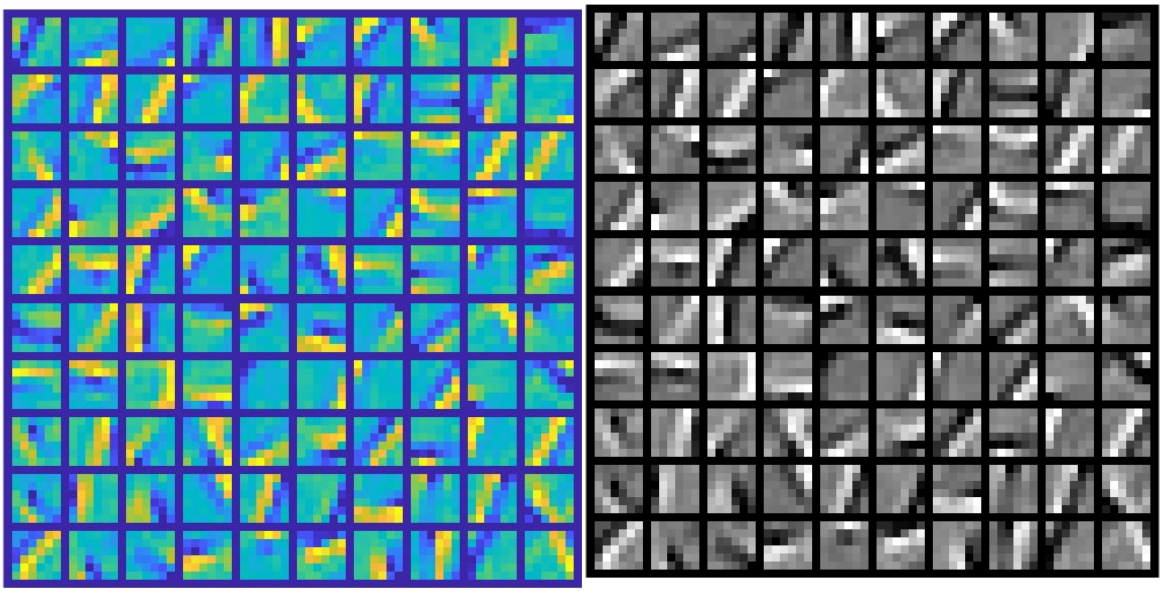
MNIST (basis functions' sizes = 8*8):

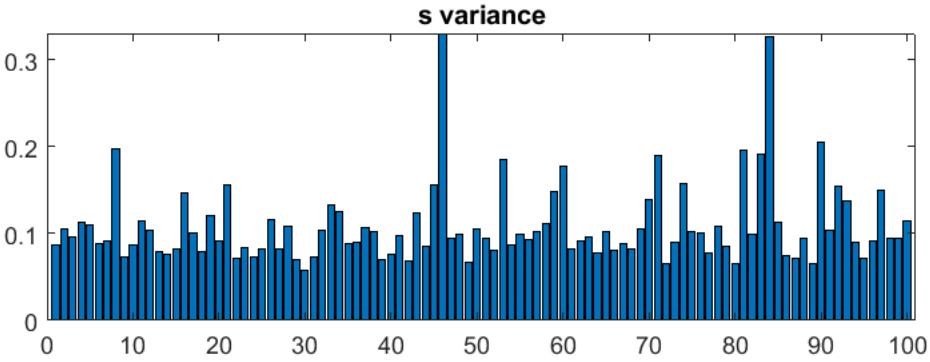


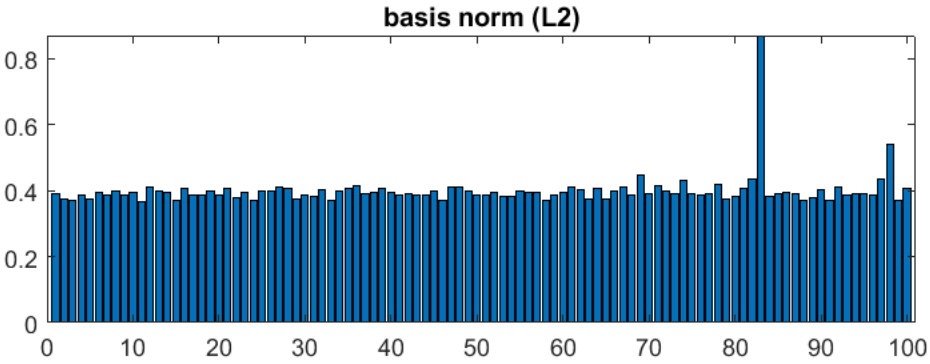




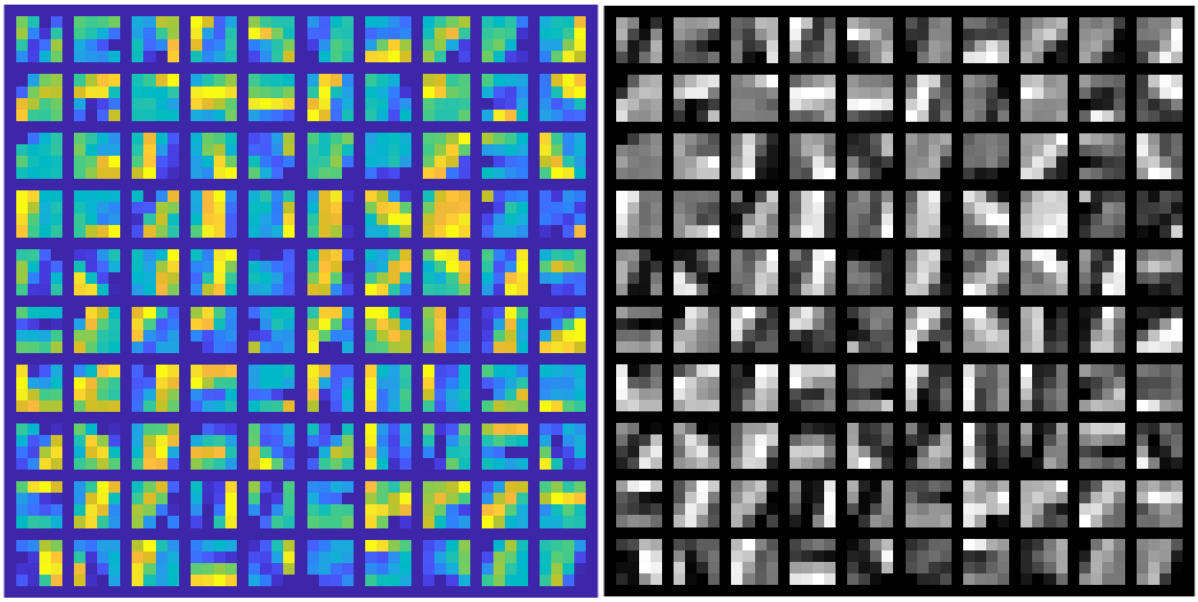
MNIST (basis functions' sizes = 6*6):

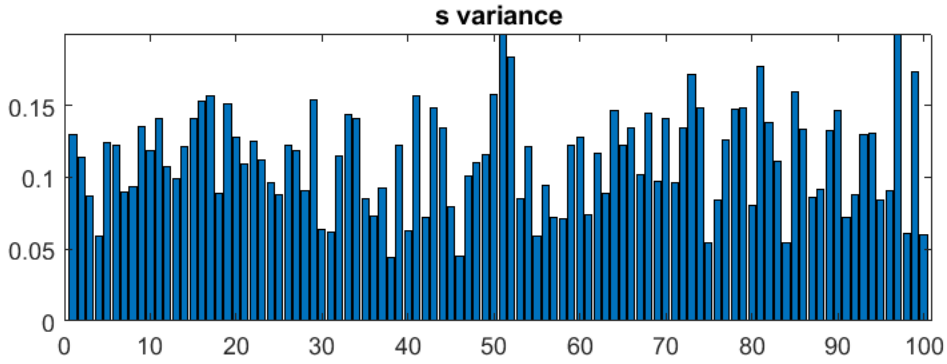


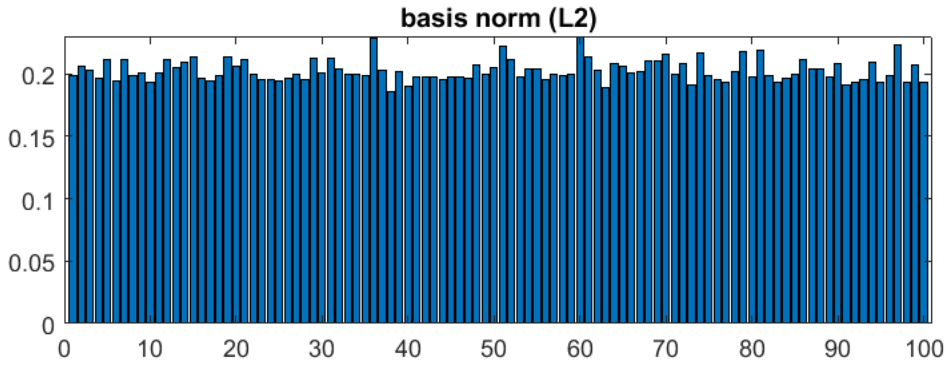




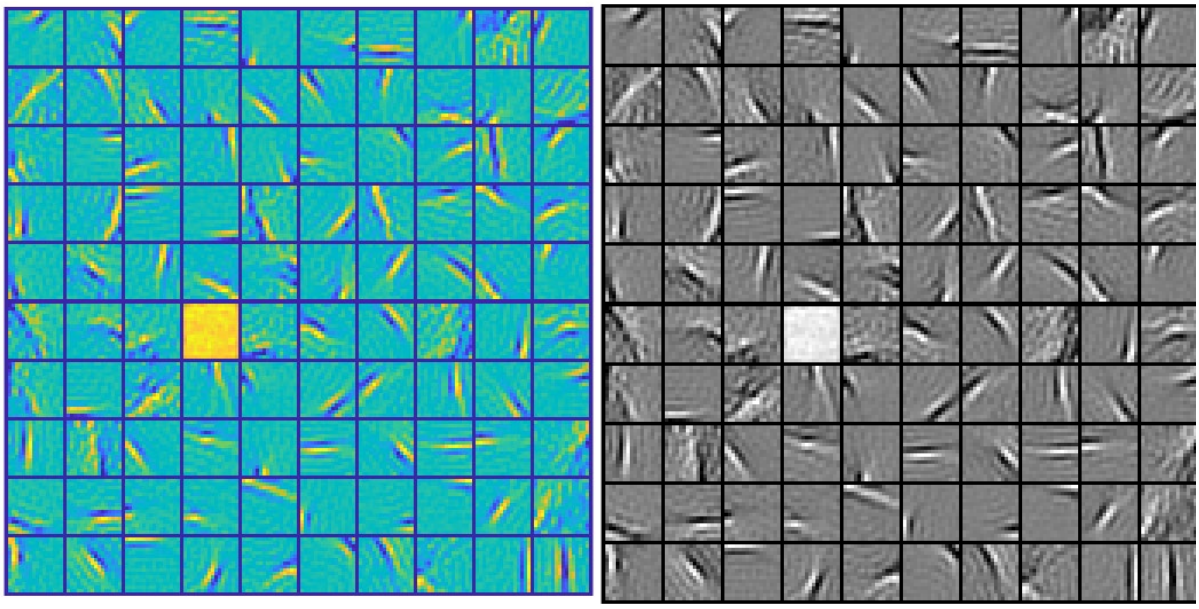
MNIST (basis functions' sizes = 4*4):

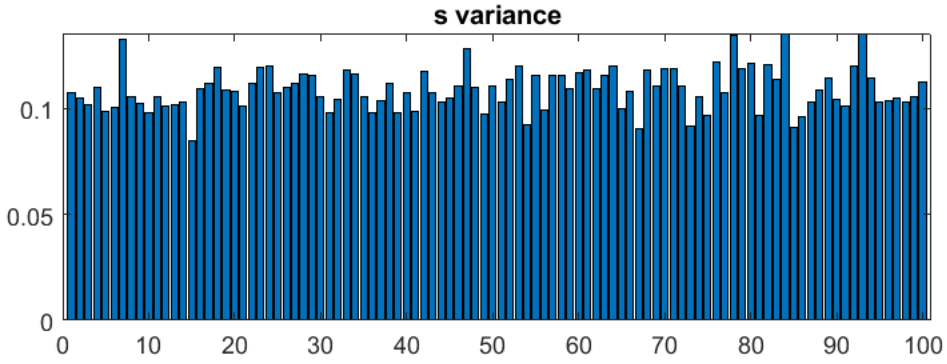


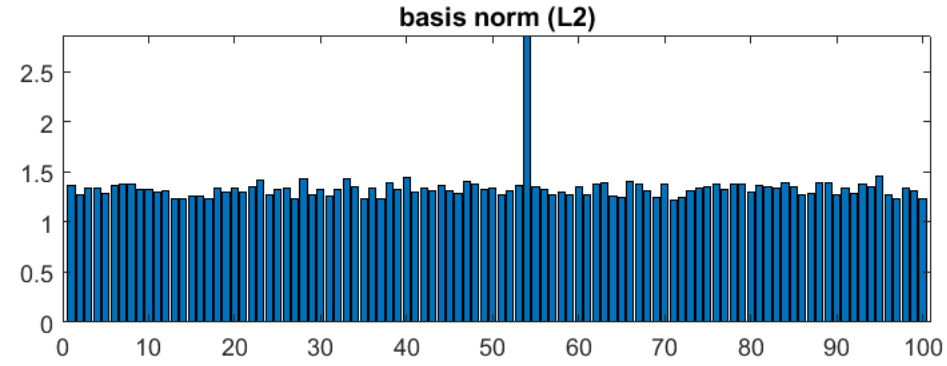




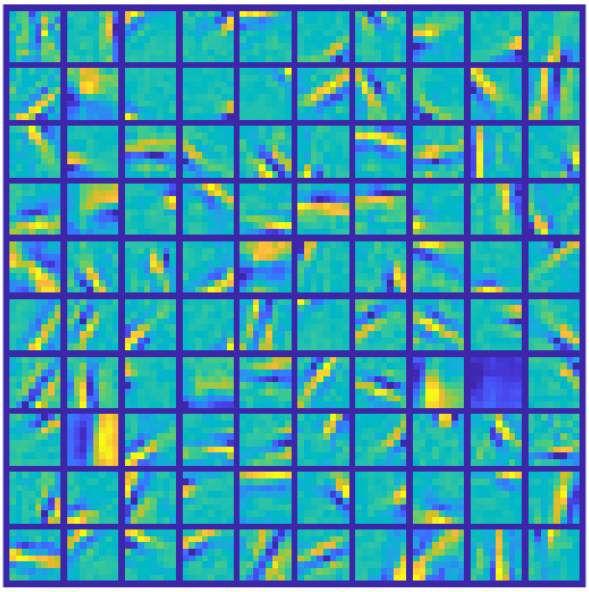
Caltech101 (basis functions' sizes = 16*16):

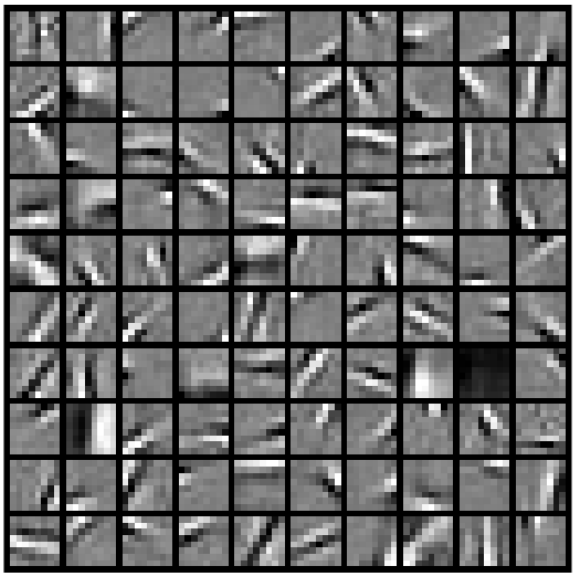


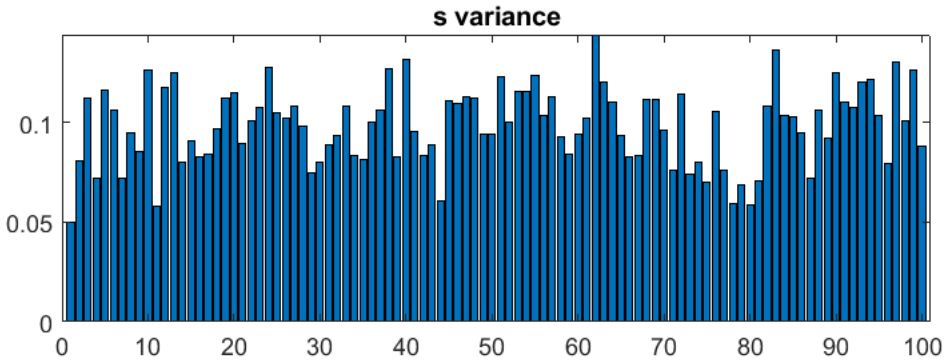


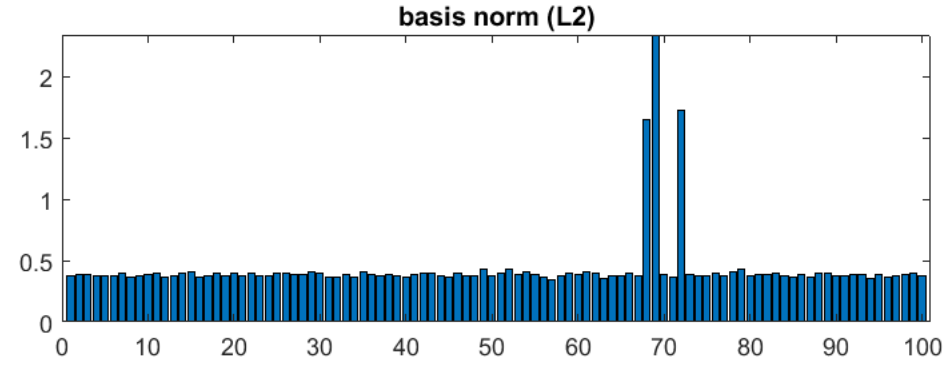


Caltech101 (basis functions' sizes = 8*8):

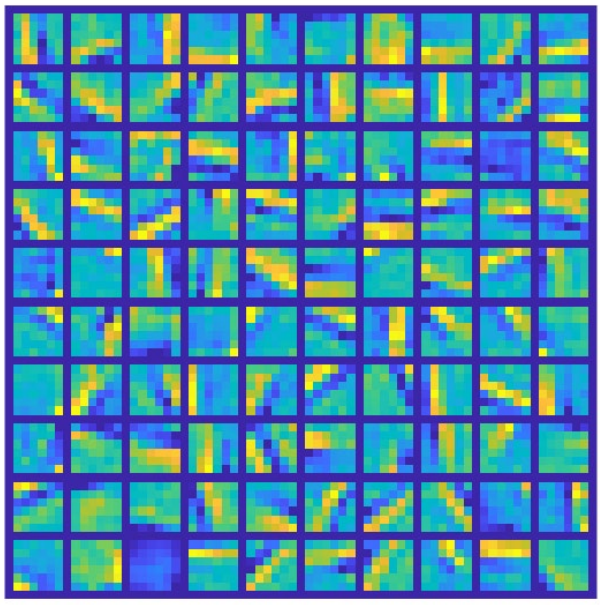


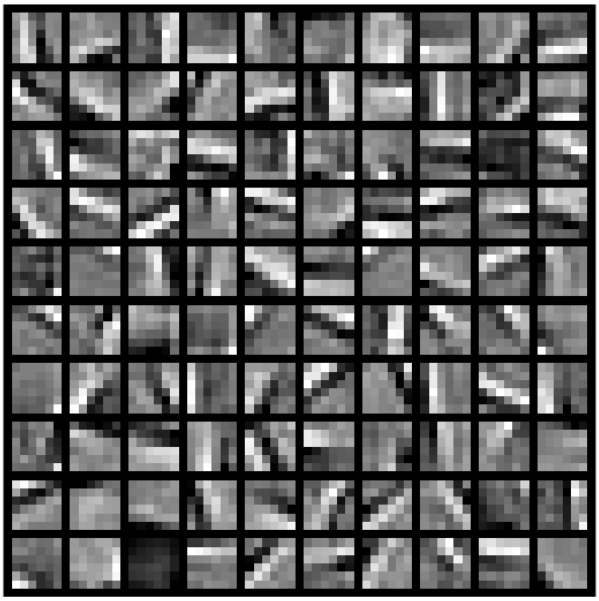


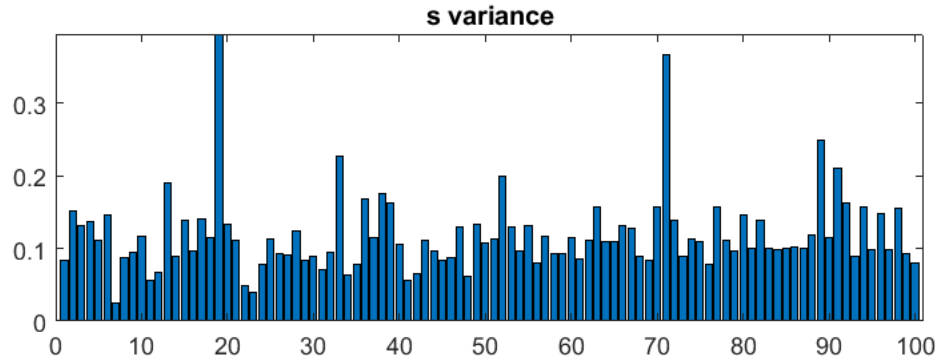


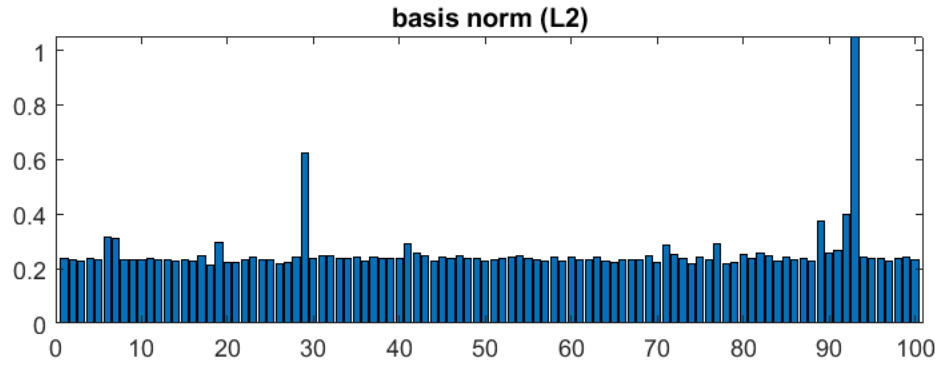


Caltech101 (basis functions' sizes = 6*6):

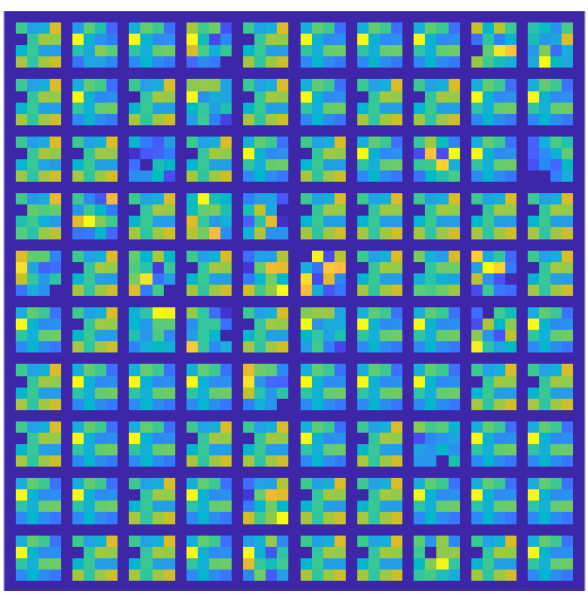


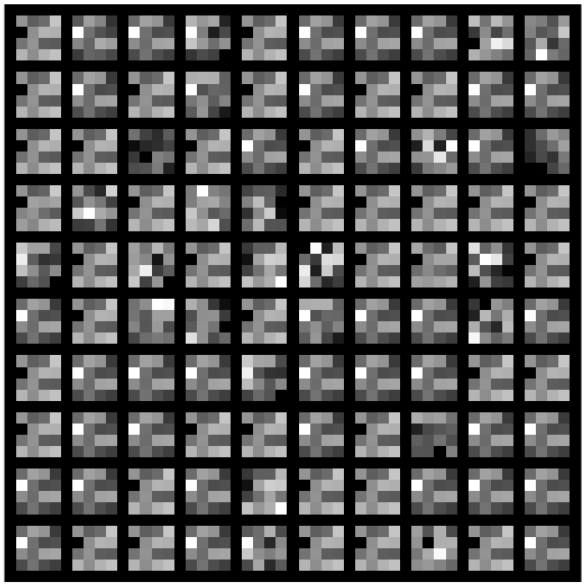


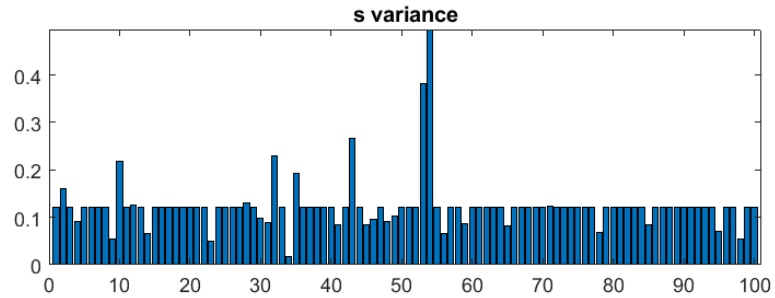


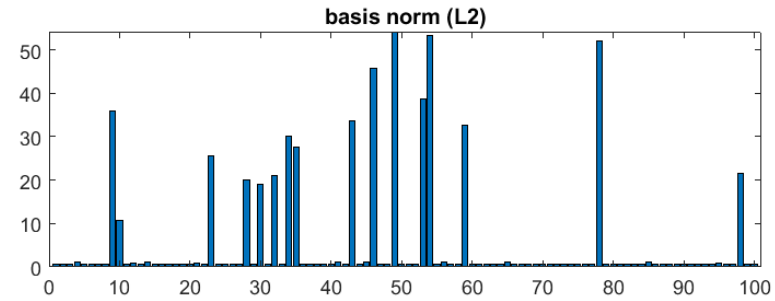


Caltech101 (basis functions' sizes = 4*4):



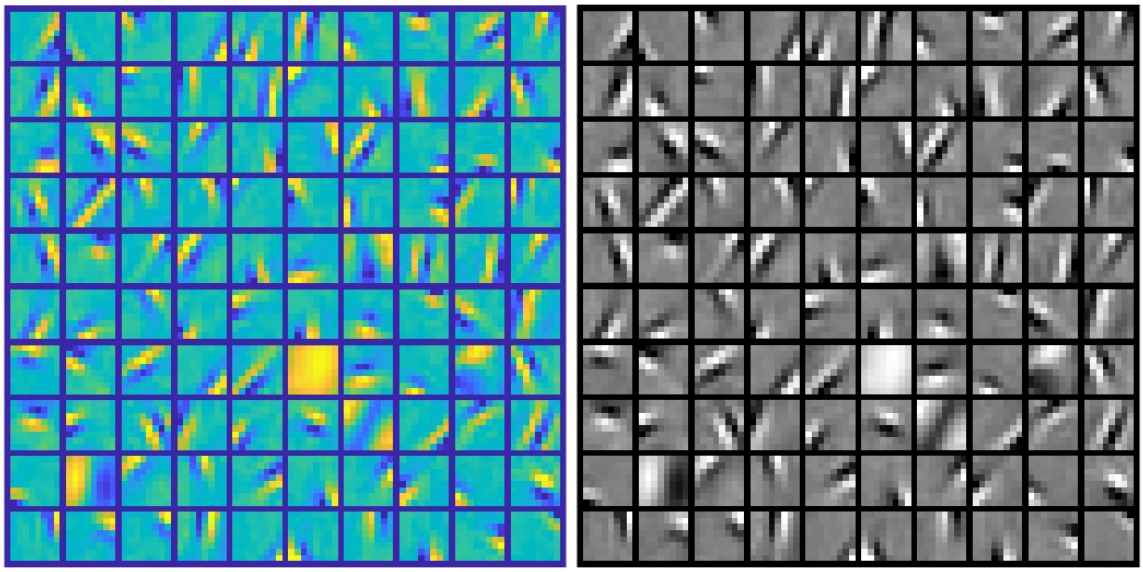


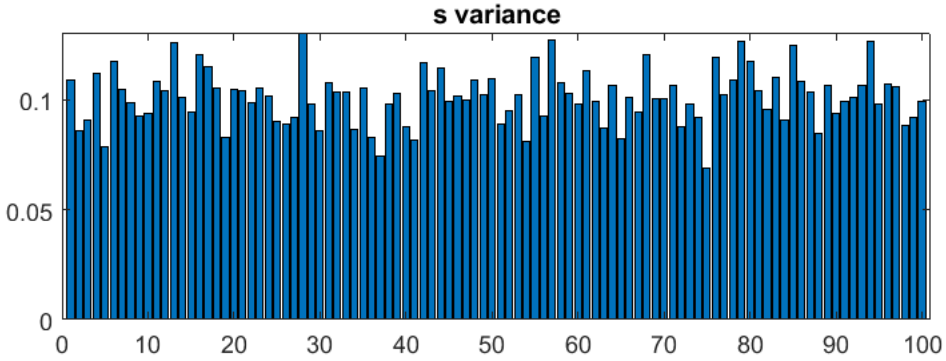


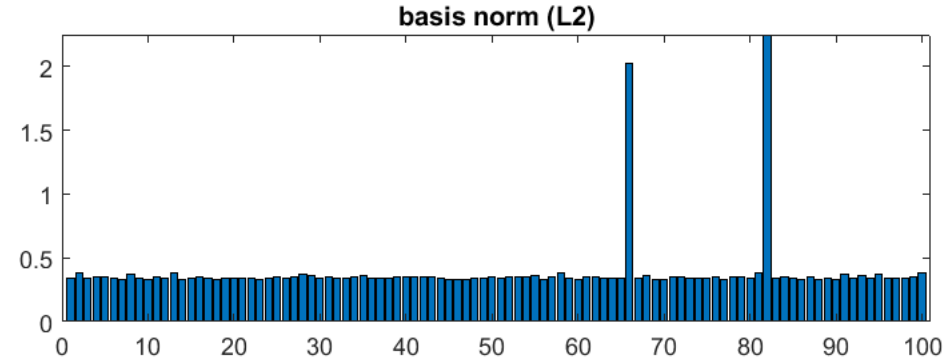


We can see that for all data sets except MNIST the 16*16 basis function size leads to the best result. However, it seems that for MNIST data set the best result is for when the basis function size is 8*8. This can be for the reason that the MNIST dataset images are not natural and have different sizes comparing to the papers' natural images.

Part 3) In this part, we study the dynamics of the sparse coefficients by finding the sparse coefficients for the BIRD video in the attachment. We selected the first 10 frames as one patch for finding 100 basis functions with size 8*8. Here are the results of training phase:







After that we break each frame of the video (from the frame 11), to 1296 patches of size 8*8 and calculate the coefficients for each on. In order to see the changes, we plotted, the heatmap of the normalized coefficients, the histogram of coefficients and the statistics (min, max, variance and mean) of the coefficients through time and made a video which is attached to this report.

Note that the average and variance correction and whitening are done for each frame at the first step.

Also, we can see the statistics below: