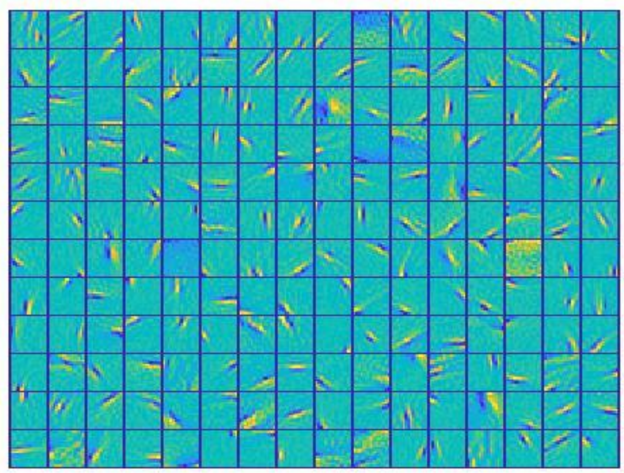
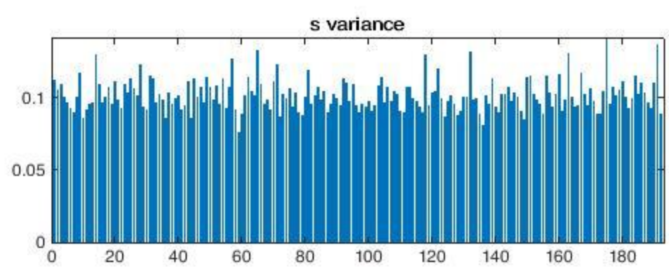
In the name of God

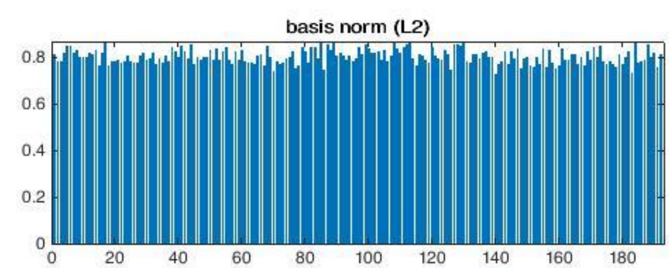
Arsalan Firoozi, 97102225

Homework 9 – Advanced Neuroscience

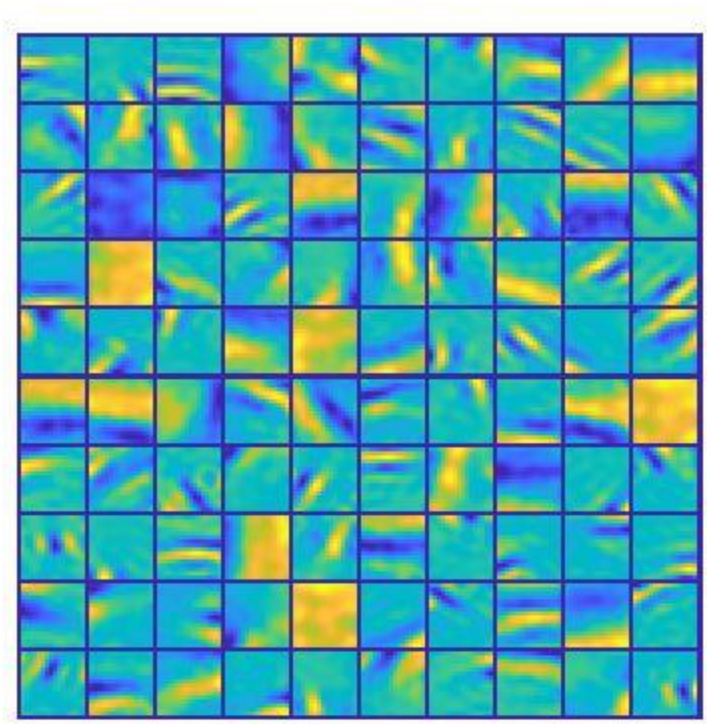
1. I have simulated 192 basis functions with size of 16x16 for natural images proposed in the Olshausen's paper. To do so, I've used IMAGES.mat and also change images to have an equal 0.1 variance for each image. The training was done by selecting 100 random patches from each image.
   You can see the basis functions below:

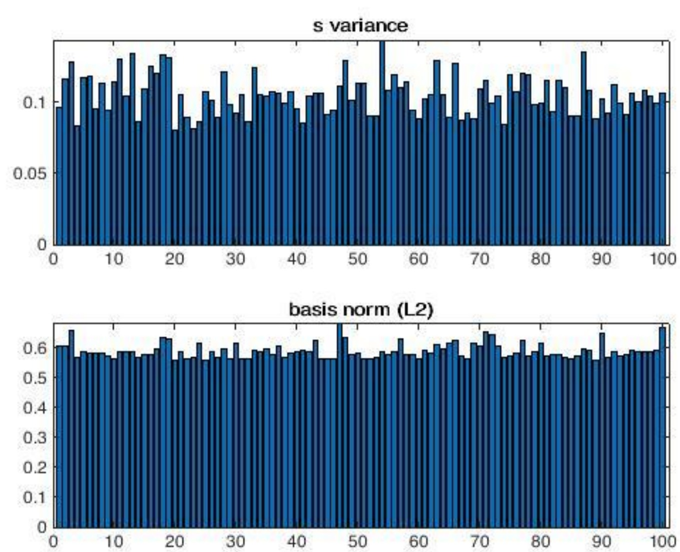




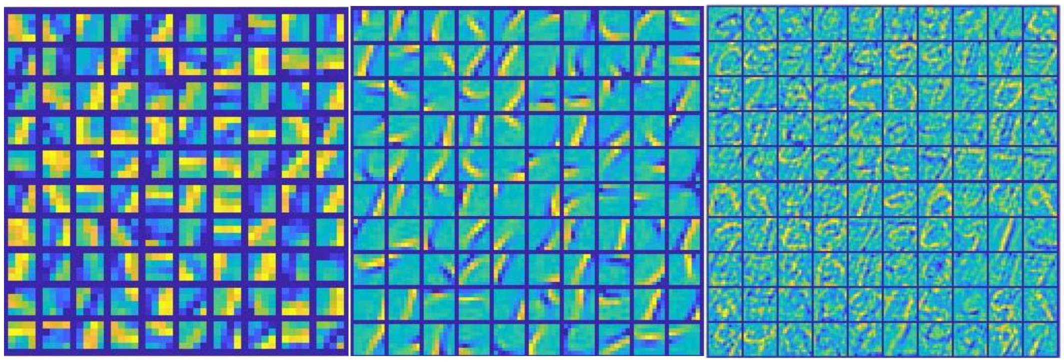


2. For Yale dataset, I’ve used the code in make-your-own-images file in the package to make image whitened and also scaled the image in a way that the mean becomes zero and all the variances be 0.1 .
   I’ve simulated with 100 basis functions with size of 16x16. You can see the result below:

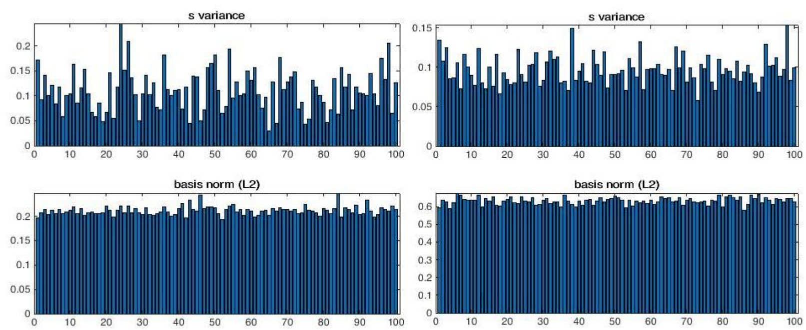


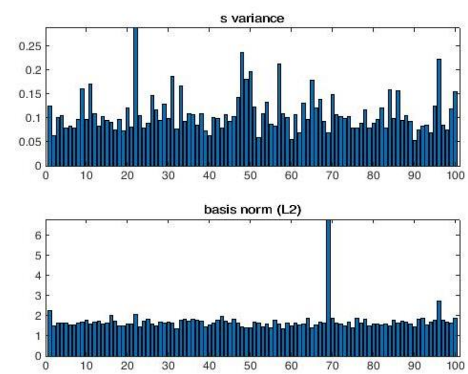


3. For MNIST dataset, size of basis functions is vital and changing it may leads to inappropriate result. Here you can see the result for 100 basis functions in order of 4x4, 8x8 and 16x16:



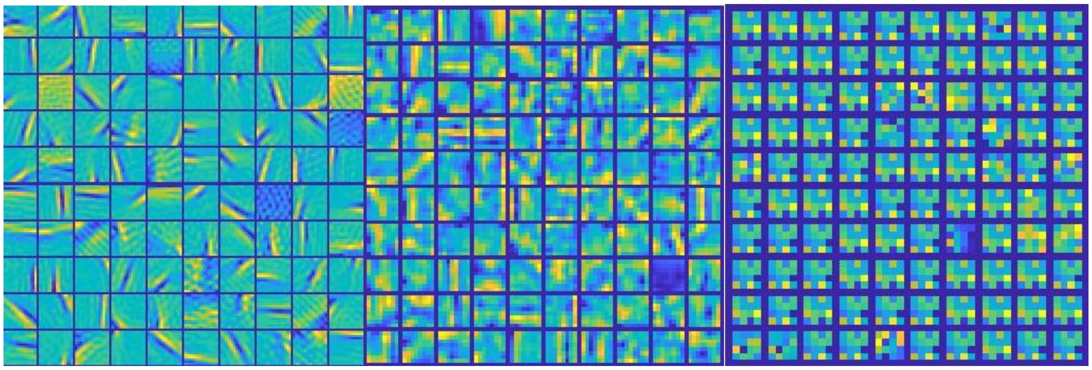
S variance and basis norm in the same order:



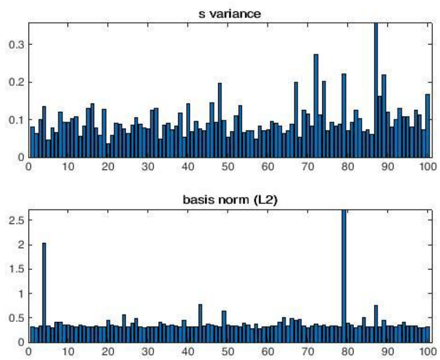


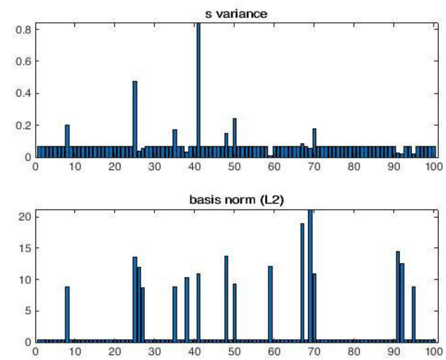
You can see that the best result is by size of 8x8 for basis functions. Increasing or decreasing the size has bad effect on basis functions. This can be due to the images which are not natural and also they have small size compared to paper's dataset.

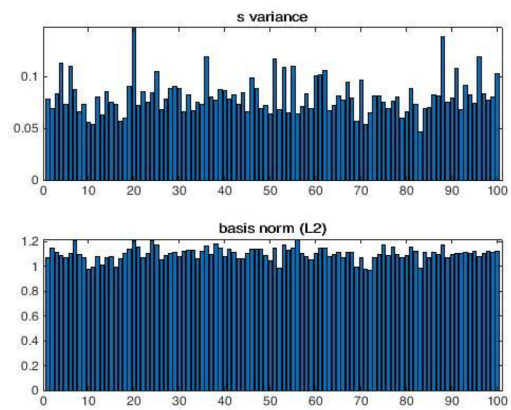
4. Simulated by the Caltech101 dataset for 100 basis functions with size of 16x16, 8x8 and 4x4:



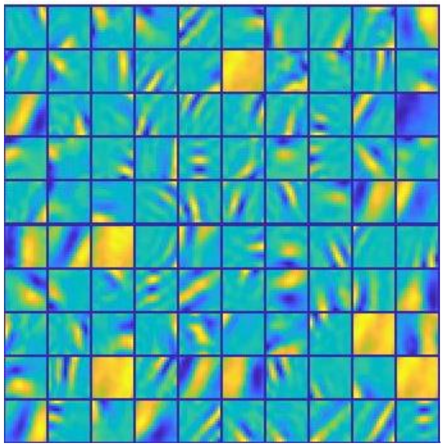
S variance and basis norm in the same order:

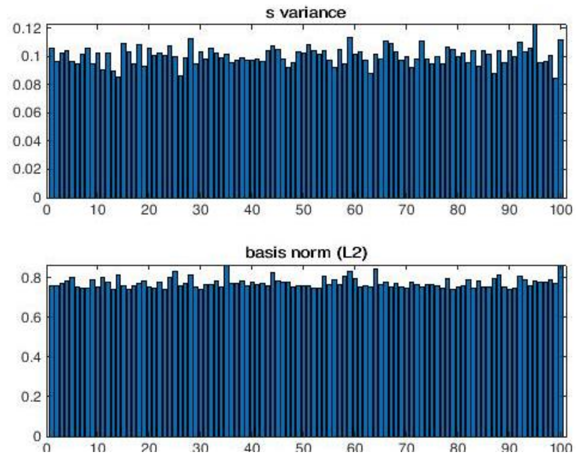






5. To study the dynamic of the sparse coefficients, I’ve trained using first 10 frames of bird movie for 100 basis functions with size of 16x16. You can see the basis functions below:





Then I’ve calculated the coefficients for each 324 patches resulted extracted for each frame after training. And created a movie showing which basis function has the biggest value in coefficients in each frame named “`bird_biggest_basis.avi`”.

Also I showed the changes of all coefficients in time for 6 different patches in locations below:
(3, 4), (3, 10), (6, 5), (6,17), (13,5), (13, 15)

The file names are:

```
Coef_Changes_58.avi
Coef_Changes_64.avi
Coef_Changes_113.avi
Coef_Changes_125.avi
Coef_Changes_239.avi
Coef_Changes_249.avi
```