cs194-16-Brain_Project

December 19, 2015

```
In [1]: import numpy as np, h5py
        import matplotlib.pyplot as plt
        %matplotlib inline

        estimatedRes  = h5py.File(’EstimatedResponses.mat’,’r’)
        estimatedRes.keys()
```

```
Out[1]: [u’dataTrnS1’,
         u’dataTrnS2’,
         u’dataValS1’,
         u’dataValS2’,
         u’roiS1’,
         u’roiS2’,
         u’voxIdxS1’,
         u’voxIdxS2’]
```

```
In [2]: # Validation data
        subj1Val = np.array(estimatedRes[’dataValS1’])
        subj2Val = np.array(estimatedRes[’dataValS2’])
```

```
In [3]: # Brain data
        subj1Train = np.array(estimatedRes[’dataTrnS1’])
        subj2Train = np.array(estimatedRes[’dataTrnS2’])
```

```
In [4]: # Regions of interest
        regionInterest1 = estimatedRes[’roiS1’][0]
        regionInterest2 = estimatedRes[’roiS2’][0]
```

— The following cells load, rescale, filter and featurize images. Skip this section if you dont have the image dataset —

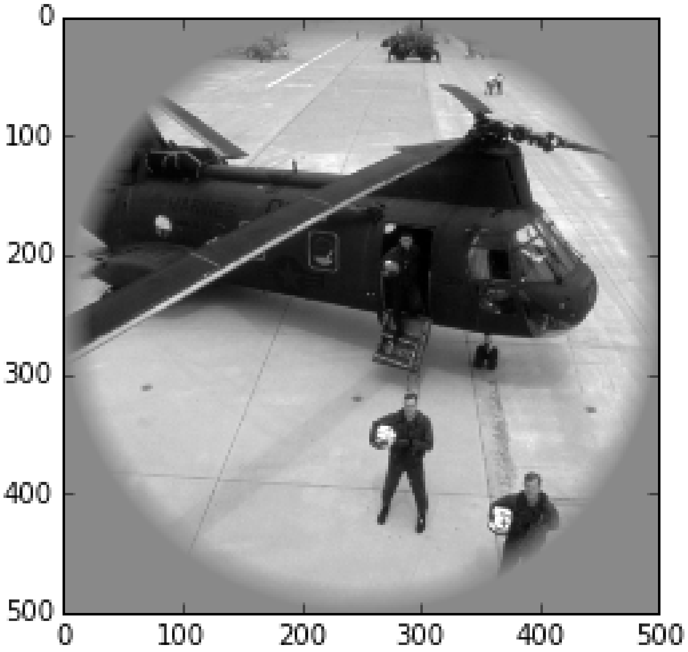
```
In [5]: # Loading Train Images
        imagesFullRes  = h5py.File(’Stimuli_Trn_FullRes_01.mat’,’r’)
        imagesFullRes = imagesFullRes[’stimTrn’][:].T

        for i in range(2,10):
            imageFile  = h5py.File(’Stimuli_Trn_FullRes_0’ + str(i) + ’.mat’,’r’)
            imagesFullRes = np.vstack([imagesFullRes , imageFile[’stimTrn’][:].T])

        for i in range(10,16):
            imageFile  = h5py.File(’Stimuli_Trn_FullRes_’ + str(i) + ’.mat’,’r’)
            imagesFullRes = np.vstack([imagesFullRes , imageFile[’stimTrn’][:].T])

        imagesFullRes.shape
```

```
Out[5]: (1750L, 500L, 500L)
```

```
In [6]: # Loading Validation Images
        valImgFull = h5py.File('Stimuli_Val_FullRes.mat','r')
        valImgFull =  valImgFull['stimVal'][:].T
```

```
In [7]: plt.imshow(imagesFullRes[1749], cmap='gray')
```

```
Out[7]: <matplotlib.image.AxesImage at 0x1115b400>
```



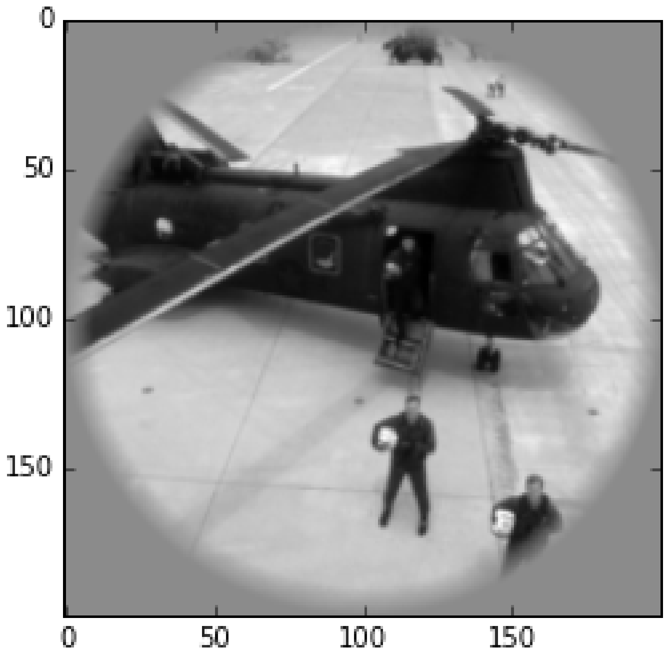
```
In [8]: # Resizing Train Images
        import scipy.misc as scipyMisc
        resizedImages = []
        for img in imagesFullRes:
            resizedImages.append(scipyMisc.imresize(img, size=(200,200)))

        resizedImages = np.asarray(resizedImages)
        resizedImages.shape
```

```
Out[8]: (1750L, 200L, 200L)
```

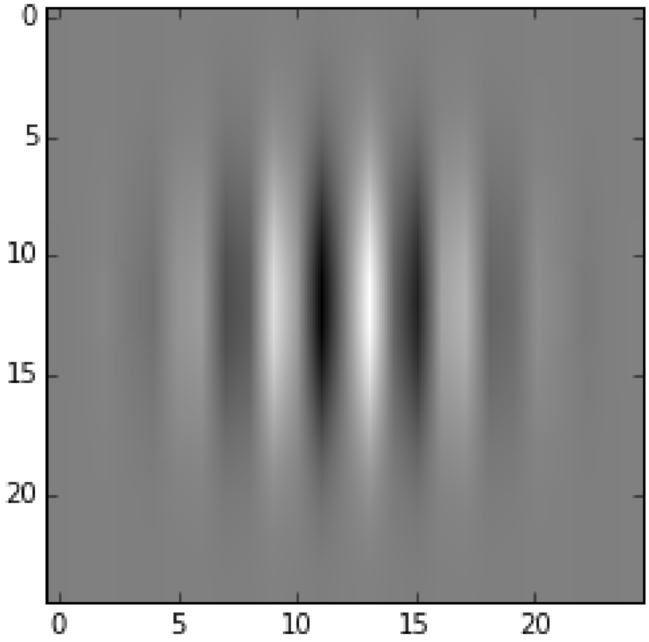
```
In [9]: # Resizing Validation Images
        resValImages = []
        for img in valImgFull:
            resValImages.append(scipyMisc.imresize(img, size=(200,200)))

        resValImages = np.asarray(resValImages)
        resValImages.shape
```

```
Out[9]: (120L, 200L, 200L)
```

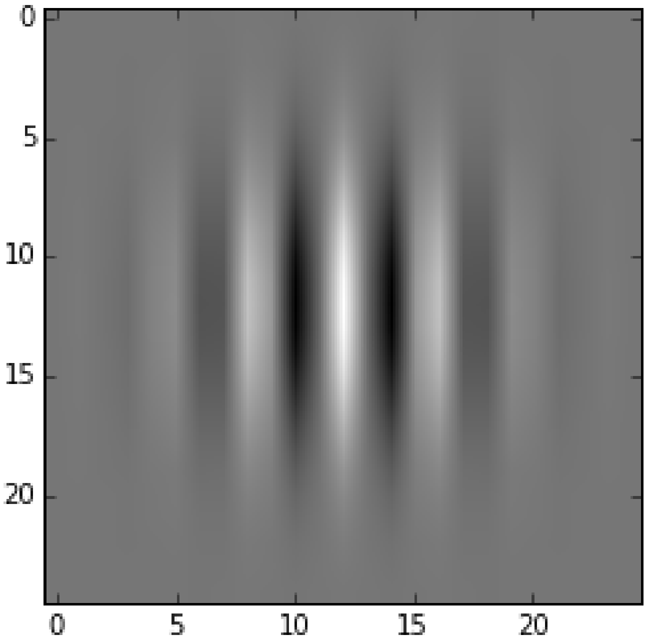
```
In [10]: plt.imshow(resizedImages[1749], cmap='gray')

Out[10]: <matplotlib.image.AxesImage at 0x10e6f780>
```



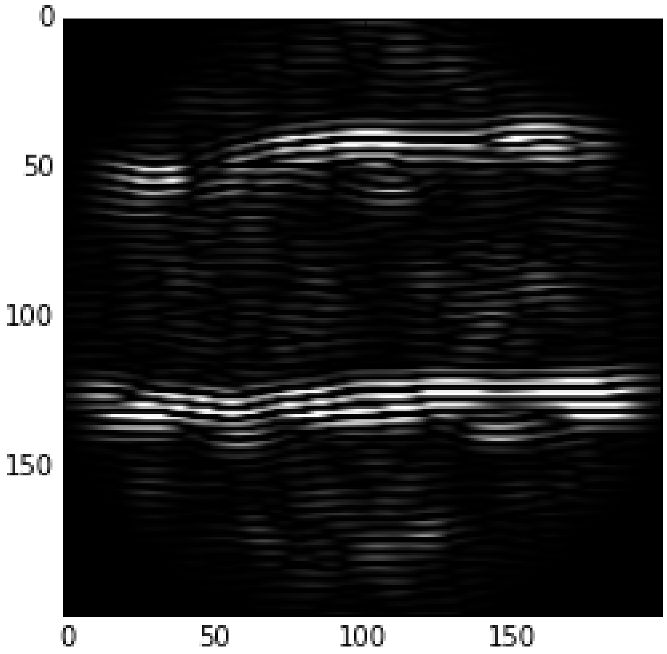
```
In [11]: # Gabor filters
         import cv2

         # 5 scales and 8 orientations
         def build_filters():
             scales = [200, 100, 50, 25, 10]
             filters = []
             for scal in scales:
                 for theta in np.arange(0, np.pi, np.pi / 6):
                     kern = cv2.getGaborKernel((scal, scal), 4.0, theta, 0.5, 1, 0, ktype=cv2.CV_32F)
                     kern2 = cv2.getGaborKernel((scal, scal), 4.0, theta, 0.5, 1, np.pi/2.0, ktype=cv2.
                     #kern /= 1.5*kern.sum()
                     #kern2 /= 1.5*kern2.sum()
                     filters.append(kern)
                     filters.append(kern2)
             return np.asarray(filters)

         def process(img, filters):
             convImg = []
             for kern in filters:
                 accum = np.zeros_like(img)
                 cv2.filter2D(src=img, ddepth=cv2.CV_8UC3, dst=accum, kernel=kern)
                 convImg.append(accum)
             return np.asarray(convImg)
         filters = build_filters()
         filters.shape

Out[11]: (60L,)

In [12]: plt.imshow(filters[47], cmap='gray')

Out[12]: <matplotlib.image.AxesImage at 0xd4b0cf8>
```



```
In [13]: plt.imshow(filters[46], cmap='gray')

Out[13]: <matplotlib.image.AxesImage at 0xd662d68>
```



```
In [15]: # Filtering Train images
         filteredImg = []
         for img in resizedImages:
             filteredImg.append(process(img, filters))

         filteredImg = np.asarray(filteredImg)

In [16]: plt.imshow(filteredImg[102][20], cmap='gray')

Out[16]: <matplotlib.image.AxesImage at 0x2a3a91d0>
```



```
In [17]: # Filtering Validation images
         filteredValImg = []
         for img in resValImages:
             filteredValImg.append(process(img, filters))

         filteredValImg = np.asarray(filteredValImg)

In [18]: # extracting Local Energy features - Train
         localEnergyFeat = []

         for img in filteredImg:
             features = []
             for feat in img:
                 alpha = np.dot(feat.flatten(), feat.flatten())
                 features.append(np.sqrt(alpha))
             localEnergyFeat.append(features)

         localEnergyFeat = np.asarray(localEnergyFeat)

In [19]: localEnergyFeat.shape

Out[19]: (1750L, 60L)

In [20]: # extracting Local Energy features - Validation
         valLocalEnergyFeat = []

         for img in filteredValImg:
             features = []
             for feat in img:
                 alpha = np.dot(feat.flatten(), feat.flatten())
```

```
                features.append(np.sqrt(alpha))
            valLocalEnergyFeat.append(features)

        valLocalEnergyFeat = np.asarray(valLocalEnergyFeat)
```

```
In [21]: # extracting Mean Amplitude - Train
         meanAmpFeat = []

         for img in filteredImg:
             features = []
             for feat in img:
                 alpha = np.sum(np.absolute(feat.flatten()))
                 features.append(alpha)
             meanAmpFeat.append(features)

         meanAmpFeat = np.asarray(meanAmpFeat)
```

```
In [22]: meanAmpFeat.shape
```

```
Out[22]: (1750L, 60L)
```

```
In [23]: # extracting Mean Amplitude - Validation
         valMeanAmpFeat = []

         for img in filteredValImg:
             features = []
             for feat in img:
                 alpha = np.sum(np.absolute(feat.flatten()))
                 features.append(alpha)
             valMeanAmpFeat.append(features)

         valMeanAmpFeat = np.asarray(valMeanAmpFeat)
```

```
In [24]: # Combine feature vectors - Train
         featImgs = []

         for locEng, meanAmp in zip(localEnergyFeat, meanAmpFeat):
             featImgs.append(np.hstack((locEng, meanAmp)))

         featImgs = np.asarray(featImgs)
         featImgs.shape
```

```
Out[24]: (1750L, 120L)
```

```
In [25]: # Combine feature vectors - Validation
         featValImgs = []

         for locEng, meanAmp in zip(valLocalEnergyFeat, valMeanAmpFeat):
             featValImgs.append(np.hstack((locEng, meanAmp)))

         featValImgs = np.asarray(featValImgs)
         featValImgs.shape
```

```
Out[25]: (120L, 120L)
```

```
In [26]: np.save('featImgs',featImgs)
         np.save('featValImgs', featValImgs)
```

```
In [ ]: featImgs = np.load('featImgs.npy')
        featValImgs = np.load('featValImgs.npy')
```

0.0.1 Linear Regression Voxel 1

```
In [27]: from sklearn.linear_model import LinearRegression
```

```
In [28]: classifier = LinearRegression()
         voxel = 17589
```

```
In [29]: indx = np.where( np.logical_not(np.isnan(subj1Train[:,voxel])))
         indx = indx[0]
```

```
In [30]: classifier.fit(featImgs[indx], subj1Train[indx,voxel])
```

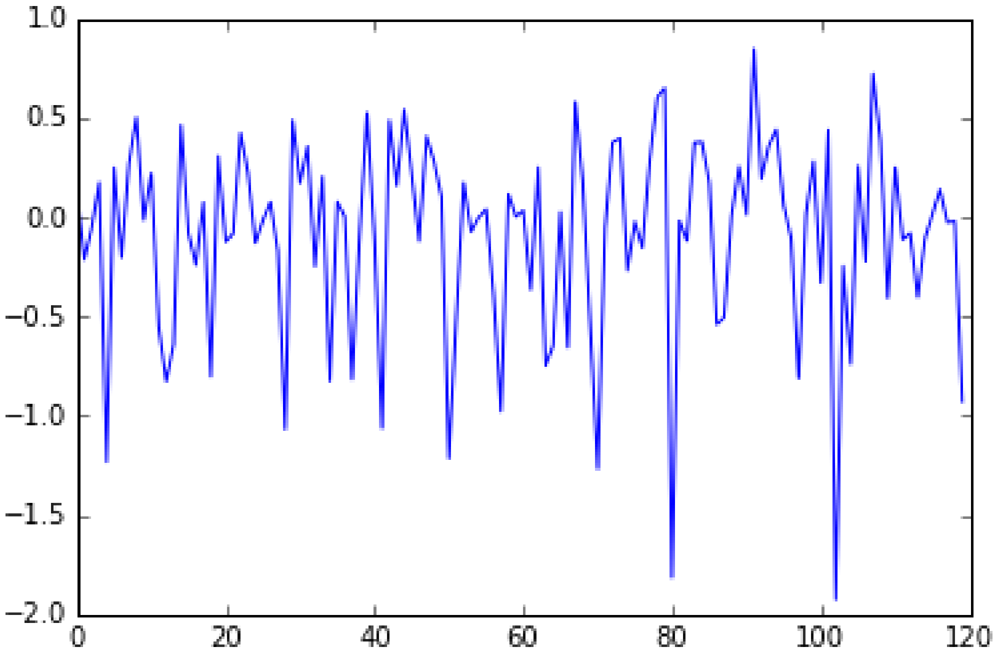
```
Out[30]: LinearRegression(copy_X=True, fit_intercept=True, n_jobs=1, normalize=False)
```

```
In [31]: indxVal = np.where( np.logical_not(np.isnan(subj1Val[:,voxel])))
         indxVal = indxVal[0]
```

```
In [32]: predictions = classifier.predict(featValImgs[indxVal])
```

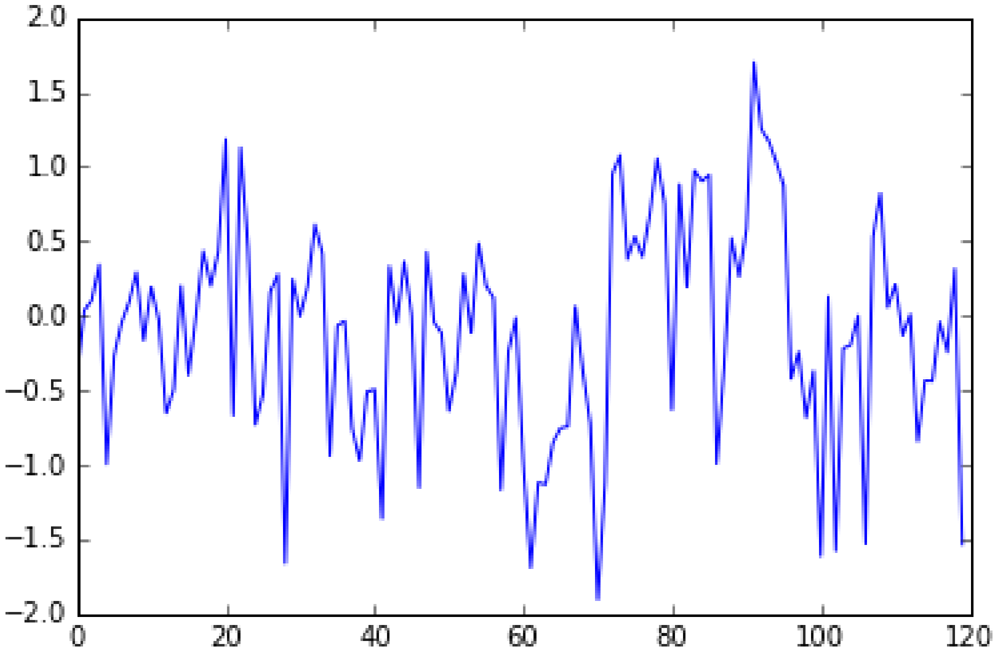
```
In [33]: plt.plot(predictions)
```

```
Out[33]: [<matplotlib.lines.Line2D at 0xc29bfd0>]
```



```
In [34]: plt.plot(subj1Val[indxVal,voxel])
```

```
Out[34]: [<matplotlib.lines.Line2D at 0xb963278>]
```

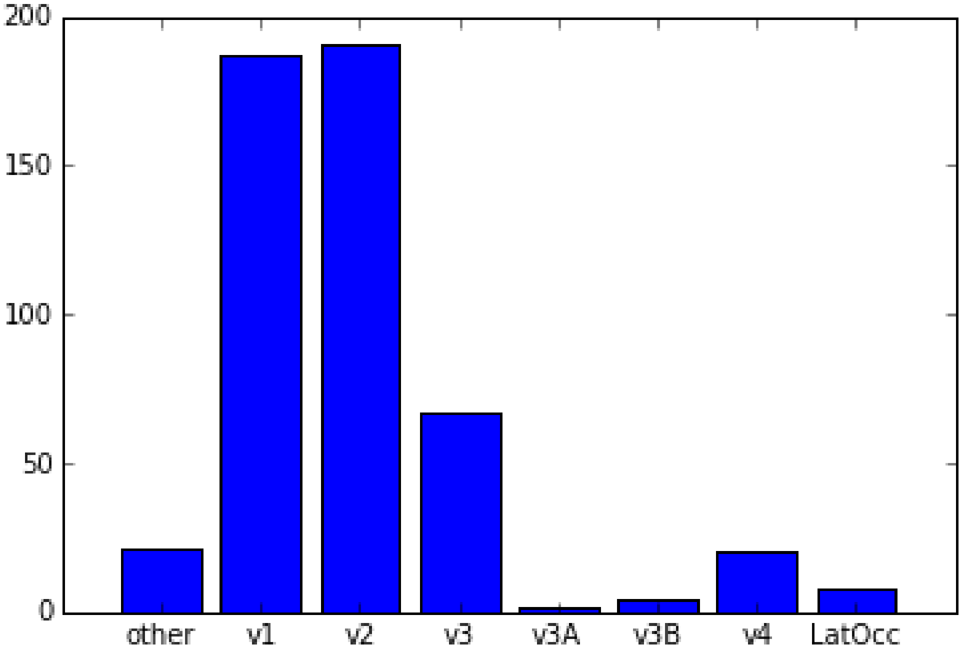


```
In [35]: classifier.score(featValImgs[indxVal],subj1Val[indxVal,voxel])

Out[35]: 0.4256087759738798
```

0.0.2 Voxels with best Prediction Score

```
In [36]: voxelScores = []
         for vox in range(subj1Val.shape[1]):
             classifierVox = LinearRegression()
             indx = np.where( np.logical_not(np.isnan(subj1Train[:,vox])))
             indx = indx[0]
             if indx.size == 0:
                 continue
             classifierVox.fit(featImgs[indx], subj1Train[indx,vox])
             indxVal = np.where( np.logical_not(np.isnan(subj1Val[:,vox])))
             indxVal = indxVal[0]
             if indxVal.size == 0:
                 continue
             score = classifierVox.score(featValImgs[indxVal],subj1Val[indxVal,vox])
             voxelScores.append((score, vox))

In [42]: sortedScores = sorted(voxelScores, key=lambda x: x[0], reverse=True)
         #sortedScores[:500]

In [39]: topVoxels = [voxel for _,voxel in sortedScores[:500]]

In [40]: topRegions = [regionInterest1[vox] for vox in topVoxels]

In [41]: from collections import Counter
```

```
regCount = Counter(topRegions)
plt.bar(range(len(regCount)), regCount.values(), align='center')
plt.xticks(range(len(regCount)), ['other', 'v1', 'v2', 'v3', 'v3A', 'v3B', 'v4', 'LatOcc'])
plt.show()
```


other
v1
v2
v3
v3A
v3B
v4
LatOcc