Machine Learning Project 4

- b03902089 資工三 林良翰

Eigenfaces with PCA

Data Sets

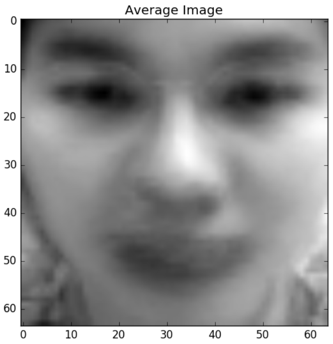
- Description: Eigenflow Based Face Authentication (http://chenlab.ece.cornell.edu/projects/FaceAuthentication/Default.html)
- Download: link (http://chenlab.ece.cornell.edu/projects/FaceAuthentication/download.html)

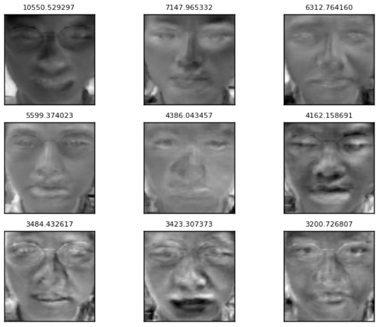
Usage

```
python pca.py
```

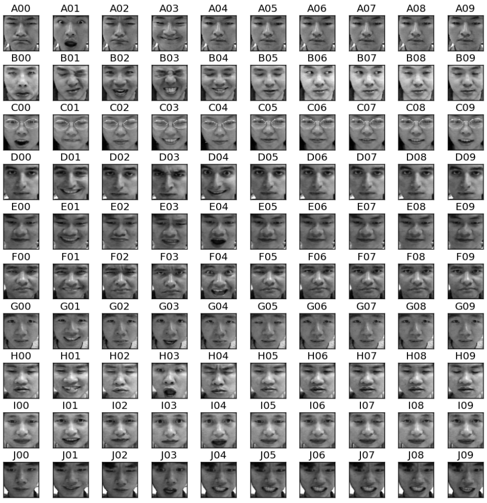
Questions

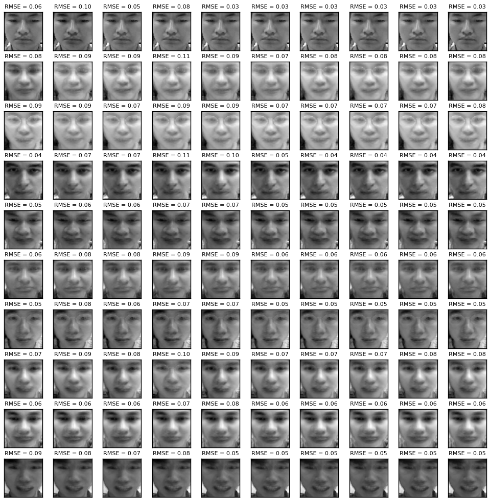
1. **Perform PCA using the first 10 faces of the first 10 subjects to obtain the eigenfaces. Plot the average face. Also plot the top 9 eigenfaces in a figure.**





2. **Project the 100 faces onto the top 5 eigenfaces, and then reconstruct the original images. Plot the 100 original faces and the recovered faces.**





3. **In 2., we can choose top k eigenfaces and check the reconstruction error (RMSE). Find the smallest k such that the error is less than 1%.**
    - Smallest $k = 56, RMSE = 0.98\%$

Visualization of Word Vectors

Usage

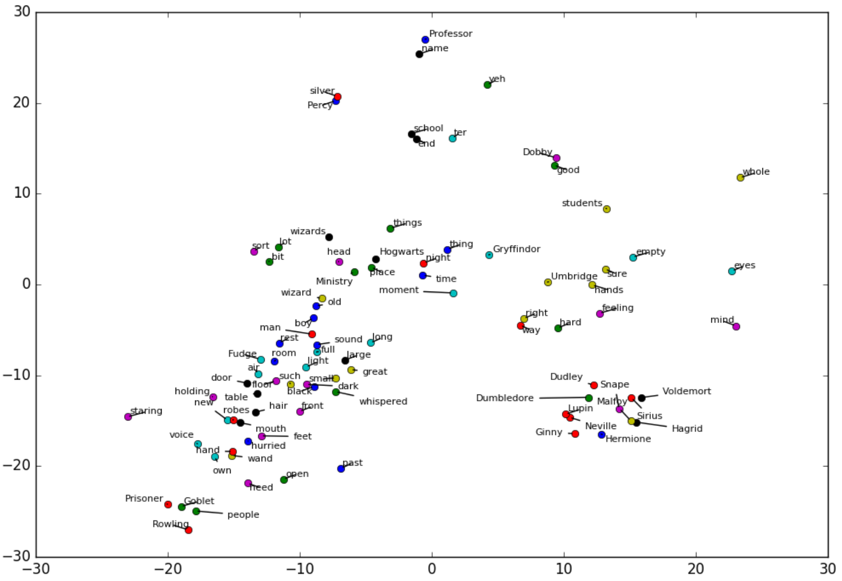
```
python wordvec.py [--download-nltk] [--load-vector]
```

Data Sets

- Corpus: Harry Potter Series
- Download: link (https://archive.org/compress/Book5TheOrderOfThePhoenix/formats=DJVUTXT&file=/Book5TheOrderOfThePhoenix.zip)

Questions

1. **Train word vectors with the toolkit. Report the parameters you used and explain what the parameters mean.**
    - `word2vec()` : `size=50` , convert words into vectors of 50 dimensions.
    - `TSNE()` : `n_component=2` , reduce the dimension of vectors to 2.
2. **Plot the visualization of word vectors on 2D space. Show the figure in your report.**



3. **Discuss your observations from the visualization.**
    - Names(labeled None) and other nouns(NN, NNP, NNS) are seperated clearly.
    - There are some words not in the two main clusters, but the meaning of words are highly related with the clusters.

Estimation of Intrinsic Dimension

Usage

```
python dim.py [--load-variance] [--load-center]
```

Data Sets

- There are 200 sets $[S_1 \dots S_{200}]$ of data. Each set contains 10k-100k datapoints in $\mathbb{R}^{100}$.
- Each Set of data are generated from oracle network: $i \in [1, 200]$

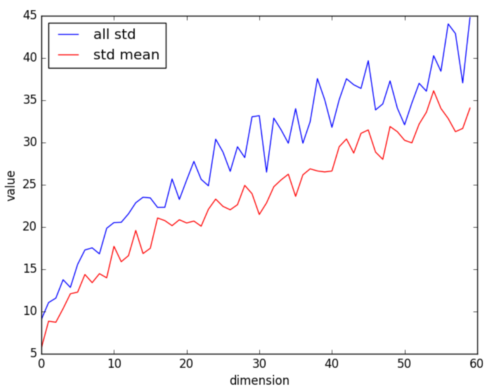
$$\mathbb{R}^{d_i} \overbrace{\longrightarrow}^{ELU} \mathbb{R}^{h_i} \overbrace{\longrightarrow}^{ELU} \mathbb{R}^{100} \overbrace{\longrightarrow}^{Linear} \mathbb{R}^{100}$$

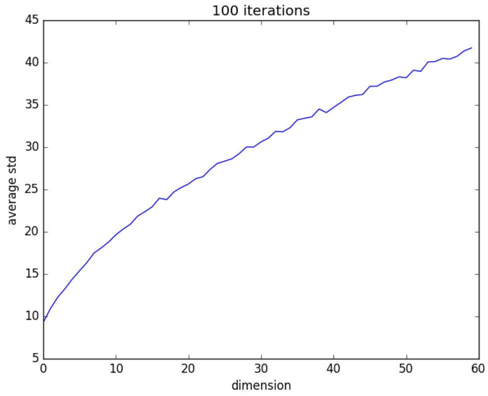
where $h_i \in [60, 79]$ uniformly, and each layer performs a transformation $f\,(Wx + b)$, both matrix W, vector b are sampled from $N\,(0, 0.5)$

Questions

1. **Please elaborate your method and why you used that method. Discuss the results in detail.**

    - I modified `gen.py` to run on $[1, 60]$ dimensions, with random sample size $N \in \left[10^4, 10^5\right]$, $h_i \in [60, 79]$, and found that the dimension of input d_i and the standard deviation of output σ_i are highly positive related.





    - Method 1: K-Means Clustering
        - According to the positive correlation between input d_i and output σ_i, use K-means clustering to find 60 clusters $[k_1, \dots, k_{60}]$ and label the dimension of each cluster with respect to the mean of standard deviation $\left[\sigma_{k1}, \dots, \sigma_{k60}\right]$.
        - Error on Kaggle public test: 0.15632
    - Method 2: K-Means Clustering with Initial Centers
        - Besides K-means clustering, I generate 60 averaged centers of output σ_i from input $d_i \in [1, 60]$ for 100 iterations, and let them be the initial centers of k-means clustering.
        - Error on Kaggle public test: 0.13157
    - Method 3: Initial Centers ONLY!
        - Simply trust the centers generated by myself, and find the closest center for each data set for labeling dimensions.
        - Error on Kaggle public test: 0.11435

2. **Download the hand rotation sequence dataset, try to estimate the intrinsic dimension of this dataset and discuss your result.**

    - Download: link (http://vasc.ri.cmu.edu//idb/html/motion/hand/index.html)