CS571 Project Report

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1 Summary

I have made the datasets of 23 alphabets, each alphabet has 400-500 samples so the total 10000 images are present in the dataset, For creating each alphabet 'np. array[]' method is used. after that dataset is converted to CSV file using 'np.savetxt(")'. Now we have a dataset in CSV file format that can be used for training and testing for the various ML model. The program is designed in such a way that we have to give the CSV file format dataset as input, after that whole data is converted to Matrix for better and easy manipulation of the data. this 2D matrix is converted to a 3D matrix such that the length of this 3D matrix is represents the total no of images and the 2nd and 3rd dimensions i.e, (4*4) represent the particular Alphabet's image. from the 10000 sets of images, 25 samples are original images without noise are plotted. As per the project requirement, we have to make a linear combination of images by adding noise, rotating by some angle, and adding images with other images. So 10 different type of noise is generated by using various Mean and Variance. this noise is added to the given dataset randomly to generate noisy images, after that this noisy image is rotated by some angle e.g., (90,180,270 and 360) degrees. after rotating and adding a noise some sample from each is displayed. after image and data preprocessing, data has to be fed to each of the mentioned methods for finding and analyzing components from the given set of images image. this data is fed to PCA, NMF, and dictionary learning algorithm for component estimation. after feeding the data and estimating the component some observations are come out. these are, 1. PCA will give clean or somewhat good enough recognizable components when No of alphabets are ¡16, i.e say (5,6) alphabet dataset. 2. For the dataset containing alphabets of more than 16, 23 here in this dataset the output components are not clear or recognizable. 3. NMF output is somewhat comparable to PCA output 4. Dictionary learning's components have resembled input data images. From this project, it is concluded that the Dictionary Learning method gives better performance for estimating and analyzing the component of images than PCA and NMF on a huge dataset.

2 Introduction

Component analysis and estimation is very important task in the data compression and dimensionality reduction process. Principle component contains most of the useful information of the huge dataset and discards the redundant data. so it helps to reduce dimensionality and compress data. For estimation of these components from a huge dataset various methods are used, Like PCA, NMF, and Dictionary Learning. But it is found that PCA wasn't able to find out this useful component when the dataset exceeds

a certain amount of data i.e (more than 16). So we need to find out the alternative method to PCA for component estimation in this problem.

3 Solution

To find out the components in a given dataset, PCA fails to estimate the important component, overcome this problem. We can use NMF, Dictionary Learning, K-SVD, Sparse Coding techniques for component estimation. by using dictionary learning and NMF method for component estimation we will overcome the drawback of PCA and we get components that are better than the component that we got from the PCA and these components closely resemble our original image dataset and we can able to recognize the given alphabet.

3.1 Assumptions/Requirment

In this project dataset of 4*4 images are taken. each image contains 400-500 image samples and the total dataset contains near about 10000 images. The estimated component will be 16*16 feature vector space.

3.2 Algorithms used

1. Give CSV formated file as input to the main program.
2. Read the file and convert whole the dataset in the matrix format.
3. Do suitable conversion on matrix and print some sample from a dataset.
4. Add different Gaussian noise models randomly in images.
5. Rotate some images randomly by some angle.
6. Combine two types of images.
7. plot some of the samples from noisy, rotated, and added images.
8. Do suitable conversion on the image dataset and apply various component estimation techniques.
    i. Apply PCA and estimate component.
    ii. Apply NMF and estimate component.
    iii. Apply dictionary Learning method and estimate component.
9. Observe the output of each model.

4 Results and analysis

Figure 1: Original Image

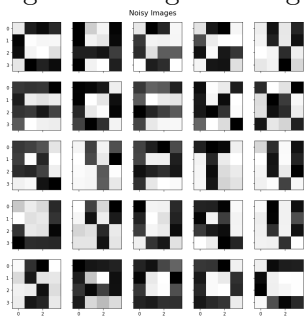

Figure 2: Noisy Images

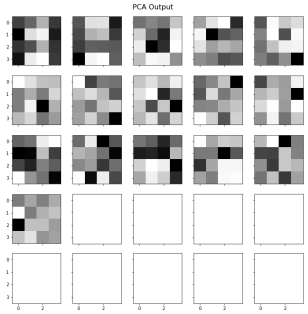

Figure 3: 16 Principle Component in PCA

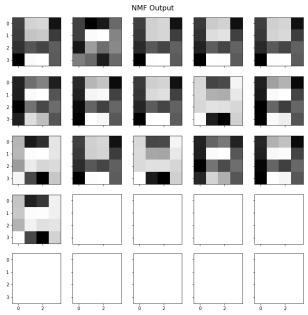

Figure 4: 16 Component in NMF

5 Conclusion

PCA, NMF, and dictionary learning are used as component analysis and estimation techniques, after comparing all these techniques' output, dictionary learning gives a much better output than the other two. NMF gives a better representation of data than PCA and PCA fails to give the expected result.

5.1 Challenges

We have to create an image dataset of 23 alphabets, as each sample is of 4*4 dimensions. While rotating the image sample by a specific angle like (30,60,120) degree, the dimension of images changed to 5*5, this will lead to computational error, as we are working on the 4*4 image dimension.

6 Project Github page

`https://github.com/prajyotmorey/PR_CS571`

7 References

[1].Scikit-learn: Machine Learning in Python, Pedregosa et al., JMLR 12, pp. 2825-2830, 2011. [2] I. Jolliffe, Principal Component Analysis. Springer-Verlag: New York, 1986. [3] K. Kreutz-Delgado, J. Murray, B. Rao, K. Engan, T.-W. Lee, and T. J. Sejnowski, "Dictionary learning algorithms for sparse representation," Neural Comput., vol. 15, no. 2, pp. 349–396, 2003.