Unsupervised Learning of Religious Facial Features

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Abstract

A paper published by N.O. Rule, *et. al*, explored the possibility of humans being able to discern if someone was part of a relgious group or not [1], and was able to achieve 55% accuracy. This paper explores the use of unsupervised learning techniques and eigenfaces to perform the same task, with clustering algorithms obtaining up to 59.3% labeling accuracy on the clusters, and eigenfaces obtaining upwards of 80% accuracy on unseen data.

Transforming the Data

Need to transform the faces such that the corners of the eyes are in the same spot for each picture. This is done with the following equation.

$$\begin{pmatrix} x^\star \\ y^\star \end{pmatrix} = \begin{pmatrix} \phi_x \cos(\theta) & \sin(\theta) \\ -\sin(\theta) & \phi_y \cos(\theta) \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} \psi_x \\ \psi_y \end{pmatrix}$$

This transformation applied to a cropped image can be seen below.

Figure : Cropped Face

Figure : Transformed Face

We also need the "average face" of the two groups. This can be seen in the two figures below

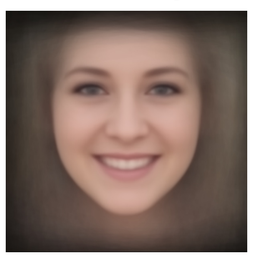

Figure : Average Mormon Face

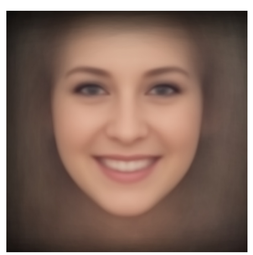

Figure : Average Non-Mormon Face

Eigenfaces

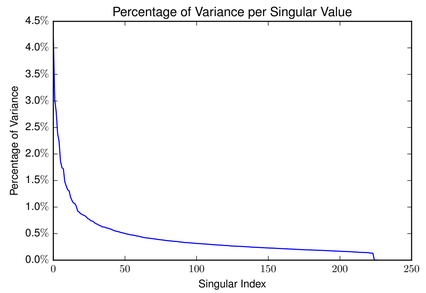

Figure : Variance of Singular Values, $\sigma_i / \sum_{i=1}^{N} \sigma_i$

Figure : Reconstruction of Face for various values of k

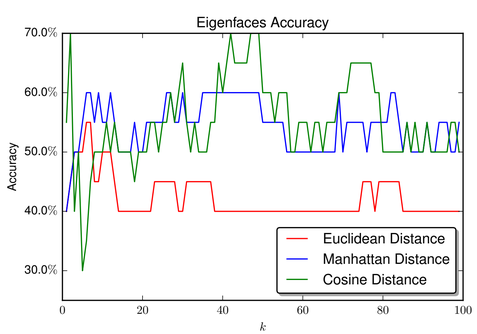

Figure : Accuracy of Eigenfaces with various metrics

Agglomerative Clustering

- Hierarchial Clustering: Complete-Link with Euclidean Distance, 58.4% Accuracy

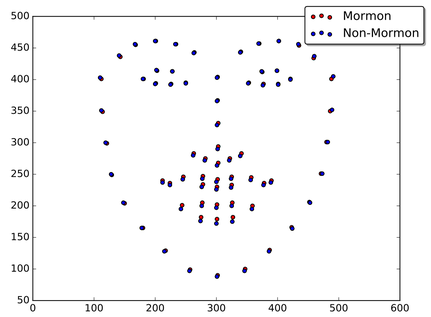

Figure : SIFT Features of "average faces"

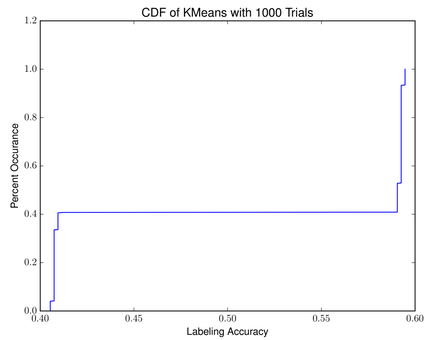

Figure : Cumulative Distribution Function for KMeans for 1000 runs

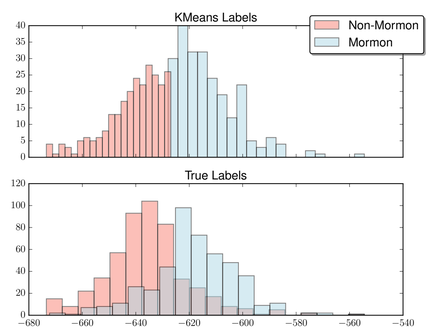

Figure : Values based on largest eigenvector and eigenvalue

Conclusion

In conclusion, the unsupervised algorithms such as hierarchical clustering and KMeans did better than humans in [1], with hierarchical clustering obtaining 58.4% accuracy and KMeans 59.3%.

The Eigenfaces algorithm performed much better with various values of k and the metric. The best metric was the Manhattan Distance which was able to achieve up to 80% labeling accuracy for $k \sim 35$. On average, the manhattan distance performed much better than either of the aforementioned clustering algorithms.

All implementations performed better than humans in [1].

References

[1] Rule, Nicholas O. AND Garrett, James V. AND Ambady, Nalini. On the Perception of Religious Group Membership from Faces. *PLOS ONE*, 5(12):1–10, 12 2010.

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[3] Tom Schad. Cody Hoffman stared as rare non-Mormon at BYU before joining Redskins. http://www.washingtontimes.com/news/2014/aug/12/cody-hoffman-starred-rare-non-mormon-byu-joining-r/.

[4] Turk, Matthew and Pentland, Alex. Eigenfaces for Recognition. *J. Cognitive Neuroscience*, 3(1):71–86, January 1991.

[5] David G. Lowe. Distinctive Image Features from Scale-Invariant Keypoints. *Int. J. Comput. Vision*, 60(2):91–110, November 2004.

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