# Comparing Supervised and Unsupervised learning in American Sign Language Recognition

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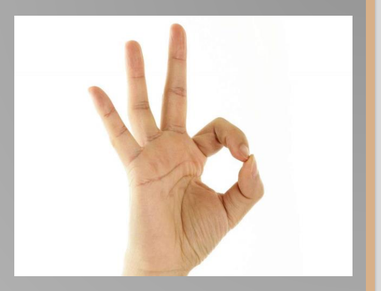
Professor Claire Monteleoni



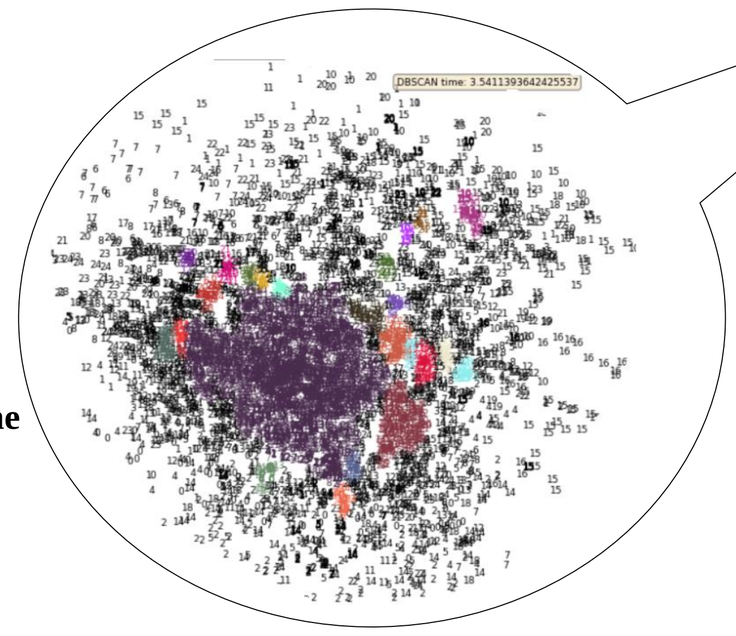
## Objective

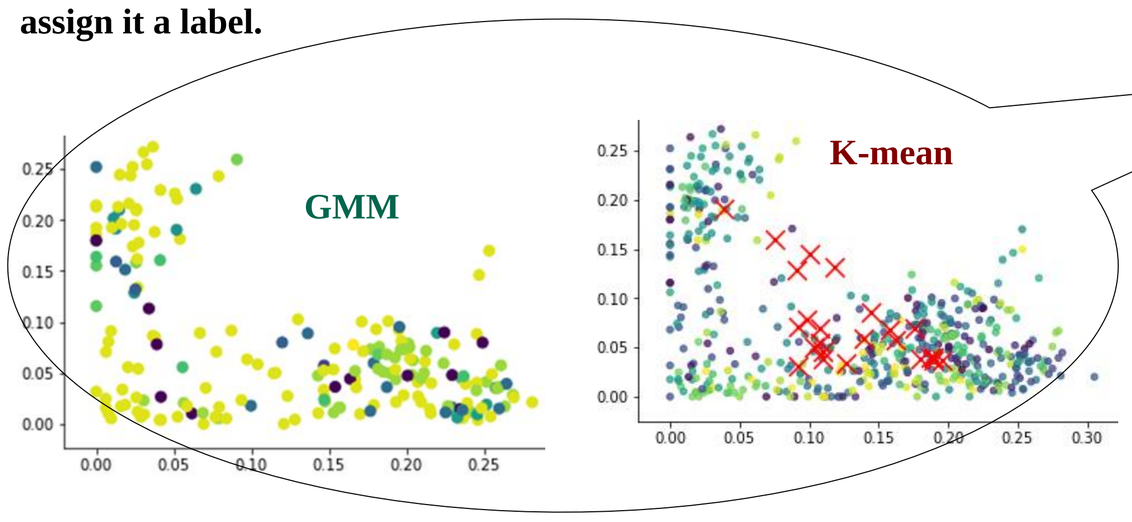
**Comparison of supervised and unsupervised learning performance for American Sign language recognition. There has been a lot of ongoing work in this area, particularly involving neural networks. We will investigate different supervised and unsupervised techniques for the automatic recognition of signs and evaluate their accuracies over the 24-signs.**

## Clustering Algorithms

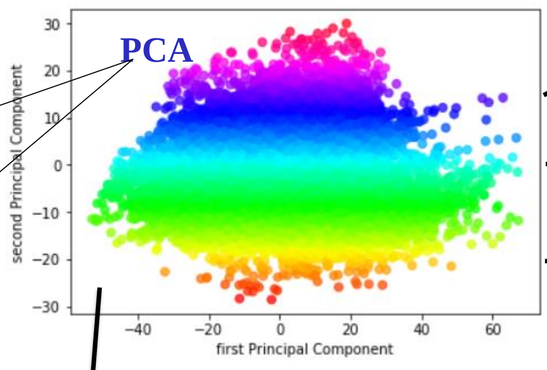
**PCA+DBSCAN:**
**There are 43 clusters when we used PCA compared to 0 cluster when no dimension reduction methods were used**

**K-means and GMM with HOG:**
**24 clusters**
**We look at the labels of the clusters to understand what label each cluster corresponds to. Then we take an unlabeled data point, see into which cluster it fits best, and assign it a label.**



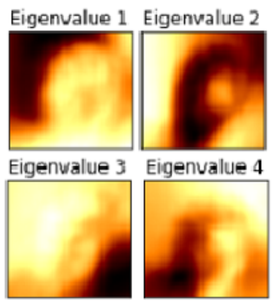

## Feature Extractor/Descriptor



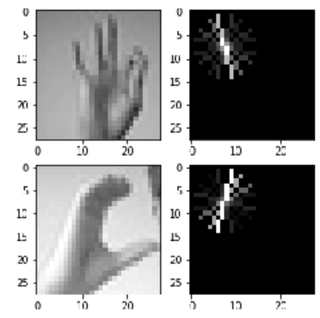

**83.40%** Random Forest **74.86%**

**82.9%** AdaBoost(SAMME) **36.60%**

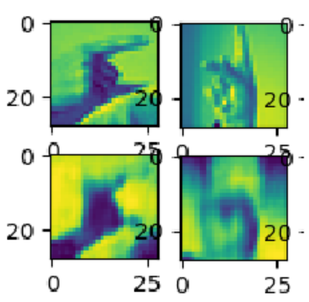
**82.9%** SVM **63.31%**




**HOG**



**Auto Encoder**



### HOG

**We can see that HOG is a good descriptor for object detection, and good performance can be achieved with Random Forest and linear SVM. One can expect even better performance with kernel SVM, if the computational complexity is not considered.**

| Feature Descriptor | Parameters | Classifier | Accuracy |
|---|---|---|---|
| HOG | Depth = 40, Estimator = 400 | Random Forest | 90.61 % |
| HOG | 1 vs Rest | SVM | 86.67 % |
| HOG | | Naive Bayes | 72.60 % |
| HOG | 24 clusters | Kmean | 50.55 % |

## Supervised Learning Algorithms

| conv1 | input | 28*28*1 |
|---|---|---|
| Kernel size 3*3*64 | output | 28*28*64 |
| ReLU | | |

| maxpool1 | input | 28*28*64 |
|---|---|---|
| Kernel size 2*2 | output | 14*14*64 |

| conv2 | input | 14*14*64 |
|---|---|---|
| Kernel size 3*3*64 | output | 14*14*64 |
| ReLU | | |

| maxpool2 | input | 14*14*64 |
|---|---|---|
| Kernel size 2*2 | output | 7*7*64 |

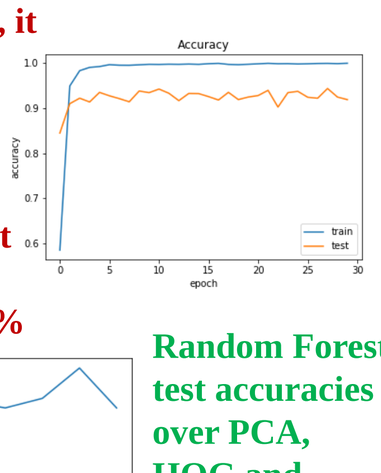
| conv2 | input | 7*7*64 |
|---|---|---|
| Kernel size 3*3*64 | output | 7*7*64 |
| ReLU | | |

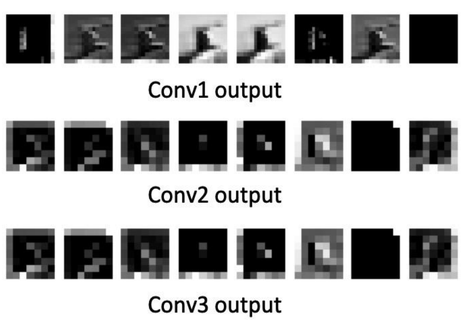
| maxpool4 | input | 7*7*64 |
|---|---|---|
| Kernel size 2*2 | output | 4*4*64 |

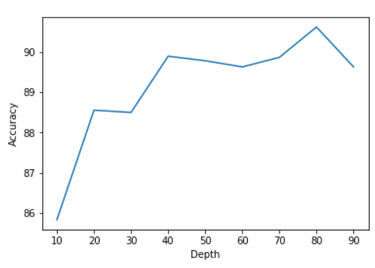
| Full-connected1 | input | 4*4*64 |
|---|---|---|
| Dropout 0.3 | output | 128*1 |
| ReLU | | |

| Full-connected2 | input | 128*1 |
|---|---|---|
| | output | 24 |
| softmax | | |

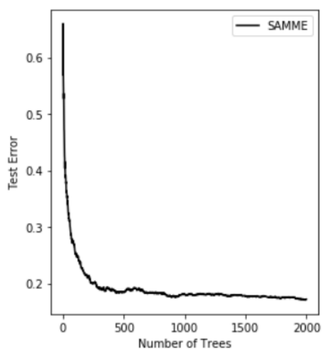
**Neural Network performs best, it can classify image data without any dimension reduction. Test accuracy reaches 94.33%**

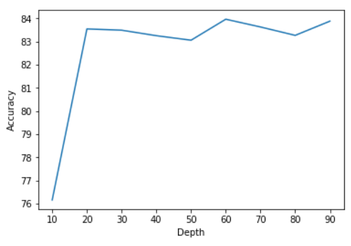


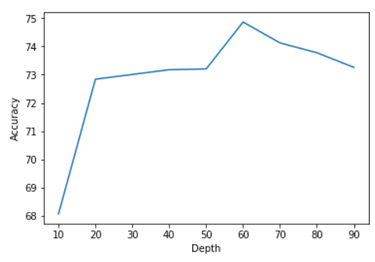



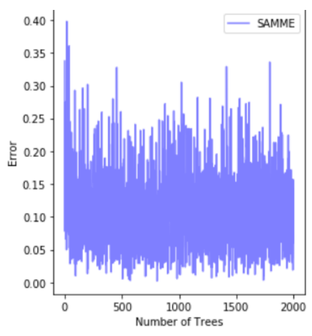

**Random Forest test accuracies over PCA, HOG and Convolutional Autoencoder**



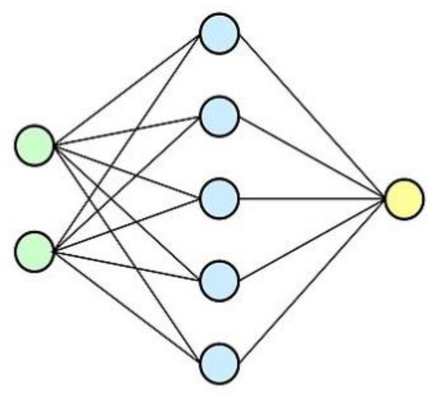

**Variation of test error over number of trees for AdaBoost SAMME classifier**




| Classifier | Feature Descriptor | Accuracy |
|---|---|---|
| Neural Net | None | 94.33% |
| Random Forest | HOG | 90.61% |
| SVM | HOG | 86.67% |
| AdaBoost | PCA | 82.90% |
| Naive Bayes | HOG | 72.60% |

## Conclusion

**For different classification or Clustering algorithms, the best feature extraction method may vary. In general, supervised classification Algorithm performs better than unsupervised clustering in our project. Based on the experiment results, HOG performs better than other two feature extraction methods. Neural Network performs best, it can classify image data without any dimension reduction. The test accuracy reaches 94.33%.**



## References

[1] Garcia, B. & Viesca, S.A. (2016) Real-time American Sign Language Recognition with Convolutional Neural Networks.
[2] S. Ameen, S. Vadera, A convolutional neural network to classify american 530 sign language fingerspelling from depth and colour image
[3] Zheng L, Lian B, Jiang A. (2017) Recent Advances of Deep Learning for Sign Language Recognition.
[4] https://www.kaggle.com/datamunge/sign-language-mnist