Spring 2018	Report#2 - 01/14/2018	Tianxiao Zhang

I. Tasks achieved Last Week (***, **, *: order of priority)

■ Project: Content-Adaptive Saak Transform

Purpose: Using content-adaptive method to further improve the accuracy of the MNIST test data.

Method: Using clustering method to cluster the content and doing Saak transform in each cluster and then combine them together as feature for each image.

Note: The time cost for running the codes should be controlled because what we want to do is beat CNN, not just running the codes without considering the time. If the time cost is long, the method is not that good.

II. Feedback and Interaction

■ ***Prof. Kuo's feedback***

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■ ***Discussion***

III. Report

1. K-means Clustering

This week, first I tried k-means clustering on 2-by-2 block in each stage. However, the results were 0.11 for both training data and testing data. The reason is that we clustered the 2-by-2 blocks in each stage, which means that the blocks from the same image may be divided into different clusters. If we just appended the clusters to each other, when we fitted the coefficients to the labels for each image, there would be some problem. We did not fit the coefficients from the same image to the corresponding image because of clustering. That's why the results were so bad. So we need to cluster the coefficients first and then put the generated coefficients back to the original position. This was a little tricky but I solved it. However, the time cost was increased because of the process of putting the generated coefficients back. Even though the accuracy for training data and testing data increased to 0.80 and 0.79 separately, they were still not good enough.

Then I clustered the images instead of 2-by-2 block.

accuracy	**10 clusters**	**15 clusters**	**20 clusters**	**30 clusters**
Train data	0.9932	0.9928	0.9931	0.9925
Test data	0.9675	0.9722	0.9720	0.9695

Even though the accuracy of training data is good enough, the accuracy of test data still cannot beat the accuracy of original Saak transform whose accuracy for test data is more than 0.98.

2. Mean-shift Clustering

It seems that K-mean is not a very good method to do the clustering in Saak transform. So we need to find a more natural clustering method to cluster the coefficients in Saak transform. Mean-shift Clustering is a good way to do the natural clustering.

Mean-shift clustering aims to discover blobs in a smooth density of samples. It is a centroid based algorithm, which works by updating candidates for centroids to be the mean of the points within a given region. These candidates are then filtered in a post-processing stage to eliminate near-duplicates to form the final set of centroids.

However, the mean-shift clustering will cost much longer time than k-means clustering, so we have to utilize the statistical property of the coefficients. Because the mean-shift clustering is so slow, we can

only use 0.1% of the whole coefficients to do the clustering and then fit the whole data. But 0.1% seems not enough because each time I run the codes, I can get different results. But if we increase the number of coefficients to be clustered, it would cost much longer time to run and the CPU got very heat very quickly. So each time I increased the number of data, I had to interrupt my computer. Even with 0.1% of data, it still cost 10 to 20 minutes to run. So how to speed up the mean-shift clustering and use more data to do the clustering is the next step we should do.

References

[1] C.-C. Jay Kuo, "Understanding convolutional neural networks with a mathematical model," the Journal of Visual Communications and Image Representation, Vol. 41, pp. 406-413, November 2016.
[2] C.-C. Jay Kuo, "The CNN as guided multi-layer RECOS transform," the IEEE Signal Processing Magazine, Vol. 34, No. 3, pp. 81-89, May 2017.
[3] C.-C. Jay Kuo and Yueru Chen, "On data-driven Saak transform," arXiv preprint arXiv: 1710.04176 (2017).
[4] http://scikit-learn.org/stable/modules/clustering.html#mean-shift

IV. Plan for the next week (***, **, *: order of priority)

- Speeding up the mean-shift clustering and use more data to do the clustering.

V. Milestone