Difficult Handwritten Digit Classification

Code available at: `https://github.com/slflmm/Miniproject-3`

COMP 598 – Miniproject 3 – Team X

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ABSTRACT

1. INTRODUCTION

2. PREPROCESSING

Standardization (x-mean/standard deviation) Contrast normalization

3. FEATURE DESIGN AND SELECTION

3.1 Pixels

3.2 Gabor

[1]

4. ALGORITHM SELECTION

4.1 Perceptron

4.2 Neural Network

4.3 Linear SVM

Use Scikit-learn implementation [9]

4.4 Convolutional Neural Network

Origin of convnets [5]. We can see it has good invariance to rotation and resistance to noise with the MNIST dataset. [8]

Problem of neural networks = overfitting. Regularization... (L1 + L2 norms). Dropout [6] Dropout in fully-connected layers of a convolutional net [7] SGD with minibatches. Momentum.

5. OPTIMIZATION

GPU for convolutional network – Theano [3]

6. PARAMETER SELECTION METHOD

Gridsearch

Random search [2]

7. TESTING AND VALIDATION

8. DISCUSSION

Using Gabor filters as a kernel rather than feature [11]

Other version of dropout [13]

Pretraining [4]

Others: [10], [12]

We hereby state that all the work presented in this report is that of the authors.

9. REFERENCES

[1] T. C. Bau. *Using Two-Dimensional Gabor Filters for Handwritten Digit Recognition*. PhD thesis, M. Sc. thesis, University of California, Irvine.

[2] J. Bergstra and Y. Bengio. Random search for hyper-parameter optimization. *The Journal of Machine Learning Research*, 13(1):281–305, 2012.

[3] J. Bergstra, O. Breuleux, F. Bastien, P. Lamblin, R. Pascanu, G. Desjardins, J. Turian, D. Warde-Farley, and Y. Bengio. Theano: a CPU and GPU math expression compiler. In *Proceedings of the Python for Scientific Computing Conference (SciPy)*, June 2010. Oral Presentation.

[4] D. Erhan, Y. Bengio, A. Courville, P.-A. Manzagol, P. Vincent, and S. Bengio. Why does unsupervised pre-training help deep learning? *The Journal of Machine Learning Research*, 11:625–660, 2010.

[5] K. Fukushima. Neocognitron: A self-organizing neural network model for a mechanism of pattern recognition unaffected by shift in position. *Biological cybernetics*, 36(4):193–202, 1980.

[6] G. E. Hinton, N. Srivastava, A. Krizhevsky, I. Sutskever, and R. R. Salakhutdinov. Improving neural networks by preventing co-adaptation of feature detectors. *arXiv preprint arXiv:1207.0580*, 2012.

[7] A. Krizhevsky, I. Sutskever, and G. E. Hinton. Imagenet classification with deep convolutional neural networks. In *Advances in neural information processing systems*, pages 1097–1105, 2012.

[8] Y. LeCun. Lenet-5, convolutional neural networks. `http://yann.lecun.com/exdb/lenet/index.html`, 2004. Accessed: 2014-10-22.

[9] F. Pedregosa, G. Varoquaux, A. Gramfort, V. Michel, B. Thirion, O. Grisel, M. Blondel, P. Prettenhofer,

R. Weiss, V. Dubourg, J. Vanderplas, A. Passos, D. Cournapeau, M. Brucher, M. Perrot, and E. Duchesnay. Scikit-learn: Machine learning in Python. *Journal of Machine Learning Research*, 12:2825–2830, 2011.

[10] H. A. Rowley, S. Baluja, and T. Kanade. Rotation invariant neural network-based face detection. In *Computer Vision and Pattern Recognition, 1998. Proceedings. 1998 IEEE Computer Society Conference on*, pages 38–44. IEEE, 1998.

[11] M. Sabri and P. Fieguth. A new gabor filter based kernel for texture classification with svm. In *Image Analysis and Recognition*, pages 314–322. Springer, 2004.

[12] P. Y. Simard, Y. A. LeCun, J. S. Denker, and B. Victorri. Transformation invariance in pattern recognition–tangent distance and tangent propagation. In *Neural networks: tricks of the trade*, pages 235–269. Springer, 2012.

[13] L. Wan, M. Zeiler, S. Zhang, Y. L. Cun, and R. Fergus. Regularization of neural networks using dropconnect. In *Proceedings of the 30th International Conference on Machine Learning (ICML-13)*, pages 1058–1066, 2013.

APPENDIX