

## About data augmentation

### 1 Multi-column Deep Neural Networks for Image Classification

In this paper [1], they used random translation to decrease the error of classification on MNIST from .28% to .20% (with a 2 layer convolution network). Scaling (up to 15% and rotations of 15% also increased the performance.

### 2 Flexible, High Performance Convolutional Neural Networks for Image Classification

This paper [2] used Affine (translation, rotation, scaling, horizontal shearing) and elastic deformations in an online fashion. to deform the images of MNIST. They do not mention what the improvements are and whether they exist.

### 3 ImageNet Classification with Deep Convolutional Neural Networks

This paper [3] uses a form of patch augmentation. It takes patches of the image, transforms them and then trains on the transformed patches. However, I doubt whether this will work on the MNIST set, since the images used in the paper are 224 x 224, but the MNIST set uses 32x32 images, making patches too small to process.

### 4 Testresults

For now, using Keras, it is possible to test whether the results of the model improve. results:

## References

- [1] Dan Ciregan, Ueli Meier, and Jürgen Schmidhuber. Multi-column deep neural networks for image classification. In *Computer vision and pattern recognition (CVPR), 2012 IEEE conference on*, pages 3642–3649. IEEE, 2012.
- [2] Dan C Ciresan, Ueli Meier, Jonathan Masci, Luca Maria Gambardella, and Jürgen Schmidhuber. Flexible, high performance convolutional neural networks for image classification. In *IJCAI Proceedings-International Joint Conference on Artificial Intelligence*, volume 22, page 1237. Barcelona, Spain, 2011.

Augmentation type	Accuracy <sup>1</sup>	Overfitting <sup>2</sup>	time per epoch
No augmentation	95.10	yes	5 sec
0-15 degree rotation	96.46	no	13 sec.
0 - 0.2 width shift	95.53	no	13 sec
0 - 0.2 height shift	95.01	no	12 sec
0 - 0.2 shear	96.06	yes	12 sec
0.8-1.2 zoom	95.62	yes	13 sec
1 - 1.2 zoom	95.46	yes	13 sec
0.8 - 1 zoom	96.05	yes	13 sec
rotation, shear, zoom	94.90	yes	15 sec
elastic_ transform	—	—	1:08 min

Table 1: 1: validation accuracy after 5 epochs; 2: overfitting is defined as training accuracy being bigger than validation accuracy after 5 epochs

- [3] Alex Krizhevsky, Ilya Sutskever, and Geoffrey E Hinton. Imagenet classification with deep convolutional neural networks. In *Advances in neural information processing systems*, pages 1097–1105, 2012.