(2) Topic: Self-similar CNNs for shape recognition

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Description:
Recent work [1,2] on understanding Convolutional Neural Networks suggests that appearance (color, texture) dominates image recognition. The research question in this MSc topic is **how to add shape recognition to CNNs?** Consider the following experiment. Convert the grayscale MNIST dataset to RGB color and specifically MNIST-R, MNIST-G, and MNIST-B variants where only a single color channel is used (only R, only G, only B). Now, train LeNet on MNIST-R, but to evaluate shape recognition, test it on MNIST-G and MNIST-B. What do you think the outcome is? Of course, color is only present in the first layer, but this behaviour is also present at later layers, only now for feature combinations. A first suggestion to to tackle this problem is to combine/replace convolution with a self-similar operator [3], but other directions may be explored as well.

Keywords: Shape recognition, Image classification,

References and pointers:

1. https://blog.usejournal.com/why-deep-learning-works-differently-than-we-thought-ec28823bdbc ImageNet-trained CNNs are biased towards texture; increasing shape bias improves accuracy and robustness
2. https://paperswithcode.com/paper/approximating-cnns-with-bag-of-local-features Approximating CNNs with Bag-of-local-Features models works surprisingly well on ImageNet (see also: https://medium.com/bethgelab/neural-networks-seem-to-follow-a-puzzlingly-simple-strategy-to-classify-images-f4229317261f)
3. http://www.wisdom.weizmann.ac.il/~vision/SelfSimilarities.html Matching Local Self-Similarities across Images and Videos, by Eli Shechtman and Michal Irani at CVPR '07