Final Project (Projet de fin d'études)
Deep network classification by scattering and homotopy dictionary learning

Supervisors :

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1. Context :

Deep convolutional networks have spectacular applications to classification and regression [1], but they are black boxes that are hard to analyze mathematically because of their architecture complexity. In addition, they need a large amount of data and a lot of computations to converge. Scattering transforms are simplified convolutional neural networks with wavelet filters which are not learned [2]. They provide state-of-the-art classification results among predefined or unsupervised representations, and are nearly as efficient as learned deep networks on relatively simple image datasets, such as digits in MNIST [2]. However, over complex datasets such as ImageNet, the classification accuracy of a learned deep convolutional network is much higher than a scattering transform. A fundamental issue is to understand the source of this improvement. In [3], the authors address this question by showing that one can reduce the learning to a single dictionary matrix, which is used to compute a positive sparse ℓ^1 code:

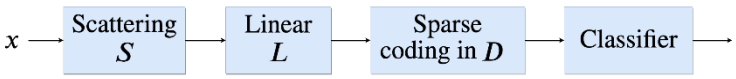

Figure 1 : a sparse scattering network ([3]).

2. Presentation and conduct of the final project

The purpose of this final project is first to analyze and explain the reference [3] and to reproduce the results obtained by the authors on images. Then, it is asked to study the question of replacing the classifier with an analogical reservoir computer.

This PFE will consist of:

1) A thorough study of the above-mentioned article [3];
2) Implement the method described in [3];
3) Test the method on images;
4) Study the possibility of replacing the classifier with a hardware reservoir computer.

Continuation by an internship

Eventually.

References

[1]: Y. LeCun, Y. Bengio, and G.E. Hinton. Deep learning. *Nature*, 521(7553): 436–444, 2015.

[2]: J. Bruna and S. Mallat. Invariant scattering convolution networks. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 35(8): 1872–1886, 2013.

[3]: John Zarka, Louis Thiry, Tomas Angles, Stephane Mallat, Deep Network Classification by Scattering and Homotopy Dictionary Learning, *International Conference on Learning Representations* (ICLR), 2020.