Jacobians of neural networks and Free Probability

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Gradient descent during the learning process of a neural network can be subject to many instabilities. The spectral density of the Jacobian is a key component for analyzing robustness. Following the works of Pennington et al., such Jacobians are modelled using free multiplicative convolutions from Free Probability Theory.

- In a substantial first part of the talk, I will present the problem from Machine Learning and introduce the necessary tools from Free Probability. It will then be clear that a good computational method is missing.
- In the second part of the talk, we present our solution: a reliable and very fast method for computing the spectral densities associated to a neural network.

Beyond machine learning, the method is certainly of independent interest in Free Probability Theory and high dimensional statistics.

Keywords: Machine learning, Robustness and design of neural networks, Back-propagation, Free probability, Free convolution