



May 23<sup>rd</sup> LECTURES

DEEP LEARNING SEMINAR

## TALK 1: Convolutional Neural Networks against the Curse of Dimensionality

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### Abstract

Convolutional Neural Networks are a powerful class of non-linear representations that have shown through numerous supervised learning tasks their ability to extract rich information from images, speech and text, with excellent statistical generalization.

These are examples of truly high-dimensional signals, in which classical statistical models suffer from the curse of dimensionality, referring to their inability to generalize well unless provided with exponentially large amounts of training data. In this talk we will start by studying statistical models defined from wavelet scattering networks, a class of CNNs where the convolutional filter banks are given by complex, multi-resolution wavelet

families. The reasons for such success lie on their ability to preserve discriminative information while being stable with respect to high-dimensional deformations, providing a framework that partially extends to trained CNNs. We will give conditions under which signals can be recovered from their scattering coefficients, and will discuss a family of Gibbs processes defined by CNN sufficient statistics, from which one can sample image and auditory textures.

Although the scattering recovery is non-convex and corresponds to a generalized phase recovery problem, gradient descent algorithms show good empirical performance and enjoy weak convergence properties. We will discuss connections with non-linear compressed sensing, applications to texture synthesis, inverse problems such as super-resolution, as well as an application to sentence modeling, where convolutions are generalized using associative trees to generate robust sentence representations.

### Short Bio

Joan graduated from Universitat de Catalunya in

Engineering, before

from ENS Cachan became a Sr.

an Image Processing startup, developing processing algorithms.



cum-laude from Politècnica de both Mathematics and Telecommunications graduating in Applied Mathematics (France). He then Research Engineer in real-time video

In 2013 he obtained his PhD in Applied Mathematics at École Polytechnique (France). After a postdoctoral stay at the Computer Science department of Courant Institute, NYU, he became a Postdoctoral fellow at Facebook AI Research. Since Jan 2015 he is an Assistant Professor at UC Berkeley, Statistics Department. His research interests include invariant signal representations, deep learning, stochastic processes, and its applications to computer vision.