Math 278B (Mathematics of information, data, and signals)

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Provable Image Recovery with Untrained Convolutional Neural Networks

Abstract:
Convolutional Neural Networks are highly successful tools for image recovery and restoration. A major contributing factor to this success is that convolutional networks impose strong prior assumptions about natural images - so strong that they enable image recovery without any training data. A surprising observation that highlights those prior assumptions is that one can remove noise from a corrupted natural image by simply fitting (via gradient descent) a randomly initialized, over-parameterized convolutional generator to the noisy image.

In this talk, we discuss a simple un-trained convolutional network, called the deep decoder, that provably enables image denoising and regularization of inverse problems such as compressive sensing with excellent performance. We formally characterize the dynamics of fitting this convolutional network to a noisy signal and to an under-sampled signal, and show that in both cases early-stopped gradient descent provably recovers the clean signal.

Finally, we discuss our own numerical results and numerical results from another group demonstrating that un-trained convolutional networks enable magnetic resonance imaging from highly under-sampled measurements, achieving results surprisingly close to trained networks, and outperforming classical untrained methods.

Host: Rayan Saab

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11:30 AM
https://msu.zoom.us/j/96421373881
(Password: first prime number greater than 100)