Deep Networks for Low-Dimensional Structure: Mathematical Guarantees and Network Constructions

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In this talk, the speaker will describe recent attempts to unravel when and how deep networks learn with structured data. The speaker will first describe results on learning generic (black box) networks on data with low-dimensional manifold structure. Our results provide end-to-end guarantees, which articulate sufficient resource requirements (depth / width / samples) in order to guarantee that gradient descent converges to a solution which generalizes to unseen data. Motivated by applications in astrophysics and invariant vision, The speaker will next describe efforts to build prior knowledge of data structure into network architectures, via the principle of unrolled optimization. This organizing principle allows us to interpret layers of a network as (trainable) iterations in an optimization process. The resulting networks admit guarantees of both computational and statistical efficiency, and in application, significantly outperform classical alternatives.