Numerical Analysis and Scientific Computing Seminar

Analysis and recovery of high-dimensional data with low-dimensional structures

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Abstract: High-dimensional data arise in many fields of contemporary science and introduce new challenges in statistical learning and data recovery. Many datasets in image analysis and signal processing are in a high-dimensional space but exhibit a low-dimensional structure. We are interested in building efficient representations of these data for the purpose of compression and inference, and giving performance guarantees depending on the intrinsic dimension of data. I will present two sets of problems: one is related with manifold learning; the other arises from imaging and signal processing where we want to recover a high-dimensional, sparse vector from few linear measurements. In the first problem, we model a data set in R^D as samples from a probability measure concentrated on or near an unknown d-dimensional manifold with d much smaller than D. We develop a multiscale adaptive scheme to build low-dimensional geometric approximations of the manifold, as well as approximating functions on the manifold. The second problem arises from source localization in signal processing where a uniform array of sensors is set to collect propagating waves from a small number of sources. I will present some theory and algorithms for the recovery of the point sources with high precision.

Friday, December 7, 2018, 2:00 pm
MSC N302

Mathematics
Emory University