Manifold clustering with applications to computer vision and diffusion tensor imaging

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The segmentation of complex high-dimensional data, such as videos with multiple rigid motions or diffusion tensor images of the brain, requires the development of new segmentation techniques for simultaneous segmentation and estimation of a collection of submanifolds from sample data points. This is a challenging problem that is often thought of as "chicken-and-egg".

The first part of this talk will show that for a wide class of segmentation problems (mixtures of subspaces, mixtures of fundamental matrices/trifocal tensors, mixtures of linear dynamical models), the "chicken-and-egg" dilemma can be tackled using an algebraic geometric technique called Generalized Principal Component Analysis (GPCA). In fact, it is possible to eliminate the data segmentation step algebraically and then use all the data to recover all the models without first segmenting the data.

The second part of this talk will present a novel algorithm for clustering data sampled from multiple submanifolds of a Riemannian manifold, e.g. the space of probability density functions. The algorithm, called Locally Linear Manifold Clustering (LLMC) is based on clustering a low-dimensional representation of the data learned using generalizations of local nonlinear dimensionality reduction algorithms from Euclidean to Riemannian spaces.

The third part of the talk will present a few motivating applications of manifold clustering to computer vision problems such as segmentation of rigid body motions, segmentation of dynamic textures, and segmentation of diffusion MRI.