Manifold Analysis for Visual Learning

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9/14/2015 at 11:00 am
Core A (Room 301)

Abstract

Many problems in the fields of Computer Vision deal with image data that is embedded in very high-dimensional spaces. However, it is typical that there are few variables, with a small number of degrees of freedom, that control the underlying process that generated the images. Therefore, a typical assumption behind many algorithms is that the data lie on a low-dimensional manifold. Modeling the underlying manifold would facilitate achieving a useful low-dimensional representation of the data. However, modeling the manifolds of visual data is quite challenging. This is because image formation involves several nuisance variables. These variables affect the geometry of the images as points in the image space. Any assumption about the image manifold structure has to deal with these variables collectively. As a result, typically image manifolds are neither smooth nor differentiable and they violate the local isometry property.

In this talk I will present different bodies of research related to learning manifold-based representations in different computer vision problems. First, the talk will cover the theory and applications of the concept of Homeomorphic Manifold Analysis (HMA). The approach mainly utilizes the concept of homeomorphism between the manifolds of different instances, which collectively constitute the data. Given a set of topologically equivalent manifolds, HMA models the variation in their geometries in the space of functions that maps between a topologically-equivalent common representation and each of them. To this end, I will show how the framework was utilized to learn the visual manifold for human motions, as well as for joint object recognition and pose estimation. Second, I will present a framework for learning manifolds from local features in a way that preserves their spatial arrangement, with applications to categorization and pose estimation. Third, I will briefly present research on formulating the task of motion segmentation as a manifold separation problem.
The talk will also briefly highlight other recent research activities in the HuMAN Lab and the Art and Artificial Intelligence Lab.

Faculty Host: Dimitris Metaxas