Numerical Analysis and Scientific Computing Seminar

Accelerated Diffeomorphisms for Motion Estimation and Segmentation from Video

Ganesh Sundaramoorthi
KAUST

Abstract: Accelerated optimization methods have gained wide applicability within the machine learning and optimization communities. They are known for leading to optimal convergence rates among schemes that use only use gradient (first order) information in the convex case. In the non-convex case, they appear to provide robustness to shallow local minima. The intuitive idea is that by considering a particle with mass that moves in an energy landscape, the particle will gain momentum and surpass shallow local minimum and settle in in more wider, deeper local extrema in the energy landscape. Although these techniques have been widely used, it was only within the last few years that theoretical attempts have been made to understand them and put them in a mathematical framework. Recent work has shown that accelerated methods may be formulated with variational principles, although in finite dimensions. Motivated by the success of accelerated methods in finite dimensional problems, we formulate optimization problems on infinite dimensional manifolds of diffeomorphisms using a generalization of this approach. The talk will mainly be about the mathematical formulation and some simple examples to illustrate the advantages of this approach. We note very large speed-ups in optical flow computation compared with standard approaches, and robustness to local minimum. Finally, we outline considerations for generalizing this approach to video data and applications in motion-based object segmentation, which require one to optimize diffeomorphisms not just defined on the image domain, but evolving regions of interest that encompass the domain of each of the objects in the scene.

Bio: Ganesh Sundaramoorthi received the PhD in Electrical and Computer Engineering from Georgia Institute of Technology, Atlanta, USA, and BS in Computer Engineering and BS Mathematics from the same institution in 2003. He was then a postdoctoral researcher in the Computer Science Department at the University of California, Los Angeles between 2008 and 2010. In 2011, he was appointed Assistant Professor of Electrical Engineering and Assistant Professor of Applied Mathematics and Computational Science at King Abdullah University of Science and Technology (KAUST). His research interests include computer vision and its mathematical foundations with recent interest in shape and motion analysis, video analysis, invariant representations for visual tasks, and applications. He was an area chair for IEEE ICCV 2017 and IEEE CVPR 2018.

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