EE Department Seminars

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Boğaziçi University
Electric-Electronic Engineering
Yorgo Istefanopulos Meeting Lounge

Probabilistic Graphical Models: Novel Applications in Machine Learning, Bioinformatics and Computer Vision

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Abstract. While uncertainty, high dimensionality, and complex variable interactions are prevalent in many real world phenomena, our ability to abstract and reason about them in a principled way is fairly recent, and due largely to the development of a general framework known as Probabilistic Graphical Models (PGMs). PGMs can provide compact representations of dependencies among large sets of random variables, by handling uncertainty through the use of probability theory and complexity through the use of graph theory. The two most common types of PGMs are Markov Random Fields (MRFs) and Bayesian Networks (BNs), but many of the existing statistical tools (e.g., Kalman filters, hidden Markov models etc.) can be described as graphical models. Algorithms for learning and reasoning with PGMs now support a wide range of practical domains ranging from image understanding, speech recognition, digital communication and natural language processing to biological network inference, biomarker discovery, mining big data, web search, robot navigation, and many more.
My research combines the PGM formalism with information theoretic foundations, latent hierarchies, stochastic and combinatorial optimization; and targets several open problems in machine learning, bioinformatics, and computer vision. Specifically, in this talk, I will first present a new class of latent hierarchical PGMs for learning deep dependency structures from high dimensional but limited data, and discuss its potentials in modeling shape distributions, maximum likelihood classification of handwritten digits and cancer phenotypes. Second, I will show how to realistically apply a similar multi-level BN approach to inferring protein interaction networks and their latent mechanisms in cancer for targeted treatment. As another application in computer vision, I will discuss building scene and image priors with PGMs and lay out a new scene understanding paradigm that uses sequential reduction of uncertainty. Finally, I will focus on one of the corresponding subtasks, namely view-invariant object detection and fine-grained 3D pose estimation from a single 2D visible light image, which can be solved in a near-real time efficiency using a novel conditional random field approach and branch and bound type combinatorial optimization.

Bio. Erdem Yoruk, Ph.D. is a postdoctoral researcher at Johns Hopkins University – Center for Imaging Science. He is a member of JHU - Vision, Dynamics and Learning Lab and is also

affiliated with JHU - Institute for Computational Medicine. He received his B.S. and M.S. degrees from Bogazici University, Electrical and Electronic Engineering, respectively in 2002 and 2004; and his Ph.D. From Johns Hopkins University, Applied Mathematics and Statistics, in 2011, under Prof. Donald Geman, and with concentration in mathematical bioinformatics track. His main research areas are machine learning, bioinformatics and computer vision, where he applies his statistical modeling expertise to various complex problems such as biomolecular network inference, scene understanding and view invariant object detection/recognition. Recently, Dr. Yoruk won the Microsoft Research Best Paper award in ICCV'13-3dRR for his paper on efficient object detection and pose estimation using 3D wireframe models. He has ongoing collaborations with Hopkins Engineering and Medicine, Google Inc., and Fox Chase Cancer Center.