UCF Stands For Opportunity

THE DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE, ECE DIVISION

Presents the Spring 2013 EECS Seminar Series

Professor Tara Javidi
University of California, San Diego

"Visual Information Acquisition, Noisy Search, and Active Hypothesis Testing"
Monday, February 25, 2013 • 11:00 a.m. • HEC 101

Abstract: Information acquisition problems form a class of stochastic decision problems in which a decision maker, by carefully controlling a sequence of actions with uncertain outcomes, dynamically refines the belief about (Markovian) parameters of interest. Examples arise in patient care, computer vision, spectrum utilization, and joint source--channel coding. A generalization of hidden Markov models and a special case of partially observable Markov models, information acquisition is a purely informational problem. In particular, due to the sequential nature of the problem, the decision maker relies on his current information state to constantly (re-)evaluate the trade-off between the precision and cost as well as the influence that every action has over the entire decision making horizon.

In this talk, as a special case of information acquisition, we consider the problem of two-dimensional visual search as an active hypothesis testing problem. We first provide a brief survey of the corresponding literature on active hypothesis testing and design of experiments. In particular, we review the dynamic programming interpretation of information utility introduced by De Groot as well as the notion of asymptotic optimality due to Chernoff. We connect the stochastic control theoretic notion of information utility to the test reliability in statistics and information theory. We then underline the main drawback of Chernoff's asymptotic optimality notion: his neglecting the complimentary role of the number of hypotheses, i.e. the resolution of visual search in our case. More precisely, we show that Chernoff's notion of asymptotic optimality falls short in showing the tension between using (asymptotically large number of) visual samples for a low resolution identification of the target with (asymptotically) high accuracy or a (asymptotically) high resolution of target identification with a lower degree of accuracy.

To address the above shortcomings, we connect De Groot's information utility framework with the Shannon theoretic concept of uncertainty reduction and strengthen Chernoff's lower bound to account for the resolution of the search. This lower bound, as a corollary, provides upper bounds on maximum information acquisition rate and the optimal reliability as a function of rate. We also introduce Extrinsic Jensen–Shannon (EJS) divergence as a measure of information based on which a heuristic acquisition strategy is constructed.

Via numerical and asymptotic analysis, the performance of the proposed policy, hence the utility of the EJS divergence in the context of two-dimensional visual search is investigated. In particular, under a mild technical condition, it is shown that the proposed heuristic achieves a strictly positive information acquisition rate with a strictly positive error exponent Furthermore, in the special case of uniform and mean-symmetric noise model, EJS policy is shown to achieve the upper bound on reliability function.

This is joint work with Mohammad Naghshvar, Ofer Shayevitz, and Michele Wigger.

Biography: Tara Javidi studied electrical engineering at Sharif University of Technology, Tehran, Iran from 1992 to 1996. She received the MS degrees in electrical engineering (systems), and in applied mathematics (stochastics) from the University of Michigan, Ann Arbor, in 1998 and 1999, respectively. She received her Ph.D. in electrical engineering and computer science from the University of Michigan, Ann Arbor, in 2002.

From 2002 to 2004, she was an assistant professor at the Electrical Engineering Department, University of Washington, Seattle. She joined University of California, San Diego, in 2005, where she is currently an associate professor of electrical and computer engineering.

DEPARTMENT OF ELECTRICAL ENGINEERING & COMPUTER SCIENCE