EPSTEIN INSTITUTE SEMINAR ▪ ISE 651

Active Hypothesis Testing For Fast Decision Making With Applications To SARS-CoV-2 Testing

ABSTRACT - Many modern (machine) learning strategies depend on the intelligent acquisition of informative samples. Such sampling methods can be viewed as an instantiation of the exploration-exploitation problem. Initially, one is unclear about the state of the environment and the goal is to take observations that refine the understanding of the state. If one has a series of "experiments" (or queries), each of which provide information about the state, an important question is how to design that sequence of experiments to enable a decision about the environmental state as quickly as possible. Exploration-exploitation problems abound in applications such as anomaly detection, target localization, dynamical system tracking, medical diagnosis, wireless body area sensor networks etc. The problem of experiment design for classification (hypothesis testing) has been persistently studied since the 1940s. Then and now, there has been an emphasis on the design of asymptotically optimal methods. Herein, we will provide new analysis which enables the design of strategies for the finite sample regime. In key cases, our methods are also asymptotically optimal, but provide significantly improved finite sample performance. We specialize our analysis to the problem of anomaly detection for which we can determine asymptotically tight upper and lower bounds on the misclassification error and provide an experiment design strategy with excellent finite sample performance. We further consider the application of our approach to group-testing, wherein different experiments call for the pooling of samples which can dramatically reduce the number of experiments needed. Finally, we consider the problem of testing of populations to provide good spatial estimates of the incidence of an anomaly, such as SARS-CoV-2 positivity. We have preliminary analysis of SARS-CoV-2 serological tests based on randomized testing undertaken by a colleague at USC's School of Public Policy. Our proposed strategy suggests that uniform allocation for randomized testing over heterogeneous regions may not yield the best estimates of positivity rates and offers a method by which active hypothesis testing can be used to improve such estimates.

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SPEAKER BIO – Urbashi Mitra received the B.S. and the M.S. degrees from the University of California at Berkeley and her Ph.D. from Princeton University. Dr. Mitra is currently the Gordon S. Marshall Professor in Engineering at the University of Southern California with appointments in Electrical & Computer Engineering and Computer Science. She was the inaugural Editor-in-Chief for the IEEE Transactions on Molecular, Biological and Multi-scale Communications. She has been a member of the IEEE Information Theory Society's Board of Governors (2002-2007, 2012-2017), the IEEE Signal Processing Society's Technical Committee on Signal Processing for Communications and Networks (2012-2016), the IEEE Signal Processing Society's Awards Board (2017-2018), and the Chair/Vice-Chair of the IEEE Communication Theory Technical Committee (2017-2020). Dr. Mitra is a Fellow of the IEEE. She is the recipient of: the 2017 IEEE Women in Communications Engineering Technical Achievement Award, a 2015 UK Royal Academy of Engineering Distinguished Visiting Professorship, a 2015 US Fulbright Scholar Award, a 2015-2016 UK Leverhulme Trust Visiting Professorship, IEEE Communications Society Distinguished Lecturer, 2012 Globecom Signal Processing for Communications Symposium Best Paper Award, 2012 US National Academy of Engineering Lillian Gilbreth Lectureship, the 2009 DCOSS Applications & Systems Best Paper Award, 2001 Okawa Foundation Award, 2000 Ohio State University's College of Engineering Lumley Award for Research, and a 1996 National Science Foundation CAREER Award. She has been an Associate Editor for the following IEEE publications: Transactions on Signal Processing, Transactions on Information Theory, Journal of Oceanic Engineering, and Transactions on Communications. Dr. Mitra has held visiting appointments at: King's College, London, Imperial College, the Delft University of Technology, Stanford University, Rice University, and the Eurecom Institute. Her research interests are in: wireless communications, communication and sensor networks, biological communication systems, detection and estimation and the interface of communication, sensing and control.

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