Northwestern | McCORMICK SCHOOL OF ENGINEERING
Center for Engineering and Health

CEH SEMINAR: DR. HARI BALASUBRAMANIAN

# Estimating the Prevalence of Multiple Chronic Diseases via Maximum Entropy

HOST: DR. SANJAY MEHROTRA

Patients with multiple chronic conditions, also known as multi-morbidity in the clinical literature, have a disproportionate impact on the U.S. healthcare system. According to a 2017 report by RAND, 19% of Americans (around 60 million individuals) had four or more chronic conditions, and they account for more than 50% of total healthcare expenditure. A baseline predictive model for the probabilities of co-occurring conditions is essential for quantifying epidemiological associations between condition groups, resource planning for targeted interventions, and driving decision support for personalized medicine. However, MCC patients exhibit significant heterogeneity in chronic condition combinations, and the number of individuals in a disease dataset is usually small compared to the number of possible disease combinations. Therefore, simple maximum-likelihood estimates of disease co-occurrence will erroneously assign zero probabilities to disease combinations that are missing from the dataset but are likely to occur in the larger population. In this work, we combine maximum-entropy optimization, data mining, and machine learning techniques to create an algorithm, called MaxEnt-MCC, for estimating the prevalence of chronic diseases in a population in the face of sparse data. In a case study using Medical Expenditure Panel Survey (MEPS) data, we show how MaxEnt-MCC can be used to predict previously unobserved but likely disease combinations, quantify associations between groups of chronic conditions, and estimate healthcare costs in a principled manner.

This research is joint work with Peter Haas (Professor, College of Information and Computer Sciences, University of Massachusetts, Amherst) and Pracheta Amarnath (PhD student, College of Information and Computer Sciences, University of Massachusetts, Amherst).

## BIOGRAPHY

Dr. Hari Balasubramanian is Associate Professor of Industrial Engineering at the University of Massachusetts, Amherst. He received his doctoral degree at Arizona State University in 2006. After graduation, Dr. Balasubramanian spent two years as a Research Associate at Mayo Clinic in Rochester, Minnesota before joining the University of Massachusetts in 2008. His research interests are in operations research applied to healthcare. Specific applications have included capacity planning and scheduling in outpatient, inpatient and emergency room settings. Dr. Balasubramanian's work has been supported by grants from the National Science Foundation including a National Science Foundation CAREER award (2013-2019) focused on improving primary care delivery. His papers have been published in both operations research as well as clinical journals. His recent work is on modeling the impact of care interventions on patients with complex medical and social needs.

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