Title: Statistical learning for personalized diagnostics and prognostics

Abstract:

Just as the industrial revolution has profoundly changed humanity, so too is statistical learning poised to revolutionize many aspects of our lives. This is particularly true in healthcare. In this talk, I will present three solutions based upon statistical learning that have been developed in our group to deliver improved personalized diagnostics and prognostics to the clinic.

First we will discuss the challenge of accurately labeling diseased brain anatomy in MRI which, when done well, facilitates diagnoses and therapy monitoring. Since current top performing methods are unable to accurately parcellate brains that deviate from training, we propose a solution minimizing the need for training, which begins by constructing a target-specific Bayesian brain model with Gaussian Mixture Model coefficients drawn from non-stationary Dirichlet distribution. We estimate local suitability of training for target, regularize the model with an MRF, and fit to target data using an EM framework. Head-to-head comparisons underscore its superior performance.

Second, we will look at the need for greater precision in the diagnoses and prognoses of patients with mild traumatic brain injury commonly found in accidents and contact sports. Conventional imaging provides little information from which to quantify injury severity, therefore we develop feature construction and prognostic methods for advanced functional and diffusion imaging with improved potential for quantitative guidance of patient care.

We conclude with our development of deep learning decision forests. This approach, called entanglement, uses the learned tree structure and intermediate probabilities associated with nodes in the higher levels of a tree to affect training of nodes in deeper levels. While we demonstrate clinical utility through application to labeling of many structures in whole body CT, we note that note that the learned discriminative contextual atlas enables the deep learning forest to simultaneously achieve higher accuracy predictions, faster learning rates, all the while using less memory than alternative approaches.

Bio:

Albert Montillo is an Assistant Professor in the Radiology Department at the University of Texas Southwestern where he leads the Machine Learning and Personalized Prognostics Lab situated within the neuroradiology ANSIR Research Core. Dr. Montillo completed Ph.D. training in Medical Imaging from the University of Pennsylvania, Philadelphia, PA through the departments of Computer and Information Science and Radiology. His Bachelor's and Master's degrees are in Computer Science from Rensselaer Polytechnic Institute in New York with minors in Electrical Engineering and Psychology. Prior to moving to UT Southwestern, Dr. Montillo lead neuroimaging research efforts at the General Electric Research Center in New York and has held research positions at Machine Learning and Perception Laboratory of Microsoft Research in Cambridge, United Kingdom, Rutgers University in New Jersey, and the Harvard/MIT Martinos Center for Biomedical Imaging, Boston, MA. At UTSW, his lab develops multivariable, multivariate statistical learning algorithms to make diagnoses and prognoses more quantitative and personalized for clinical neuroscience applications including neuropsychiatric, neurodegenerative, and neurodevelopmental brain disorders, and for oncological applications.