Plenary Talk 3 by João M. Pereira (University of Georgia)

Title: Fast Tensor Methods and Implicit Computations

Abstract: In this talk I will focus on fast methods for analyzing and decomposing tensor data. In the first part of the talk, I will introduce a method we proposed for symmetric tensor decomposition. We provide several guarantees for the algorithm and its relevant non-convex optimization problem. Furthermore, we observe empirically that the method is roughly one order of magnitude faster than existing decomposition algorithms, and is also robust to noise. On the second part of the talk, I will cover implicit method of moments. Higher-order moments of multivariate random variables suffer from a curse of dimensionality: the number of entries scale exponentially with the order of the moments. We introduce an implicit approach that allows for estimating parameters without explicitly forming the moments, that way avoiding the curse of dimensionality. We use this approach to estimate the parameters of Gaussian Mixture Models, obtaining a method with computational and storage costs similar to those of state-of-the arts methods, such as expectation-maximization, and opening the door to the practical use of the method of moments for multivariate variables. Finally, I will mention several related methods and applications, including on-going work on using the method introduced in the first part of the talk for decomposing moment tensors implicitly.

Plenary Talk 4 by Russell Jeter (Georgia State University)

Title: Robotics-Assisted Stroke Rehabilitation with Machine Learning-Based Residual Severity Classification

Abstract: Stroke therapy is essential to reduce impairments and improve motor movements by engaging autogenous neuroplasticity. Traditionally, stroke rehabilitation occurs in inpatient and outpatient rehabilitation facilities. However, recent literature increasingly explores moving the recovery process into the home and integrating technology-based interventions. This study advances this goal by promoting in-home, autonomous recovery for patients who experienced a stroke through robotics-assisted rehabilitation and classifying stroke residual severity using machine learning methods. We use kinematics data collected during in-home, self-guided therapy sessions to develop supervised machine learning methods, to address a clinician's autonomous classification of stroke residual severity-labeled data toward improving in-home, robotics-assisted stroke rehabilitation. Thirty-three stroke patients participate in in-home therapy sessions using the Motus Nova robotics rehabilitation technology to capture upper and lower body motion. The therapy session summary data is based on high-resolution movement and assistance data and clinician-informed discrete stroke residual severity labels. We demonstrate that the light gradient boosting method provides the most reliable autonomous detection of stroke severity. This method achieved an average of 94% accuracy, measured using the F1-score performance measure with 10-fold cross-validation. We show how objectively measured rehabilitation training paired with machine learning methods can be used to identify the residual stroke severity class with efforts to enhance in-home self-guided, individualized stroke

rehabilitation. As data from rehabilitation practices are often of comparable size and nature to the data collected in our study, this suggests that the light gradient boosting method should be considered a standard, more efficient tool for this analysis.