Statistics Seminar

Department of Mathematics and Statistics

DATE:	Thursday, March 20, 2025
TIME:	1:15pm – 2:15pm
LOCATION:	WH 100E
SPEAKER:	Praveen Niranda, Binghamton University
TITLE:	Network Reconstruction Using Nonparametric Additive ODE Models

Abstract

Network representations of biological systems are widespread and reconstructing unknown networks from data is a focal problem for computational biologists. For example, the series of biochemical reactions in a metabolic pathway can be represented as a network, with nodes corresponding to metabolites and edges linking reactants to products. In a different context, regulatory relationships among genes are commonly represented as directed networks with edges pointing from influential genes to their targets. Reconstructing such networks from data is a challenging problem receiving much attention in the literature. There is a particular need for approaches tailored to time-series data and not reliant on direct intervention experiments, as the former are often more readily available. In this paper, we introduce an approach to reconstructing directed networks based on dynamic systems models. Our approach generalizes commonly used ODE models based on linear or nonlinear dynamics by extending the functional class for the functions involved from parametric to nonparametric models. Concomitantly we limit the complexity by imposing an additive structure on the estimated slope functions. Thus the submodel associated with each node is a sum of univariate functions. These univariate component functions form the basis for a novel coupling metric that we define in order to quantify the strength of proposed relationships and hence rank potential edges. We show the utility of the method by reconstructing networks using simulated data from computational models for the glycolytic pathway of Lactococcus Lactis and a gene network regulating the pluripotency of mouse embryonic stem cells. For purposes of comparison, we also assess reconstruction performance using gene networks from the DREAM challenges. We compare our method to those that similarly rely on dynamic systems models and use the results to attempt to disentangle the distinct roles of linearity, sparsity, and derivative estimation.

Reference: Henderson, J., & Michailidis, G. (2014). Network reconstruction using nonparametric additive ODE models. PloS one, 9(4), e94003. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0094003