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“Novel Statistical Frameworks for Analysis of Structured Sequential Data”

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Abstract

We are developing a broad array of novel statistical frameworks for analyzing complex sequential data sets. Our research was originally motivated by a collaboration with neuroscientists trying to understand the neurological, genetic and evolutionary basis of human communication using bird and rodent models. The data sets comprise structured sequences of syllables or ‘songs’ produced by animals from different genotypes under different experimental conditions. The primary goals are to elucidate the roles of different genotypes and experimental conditions on animal vocalization behaviors and also to learn complex serial dependency structures and systematic patterns in the vocalizations. We are developing novel statistical methods based on first and higher order Markovian dynamics that help answer these important scientific queries. The methods have appealing theoretical properties and practical advantages and are of very broad utility, with applications not limited to analysis of animal vocalization experiments. Our research also paves the way to advanced automated methods for many other sophisticated dynamical systems that can accommodate more general data types, including higher order hidden Markov models.