

## Statistical Inference for Systems of Differential Equations

Itai Dattner

Many processes in biology, chemistry, physics, medicine, and engineering are modeled by systems of differential equations. These systems describe the interrelationships between the variables involved, and depend in a complicated way on unknown quantities (e.g., initial values, constants or time dependent parameters). Most often, the researcher would like to execute important tasks such as testing the validity of a model, analyzing its qualitative behavior or predicting future states of the system. In order to execute these tasks, one usually needs to estimate the unknown quantities of the system from real data. However, in the case of differential equations, the inverse problem of parameter estimation is considered as the bottleneck in modeling dynamical systems and estimating parameters based on observed noisy state variables has a relatively sparse statistical literature.

In this talk we focus on the fairly general and often applied class of systems of ordinary differential equations linear in (functions of) the parameter. For such systems we first characterize a necessary and sufficient condition for identifiability of parameters. Then we present a novel estimation approach and support it by a general statistical theory that enables the development of estimators tailored for specific problems. In particular, we present estimators corresponding to some common experimental setups and discuss their statistical properties. Simulation studies and application of the method to real data will be discussed.