Statistical Learning of Dynamic Systems

Dr. Itai Dattner
(University of Haifa)

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Dynamic systems are ubiquitous in nature and are used to model many processes in biology, chemistry, physics, medicine, and engineering. In particular, systems of (deterministic or stochastic) differential equations are commonly used for the mathematical modeling of the rate of change of dynamic processes. 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). Learning dynamic systems involves the "standard" statistical problems such as studying the identifiability of a model, estimating model parameters, predicting future states of the system, testing hypotheses, and choosing the "best" model. However, modern dynamic systems are typically very complex: nonlinear, high dimensional and only partly measured. Moreover, data may be sparse and noisy. Thus, statistical learning (inference, prediction) of dynamical systems is not a trivial task in practice.

In this talk we will present some recent theoretical results and methodologies concerning identifiability and estimation of dynamic systems. We will also discuss real data examples coming from diverse areas such as infectious diseases and biology.