MODELING FUNCTIONAL/LONGITUDINAL DYNAMIC SYSTEMS WITH APPLICATIONS TO LONG-TERM HIV DYNAMICS

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Functional/longitudinal data are collected from a number of subjects along the time scale in many biomedical studies. In some biomedical applications, the biological mechanisms are well studied and the mathematical representations of the biomedical systems are available. The questions that we are concerned include (1) how to estimate the parameters in the dynamic systems (described by a set of differential or difference equations) based on functional/longitudinal data; (2) how to forecast the future outcomes for both individual subjects and for the whole population using the identified models; and (3) how to "borrow the strength" across the subjects if the functional system is monitored longitudinally. In this talk, I will present two different models for HIV dynamic systems from AIDS clinical trials. One model is a deterministic model with a set of differential equations and another model is a state-space model. In both models, we consider the important features of longitudinal data such as within-subject variation and between-subject variation as well as within-subject correlations. The hierarchical mixed-effects modeling idea is used in both models. The hierarchical Bayesian approach is proposed to estimate the parameters in the deterministic dynamic models and several methods such as a two-stage method, MLE and Bayesian approach are studied under the state-space model setup. Applications to AIDS clinical data will be presented to illustrate the methodologies. Some open questions in this area will be posed.