Learning dynamical systems from time and frequency-response data

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Dynamical systems are a principal tool in the modeling, prediction, and control of physical phenomena with applications ranging from structural health monitoring to electrical power network dynamics, from heat dissipation in complex microelectronic devices to vibration suppression in large wind turbines. Direct numerical simulation of these mathematical models may be the only possibility for accurate prediction or control of such complex phenomena. However, in many instances, a high-fidelity mathematical model describing the dynamics is not readily available. Instead, one has access to an abundant amount of input/output data via either experimental measurements or a black-box simulation. The goal of data-driven modeling is, then, to accurately model the underlying dynamics using input/output data only.

In this talk, we will investigate various approaches to data-driven modeling of dynamical systems using systems-theoretical concepts. We will consider both frequency-domain and time-domain measurements of a dynamical system including parametrically varying dynamics. In some instances we will have true experimental data, and in others we will have access to simulation data. We will illustrate these concepts in various examples ranging from structural dynamics to microelectromechanical systems.