From Data to Differential Equations

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Differential equations are the natural way to model systems with functional inputs and functional outputs. They allow us to study the system's dynamics in the sense of explicitly modelling how the output changes in response to sudden changes in input. For example, engineers developing control systems for industrial processes routinely use DIFE's as modelling tools.

A new method is described for going directly from noisy discrete data, not necessarily sampled at equally spaced times, to a system of differential equations of arbitrary orders, linear or nonlinear, that describes the data. The method involves a generalization of nonparametric curve estimation in which the penalty functional rather than the smoothing functions is estimated.

Examples are drawn from biology, chemical engineering and medicine.