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Introduction to Nonlinear Methodology Part 2: Domain-specific Problems

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Welcome to the second part of our special feature on nonlinear methods. The articles in this issue elaborate methodological concerns that the authors encountered while researching specific topic areas.

Biomedical data sources typically generate long series of complex data. Chon, Zhong, Wang, Ju, and Jan introduce a method based on principal components analysis for decomposing the observed series into multiple constructs. Kriendler and Lumsden address the issue of missing data, which social scientists confront at least as often as biomedical researchers. For nonlinear processes, however, the conventional approaches of linear interpolation or substituting means would produce inappropriate results; a process based on nonlinear interpolation is thus offered.

Phase portraits and recursion plots became attractive long ago as a means of visualizing dynamics in data. Li, Krauth, and Huston, examined the specific link between phase portrait patterns as the dynamics of learning processes and explain how it is possible to extract meaning from a combination of analytic and graphical procedures. Learning and other cognitive experiments often require the experimenter to deliver stimuli sequentially over time. Frey addresses the complications associated with separating the timing of the stimuli from the temporal dynamics of the responses.

Social scientists have often reminded each other not to rely in a single experimental paradigm or only one dependent measure to illustrate their theoretical points. Amunategui and Dowd address the challenges

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associated with trying to integrate different types of dynamics in psychotherapy and introduced a theory about how that might be accomplished. Phase portraits are relevant here as well. NDPLS readers might want to take this opportunity to revisit a question that was raised in this journal once before, "Why do the classic attractors such as the Lorenz and the Rossler look so slick, and the ones from my data look so ugly?" (Guastello & Bock, 2001, p. 175-176).

In thinking about general points to be made, one can hardly do better than to read again the introductory chapter in Cochran and Cox (1966), and their warnings (p. 91) on how much-taught data analysis methods can go horribly wrong if variability is not stationary over time, and if conditions of independence are not met. All that was written before the rapid growth of interest in nonlinear processes across diverse disciplines, but it still matters.

Many of us who come to nonlinear dynamics from mainstream teaching in applied psychology up to now would have been comfortable with planned experiments that can be tractably handled with such books as Tabachnick and Fidell (1989) and a computer package. Often the available statistical models drive the assumptions about the data, particularly about data stability and the relative roles of endogenous and exogenous transient variables.

The problems that we must face to be realistic do not exist just because the nonlinear processes that we explore are nonlinear. There is a solid tradition of modeling nonlinear processes using differential equations in chemistry and biology where the variables are well defined and measured with valid metrics (Murray, 1977); thus the rates of change over time can be intrinsic parameters of the system studied. It is when three almost intractable things come together – unidentified metrics, nonlinearity, and non-stationarity – that we need special methods to explore them. Oddly, such systems can sometimes be controlled within limits even when they are unpredictable in the long term. Their sheer controllability in applied situations can mask their underlying dynamics. Putting a nonlinear process into a nonlinear environment, with feedback between the two, resembles life and is the challenge that we scientists face.

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