Book Review


In this informative book on the applications of nonlinear dynamics in cognitive science, Ward maintains the three R’s of good scientific writing, Readable, Researched and Recommended. Ward’s basic tenet is that time plays a crucial role in all psychological processes and so must be included in any viable cognitive theory. He remarks cogently on the tendency for much of cognitive psychology to concentrate on static outcomes of cognitive processes, such as semantic structures, rather than on their temporal evolution.

One aim of the book is to redress the imbalance in cognitive psychology arising from the application of conventional technologies to data analysis and theory. These include experimental techniques, such as analysis of variance that search for causal agents among a set of independent variables, as well as some early cognitive models that emphasize representations in terms of modular structures rather than the time course of their generation. In one challenge to convention in Chapter 16, Ward uses innovative research by Gilden, Thornton and Mallon (1995) to suggest that the temporal fluctuations in dependent variables are possibly more diagnostic of fundamental cognitive processes than any effects of the experimental variables. Based on more recent work by Gilden (2001), residual time series provide evidence for both self-similarity in cognitive processes and perhaps quantification of a cognitive “representation.” Surprisingly, as much as 20–30% of the residual variability in cognitive data may be due to nonlinear deterministic processes, rather than being the measurement noise assumed by those using analyses of variance. Perhaps the most important research strategy change is a renewed emphasis on the analysis of single participant data sets, rather than relying on group means. To this extent, dynamic cognitive science reestablishes psychology as the science of the individual, a person with a unique brain and psychological functioning.

Ward’s book covers a wide range of topics linking cognitive science with recent developments in dynamic system theory, each compartmentalized
into small chunks, known as Chapters (less than 10 pages per chapter on average!). This writing strategy might give the book a discordant impact, but Ward has skillfully arranged the subject matter so that the book flows rather than being disjointed. The book begins with a summary of familiar topics such as serial processes in behavior, brain rhythms, timing of cognitive processes, and then continues with a more formal introduction to dynamical systems theory, and the role of structural models. This is followed by a comparison of these models with more familiar stochastic ones, including the fundamental ideas behind linear time series modeling.

Ward then embarks on a dynamic adventure introducing the reader to possibly unfamiliar material from modern physics, such as the basic properties of “ordinary” and colored noise, stochastic resonance, chaos and, somewhat later in the book, relaxation oscillators. This material is presented in a readable way, unobscured by the complexities of the underlying mathematics. The relevance to cognitive theory is clear from examples such as time estimation, music aesthetics, brain electrophysiology, and visual pattern recognition.

Readers of a dynamics textbook expecting material on chaotic and other nonlinear dynamic processes will not be disappointed. Six of the chapters focus on applications of chaotic systems in human cognition, including the detection of chaos in time estimation data acquired of course from single subjects, and the cognitive prediction of chaotic sequences. The book concludes with a brief summary of contemporary ideas in computational neuroscience and some speculative comments on the “grand-daddy” of all scientific problems, consciousness.

In the chapter on General Systems Theory, Ward highlights the importance of system-environment interaction, a dynamic interplay between nature and nurture that has attained even more importance with the advent of coupled network models, most particularly in computational neuroscience (mentioned in Chapter 18). Ward notes in particular the perplexing nature of complicated systems, such as the brain and behavior, that exhibit “organized complexity.”

There are some problems and omissions in a field that is advancing more rapidly than anyone can possibly chronicle. For example, in a discussion of the relative merits of deterministic and stochastic models, there is no reference to the ground-breaking work of Smith (1995) who has successfully solved the difficult technical task of fitting leaky stochastic models to RT distributions in luminosity discrimination tasks. Equation 11.4 is a non-standard definition of a first-order MA process, the more usual RHS term being a zero-mean white-noise random variable. There are other slight inaccuracies, such as just below Eq. 12.6, the definition of a function as the “parameter” of the model is a bit obscure. On p. 103 a random walk, or