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## Preface

Life is change.

How it differs from the rocks.

—Jefferson Airplane, *Crown of Creation*

The times they are a-changin’.

—Bob Dylan

Changing time, timely change, change creating time, time measuring change—the themes of this book are change and time in various permutations and combinations. The book also deals with nonlinearity, chaos, randomness, and stochastic models, the use of computers to study complicated systems of differential equations, systems theory, complementarity, the importance of formal models, methods from physics and mathematics for the analysis of cognitive systems, and interdisciplinarity, among other topics. Dynamical cognitive science is a potpourri of the old and the new, the borrowed and the “true” (in the carpenter’s sense, meaning “linear”).

Many have proclaimed it was about time we began to focus on dynamics in cognitive science—or in psychology as a whole. Gregson (1983) was perhaps the most forceful of the moderns, but you will find many others referenced within, notably, van Gelder and Port (1995), Port and van Gelder (1995), Kelso (1995), van Gelder (1998), and Beer (2000). Their articles and books discuss the advantages and disadvantages of the dynamical approach to cognition and provide many examples of its usefulness in cognitive science. The present book is both more and less than these others. It is more because it discusses different topics in different ways, for example, noise and relaxation oscillators. It is less because it often touches on material covered in depth elsewhere and does not address at all approaches championed by other dynamical authors, for

example, the dynamical psychophysics of Gregson (1988, 1992) and the dynamical hypothesis of van Gelder (1998). *Dynamical Cognitive Science* is intended to be a deep introduction to the field. Its purpose is to whet appetites, not to give a complete meal: although it treats usually neglected topics such as noise in depth, where it considers deep topics such as time and differential equation models of cognition, it does so in interesting, rather than exhaustive ways.

The book's thirty-five chapters are relatively short. Some introduce important topics presented elsewhere in detail, others together present an important topic in depth (e.g., chaps. 14–19 on noise). Each chapter is self-contained, making a few major points or introducing a few important topics amply yet succinctly, so that it can be read at a short sitting. Although I hope something in the book will appeal to a wide range of readers, from cognitive psychologists and neuroscientists to computer scientists, engineers, physicists, mathematicians, and philosophers, I do not expect that every reader will find every chapter of interest. Thus mathematicians will probably want to skip over sections where familiar equations are explained, just as physicists will the introductory discussions of the master equation, quantum theory, and oscillators. On the other hand, psychologists will probably find most of the chapters of interest, and much of the material new. Although some chapters are difficult, there is really no serious mathematics in the book, only relatively simple equations that will become familiar as readers progress. I hope to show how the relevant mathematical forms (mostly difference or differential equations) can be approached in a more-or-less empirical way, especially by computer exploration, so that their meaning and usefulness to cognitive science is revealed.

This book is much less than I had hoped it would be, or than it could have been had I spent ten more years working on it. The cascade of new dynamical work being undertaken by psychologists and other cognitive scientists promises to undercut the timeliness of one theme of this book, that dynamics should form a core approach to cognitive science. On the other hand, coming after decades of neglect, the new work makes a wide-ranging, comprehensible, yet deep introduction to the promise of the dynamical approach even more timely.

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