
Preface

The title of this book, *Computational Developmental Psychology*, intentionally suggests the designation of a new subfield, on the interface of developmental and computational psychology. The basic theme of the book is that the study of developmental psychology can benefit from taking a computational perspective on longstanding developmental issues, and conversely that computational approaches can find significant and enriching challenges in the areas of psychological development.

Although it can be difficult to know precisely when a new field appears, eventually and gradually it begins to look and feel like a somewhat distinct entity, even when we consider its derivations from more established disciplines. A new field can often be identified by the presence of at least a few major books as well as review and encyclopedia articles, all of which are, in turn, based on extensive journal literatures. Probably the first book in this area was Klahr and Wallace's *Cognitive development: an information processing view* (1976), which introduced developmental psychologists to the revolutionary notion that cognitive development can be computationally modeled, with a number of ensuing advantages to theoretical understanding. These first models were of the symbolic, rule-based type, in which condition-action rules were used to code the child's procedural knowledge at various stages of development, particularly on Piagetian tasks. Another significant book appeared nineteen years later. This was a volume edited by Simon and Halford called *Developing cognitive competence: new approaches to process modeling* (1995). This book signaled that rule-based approaches, while still thriving, were not the only game in town. By the mid 1990s, it was also possible to model psychological development with subsymbolic, neurally

inspired techniques, as well as a variety of less mainstream methods. The neural approach to development was firmly established by Elman and his colleagues in a book called *Rethinking innateness: a connectionist perspective on development* (1996). This offered a comprehensive, subsymbolic analysis of psychological development using so-called artificial neural networks. Any significant academic field will develop major, opposing theoretical approaches, and since the mid 1990s this has certainly been true of computational developmental psychology. The opposition is between rule-based and neural methods. Klahr and MacWhinney wrote an important chapter in the venerable *Handbook of child psychology* under the title of “Information processing” (1998). This review chapter covered a substantial number of rule-based, connectionist, and more eclectic computational models of cognitive and language development.

From the computational side, this new subfield is also identified by a spate of review articles in the influential *Handbook of brain theory and neural networks* (Arbib, 1995) on topics such as “Cognitive development” (McClelland & Plunkett, 1995), “Developmental disorders” (Karmiloff-Smith, 1995), and “Language acquisition” (Plunkett, 1995) and by recent encyclopedia articles with titles such as “Connectionist models of development” (Shultz, 2001).

Combining computational and psychological approaches places this new field squarely in the realm of cognitive science, the multidisciplinary study of cognition. As part of cognitive science, it can be traced to a number of different cognitive-science disciplines, including developmental cognitive neuroscience, artificial intelligence, and connectionism.

The aim of the present book is to provide a current and comprehensive account of this new subfield. Unlike most previous accounts, the book offers an inclusive and comparative approach, emphasizing the two principal approaches of rule-based and connectionist modeling. Although my coverage is meant to be fairly thorough in both breadth and depth, this new field is already large enough that it needs to be approached from a particular perspective, in this case my own. My background in empirical developmental psychology and in rule-based and connectionist modeling partly accounts for my motivation to integrate these distinct approaches.

The book is intended for advanced students and researchers in developmental psychology, connectionism, symbolic modeling, and cognitive science more generally. It could be used as a textbook in courses or seminars on computational modeling in developmental psychology. There are no particular prerequisites for reading this book, apart from an interest in learning more about computational modeling and psychological development. I have made an attempt to provide a self-contained book that does not continually send the reader off to other sources just to understand the current text. This background coverage includes some of the important mathematical underpinnings of connectionist techniques. Readers with knowledge of algebra and some calculus should be able to follow the mathematical content of this book. Appendices provide additional background on required mathematical concepts. In addition, pointers on the book's web site (http://www.psych.mcgill.ca/perpg/fac/shultz/computational_developmental_psychology.htm) to easy-to-use and widely available computational packages enable the interested reader to explore some of these modeling issues firsthand. In particular, computer-programming experience is not required, although it would, of course, be helpful. In general, the additional sources referred to make it possible for readers to brush up on topics for which they would like more background or practical experience.