This book is a definitive reference source for the growing, increasingly important, and interdisciplinary field of computational cognitive modeling, that is, computational psychology. It combines breadth of coverage with definitive statements by leading scientists in this field. Research in computational cognitive modeling (or, simply, computational psychology) explores the essence of cognition and various cognitive functionalities through developing detailed, process-based understanding by specifying computational mechanisms, structures, and processes. Given the complexity of the human mind and its manifestation in behavioral flexibility, process-based computational models may be necessary to explicate and elucidate the intricate details of the mind. The key to understanding cognitive processes is often in fine details. Computational models provide algorithmic specificity: detailed, exactly specified, and carefully thought-out steps, arranged in precise yet flexible sequences. These models provide both conceptual clarity and precision at the same time. This book substantiates this approach through overviews and many examples.

Ron Sun is professor of cognitive science at Rensselaer Polytechnic Institute. A well-known researcher in the field of cognitive science, Sun explores the fundamental structure of the human mind and aims for the synthesis of many interesting intellectual ideas into one coherent model of cognition. The goal is to form a generic cognitive architecture that captures a variety of cognitive processes in a unified way and, thus, to provide unified explanations for a wide range of cognitive data. To do so, for the last two decades, he has been advocating the use of hybrid connectionist-symbolic systems in developing cognitive models, and he has been developing theories of human skill learning and human everyday reasoning as the centerpieces of the cognitive architecture.
The Cambridge Handbook of Computational Psychology

Edited by

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Contents

Preface
List of Contributors

PART I: INTRODUCTION

1 Introduction to Computational Cognitive Modeling
   Ron Sun

PART II: COGNITIVE MODELING PARADIGMS

2 Connectionist Models of Cognition
   Michael S. C. Thomas and James L. McClelland

3 Bayesian Models of Cognition
   Thomas L. Griffiths, Charles Kemp, and Joshua B. Tenenbaum

4 Dynamical Systems Approaches to Cognition
   Gregor Schöner

5 Declarative/Logic-Based Cognitive Modeling
   Selmer Bringsjord

6 Constraints in Cognitive Architectures
   Niels A. Taatgen and John R. Anderson

PART III: COMPUTATIONAL MODELING OF VARIOUS COGNITIVE
FUNCTIONALITIES AND DOMAINS

7 Computational Models of Episodic Memory
   Kenneth A. Norman, Greg Detre, and Sean M. Polyn
vi CONTENTS

8 Computational Models of Semantic Memory
Timothy T. Rogers  226

9 Models of Categorization
John K. Kruschke  267

10 Micro-Process Models of Decision Making
Jerome R. Busemeyer and Joseph G. Johnson  302

11 Models of Inductive Reasoning
Evan Heit  322

12 Mental Logic, Mental Models, and Simulations of Human Deductive Reasoning
Philip N. Johnson-Laird and Yingrui Yang  339

13 Computational Models of Skill Acquisition
Stellan Ohlsson  359

14 Computational Models of Implicit Learning
Axel Cleeremans and Zoltán Dienes  396

15 Computational Models of Attention and Cognitive Control
Nicola De Pisapia, Grega Repovš, and Todd S. Braver  422

16 Computational Models of Developmental Psychology
Thomas R. Shultz and Sylvain Sirois  451

17 Computational Models of Psycholinguistics
Nick Chater and Morten H. Christiansen  477

18 Computational Models in Personality and Social Psychology
Stephen J. Read and Brian M. Monroe  505

19 Cognitive Social Simulation
Ron Sun  530

20 Models of Scientific Explanation
Paul Thagard and Abninder Litt  549

21 Cognitive Modeling for Cognitive Engineering
Wayne D. Gray  565

22 Models of Animal Learning and Their Relations to Human Learning
Francisco J. López and David R. Shanks  589

23 Computational Modeling of Visual Information Processing
Pawan Sinha and Benjamin J. Balas  612

24 Models of Motor Control
Ferdinando A. Mussa-Ivaldi and Sara A. Solla  635

PART IV: CONCLUDING REMARKS

25 An Evaluation of Computational Modeling in Cognitive Science
Margaret A. Boden  667

26 Putting the Pieces Together Again
Aaron Sloman  684

Index  711
Preface

The goal of the *Cambridge Handbook of Computational Psychology* is to provide a definitive reference source for the rapidly growing, increasingly important, and strongly interdisciplinary field of computational cognitive modeling – that is, computational (and theoretical) psychology. It is part of the *Cambridge Handbook in Psychology* series.

This volume combines the breadth of coverage of the field with the authoritative statements by leading scientists in this discipline. It should thus appeal to researchers and advanced students working in this research field, as well as to researchers and advanced students working in cognitive science (in general), philosophy, experimental psychology, linguistics, anthropology, neuroscience, and artificial intelligence. For example, it could serve as a textbook for a course in a cognitive science program or, more generally, in social and behavioral sciences programs. This book could also be used by social science researchers, education researchers, intelligent systems engineers, and psychology and education software developers.

Models in cognitive science are often roughly divided into computational, mathematical, or verbal-conceptual models. Although each of these types of models has its role to play, in this volume, we are mainly concerned with computational modeling. The reason for this emphasis is that, at least at present, computational modeling appears to be the most promising approach in many ways and offers the flexibility and the expressive power that no other approaches can match. (Mathematical models may be viewed somehow as a subset of computational models, as they may lead readily to computational implementations.) A computational model may often be viewed as a theory of the phenomena it aims to capture and may be highly intellectually enlightening in this way.

Each chapter in this volume introduces and explains basic concepts, techniques, and findings for a major topic area within the realm of computational cognitive modeling (e.g., computational models and theories of a particular cognitive domain or functionality); sketches its history; assesses its
successes and failures; and evaluates the directions of current and future research. This handbook thus provides quick overviews for experts in each topic area and also for researchers in allied topic areas. However, equally important, the book provides an introduction to the field of computational cognitive modeling (computational psychology). It discusses the methodologies of computational cognitive modeling and justifies its use in cognitive science. It introduces influential approaches, describing in detail these approaches and providing ample examples. Thus, this volume provides an entry point into the field for the next generation of researchers by supplying a text for courses for graduate students and upper-level undergraduate students and for self-study.

I would like to thank all the contributing authors. Many of them not only contributed chapters, but also participated in mutual reviews of draft chapters, thus helping to ensure the quality of this book.

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