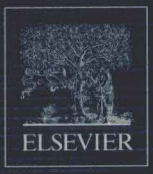

A Practical Logic of Cognitive Systems

VOLUME 2

The Reach of Abduction

Insight and Trial

BY
DOV M. GABBAY AND JOHN WOODS

A Practical Logic of Cognitive Systems
Volume 2

The Reach of Abduction
Insight and Trial

ELSEVIER B.V.
Sara Burgerhartstraat 25
P.O. Box 211, 1000 AE
Amsterdam, The Netherlands

ELSEVIER Inc.
525 B Street
Suite 1900, San Diego
CA 92101-4495, USA

ELSEVIER Ltd.
The Boulevard
Langford Lane, Kidlington,
Oxford OX5 1GB, UK

ELSEVIER Ltd.
84 Theobalds Road
London WC1X 8RR
UK

© 2005 Elsevier B.V. All rights reserved.

This work is protected under copyright by Elsevier B.V., and the following terms and conditions apply to its use:

Photocopying
Single photocopies of single chapters may be made for personal use as allowed by national copyright laws. Permission of the Publisher and payment of a fee is required for all other photocopying, including multiple or systematic copying, copying for advertising or promotional purposes, resale, and all forms of document delivery. Special rates are available for educational institutions that wish to make photocopies for non-profit educational classroom use.

Permissions may be sought directly from Elsevier's Rights Department in Oxford, UK: phone (+44) 1865 843830, fax (+44) 1865 853333, e-mail: permissions@elsevier.com. Requests may also be completed on-line via the Elsevier homepage (http://www.elsevier.com/locate/permissions).

In the USA, users may clear permissions and make payments through the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923, USA; phone: (+1) (978) 7508400, fax: (+1) (978) 7504744, and in the UK through the Copyright Licensing Agency Rapid Clearance Service (CLARCS), 90 Tottenham Court Road, London W1P 0LP, UK; phone: (+44) 20 7631 5555; fax: (+44) 20 7631 5500. Other countries may have a local reprographic rights agency for payments.

Derivative Works
Tables of contents may be reproduced for internal circulation, but permission of the Publisher is required for external resale or distribution of such material. Permission of the Publisher is required for all other derivative works, including compilations and translations.

Electronic Storage or Usage
Permission of the Publisher is required to store or use electronically any material contained in this work, including any chapter or part of a chapter.

Except as outlined above, no part of this work may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without prior written permission of the Publisher.
Address permissions requests to: Elsevier's Rights Department, at the fax and e-mail addresses noted above.

Notice
No responsibility is assumed by the Publisher for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions or ideas contained in the material herein. Because of rapid advances in the medical sciences, in particular, independent verification of diagnoses and drug dosages should be made.

First edition 2005

Library of Congress Cataloging in Publication Data
A catalog record is available from the Library of Congress.

British Library Cataloguing in Publication Data
A catalogue record is available from the British Library.

ISBN: 0-444-51791-X

♾ The paper used in this publication meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper).
Printed in The Netherlands.

In Memoriam

Raymond Reiter
12 June 1939–16 September 2002

Víctor Sánchez-Valencia
10 January 1951–7 June 2003

Acknowledgements

The present work arises from conversations the authors had at the 1999 meeting of the Society for Exact Philosophy in Lethbridge, organized by Bryson Brown. Early results were presented to a seminar on abduction in June 1999 in the Department of Computing and Electrical Engineering, Heriot-Watt University, arranged by Fairouz Kamareddine, and to the Conference on the Frontiers of Logic at King's College, London in November 1999, organized by Dov Gabbay. Additional work formed the basis of presentations in May 2000 to the conference on Modelling at the University of Lethbridge in June 2000, presided over by Paul Viminitz. Further results were worked up at the University of British Columbia in the Spring of 2000, where Gabbay was Visiting Fellow of the Wall Institute for Advanced Study and Woods a visitor in the Noted Scholars Programme. Arrangements in Vancouver were organized by Mohan Matthen.

A first draft of the book served as the text for a course the authors taught at the European Summer School on Logic, Language and Information at the University of Birmingham in August 2000. Achim Jung was responsible for the organization of these meetings.

Subsequent results were discussed at the Conference on Formal and Applied Practical Reasoning, Imperial College, London in September 2000, organized by Jim Cunningham and Johan van Benthem; at meetings of the Ontario Society for Study of Argumentation at the University of Windsor in May 2001, organized by Hans Hansen and Christopher Tindale; and at the University of Groningen where Woods was the Vonhoff Professor in the Spring Term of 2001. Arrangements in Groningen were made by Erik Krabbe and Theo Kuipers. Further revisions were presented to the Conference on the Logic of Rational Agency, in Dagstühl in December 2001. Mike Woolridge and Wiebe van der Hoek were the organizers. Woods also acknowledges the support of Frans van Eemeren's Vakgroep Taalbeheersing, Argentatietheorie an Rhetorica in the University of Amsterdam where he was Visiting Professor in the Spring and Summer 1999, and most years since 1987.

此为试读,需要完整PDF请访问: www.ertongbook.com

Two lectures were presented to the Conference on Mistakes of Reason, at the University of Lethbridge in 2002. Kent Peacock and Andrew Irvine were in charge of arrangements. More recent developments were presented as a lecture to the Cognitive Science Society, in Chicago, August 2004, organized by Lorenzo Magnani, and to the De Morgan Workshop on Logic and Law at King's College London in November 2004, organized by the authors and their colleagues Andrew Jones and Matthias Baaz. Additional materials were presented in two lectures delivered to the Conference on Model-Based Reasoning in Science and Engineering: Abduction, Visualization and Simulation, in December 2004 in Pavia. Lorenzo Magnani was in charge of the Programme.

Alex Boston was Woods' research assistant at UBC, as were Dawn Collins and Brian Hepburn at the University of Lethbridge, and Carol Woods in Vancouver. Brian Hepburn also formatted the early drafts of the book in LaTeX. The project was supported in London by Jane Spurr, Publications Administrator to Dov Gabbay. The authors express their warm thanks to all.

Woods's research is supported by grants from the Social Science and Humanities Research Council of Canada; the University of Lethbridge Research Fund; the Engineering and Physical Sciences Research Council of the United Kingdom, of which he was Visiting Fellow in the academic years 2003-2004; the Department of Computer Science at King's College London; where he is the Charles S. Peirce Visiting Professor of Logic; and the former Dean of Arts and Science of the University of Lethbridge, Professor Bhagwan Dua, and his successor, Christopher Nicol; Professor Margaret Schabas, Head, Department of Philosophy and Professor Nancy Gallini, Dean of Arts, University of British Columbia, to whom the authors owe a particular debt of gratitude. Thanks are also due, and happily given, to our colleagues at Elsevier, Arjen Sevenster our Publishing Editor and Andy Deelen, Production Associate.

Gabbay's research for this book was partially supported by the European Community's PLATO PROJECT, a joint project with Edinburgh University. The objective of this project is to develop logical tools and a goal directed database for modelling some of the arguments of Plato. The mechanism of abduction plays a central role in such models. Further support is acknowledged from the Alexander von Humboldt Foundations which provided a generous fellowship for work on the logics of practical reasoning. We are also grateful to King's College London for a Sabbatical leave allowing for the research on practical reasoning mechanisms, and finally both authors are grateful for the EPSRC fellowship (Grant GR/R59564/01) supporting Woods's visits to King's College in 2002 and 2003–04.

Parts of chapter 2 are drawn or adapted from chapter 2 of *Agenda Relevance* [Gabbay and Woods, 2003a], as are section 6.7 and chapter 11. We are grateful to our publisher, Elsevier, for permission to reprint this material.

A word of special thanks to Atocha Aliseda, and Paul Bartha for the courtesy of allowing us to benefit from pre-publication versions of their respective books *Abductive Reasoning: Logical Investigations into the Process of Discovery and Evaluation*, and *Analogical Reasoning and Plausibility in the Sciences*; and to Nicholas Rescher for the stimulation afforded by his pioneering studies in logic and cognitive rationality.

In addition to those already mentioned, we are grateful for discussions bearing on our work to Tom Addis, Ardis Anderson, Bradley Armour-Garb, David Atkinson, Diderik Batens, John Beatty, Krystia Broda, Peter Bruza, Balakishnam Chandrasekaran, Jim Cunningham, Donald Davidson, Stephen Friesen, Artur Garcez, Donald Gillies, Alvin Goldman, Nick Griffin, Jaakko Hintikka, David Hitchcock, Dale Jacquette, Ruth Kempson, Shalom Lappin, Dominic McIvor Lopesz, Peter McBurney, Tom Maibaum, David Makinson, Joke Meheus, Rolf Nossum, Sami Paavolva, Jeanne Peijnenberg, Gabriella Pigozzi, David Poole, Graham Priest, Michael Rabin, Chris Reed, Ray Reiter, Odinaldo Rodriques, Victor Rodych, Menno Rol, Jan-Willem Romeyn, Patrick Rysiew, Victor Sánchez Valencia, Matti Sintonen, Roy Sorensen, Patrick Suppes, Jason Tangen, Alice ter Meulen, Alexander van den Bosch, Bas van Fraassen, Jan Albert van Laar, John Vokey, Joe Wells and Jon Williamson.

Preface

Although *A Practical Logic of Cognitive Systems* exhibits some common themes, we have written the individual volumes with a view to their being read either as stand-alone works or as linked and somewhat overlapping items in the series, depending on the interests of particular readers. Relevance was our main theme in volume one; abduction will occupy us in the present volume; and volume three will concern itself with fallacious reasoning. Here too, we intend to honour the pledge of independent readability. Even so, certain continuities will also be evident in all volumes, of which the first and foremost is what we suggest about the structure of practical reasoning. In some cases, it will be unavoidable that we repeat a point made in a predecessor volume. Sometimes we will elaborate upon a prior point. On occasion, we will correct what we now see as a mistake.

In writing our predecessor volume on relevance, we were mindful of two approaches to the subject that had attained dominant purchase. One is the output of a generation's research on relevant logic, ensuing from the work of Alan Ross Anderson and Nuel D. Belnap, Jr., beginning in the late 1950s. The other is the theory of the communication theorists, Dan Sperber and Deirdre Wilson, whose influential pragmatic account appeared in 1986. We did not want to write a derivative book; neither were we much attracted by the prospects of polemical attack. We desired to take an approach that at once recognized the significance of the dominant views, while attempting to advance beyond them in substantial measure.

Abduction faces us with a somewhat different challenge. No less central a factor in practical reasoning than relevance, we trust that we give no offence in observing that the abductive landscape is not yet presided over by dominant theoretical presences, in the manner of relevance. A possible exception to this are the scattered contributions by the modern founder of abductive logic, Charles Peirce. Peirce's sallies are indeed seminal, and dotted with some brilliantly original insights. But unlike the cumulative record of modern relevant logicians and the detailed theoretical articulation of Sperber's and Wilson's account, Peirce left the logic of abduction in a comparatively undeveloped state. It is true that there is by now a large literature on abduction, created by an impressive number of authors

from philosophy, cognitive psychology, computer science, artificial intelligence and, of course, logic. From philosophy alone it may be suggested that, contrary to our present suggestion, an important approach has indeed presented itself in the literature that has grown up around Gilbert Harman's significant paper from 1965 on inference to the best explanation. There can be no doubt that inference to the best explanation is an important idea which has been ably probed by a generally sophisticated literature. Even so, we are not quite ready to accede to a dominance that is more arguably to be found in the literature on relevance. There are three reasons for this reluctance. One is that various kinds of abductive practice have nothing to do with achieving explanations. Another is that even in those cases in which abduction has an explanationist character, the factor of explanation is but a part, albeit an important part, of the abductive pie. Thirdly, in some versions of it, inference to the best explanation is not abductive, surprising as that may strike us initially.

If we are correct in these observations, abduction is a more wide-open field than relevance. For the would-be theorist this is an advantage and a disadvantage. The advantage is that achieving a dominant position is, in principle, a target still to be aimed at. The disadvantage is that there are fewer stout shoulders on which the theorist might secure a purchase. Still, we don't wish to leave the impression that the abductive theorist's is a voice in a solitary wilderness. There is much good work that has already been published, of which three recent examples are [Aliseda, forthcoming; Magnani, 2001a] and [Meheus *et al.*, forthcoming].

The comparative openness of the logic of abduction makes a book such as this in like degree an enterprise of first words rather than last. Even in what we think we have already come to understand about abduction, there is ample discouragement of the idea that all of abduction can be gobbled up in a single try. Accordingly, the best we can hope for is new ground decisively broken in ways that portend favourably for the grand theory, whenever it appears.

Part I

A Practical Logic of Cognitive Systems

Contents

Acknowledgements xiii

Preface xvii

A Practical Logic of Cognitive Systems 1

1 Introduction 1

2 Practical Logic 9
2.1 First Thoughts on a Practical Logic 9
2.1.1 A Hierarchy of Agency Types 10
2.1.2 Peculiarities of Institutional Agents 15
2.1.3 Normativity 18
2.1.4 Mathematical Models 22
2.1.5 Slight-resource Adjustment Strategies 24
2.1.6 Hasty Generalization 24
2.1.7 Generic Inference 24
2.1.8 Natural Kinds 25
2.1.9 Defaults 26
2.1.10 Discourse Economies 26
2.1.11 Consciousness 27
2.2 Practical Logic 30
2.3 Connectionist Logic 32
2.3.1 Fallacies 33

Conceptual Models of Abduction 37

3 The Structure of Abduction 39

此为试读,需要完整PDF请访问: www.ertongbook.com

3.1 Introductory Remark on Abduction 39
3.2 The Elementary Structure of Abductive Logic 40
3.3 Expanding the Schema 42
3.4 Frames 44
3.5 Generalizing IPs 45
3.6 Avoiding a Confusion 45
3.7 Locating Abduction on the Logical Map 46
3.8 Abductive Schematics 47
3.8.1 Consequentialist Abduction 47
3.8.2 The Good that AKM Does 53
3.8.3 The Reach of Abduction 54
3.8.4 Simplicity 56
3.9 The Cut Down Problem 56
3.9.1 Abduction as Practical 58
3.9.2 Proof-theoretic Abduction 58
3.10 The Adaptive and the Epistemically Subpar 62
3.11 Knowledge-Sets 63
3.12 Filtration Structures 66
3.13 Hypothesis-Engagement 69
3.14 Grounds of Action 70
3.15 Tasks for an Abductive Logic 71

4 Explanationist Abduction **75**
4.1 Peirce 75
4.1.1 Surprise 81
4.1.2 Testability and Economics 82
4.1.3 Insight and Trial 85
4.2 Rationality and Diminished Epistemic Virtue 86
4.3 Explanationism 87
4.3.1 The Covering Law Model 90
4.3.2 The Rational Model 93
4.3.3 Teleological Explanation 96
4.3.4 The Pluralism of Explanation 99
4.4 Assessing *IBE* 100
4.5 Characteristicness 102
4.6 Hanson 104
4.7 Darden 109
4.8 Fodor 109
4.9 Adaptive Explanationism 110
4.10 Non-abductive Conjecture 113

5 Non-Plausibilistic Abduction **115**
5.1 Introductory remark . . . 115
5.2 Newton . . . 116
5.3 Planck . . . 121
5.4 Physical Dependencies . . . 122
5.5 The Superstring Controversy . . . 123
5.6 Russell and Gödel . . . 125
5.7 The Consequence Relation . . . 129
5.8 Lakatos . . . 134
5.9 Hintikka . . . 138
5.10 Empirical Progress . . . 141
5.11 Semantic Tableaux . . . 142
5.11.1 Assessing Semantic Tableau Abduction . . . 146
5.11.2 Is It Abduction? . . . 147
5.12 Inconsistency Again . . . 148
5.12.1 Bayesian Inference . . . 150

6 Diagnostic Abduction in AI **155**
6.1 Explanationist Diagnostics . . . 155
6.1.1 Difficulties with AP . . . 161
6.2 Another Example . . . 163
6.2.1 Remarks . . . 169
6.3 Coherentism and Probabilism . . . 170
6.3.1 The Rivalry of Explanationism and Probabilism . . . 170
6.4 Explanatory Coherence . . . 171
6.4.1 Probabilistic Networks . . . 174
6.5 Pearl Networks for ECHO . . . 176
6.6 Neuropharmacological Intervention . . . 180
6.7 Mechanizing Abduction . . . 184
6.8 Abduction in Neural-Symbolic Networks . . . 189

7 The Characteristic and the Plausible **195**
7.1 The Open Door . . . 195
7.1.1 The Element of Surprise . . . 196
7.1.2 Plausibility . . . 200
7.1.3 A Resolution Point . . . 201
7.1.4 How to Get Determinacy Out of Indeterminacy . . . 202
7.1.5 Alternatives . . . 204
7.2 The Piccadilly Line . . . 206
7.3 Plausibility Again . . . 209
7.3.1 Historical Note on Plausibility . . . 210

7.3.2 Cut-to-the Chase Abduction 212
7.4 Characteristicness 213
7.5 Common Knowledge 219
7.6 Rescher's Plausibility Logic 222
7.6.1 Reliability 227
7.6.2 Axioms for Plausibility 228
7.7 Plausibility and Presumption 232
7.8 Brief Concluding Remarks 237

8 Relevance and Analogy **239**
8.1 Relevance 239
8.1.1 Relevance as Cognitive 240
8.1.2 Topical Relevance 243
8.1.3 Contextual Effects 247
8.2 Irredundancy Relevance 248
8.3 Relevance and Cutting to the Chase 250
8.4 Legal Relevance 254
8.4.1 Ideology 256
8.5 Legal Presumption 258
8.5.1 Types of Presumption 260
8.5.2 The Reasonable Person 264
8.5.3 Reasonable Doubt 265
8.6 Hypothesis-Discharge 268
8.7 The Probativity Question 269
8.8 Revision Structures 270
8.8.1 Proof Standards 272
8.8.2 Analogy 274
8.8.3 The Meta Approach 276
8.8.4 Similarity 281
8.9 Analogy in Law 282
8.9.1 Precedent 284
8.10 Analogue Modelling 286

9 Interpretation Abduction **289**
9.1 Hermeneutics 289
9.1.1 Enthymemes 291
9.1.2 Fermat's Last Theorem 294
9.2 Enthymeme Resolution as Abductive 296
9.2.1 The Attack on Analyticity 298
9.2.2 Inarticulacy as Economics 300
9.2.3 Some Virtual Guidelines 302

9.2.4 Background Knowledge . . . 303
9.3 Charity . . . 305
9.3.1 Indeterminacy of Translation . . . 307
9.4 Is it Abduction (Again)? . . . 312
9.5 Constitutional Inarticulacies . . . 313
9.5.1 Inarticulate Understanding . . . 313
9.6 Visual Abduction . . . 317
9.7 Empathy . . . 319
9.7.1 Discourse Empathies . . . 321
9.8 Semantic Space Interpretation of Texts . . . 323
9.8.1 The Raynaud-Fish Oil Abduction . . . 328

Formal Models of Abduction **333**

10 A Glimpse of Formality **335**
10.1 Introduction . . . 335
10.1.1 The AKM model . . . 336
10.1.2 The GW Model . . . 342
10.2 Some Schematic Remarks . . . 344
10.3 Case Study: Defeasible Logic . . . 351

11 A General Theory of Logical Systems **357**
11.1 Introduction . . . 357
11.2 Logical Systems . . . 360
11.3 Refining the Notion of a Logical System . . . 372
11.3.1 Structured consequence . . . 372
11.3.2 Algorithmic structured consequence relation . . . 373
11.3.3 Mechanisms . . . 376
11.3.4 Modes of Evaluation . . . 378
11.3.5 TAR-Logics . . . 380
11.3.6 Relevance . . . 382
11.4 Discussion and Further Reading . . . 382

12 A Base Logic **383**
12.1 Formal Abduction: An Overview . . . 383
12.2 Introducing LDS . . . 388
12.2.1 LDS for $\Rightarrow$ . . . 388
12.2.2 Examples of Resource LDS . . . 391
12.3 Goal Directed Algorithm for $\Rightarrow$ . . . 397
12.3.1 The Algorithm . . . 398
12.3.2 Examples . . . 400

12.4 Intuitive Theory of Labelled Abduction 402
12.4.1 Abduction in Knowledge Bases 403
12.4.2 Abduction in Planning and Natural Language 409
12.4.3 Abduction in Logic Programming 411
12.4.4 A Conversation Between Two Intelligent Databases 418

13 An Abductive Mechanism for the Base Logic 423
13.1 Introduction 423
13.2 Abduction Algorithm for $\Rightarrow$ 430
13.3 Case Study: Abduction for Intuitionistic Implications 432
13.4 Case Study: Abduction for Relevance Logic 437
13.5 Conclusion 441

Bibliography 443

Index 473

Chapter 1

Introduction

> It is sometimes said that the highest philosophical gift is to invent important new philosophical problems. If so, Peirce is a major star on the firmament of philosophy. By thrusting the notion of abduction to the forefront of philosophers' consciousness he created a problem which — I will argue — is the central one in contemporary epistemology.
>
> Jaakko Hintikka,

> The surprising fact C is observed. But if A were true, C would be a matter of course. Hence there is reason to suspect that A is true.
>
> Charles S. Peirce

Abduction is our subject here. We meet it in a state of heightened theoretical activity. It is part of the contemporary research programmes of logic, cognitive science, AI, logic programming, and the philosophy of science. This is a welcome development. It gives us multiple places to look for instruction and guidance.

The approach that we take in this book is broadly logical. Any fears, even so, that this will be an over-narrow orientation may be allayed by our decision to define logic as the disciplined description of the behaviour of real-life logical agents. In this we command a theme that has played since antiquity: that logic is an account of how thinking agents reason and argue. Because we wish to give due attention to the process side of the process-product distinction, we propose a rapprochement between logic and psychology, with a special emphasis on developments in cognitive science. It would be foolish to suggest that the hugely profitable theoretical attainments of modern mathematical logic have no place in an agent-based, psychologically realistic account of abduction. The rich yield in

此为试读,需要完整PDF请访问: www.ertongbook.com