

Lorenzo Magnani and Ping Li (Eds.)

Model-Based Reasoning in Science, Technology, and Medicine

Studies in Computational Intelligence, Volume 64

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(Eds.)

Model-Based Reasoning in Science, Technology, and Medicine

With 77 Figures, 10 in Color and 7 Tables

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&
Department of Philosophy, University of Pavia (Italy)



When a chicken first emerges from the shell, it does not try fifty random ways of appeasing its hunger, but within five minutes is picking up food, choosing as it picks, and picking what it aims to pick. That is not reasoning, because it is not done deliberately; but in every respect but that, it is just like abductive inference.

Charles Sanders Peirce

Preface

The volume is based on the papers that were presented at the international conference *Model-Based Reasoning in Science and Medicine* (MBR'06_China), held at Sun Yat-sen University, Guangzhou, P.R. China in July 2006. The previous volume *Model-Based Reasoning in Scientific Discovery*, edited by L. Magnani, N.J. Nersessian, and P. Thagard (Kluwer Academic/Plenum Publishers, New York, 1999; Chinese edition, China Science and Technology Press, Beijing, 2000), was based on the papers presented at the first “model-based reasoning” international conference, held at the University of Pavia, Pavia, Italy in December 1998. Other two volumes were based on the papers presented at the second “model-based reasoning” international conference, held at the same place in May 2001: *Model-Based Reasoning. Scientific Discovery, Technological Innovation, Values*, edited by L. Magnani and N.J. Nersessian (Kluwer Academic/Plenum Publishers, New York, 2002) and *Logical and Computational Aspects of Model-Based Reasoning*, edited by L. Magnani, N.J. Nersessian, and C. Pizzi (Kluwer Academic, Dordrecht, 2002). Another volume *Model-Based Reasoning in Science and Engineering*, edited by L. Magnani (College Publications, London, 2006), was based on the papers presented at the third “model-based reasoning” international conference, held at the same place in December 2004.

The presentations given at the conference explored how scientific thinking uses models and explanatory reasoning to produce creative changes in theories and concepts. Some addressed the problem of model-based reasoning in technology, and stressed the issue of technological innovation and medical reasoning. Moreover, there still are some presentations in Chinese given at the conference that deal with problem-solving in science and ordinary reasoning, which were published in the volume *Philosophical Investigations from a Perspective of Cognition*, edited by L. Magnani and P. Li (Guangdong People's Publishing House, Guangzhou, 2006).

The study of diagnostic, visual, spatial, analogical, and temporal reasoning has demonstrated that there are many ways of performing intelligent and creative reasoning that cannot be described with the help only of traditional

notions of reasoning such as classical logic. Understanding the contribution of modeling practices to discovery and conceptual change in science requires expanding scientific reasoning to include complex forms of creative reasoning that are not always successful and can lead to incorrect solutions. The study of these heuristic ways of reasoning is situated at the crossroads of philosophy, artificial intelligence, cognitive psychology, and logic; that is, at the heart of cognitive science. There are several key ingredients common to the various forms of model-based reasoning. The term “model” comprises both internal and external representations. The models are intended as interpretations of target physical systems, processes, phenomena, or situations. The models are retrieved or constructed on the basis of potentially satisfying salient constraints of the target domain. Moreover, in the modeling process, various forms of abstraction are used. Evaluation and adaptation take place in light of structural, causal, and/or functional constraints. Model simulation can be used to produce new states and enable evaluation of behaviors and other factors.

The various contributions of the book are written by interdisciplinary researchers who are active in the area of creative reasoning in science and technology: the most recent results and achievements about the topics above are illustrated in detail in the papers.

The editors express their appreciation to the members of the Scientific Committee for their suggestions and assistance: – Thomas Addis, Department of Computer Science and Software Engineering, University of Portsmouth, UK – Atocha Aliseda, Instituto de Investigaciones Filosóficas Universidad Nacional Autónoma de México (UNAM), Mexico City, MEXICO – Diderik Batens, Center for Logic and Philosophy of Science, Universiteit Gent, BELGIUM – David Brown, Institute of Industrial Research University of Portsmouth, Portsmouth, UK – Walter Carnielli, Centre for Logic, Epistemology and the History of Science, State University of Campinas, UNICAMP, Campinas, SP, BRAZIL – Xiang Chen, Department of Philosophy, California Lutheran University, CA, USA – Roberto Cordeschi, Department of Communication Sciences, University of Salerno, Salerno, ITALY – Dov Gabbay, Department of Computer Science, King’s College, London, UK – Shenchun Gao, College of Philosophy and Sociology, Jilin University, Changchun, CHINA – Michael E. Gorman, School of Engineering and Applied Science, University of Virginia, Charlottesville, VA, USA – David Gooding, Science Studies Centre, Department of Psychology, University of Bath, Bath, UK – Sundari Krishnamurthy, Stella Maris College (Autonomous), University of Madras, INDIA – Michael Leyton, DIMACS, Busch Campus, Rutgers University, New Brunswick, NJ, USA – Ping Li, Department of Philosophy, Sun Yat-sen University, Guangzhou, CHINA – Xingmin Li, Graduate School, Chinese Academy of Sciences, Beijing, CHINA – Xiaoli Liu, Department of Philosophy, Beijing Normal University, Beijing, CHINA – Honghai Liu, Department of Computing Science, University of Aberdeen, Aberdeen, UK – Shangmin Luan, Institute of Software, Chinese Academy of Sciences,

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Several papers concerning model-based reasoning deriving from the previous conferences MBR98 and MBR01 can be found in Special Issues of Journals: in *Philosophica: Abduction and Scientific Discovery*, 61(1), 1998, and *Analogy and Mental Modeling in Scientific Discovery*, 61(2) 1998; in *Foundations of Science: Model-Based Reasoning in Science: Learning and Discovery*, 5(2) 2000, all edited by L. Magnani, N.J. Nersessian, and P. Thagard; in *Foundations of Science: Abductive Reasoning in Science*, 9, 2004, and *Model-Based Reasoning: Visual, Analogical, Simulative*, 10, 2005; in *Mind and Society: Scientific Discovery: Model-Based Reasoning*, 5(3), 2002, and *Commonsense and Scientific Reasoning*, 4(2), 2001, all edited by L. Magnani and N.J. Nersessian. Finally, other related philosophical, epistemological, and cognitive oriented papers deriving from the presentations given at the conference MBR04 have been published in a Special Issue of *Logic Journal of the IGPS: Abduction, Practical Reasoning, and Creative Inferences in Science* 14(1) (2006) and will be published in two Special Issues of *Foundations of Science: Tracking Irrational Sets: Science, Technology, Ethics, and Model-Based Reasoning in Science and Engineering*, all edited by L. Magnani.

Lorenzo Magnani

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Sun Yat-sen University, Guangzhou, P.R. China

Pavia, Italy, February 2007

Contents

Part I Abduction, Problem Solving, and Practical Reasoning

Animal Abduction

From Mindless Organisms to Artifactual Mediators

Lorenzo Magnani 3

Communicative Gestures Facilitate Problem Solving for Both Communicators and Recipients

Sandra C. Lozano, Barbara Tversky 39

The Concept of Fallacy is Empty

A Resource-Bound Approach to Error

John Woods 69

Abductive Reasoning, Information, and Mechanical Systems

Maria Eunice Quilici Gonzalez, Mariana Claudia Broens

and Fabricio Loffredo D'Ottaviano 91

Automated Abduction in Scientific Discovery

Oliver Ray 103

Abduction, Medical Semeiotics and Semioethics

Individual and Social Symptomatology from a Semiotic Perspective

Susan Petrilli 117

Abduction and Modeling in Biosemiotics and Sociosemiotics

Augusto Ponzio 131

Reason out Emergence from Cellular Automata Modeling

Leilei Qi, Huaxia Zhang 147

Belief Ascription and *De Re* Communication

Yuan Ren 161

Multiagent-Based Simulation in Biology

A Critical Analysis

Francesco Amigoni, Viola Schiaffonati 179

**Mathematics through Diagrams: Microscopes
in Non-Standard and Smooth Analysis**

Riccardo Dossena, Lorenzo Magnani 193

**Part II Models, Mental Models, Representations,
and Medical Reasoning**

Cognition, Environment and the Collapse of Civilizations

Michael E. Gorman 217

**Cognitive Aspects of Tacit Knowledge
and Cultural Diversity**

Riccardo Viale, Andrea Pozzali 229

**The Functional-Analogical Explanation in Chinese Science
and Technology**

A Case Study of the Theory of Yin-Yang and Five Elements

Huaxia Zhang, Zhilin Zhang 245

**Model-Based Reasoning and Diagnosis
in Traditional Chinese Medicine (TCM)**

Zhikang Wang 261

Model-Based Reasoning in Cognitive Science

Yi-dong Wei 273

**An Examination of Model-Based Reasoning
in Science and Medicine in India**

Sundari Krishnamurthy 293

Ontology, Artefacts, and Models of Reasoning

Pasi Pohjola 315

The Wondering Angels of the Fractal Art

Viorel Guliciuc 333

**Part III Logical and Computational Aspects
of Model-Based Reasoning**

**Polynomizing: Logic Inference in Polynomial Format
and the Legacy of Boole**

Walter Carnielli 349

Abductive Inference and Iterated Conditionals <i>Claudio Pizzi</i>	365
Peircean Pragmatic Truth and da Costa's Quasi-Truth <i>Itala M. Loffredo D'Ottaviano, Carlos Hifume</i>	383
Sliding Mode Motion Control Strategies for Rigid Robot Manipulators <i>Antonella Ferrara, Lorenza Magnani</i>	399
Model-Based Chemical Compound Formulation <i>Stefania Bandini, Alessandro Mosca and Matteo Palmonari</i>	413
Model-Based Reasoning for Self-Repair of Autonomous Mobile Robots <i>Michael Hofbaur, Johannes Köb, Gerald Steinbauer and Franz Wotawa</i>	431
Application of Bayesian Inference to Automatic Semantic Annotation of Videos <i>Fangshi Wang, De Xu, Hongli Xu, Wei Lu and Weixin Wu</i>	447
An Algebraic Approach to Model-Based Diagnosis <i>Shangmin Luan, Lorenzo Magnani and Guozhong Dai</i>	467
CYBERNARD: A Computational Reconstruction of Claude Bernard's Scientific Discoveries <i>Jean-Gabriel Ganascia, Claude Debru</i>	497
Do Computational Models of Reading Need a Bit of Semantics? <i>Remo Job, Claudio Mulatti</i>	511