

PREFACE

This special issue of the journal *Philosophica* "Analogy and mental modeling in scientific discovery" is based on a selection of the papers that were presented at the International Conference *Model-Based Reasoning in Scientific Discovery* (MBR'98), held at the Collegio Ghislieri, University of Pavia, Pavia, Italy, in December 1998. Over fifty papers exploring how scientific thinking uses models and explanatory reasoning to produce creative changes in theories and concepts were presented at the conference.

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 provided by classical logic. Traditional accounts of scientific reasoning have restricted the notion of reasoning primarily to deductive and inductive arguments. 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.

Several key ingredients common to the various forms of model-based reasoning have been considered. 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. In the modeling process, various forms of abstraction are utilized. Evaluation and adaptation take place in light of structural, causal, and/or functional constraints. Simulation can be used to produce new states and enable evaluation of behaviors and other factors.

The conference also addressed some of the main aspects of the nature of the relation between model-based reasoning and abduction, with many of the analyses connecting it to the central epistemological question of hypothesis withdrawal in science.

The various contributions to this special issue are written by interdisciplinary researchers in philosophy, artificial intelligence, and cognitive science who are active in the area of creative reasoning in science. They illustrate some of the most recent results and achievements about the problem of analogy and mental modeling as forms of model-based creative reasoning: mental modeling in terms of the computational perspective of the “constructive induction” (S. Bandini, G. Lanzarone, and A. Valpiani), the role played by the so-called executive control process model in allocating mental resources in scientific discovery processes (E.G. Freedman), the role, explicated by analogy, of the exploratory and testing aspects of experiments and models in “non-laboratory sciences” (F. Guala), the relationships between modeling at perceptual level and modeling in science (J.A. Myrstad), and model-based analogical reasoning in mathematics (S. Visokolskis).

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Several of the remaining papers deriving from the presentations given at the Conference have already been published in the book L. Magnani, N.J. Nersessian, and P. Thagard, eds., *Model-Based Reasoning in Scientific Discovery*, Kluwer Academic/Plenum Publishers, New York, 1999. The book is divided in three parts. The first part, *Models, mental models, and representations*, that contains the contributions of N.J. Nersessian; D. Bailer-Jones; R. Giere; K. Knoespel; M. Suarez; and K. Dunbar. The second part *Discovery processes and mechanism* is composed of the papers of D. Gooding and T.R. Addis; P. Thagard and D. Croft; T. Harris; V. Rasis; S. Krauss, L. Martignon, and U. Hoffrage; and F.T. Arecchi. Finally, the last part, *Creative inferences and abduction*, include the contributions of J. Meheus; L. Magnani; I. Niiniluoto; E. Winsberg; F. Hendricks and J. Faye; C. Pizzi; J. Zytkow. Other selected papers will appear in other two Special Issues of Journals: in *Philosophica*, "Abduction and scientific discovery," and in *Foundations of Science*, "Model-based reasoning in science: learning and discovery."

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