Lorenzo Magnani, Walter Carnielli, and Claudio Pizzi (Eds.)

Model-Based Reasoning in Science and Technology

Abduction, Logic, and Computational Discovery

Springer
The psychologists undertake to locate various mental powers in the brain; and above all consider it as quite certain that the faculty of language resides in a certain lobe; but I believe it comes decidedly nearer the truth (though not really true) that language resides in the tongue. In my opinion, it is much more true that the thoughts of a living writer are in any printed copy of his book than that they are in his brain.

Charles Sanders Peirce
This volume is a collection of selected papers that were presented at the international conference Model-Based Reasoning in Science and Technology. Abduction, Logic, and Computational Discovery (MBR09_BRAZIL), held at the University of Campinas, Campinas, Brazil in December 2009.


The presentations given at the Campinas conference explored how scientific thinking uses models and explanatory reasoning to produce creative changes in theories and concepts. Some speakers addressed the problem of model-based reasoning in technology, and stressed the issue of science and technological innovation. 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 modeling reasoning and creative reasoning in logic, 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: Atocha Aliseda, Instituto de Investigaciones Filosoficas, Universidad Nacional Autonoma de Mexico (UNAM) – Silvana Borutti, Department of Philosophy, University of Pavia, ITALY – Eduardo Bustos, Department of Logic, History and Philosophy of Science at UNED (Spanish Open University), Madrid, SPAIN – Marcelo Esteban Coniglio, Department of Philosophy, CLE and Institute of Philosophy and Human Sciences, State University of Campinas, BRAZIL – Itala D’Ottaviano, CLE and Department of Philosophy, Institute of Philosophy and Human Sciences, State University of Campinas, BRAZIL – Roberto Cordeschi, Department of Philosophy, “La Sapienza” University of Rome, ITALY – Roberto Feltrero, Department of Logic, History and Philosophy of Science at UNED (Spanish Open University), Madrid, SPAIN – Marcello Frixione, Department of Communication Sciences, University of Salerno, ITALY – Michel Ghins, Institut Supérieur de Philosophie, Université de Louvain, BELGIUM - David Gooding, Department of Psychology, University of Bath, UK – Mike E. Gorman, Technology, Culture & Communications, SEAS University of Virginia, USA – Marcello Guarini, Department of Philosophy, University of Windsor, CANADA – Ricardo Gudwin, Department of Computer Engineering and Industrial Automation, the School of Electrical Engineering and Computer Science, State University of Campinas, BRAZIL – Viorel Guliciuc, Stefan cel Mare University, Suceava, ROMANIA – Michael Leyton, Psychology Department, and DIMACS Center for Discrete Mathematics, & Theoretical Computer Science, Rutgers University, USA – Mamede Lima-Marques, Department of Information Science and
Preface

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Other more technical logical papers presented at (MBR09_BRAZIL) will be published in a special issue of the Logic Journal of the IGPL, edited by L. Magnani, W. Carnielli, and C. Pizzi.

Finally, the present book also includes a brief paper that two of the editors, Walter Carnielli and Lorenzo Magnani, have devoted to the 65th birthday of Claudio Pizzi.

Pavia, Italy
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Years of Reasoning
In Honor of the 65th Birthday of Claudio Pizzi

Walter Carnielli and Lorenzo Magnani

Abstract. This paper is devoted to Claudio Pizzi on the occasion of his 65th birthday. Looking at the essential bibliography reported below, Pizzi’s reserved character is manifest in the few co-authors he had in his publications. However, it is hard to find among philosophers and logicians a colleague so unanimously recognized as gentlemanly in his attitude towards science and academic life. The blend of rigor and philosophical scope that characterizes Pizzi’s work is, at the same time, analytic philosophy and philosophical logic as its best, as it is demonstrated in his intellectual career. Claudio Pizzi is also a fine cooker, and one of the best connoisseurs of Brazilian music we know.

1 Four Decades of Conditionals and Rational Inference

Claudio Pizzi obtained his degree in Philosophy in March 1969 at the State University of Milan, with a dissertation about subjunctive and counterfactual conditionals (titled I Condizionali Congiuntivi: Aspetti Epistemologici e Problemi di Formalizzazione).

This subject was considered quite abstruse in Italy in those years, and it is relevant to have in sight that the best accepted and most elaborated counterfactual theory of causation, represented by the work of David Lewis, would only see the light in 1973. The epistemological panorama was still dom-
inated by logical positivism, and the only logic which in Italy was considered a reverent object of study was mathematical logic. Modal logic was almost completely ignored or considered an oddity, to be avoided even more than many-valued logic.

The attitude towards modal logic in Italy began to change after the publication of the Italian translation of Hughes and Cresswell’s *Introduction to Modal Logic* (Il Saggiatore, Milan, 1973). Pizzi, as he says, had the luck to be charged with the translation and the editing of the book (for which he also wrote an introduction); the work was a good opportunity for him to get well acquainted with the basic elements of possible-worlds semantics.

The volume [3] was, at that time, an updated collection of papers on the topic of counterfactual reasoning and physical modalities. In preparing the long introduction for this book Pizzi developed an impression that the “consequentialist” view about conditionals (Chisholm-Goodman-Reichenbach) and the attempts to give it a formalization (especially in Angell and McCall’s connexive logic) had been too hastily dismissed. [2] proposes to recover the basic idea of connexive logic by: (a) treating it as an extension of standard logic, and (b) introducing a distinction between an analytical and synthetic (context-dependent) variant of it via a simple axiomatization of Åqvist’s circumstantial operator ∗. What is called *Boethius’ Thesis* in the synthetic variant had the form (∗A → B) ⊃ ¬(A → ¬B). Unfortunately, the system introduced in the paper could be accepted only as a limit case since the trivializing equivalence p ≡ ∗p may be proved. What this family of systems needed was a decision procedures, and Pizzi tried to provide it in [8] and [9]. With respect to the 1977 paper, the analytical fragment of the basic system of [8], named CI.0, has the important difference of excluding the Factor Law (A ∧ B) ⊃ (A ∧ C → B ∧ C), which may be accepted only in a weakened variant. For this reason the logics belonging to this family cannot be qualified as connexive anymore, and need a different classification: Pizzi called them logics of consequential implication. The key idea of the decision procedure is very simple: every formula of form A → B is translated into a strict implication A ⊢ B conjoined with the assertion that A and B have the same modal status, i.e., the same position in Aristotle’s square of modalities; the resulting translation is then tested with the tableaux methods used in standard modal logic. It turns out then that CI.0 is definitionally equivalent to the modal system KT, and weaker consequential systems are equivalent to weaker systems of modal logics.

The paper [17] is centered on the idea that consequential logics grasp in a special sense the relevance of A to B; in fact, in order of A → B being true, A and B have actually something in common, namely their modal status. Implication relations weaker than → may be represented as “truncations” of analytical consequential implication preserving basic properties such as Aristotle’s Thesis (namely ¬(A → ¬A)). The interrelations between such different kinds of consequential implication may be visualized into three-dimensional pictures named “Aristotle’s cubes” (see [23]). According to the
Years of Reasoning

Italian historian Mauro Nasti de Vincentis consequential implication grasps some basic intuitions about conditionals that can be found in Aristotle and Chrysippus.

In two papers written in collaboration with T. Williamson [12, 18] two pathological extensions of systems of consequential implication are analyzed: the former by means of the Strong Boethius’ Thesis \((A \rightarrow B) \rightarrow \neg (A \rightarrow \neg B)\) and the latter by means of the “Conditional Excluded Middle” \((A \rightarrow B) \lor (A \rightarrow \neg B)\). The first paper introduces a general schema of one-one translation between consequential-implication logics and normal modal logics, and it may be considered as providing the most advanced theoretical framework for any research on consequential implication.

Analytical consequential implication has been fundamentally studied at the propositional level only. A first attempt of studying it at first order level appears in [25], where the possibility of translating consequential implication directly in terms of quantifiers is explored for the first time.

Inquiries about consequential implication have mainly been concerned with analytical consequential implication. What about “synthetical” or context-dependent consequential conditionals? This leads to new proposals on two different directions. The first is a criticism of classical conditional logic, in which room is given to logical theses lacking a consequential nexus, such as for instance \((A \land B) \supset (A \mathcal{C}\rightarrow B)\). Such logics may be interpreted, it was Pizzi’s idea, as “holistic” conditional logics and it is argued that one may devise, in the extensions of the basic Lewis’ system \(\text{CI}\), at least “three grades of holistic involvement” (see [6]).

The second line of inquiry lends to the idea of working out an intuitive semantics allowing a definition of a consequential nexus on the basis of a context of factual presuppositions. Such a connection is identified in the result of performing “the best choice” between incompatible alternative consequents. This feature is seen (according to [20]) as a common feature of inductive, counterfactual and abductive inference.

The logics based on this choice are special cases of what Pizzi proposes to call rational inference, where it is understood that the basic aim in performing the choice of the best conclusion is the one of preserving maximal information. As a matter of fact, this idea was already at the center of a book published in Italian [4], and he has been encouraged to develop it by a positive review of the book written by Newton da Costa.

Moving from the mentioned considerations Pizzi attempted to stress the analogy between abductive and counterfactual reasoning. It was relevant in this connection, in his own words, the cooperation with Lorenzo Magnani who, he says, “had the merit of introducing in Italy the topic of abductive and model-based reasoning”. Being engaged with Magnani in the joint organization of the six international conferences on Model-Based Reasoning – cf. for example [16] – (MBR98, MBR01, MBR04 in Pavia, Italy, MBR06_CHINA, in Guangzhou, P. R. China, and the last one MBR09_BRAZIL, held in Camp-
inas, Brazil, in December 2009), he has been stimulated in going deeper into
the analysis of causal and abductive reasoning.

2 Tense Logic, Causality and Abduction

In 1974 Pizzi edited an anthology about tense logic [1], in which the trans-
lations are preceded by a lengthy introduction. This collection was the first,
and perhaps the unique, published on this subject. But Pizzi has also original
contributions to the field of tense logic: in [23] a completeness proof of the
logic $K_t$ via tableaux has been published, quite different from a proof of the
same theorem presented by Rescher and Urquhart.

A talk delivered in Campinas (published in [10]) discusses the problem
of the existence of time without change. The problem is treated along the
lines already developed by Prior, but carried out in the framework of second
order tense logic, with the aim of distinguishing between “real changes” and
“Cambridge changes”, and by making use of determinate-determinable dis-
tinction. The question of determination among predicates has been treated in
several papers Pizzi wrote in Italian, mainly with the aim of giving notice of
an interesting and forgotten theory sketched by W.E. Johnson in his “Logic”
(1921).

Starting from 1988, a certain number of papers have been devoted by Pizzi
to the question of the iteration of conditionals, whose treatment is generally
neglected even in classical conditional logic. The interest for this topic was
due to Pizzi’s conviction that the problem of causal redundancy (overdeter-
mination and preemption) can be solved by making use of conditionals with
iterated antecedents. Lewis’ counterfactual theory of causality does not offer
a satisfactory treatment to the problem of causal redundancy; furthermore,
many logicians seem to ignore that the conditio sine qua non theory of cau-
sation is part of the European juridical tradition, and that in this realm the
question has been discussed at length.

The idea of using nested conditionals to define “concurring” (i.e. redundant)
causes is quite original. It is the core of a book [11] written in Italian for a
publishing house specialized in juridical studies. A more formal treatment
was anticipated in [5]. The idea, presented by the occasion of talks delivered
in Lund and Uppsala in 1988, appears to be shared by the Swedish logician P.
Gärdenfors (see “An Epistemic Analysis of Explanation and causal Beliefs”,
$Topoi$ 9 (1990) 109–124 (p.122)).

The interest for abduction has been a natural corollary of the reflections
about rational inference on one side, and causality on the other. Beginning
from year 2007, beyond teaching at the Faculty of Letters in Siena, Pizzi was
also charged with courses on “Logic of Proof” at the Faculty of Law of the
Second State University of Milan. The contact with the new environment
furthered his interest for abduction. On the one hand, the question of condi-
tional iteration has been tackled also with reference to abductive reasoning
(see [22]). On the other hand, the problem of applying the logic of abduction to concrete problems actually discussed by jurists also stimulated reflections: a recently published collection of essays [25] is devoted to this topic.

3 From Contingency to Multimodalities

The idea of defining necessity in terms of contingency received a negative answer from Cresswell for systems weaker than KT. However, Pizzi showed that the problem is solvable in linguistic extensions of contingential logic: to begin with, in a logic with propositional quantifiers (see [14]), but more economically in contingential logics whose language contains an axiomatized propositional constant [21]. The idea of using such systems to yield multimodal logics has been proposed in a recent conference in Lisbon.

From the perspective of his interest in general modal logic, Pizzi not only devoted his energy to the Italian translation of Hughes and Cresswell’s first handbook, but also promoted the Italian translation of “A companion to Modal Logic” for which he also wrote an introduction (CLUEB, Bologna, 1990). In October 1991 he was invited by the Centre for Logic, Epistemology and the History of Science (CLE) of the State University of Campinas to give a course in modal logic, which was then a new subject for many Brazilian logicians. It was only the beginning of a long cooperation, during which he also became member of the direction of CLE. The most recent fruit of it was a book written in Italian with W. Carnielli in 2001 [15], recently revised and published in English [24]. This is the first book in which the subject of multimodalities is proposed also at the level of a teaching tool, and which intends to provide a philosophically- and historically-based introduction to modal logic without casting out neither rigor nor the mathematical aspects.

Knowing how much Brazilian music won Pizzi’s heart, an artistic inclination he certainly inherited from his father, the painter and musician Walter Pizzi-Bonafous (1908-1987), and from his grandfather Ercole Pizzi, a belcanto’s maestro, we cannot refrain from quoting the Brazilian idol João Gilberto. According to [7], João Gilberto is the only non-Italian (perhaps the only person) ever to turn an Italian song, the famous Estate, into a worldwide jazz success. He will certainly appreciate the comparison: for Claudio, many splendid summers!

Estate... che splendidi tramonti dipingeva! ¹

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¹“Estate”, by Bruno Martino and Bruno Brighetti, voice of João Gilberto.
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**Smart Abducers as Violent Abducers: Hypothetical Cognition and “Military Intelligence”**

*Lorenzo Magnani*

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