

For a Better Understanding of Causality¹

Phyllis McKay Illari, Federica Russo, Jon Williamson (eds.): *Causality in the Sciences*. Oxford: Oxford University Press, 2011, xiii+938pp, £95,00

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After causality was a more or less stepmotherly treated concept for many decades, it became step by step more important for the sciences since the turn of the 21st century. This development happened mainly thanks to computer scientists' and philosophers' invention of formal approaches to investigate causal relations by means of graphical models and to the insight that these models can be applied to explain/predict empirical data. These days, more and more researchers see the potential of these approaches to shed a new light on their fields of research. On the other hand, these causal models and philosophical understanding of the nature of causality in general can strongly benefit from a close co-operation with the researchers working in the respective sciences. *Causality in the Sciences* provides evidence for the mentioned present development and delivers insight into many of the most current points of contact between philosophy and the sciences concerning causality.

The volume consists of seven parts which all in all include 42 contributions of 72 researchers, philosophers as well as practicing scientists. Some of the authors were invited to contribute to the volume, but most of the contributions were submissions to an open call for papers. The titles of the contributions were chosen by the authors themselves. All contributions were refereed. We will now give a brief overview of the seven parts of the volume followed by some remarks on how these parts are connected to each other.

“Part I: Introduction”, pp. 1-22, consists of only one article (1) entitled “Why look at causality in the sciences? A manifesto” written by the editors of the volume themselves. This short introduction consists of two parts: In the first part—the “manifesto”—they report that the main motivation for the volume were the following two theses: Firstly, that “the sciences are the best place to turn in order to understand causality”, and secondly, that “scientifically-informed philosophical investigation can bring something to the sciences too”. In the second part the editors describe the structure and contents of parts II-

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VII and discuss the contributions and some of the problems and questions which resulted from them.

“Part II: Health Sciences”, pp. 23-125, consists of five contributions. In (2) “Causality, theories and medicine”, pp. 25-44, R. Paul Thompson argues that randomized controlled trials in clinical medicine do not reveal causal relations. Instead, causal connections can be determined/confirmed by robust theories. Alex Broadbent argues in (3) “Inferring causation in epidemiology: Mechanisms, black boxes, and contrasts”, pp. 45-69, that mechanistic explanations are especially fruitful in epidemiology because they provide knowledge about why some manipulations of parameters of the systems of interest lead to the intended consequences while others do not. Though the author claims that mechanisms are important in epidemiology, he gives examples which demonstrate that information about mechanisms is not necessary for causal inference. In (4) “Causal modelling, mechanism, and probability in epidemiology”, pp. 70-90, Harold Kincaid demonstrates how directed acyclic graphs as well as mechanisms can be useful tools for finding causal connections in epidemiology and identifies certain cases in which they fail to do so. Bert Leuridan and Erik Weber explain in (5) “The IARC and mechanistic evidence”, pp. 91-109, why the studies of the International Agency for Research on Cancer (a division of the World Health Organization) may fall prey to the problem of confounders. They suggest to use mechanistic evidence to rule out this possibility. In (6) “The Russo–Williamson thesis and the question of whether smoking causes heart disease”, pp. 110-125, Donald Gillies argues for the “Russo–Williamson thesis” (in order to establish that c causes e , statistical evidence alone is insufficient; in addition, one has to show that c and e are linked by a mechanism) by giving three examples from medicine in which scientists agreed to interpret correlations causally only after the underlying mechanisms could have been discovered.

“Part III: Psychology”, pp. 127-239, consists of six contributions. David Lagnado argues in (7) “Causal thinking”, pp. 129-149, that there is a strong connection between causal learning and reasoning: both of them rely on mental models and on the simulation of these models. In (8) “When and how do people reason about unobserved causes?”, pp. 150-183, by Benjamin Rottman, Woo-kyoung Ahn, and Christian Luhmann empirical work is used to demonstrate that people typically infer unobserved causes when they are confronted with unexplained data. This may be data that is yet lacking any causal explanation or cannot be explained by the (till now) best available causal models. In (9) “Counterfactual and generative accounts of causal attribution”, pp. 184-201, Clare R. Walsh and Steven A. Sloman argue that counterfactual as well as mechanistic concepts play a major role in reasoning whether a specific event c caused a specific event e . They find that the mechanistic approach is even more fundamental than the counterfactual when it comes to positive causation. (10) “The autonomy of psychology in the age of neuroscience”, pp. 202-223, by Ken Aizawa and Carl Gillett provides reasons against the claim that a single psychological property should be substituted by two, three, or more psychological properties whenever multiple neuronal realizers of said property are discovered. The authors demonstrate that the respective psychological theory plays a major

role in deciding whether psychological properties should be splitted. Otto Lappi and Anna-Mari Rusanen investigate the mechanistic approach to explanation in the cognitive sciences in (11) “Turing machines and causal mechanisms in cognitive science”, pp. 224-239. Since Turing machines, which are, in contrast to mechanisms, neither concrete nor causal systems, play an important role for explanations in the cognitive sciences, they conclude that a wider concept of explanation is required for the cognitive sciences. In (12) “Real causes and ideal manipulations: Pearl’s theory of causal inference from the point of view of psychological research methods”, pp. 240-269, Keith A. Markus takes a closer look at Judea Pearl’s theory of causation from the psychologist’s point of view. He advocates for interpreting Pearl’s axioms not as universal truths about causality, but as delimiters of the range of applicability of Pearl’s theory instead.

“Part IV: Social sciences”, pp. 271-403, consists of six contributions. In (13) “Causal mechanisms in the social realm”, pp. 273-295, Daniel Little argues for the thesis that causality in the social sciences cannot be analyzed in terms of correlations alone—knowledge of the underlying mechanisms is essential for understanding regularities as well as for determining causal relations. Ruth Groff discusses the question how a Humean perspective of causation can be substituted by other metaphysical approaches (e.g., the power-approach) in the social sciences in (14) “Getting past Hume in the philosophy of social science”, pp. 296-316. Michel Mouchart and Federica Russo demonstrate in (15) “Causal explanation: Recursive decompositions and mechanisms”, pp. 317-337, how the structural modeling approach can be used to explain diverse phenomena in quantitative-oriented social sciences; recursive decomposition is thereby interpreted in terms of a mechanism. In (16) “Counterfactuals and causal structure”, pp. 338-360, Kevin D. Hoover carves out the connections between causal structures and counterfactuals by means of modeling causation via structural equations. Damien Fennell explores in (17) “The error term and its interpretation in structural models in econometrics”, pp. 361-378, what the error term in structural equation models may stand for and what role it plays for causal inference. Hossein Hassani, Anatoly Zhigljavsky, Kerry Patterson, and Abdol S. Soofi present an approach for testing causal relations between arbitrary time series on the basis of the Singular Spectrum Analysis in (18) “A comprehensive causality test based on the singular spectrum analysis”, pp. 379-403. They apply it on the euro/dollar and on the pound/dollar rates and detect a causal relation in both directions.

“Part V: Natural sciences”, pp. 405-539, consists of seven contributions. In (19) “Mechanism schemas and the relationship between biological theories”, pp. 407-424, Tudor M. Baetu argues that classical genetics and molecular biology are closely related. He explains this relationship by means of mechanism schemes. Roberta L. Millstein argues that there is a concept of chance that unifies seven different meanings of the term ‘chance’ in evolutionary biology in (20) “Chances and causes in evolutionary biology: How many chances become one chance”, pp. 425-444. As a second step Millstein demonstrates how these different meanings can be extracted from said unified concept by which causes are considered, ignored, or prohibited. In (21) “Drift and the causes of evo-

lution”, pp. 445-469, Sahotra Sarkar takes evolution as a stochastic dynamic process. He shows that whether drift occurs in a specific model depends only on whether the population is finite or infinite and thus, that drift cannot be a causal factor for evolution. Garrett Pendergraft argues in (22) “In defense of a causal requirement on explanation”, pp. 470-492, that explanations of equilibrium states of dynamic systems, contrary to the fact that the best explanations for specific behavior of dynamic systems—at least at first glance—seem not to include any causal notions, actually *are* causal explanations. Epistemological issues raised by climate change research are discussed by Paolo Vineis, Aneire Khan, and Flavio D’Abramo in (23) “Epistemological issues raised by research on climate change”, pp. 493-501. Knowing the causes and effects of climate change is important for manipulating it—unmanipulated climate change may lead to devastating consequences. Giovanni Boniolo, Rossella Faraldo, and Antonio Saggion develop an empirical explication of the term ‘causation’ based on the process-theoretic idea that causation requires an exchange of a conserved quantity in (24) “Explicating the notion of ‘causation’: The role of extensive quantities”, pp. 502-525. But instead of conserved quantities the authors use the more general notion of an extensive quantity for their explication. In (25) “Causal completeness of probability theories – Results and open problems”, pp. 526-539, Miklós Rédei and Balázs Gyenis explore in which probability spaces the common cause principle (random events are screened off when conditioning on all common causes) can be satisfied; they consider classical as well as non-classical probability spaces.

“Part VI: Computer science, probability, and statistics”, pp. 541-768, consists of ten contributions. A web-based project (<http://clopinet.com/causality>) for benchmarking causal discovery algorithms is presented by Isabelle Guyon, Constantin Aliferis, Gregory Cooper, André Elisseeff, Jean-Philippe Pellet, Peter Spirtes, and Alexander Statnikov in (26) “Causality Workbench”, pp. 543-561. In (27) “When are graphical causal models not good models?”, pp. 562-582, Jan Lemeire, Kris Steenhaut, and Abdellah Touhafi argue that it is not always the case that a causally interpreted minimal Bayesian network represents the correct causal structure of the system under investigation. Dawn E. Holmes argues in (28) “Why making Bayesian networks objectively Bayesian makes sense”, pp. 583-599, that Bayesian networks should be interpreted objectively Bayesian; she also discusses how prior distributions should be chosen. In (29) “Probabilistic measures of causal strength”, pp. 600-627, Branden Fitelson and Christopher Hitchcock present an overview of measures of causal strength in terms of probabilities and investigate the diverse relations among them. In (30) “A new causal power theory”, pp. 628-652, Kevin B. Korb, Erik P. Nyberg, and Lucas Hope develop a new and widely applicable measure of causal power based on interventions and information theory. Samantha Kleinberg and Bud Mishra use methods for testing causal hypotheses from computer science and statistics in (31) “Multiple testing of causal hypotheses”, pp. 653-672; they test their approach on some examples afterwards. Ricardo Silva develops a discovery-approach for latent variables in (32) “Measuring latent causal structure”, pp. 673-696, and gives examples of how this approach can be applied. In

(33) “The structural theory of causation”, pp. 697-727, Judea Pearl presents a general theory of causation. He demonstrates that his theory of causality based on the Structural Causal Model is more general than probabilistic approaches or the potential–outcome framework. (34) “Defining and identifying the effect of treatment on the treated”, pp. 728-749, by Sara Geneletti and A. Philip Dawid provides a decision–theoretic analysis of the concept of “effect of treatment on the treated” and demonstrates that it is a generalization of the possible–outcome approach. In (35) “Predicting ‘It will work for us’: (Way) beyond statistics”, pp. 750-768, Nancy Cartwright argues that causal hypotheses supported by statistical studies are insufficient for policy makers to determine what interventions would lead to the intended effects in specific populations. To apply such causal hypotheses, a lot of additional information about these populations is required.

“Part VII: Causality and mechanisms”, pp. 769-927, consists of seven contributions. Stathis Psillos gives a historical introduction to the notion of mechanism in (36) “The idea of mechanism”, pp. 771-788; he then argues that, though they are not “building blocks of nature”, detection of mechanisms is useful for epistemological and methodological purposes. In (37) “Singular and general causal relations: A mechanist perspective”, pp. 789-817, Stuart Glennan discusses the connection between singular and general causal relations. He argues from a mechanist’s point of view that singular causal relations are more fundamental than general causal relations. Phyllis McKay Illari and Jon Williamson argue in (38) “Mechanisms are real and local”, pp. 818-844, that mechanistic explanation is only possible if mechanisms are real and local. They conclude that the best metaphysics therefore is an active metaphysics (e.g., Cartwright’s capacities approach). (39) “Mechanistic information and causal continuity”, pp. 845-864, by Jim Bogen and Peter Machamer, analyzes causal continuity by means of the concept of mechanistic information which can be understood in terms of goals of the mechanisms under investigation. Phil Dowe presents a mechanistic approach that, even though it supports causal processes as conserved quantities, is compatible with the formerly problematic idea of absences being causally relevant in (40) “The causal–process–model theory of mechanism”, pp. 865-879. In (41) “Mechanisms in dynamically complex systems”, pp. 880-906, Meinard Kuhlmann argues that the notion of a mechanism is inappropriate for analyzing dynamically complex systems. Kuhlmann demonstrates how the concept of a mechanism must be modified to avoid this problem and that the notion of a mechanism then becomes much too wide due to such a modification. In (42) “Third time’s charm: Causation, science and Wittgensteinian pluralism”, pp. 907-927, Julian Reiss proposes an inferentialist approach to causality. According to this approach, causality and inference are closely related and thus, the method of inferring causal relations determines the diverse kinds of these causal relations.

Parts II-V of the volume are predominantly concerned with the application of causal concepts in the sciences leading to questions what can be learnt about causality from the sciences, which methods for causal inference/modeling should be used in the several research fields and how these methods could be advanced.

Part VI's focus lies primarily on the enhancements of these methods on a more general level detached from the specific needs of the sciences. Particularly remarkable is the editors' decision to add an entire more philosophically oriented part, viz. part VII, that discusses the diverse connections between causality and mechanisms and thereby follows the actual mechanistic trend in the philosophy of science—a view which will have to proof oneself in the future.

This volume is a highly welcome addition to the current discussion of causality at the intersection of philosophy and the sciences. Although it may overestimate the importance of mechanisms for causal analysis a little, the volume provides a well-chosen compilation of contributions proving the ongoing progress in exploring the nature of causality and in developing applicable causal concepts in co-operation of philosophy and science. We can warmly recommend *Causality in the Sciences* to any philosophically interested scientist or philosopher interested in causality (or mechanisms) and its (their) applications in the sciences.

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