

## **CAUSALITY: MODELS, REASONING, AND INFERENCE**

by Judea Pearl

*Cambridge University Press, 2000*

REVIEWED BY  
**LELAND GERSON NIEUBERG**  
*Boston University*

This book seeks to integrate research on cause and effect inference from cognitive science, econometrics, epidemiology, philosophy, and statistics. It puts forward the work of its author, his collaborators, and others over the past two decades as a new account of cause and effect inference that can aid practical researchers in many fields, including econometrics. Pearl adheres to several propositions on cause and effect inference. Though cause and effect relations are fundamentally deterministic (he explicitly excludes quantum mechanical phenomena from his concept of cause and effect), cause and effect analysis involves probability language. Probability language helps to convey uncertainty about cause and effect relations but is insufficient to fully express those relations. In addition to conditional probabilities of events, cause and effect analysis requires graphs or diagrams and a language that distinguishes intervention or manipulation from observation. Cause and effect analysis also requires counterfactual reasoning and causal assumptions in addition to observations and statistical assumptions.

Chapter 1 sketches some of the ingredients of the new approach to cause and effect inference: probability theory, graphs, Bayesian causal networks, causal models, and causal and statistical terminology. Chapter 2 builds the elements of Chapter 1 into a theory of inferred causation. Chapter 3 focuses on causal diagrams and identifying causal effects. Chapter 4 studies intervention or manipulation and direct causal effects. Chapter 5 considers causality and structural equation models. Chapter 6 examines Simpson's paradox and confounding. Chapter 7 blends structural modeling with counterfactual reasoning. Chapter 8 is an approach to imperfect random assignment experiments through bounding effects and counterfactuals. Chapter 9 analyzes notions of necessary cause and sufficient cause. Chapter 10 explicates a concept of single event causality. The epilogue is a public lecture that Pearl gave at UCLA that, in mostly not too technical language, places the new approach to causality within the long history of thought on the subject.

The interdisciplinary nature of the book, a great strength, at times makes it difficult to read because its theory of inferred causation blends the languages

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# Causality Models Reasoning And Inference

**Hector Geffner, Rita Dechter, Joseph  
Halpern**

## **Causality Models Reasoning And Inference:**

**Causality** Judea Pearl,2009-09-14 Causality offers the first comprehensive coverage of causal analysis in many sciences including recent advances using graphical methods Pearl presents a unified account of the probabilistic manipulative counterfactual and structural approaches to causation and devises simple mathematical tools for analyzing the relationships between causal connections statistical associations actions and observations The book will open the way for including causal analysis in the standard curriculum of statistics artificial intelligence

**Causality** Judea Pearl,2000

**Causality** Judea

Pearl,2009 **Causality** Judea Pearl,2014-05-14 Written by one of the preeminent researchers in the field this book provides a comprehensive exposition of modern analysis of causation It shows how causality has grown from a nebulous concept into a mathematical theory with significant applications in the fields of statistics artificial intelligence economics philosophy cognitive science and the health and social sciences Judea Pearl presents and unifies the probabilistic manipulative counterfactual and structural approaches to causation and devises simple mathematical tools for studying the relationships between causal connections and statistical associations The book will open the way for including causal analysis in the standard curricula of statistics artificial intelligence business epidemiology social sciences and economics Students in these fields will find natural models simple inferential procedures and precise mathematical definitions of causal concepts that traditional texts have evaded or made unduly complicated The first edition of Causality has led to a paradigmatic change in the way that causality is treated in statistics philosophy computer science social science and economics Cited in more than 5 000 scientific publications it continues to liberate scientists from the traditional molds of statistical thinking In this revised edition Judea Pearl elucidates thorny issues answers readers questions and offers a panoramic view of recent advances in this field of research Causality will be of interests to students and professionals in a wide variety of fields Anyone who wishes to elucidate meaningful relationships from data predict effects of actions and policies assess explanations of reported events or form theories of causal understanding and causal speech will find this book stimulating and invaluable

**A Logical**

**Theory of Causality** Alexander Bochman,2021-08-17 A general formal theory of causal reasoning as a logical study of causal models reasoning and inference In this book Alexander Bochman presents a general formal theory of causal reasoning as a logical study of causal models reasoning and inference basing it on a supposition that causal reasoning is not a competitor of logical reasoning but its complement for situations lacking logically sufficient data or knowledge Bochman also explores the relationship of this theory with the popular structural equation approach to causality proposed by Judea Pearl and explores several applications ranging from artificial intelligence to legal theory including abduction counterfactuals actual and proximate causality dynamic causal models and reasoning about action and change in artificial intelligence As logical preparation before introducing causal concepts Bochman describes an alternative situation based semantics for classical logic that provides a better understanding of what can be captured by purely logical means He then presents another

prerequisite outlining those parts of a general theory of nonmonotonic reasoning that are relevant to his own theory These two components provide a logical background for the main two tier formalism of the causal calculus that serves as the formal basis of his theory He presents the main causal formalism of the book as a natural generalization of classical logic that allows for causal reasoning This provides a formal background for subsequent chapters Finally Bochman presents a generalization of causal reasoning to dynamic domains

**Probabilistic and Causal Inference** Hector Geffner,Rina Dechter,Joseph

Halpern,2022-03-10 Professor Judea Pearl won the 2011 Turing Award for fundamental contributions to artificial intelligence through the development of a calculus for probabilistic and causal reasoning This book contains the original articles that led to the award as well as other seminal works divided into four parts heuristic search probabilistic reasoning causality first period 1988 2001 and causality recent period 2002 2020 Each of these parts starts with an introduction written by Judea Pearl The volume also contains original contributed articles by leading researchers that analyze extend or assess the influence of Pearl s work in different fields from AI Machine Learning and Statistics to Cognitive Science Philosophy and the Social Sciences The first part of the volume includes a biography a transcript of his Turing Award Lecture two interviews and a selected bibliography annotated by him

**Probabilistic and Causal Inference** Hector Geffner,Rita Dechter,Joseph

Halpern,2022-03-10 Professor Judea Pearl won the 2011 Turing Award for fundamental contributions to artificial intelligence through the development of a calculus for probabilistic and causal reasoning This book contains the original articles that led to the award as well as other seminal works divided into four parts heuristic search probabilistic reasoning causality first period 1988 2001 and causality recent period 2002 2020 Each of these parts starts with an introduction written by Judea Pearl The volume also contains original contributed articles by leading researchers that analyze extend or assess the influence of Pearl s work in different fields from AI Machine Learning and Statistics to Cognitive Science Philosophy and the Social Sciences The first part of the volume includes a biography a transcript of his Turing Award Lecture two interviews and a selected bibliography annotated by him

*Causality I. A Theory of Energy, Time and Space* Ilijja Baruk*?i?*,2008-11-07

Volume 1 August 21th 2010 This highly original book gives an exact insight into the philosophical logical mathematical and physical foundations of causality Causality is designed to provide both the new methodology for making causal inferences on the basis of non experimental data and the underlying theory The new mathematical tools for evaluating causal relationships from non experimental data are presented in the simplest and most intelligible form Causality is thus an excellent book for self study and a pragmatic help for researchers Anyone who wishes to elucidate cause effect relationships from non experimental data will find this book invaluable The reader will enjoy to read and use this book Finally a unified mathematical and statistical model of causation is available

*Handbook of Causal Analysis for Social Research* Stephen L.

Morgan,2013-04-22 What constitutes a causal explanation and must an explanation be causal What warrants a causal

inference as opposed to a descriptive regularity What techniques are available to detect when causal effects are present and

when can these techniques be used to identify the relative importance of these effects What complications do the interactions of individuals create for these techniques When can mixed methods of analysis be used to deepen causal accounts Must causal claims include generative mechanisms and how effective are empirical methods designed to discover them The Handbook of Causal Analysis for Social Research tackles these questions with nineteen chapters from leading scholars in sociology statistics public health computer science and human development *Causal Models* Steven Sloman,2005-07-28

Human beings are active agents who can think To understand how thought serves action requires understanding how people conceive of the relation between cause and effect between action and outcome In cognitive terms how do people construct and reason with the causal models we use to represent our world A revolution is occurring in how statisticians philosophers and computer scientists answer this question Those fields have ushered in new insights about causal models by thinking about how to represent causal structure mathematically in a framework that uses graphs and probability theory to develop what are called causal Bayesian networks The framework starts with the idea that the purpose of causal structure is to understand and predict the effects of intervention How does intervening on one thing affect other things This is not a question merely about probability or logic but about action The framework offers a new understanding of mind Thought is about the effects of intervention and cognition is thus intimately tied to actions that take place either in the actual physical world or in imagination in counterfactual worlds The book offers a conceptual introduction to the key mathematical ideas presenting them in a non technical way focusing on the intuitions rather than the theorems It tries to show why the ideas are important to understanding how people explain things and why thinking not only about the world as it is but the world as it could be is so central to human action The book reviews the role of causality causal models and intervention in the basic human cognitive functions decision making reasoning judgment categorization inductive inference language and learning In short the book offers a discussion about how people think talk learn and explain things in causal terms in terms of action and manipulation *Causality in the Sciences* Phyllis McKay Illari,Federica Russo,Jon Williamson,2011-03-17

Why do ideas of how mechanisms relate to causality and probability differ so much across the sciences Can progress in understanding the tools of causal inference in some sciences lead to progress in others This book tackles these questions and others concerning the use of causality in the sciences *Handbook of Structural Equation Modeling* Rick H. Hoyle,2023-02-17 This accessible volume presents both the mechanics of structural equation modeling SEM and specific SEM strategies and applications The editor along with an international group of contributors and editorial advisory board are leading methodologists who have organized the book to move from simpler material to more statistically complex modeling approaches Sections cover the foundations of SEM statistical underpinnings from assumptions to model modifications steps in implementation from data preparation through writing the SEM report and basic and advanced applications including new and emerging topics in SEM Each chapter provides conceptually oriented descriptions fully explicated analyses and engaging examples that reveal

modeling possibilities for use with readers data Many of the chapters also include access to data and syntax files at the companion website allowing readers to try their hands at reproducing the authors results *Causality and Probability in the Sciences* Federica Russo, Jon Williamson, 2007 Causal inference is perhaps the most important form of reasoning in the sciences A panoply of disciplines ranging from epidemiology to biology from econometrics to physics make use of probability and statistics in order to infer causal relationships However the very foundations of causal inference are up in the air it is by no means clear which methods of causal inference should be used nor why they work when they do This book brings philosophers and scientists together to tackle these important questions The papers in this volume shed light on the relationship between causality and probability and the application of these concepts within the sciences With its interdisciplinary perspective and its careful analysis *Causality and Probability in the Sciences* heralds the transition of causal inference from an art to a science

**Information-based methods for neuroimaging: analyzing structure, function and dynamics** Jesus M. Cortés, Daniele Marinazzo, Miguel Angel Muñoz, 2015-05-07 The aim of this Research Topic is to discuss the state of the art on the use of Information based methods in the analysis of neuroimaging data Information based methods typically built as extensions of the Shannon Entropy are at the basis of model free approaches which being based on probability distributions rather than on specific expectations can account for all possible non linearities present in the data in a model independent fashion Mutual Information like methods can also be applied on interacting dynamical variables described by time series thus addressing the uncertainty reduction or information in one variable by conditioning on another set of variables In the last years different Information based methods have been shown to be flexible and powerful tools to analyze neuroimaging data with a wide range of different methodologies including formulations based on bivariate vs multivariate representations frequency vs time domains etc Apart from methodological issues the information bit as a common unit represents a convenient way to open the road for comparison and integration between different measurements of neuroimaging data in three complementary contexts Structural Connectivity Dynamical Functional and Effective Connectivity and Modelling of brain activity Applications are ubiquitous starting from resting state in healthy subjects to modulations of consciousness and other aspects of pathophysiology Mutual Information based methods have provided new insights about common principles in brain organization showing the existence of an active default network when the brain is at rest It is not clear however how this default network is generated the different modules are intra interacting or disappearing in the presence of stimulation Some of these open questions at the functional level might find their mechanisms on their structural correlates A key question is the link between structure and function and the use of structural priors for the understanding of the functional connectivity measures As effective connectivity is concerned recently a common framework has been proposed for Transfer Entropy and Granger Causality a well established methodology originally based on autoregressive models This framework can open the way to new theories and applications This Research Topic brings

together contributions from researchers from different backgrounds which are either developing new approaches or applying existing methodologies to new data and we hope it will set the basis for discussing the development and validation of new Information based methodologies for the understanding of brain structure function and dynamics

**Advances in Economics and Econometrics** Richard Blundell, Whitney K. Newey, Torsten Persson, 2006 Publisher description

Recent Developments in the Econometrics of Program Evaluation Guido Imbens, Jeffrey M. Wooldridge, 2008 Many empirical

questions in economics and other social sciences depend on causal effects of programs or policy interventions In the last two decades much research has been done on the econometric and statistical analysis of the effects of such programs or treatments This recent theoretical literature has built on and combined features of earlier work in both the statistics and econometrics literatures It has by now reached a level of maturity that makes it an important tool in many areas of empirical research in economics including labor economics public finance development economics industrial organization and other areas of empirical micro economics In this review we discuss some of the recent developments We focus primarily on practical issues for empirical researchers as well as provide a historical overview of the area and give references to more technical research

**International Encyclopedia of the Social & Behavioral Sciences** Neil J. Smelser, Paul B. Baltes, 2001 The largest work ever published in the social and behavioural sciences It contains 4000 signed articles 15 million words of text 90 000 bibliographic references and 150 biographical entries

**Storia del pensiero economico**, 2006 Causation and Explanation Joseph Keim Campbell, Michael O'Rourke, Harry Silverstein, 2007 Leading scholars discuss the development and application of theories of causation and explanation offering a state of the art view of current work on these two topics

**Philosophie als Wissenschaft** Christian Nimtz, Gesellschaft für Analytische Philosophie. Internationaler Kongress, Ansgar Beckermann, 2005 Man kann die Vielfalt und Dynamik der gegenwärtigen Analytischen Philosophie kaum besser unter Beweis stellen als durch sachorientierte Streitgespräche zwischen ihren herausragenden Vertretern Die Kolloquien der GAP 5 Konferenz waren solche Streitgespräche In ihnen haben international renommierte Philosophinnen und Philosophen über aktuelle Fragen aus dem Spektrum der Analytischen Philosophie debattiert von Willensfreiheit bis Wohlfahrt und Armut von Bedeutung und Normativität bis Feministische Wissenschaftstheorie von Philosophie als Wissenschaft bis Physikalismus Mit Beiträgen von Daniela Bailer Jones, Paul A. Boghossian, Ansgar Beckermann, Jonathan Dancy, Hans Johann Glock, Jane Heal, Frank Jackson, Pierre Jacob, Janet A. Kourany, Brian P. McLaughlin, Margaret Morrison, Jan Narveson, Julian Nida-Rümelin, Cassandra L. Pinnick, Wolfgang Prinz, Michael Ruse, Ludwig Siep, Wolfgang Spohn, Larry Temkin und Holm Tietens

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