# DISCOVERING CAUSAL STRUCTURE

Artificial Intelligence, Philosophy of Science, and Statistical Modeling

> CLARK GLYMOUR RICHARD SCHEINES PETER SPIRTES KEVIN KELLY

## **Discovering Causal Structure From Observations**

**Bernhard Nebel** 

#### **Discovering Causal Structure From Observations:**

**Discovering Causal Structure** Clark Glymour, Richard Scheines, Peter Spirtes, 2014-05-10 Discovering Causal Structure Artificial Intelligence Philosophy of Science and Statistical Modeling provides information pertinent to the fundamental aspects of a computer program called TETRAD This book discusses the version of the TETRAD program which is designed to assist in the search for causal explanations of statistical data or alternative models This text then examines the notion of applying artificial intelligence methods to problems of statistical model specification Other chapters consider how the TETRAD program can help to find god alternative models where they exist and how it can help detect the existence of important neglected variables. This book discusses as well the procedures for specifying a model or models to account for non experimental or quasi experimental data The final chapter presents a description of the format of input files and a description of each command This book is a valuable resource for social scientists and researchers **Machine Learning and** Knowledge Discovery in Databases. Research Track Albert Bifet, Jesse Davis, Tomas Krilavičius, Meelis Kull, Eirini Ntoutsi, Indrė Žliobaitė, 2024-08-29 This multi volume set LNAI 14941 to LNAI 14950 constitutes the refereed proceedings of the European Conference on Machine Learning and Knowledge Discovery in Databases ECML PKDD 2024 held in Vilnius Lithuania in September 2024 The papers presented in these proceedings are from the following three conference tracks Research Track The 202 full papers presented here from this track were carefully reviewed and selected from 826 submissions These papers are present in the following volumes Part I II III IV V VI VII VIII Demo Track The 14 papers presented here from this track were selected from 30 submissions These papers are present in the following volume Part VIII Applied Data Science Track The 56 full papers presented here from this track were carefully reviewed and selected from 224 submissions These papers are present in the following volumes Part IX and Part X **Lectures on Advanced Topics in Categorical Data Analysis** Tamás Rudas, 2024-12-16 This book continues the mission of the previous text by the author Lectures on Categorical Data Analysis by expanding on the introductory concepts from that volume and providing a mathematically rigorous presentation of advanced topics and current research in statistical techniques which can be applied in the social political behavioral and life sciences It presents an intuitive and unified discussion of an array of themes in categorical data analysis and the emphasis on structure over stochastics renders many of the methods applicable in machine learning environments and for the analysis of big data The book focuses on graphical models their application in causal analysis the analytical properties of parameterizations of multivariate discrete distributions marginal models and coordinate free relational models To guide the readers in future research the volume provides references to original papers and also offers detailed proofs of most of the significant results Like the previous volume it features exercises and research questions making it appropriate for graduate students as well as for active researchers **Explainable and Interpretable Models** in Computer Vision and Machine Learning Hugo Jair Escalante, Sergio Escalera, Isabelle Guyon, Xavier Baró, Yağmur

Güçlütürk, Umut Güçlü, Marcel van Gerven, 2018-11-29 This book compiles leading research on the development of explainable and interpretable machine learning methods in the context of computer vision and machine learning Research progress in computer vision and pattern recognition has led to a variety of modeling techniques with almost human like performance Although these models have obtained astounding results they are limited in their explainability and interpretability what is the rationale behind the decision made what in the model structure explains its functioning Hence while good performance is a critical required characteristic for learning machines explainability and interpretability capabilities are needed to take learning machines to the next step to include them in decision support systems involving human supervision This book written by leading international researchers addresses key topics of explainability and interpretability including the following Evaluation and Generalization in Interpretable Machine Learning Explanation Methods in Deep Learning Learning Functional Causal Models with Generative Neural Networks Learning Interpretable Rules for Multi Label Classification Structuring Neural Networks for More Explainable Predictions Generating Post Hoc Rationales of Deep Visual Classification Decisions Ensembling Visual Explanations Explainable Deep Driving by Visualizing Causal Attention Interdisciplinary Perspective on Algorithmic Job Candidate Search Multimodal Personality Trait Analysis for Explainable Modeling of Job Interview Decisions Inherent Explainability Pattern Theory based Video Event Interpretations

Proceedings of the Twenty-fourth Annual Conference of the Cognitive Science Society Wayne D. Gray, Christian D. Schunn, 2019-04-24 This volume features the complete text of the material presented at the Twenty Fourth Annual Conference of the Cognitive Science Society As in previous years the symposium included an interesting mixture of papers on many topics from researchers with diverse backgrounds and different goals presenting a multifaceted view of cognitive science The volume includes all papers posters and summaries of symposia presented at this leading conference that brings cognitive scientists together The 2002 meeting dealt with issues of representing and modeling cognitive processes as they appeal to scholars in all subdisciplines that comprise cognitive science psychology computer science neuroscience linguistics and philosophy Proceedings of the 2021 Joint Workshop of Fraunhofer IOSB and Institute for Anthropomatics, Vision and Fusion Laboratory Beyerer, Jürgen, Zander, Tim, 2022-07-05 2021 the annual joint workshop of the Fraunhofer IOSB and KIT IES was hosted at the IOSB in Karlsruhe For a week from the 2nd to the 6th July the doctoral students extensive reports on the status of their research The results and ideas presented at the workshop are collected in this book in the form of detailed technical reports **Knowledge Graph and Semantic Computing: Knowledge Graph Empowers** the Digital Economy Maosong Sun, Guilin Qi, Kang Liu, Jiadong Ren, Bin Xu, Yansong Feng, Yongbin Liu, Yubo Chen, 2022-11-18 This book constitutes the refereed proceedings of the 7th China Conference on Knowledge Graph and Semantic Computing Knowledge Graph Empowers the Digital Economy CCKS 2022 in Qinhuangdao China August 24 27 2022 The 15 full papers and 2 short papers included in this book were carefully reviewed and selected from 100 submissions

They were organized in topical sections as follows knowledge representation and reasoning knowledge acquisition and knowledge base construction linked data knowledge integration and knowledge graph storage managements natural language understanding and semantic computing knowledge graph applications and knowledge graph open resources

Causal Discovery Luis Enrique Sucar, 2025-10-27 This book presents an overview of causal discovery an emergent field with important developments in the last few years and multiple applications in several fields The book is divided into three parts The first part provides the necessary background on causal graphical models and causal reasoning The second describes the main algorithms and techniques for causal discovery a causal discovery from observational data b causal discovery from interventional data c causal discovery from temporal data and d causal reinforcement learning The third part provides several examples of causal discovery in practice including applications in biomedicine social sciences artificial intelligence and robotics Topics and features if supportLists Includes the necessary background material a review of probability and graph theory Bayesian networks causal graphical models and causal reasoning Covers the main types of causal discovery learning from observational data learning from interventional data and learning from temporal data if supportLists Illustrates the application of causal discovery in practical problems if supportLists Includes some of the latest developments in the field such as continuous optimization causal event networks causal discovery under subsampling subject specific causal models and causal reinforcement learning if supportLists Provides chapter exercises including suggestions for research and programming projects This book can be used as a textbook for an advanced undergraduate or a graduate course on causal discovery for students of computer science engineering social sciences etc It can also be used as a complement to a course on causality together with another text on causal reasoning It could also serve as a reference book for professionals that want to apply causal models in different areas or anyone who is interested in knowing the basis of these techniques The intended audience are students and professionals in computer science statistics and engineering who want to know the principles of causal discovery and or applied them in different domains It could also be of interest to students and professionals in other areas who want to apply causal discovery for instance in medicine and economics

Machine Learning and Knowledge Discovery in Databases Paolo Frasconi, Niels Landwehr, Giuseppe Manco, Jilles Vreeken, 2016-09-03 The three volume set LNAI 9851 LNAI 9852 and LNAI 9853 constitutes the refereed proceedings of the European Conference on Machine Learning and Knowledge Discovery in Databases ECML PKDD 2016 held in Riva del Garda Italy in September 2016 The 123 full papers and 16 short papers presented were carefully reviewed and selected from a total of 460 submissions. The papers presented focus on practical and real world studies of machine learning knowledge discovery data mining innovative prototype implementations or mature systems that use machine learning techniques and knowledge discovery processes in a real setting recent advances at the frontier of machine learning and data mining with other disciplines Part I and Part II of the proceedings contain the full papers of the contributions presented in the scientific track

and abstracts of the scientific plenary talks Part III contains the full papers of the contributions presented in the industrial track short papers describing demonstration the nectar papers and the abstracts of the industrial plenary talks **Inference and Discovery in Python** Aleksander Molak, 2023-05-31 Demystify causal inference and casual discovery by uncovering causal principles and merging them with powerful machine learning algorithms for observational and experimental data Get With Your Book PDF Copy AI Assistant and Next Gen Reader Free Key Features Examine Pearlian causal concepts such as structural causal models interventions counterfactuals and more Discover modern causal inference techniques for average and heterogenous treatment effect estimation Explore and leverage traditional and modern causal discovery methods Book DescriptionCausal methods present unique challenges compared to traditional machine learning and statistics Learning causality can be challenging but it offers distinct advantages that elude a purely statistical mindset Causal Inference and Discovery in Python helps you unlock the potential of causality You ll start with basic motivations behind causal thinking and a comprehensive introduction to Pearlian causal concepts such as structural causal models interventions counterfactuals and more Each concept is accompanied by a theoretical explanation and a set of practical exercises with Python code Next you ll dive into the world of causal effect estimation consistently progressing towards modern machine learning methods Step by step you ll discover Python causal ecosystem and harness the power of cutting edge algorithms You ll further explore the mechanics of how causes leave traces and compare the main families of causal discovery algorithms The final chapter gives you a broad outlook into the future of causal AI where we examine challenges and opportunities and provide you with a comprehensive list of resources to learn more By the end of this book you will be able to build your own models for causal inference and discovery using statistical and machine learning techniques as well as perform basic project assessment What you will learn Master the fundamental concepts of causal inference Decipher the mysteries of structural causal models Unleash the power of the 4 step causal inference process in Python Explore advanced uplift modeling techniques Unlock the secrets of modern causal discovery using Python Use causal inference for social impact and community benefit Who this book is for This book is for machine learning engineers researchers and data scientists looking to extend their toolkit and explore causal machine learning It will also help people who ve worked with causality using other programming languages and now want to switch to Python those who worked with traditional causal inference and want to learn about causal machine learning and tech savvy entrepreneurs who want to go beyond the limitations of traditional ML You are expected to have basic knowledge of Python and Python scientific libraries along with knowledge of basic probability and statistics 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 Database Systems for Advanced Applications Sourav S. Bhowmick, Curtis Dyreson, Christian S. Jensen, Mong Li Lee, Agus Muliantara, Bernhard Thalheim, 2014-04-16 These two volumes set LNCS 8421 and LNCS 8422 constitutes the refereed proceedings of the 19th International Conference on Database Systems for Advanced Applications DASFAA 2014 held in Bali Indonesia in April 2014 The 62 revised full papers presented together with 1 extended abstract paper 4 industrial papers 6 demo presentations 3 tutorials and 1 panel paper were carefully reviewed and selected from a total of 257 submissions. The papers cover the following topics big data management indexing and query processing graph data management spatio temporal data management database for emerging hardware data mining probabilistic and uncertain data management web and social data management security privacy and trust keyword search data stream management and data quality **Physical Reality -Construction or Discovery?** Michael Grodzicki,2021-05-03 This book provides a well grounded account of the methodology of physics the structure of physical knowledge and theories and in particular of the relations between theory and experience An important feature of the book is that all its essential conclusions are elucidated with the help of representative examples from theoretical molecular and solid state physics All young physicists as well as physics teachers will find here valuable insights into the philosophy and tools of their trade Innovations in Bayesian Networks Dawn E. Holmes, 2008-10-02 Bayesian networks currently provide one of the most rapidly growing areas of research in computer science and statistics In compiling this volume we have brought together contributions from some of the most prestigious researchers in this field Each of the twelve chapters is self contained Both theoreticians and application scientists engineers in the broad area of artificial intelligence will find this volume valuable It also provides a useful sourcebook for Graduate students since it shows the direction of current research Advances in Artificial Intelligence Robin Cohen, Bruce Spencer, 2003-08-01 The AI conference series is the premier event sponsored by the Canadian ciety for the Computational Studies of Intelligence Soci et e canadienne pour l'etude d'intelligence par ordinateur Attendees enjoy our typically Canadian mosphere hospitable and stimulating The Canadian AI conference showcases the excellent research work done by Canadians their international colleagues and others choosing to join us each spring International participation is always high this year almost 40% of the submitted papers were from non Canadian searchers We accepted 24 papers and 8 poster papers from 52 full length papers submitted We also accepted eight of ten abstracts submitted to the Graduate Student Symposium All of these accepted papers appear in this volume The Canadian AI Conference is the oldest continuously held national AI c ference in the world

ECCAI s predecessor AISB held meetings in 1974 but these have since become international Conferences have been held biennially since 1976 and annually since 2000 AI 2002 again joined its sister Canadian computer science conferences Vision Interface and Graphics Interface enri ing the experience for all participants The joint meeting allows us to stay formed about other areas to make new contacts and perhaps to investigate cross disciplinary research This year the conferences was held on the beautiful campus of the University of Calgary and many participants took the opportunity to tour nearby Ban and the magni cent Rocky Mountains Advances in Artificial Intelligence Canadian Society for Computational Studies of Intelligence. Conference, Robin Cohen, Bruce Spencer, 2002-05-17 This book constitutes the refereed proceedings of the 15th conference of the Canadian Society for Computational Studies of Intelligence AI 2002 held in Calgary Canada in May 2002 The 24 revised full papers presented together with eight posters and ten abstracts of the graduate student symposium were carefully reviewed and selected from 52 full length paper submissions. The book offers topical sections on agents searching neural nets learning probability and natural language Models of Discovery Herbert A. Simon, 2012-12-06 We respect Herbert A Simon as an established leader of empirical and logical analysis in the human sciences while we happily think of him as also the loner of course he works with many colleagues but none can match him He has been writing fruitfully and steadily for four decades in many fields among them psychology logic decision theory economics computer science management production engineering information and control theory operations research confirmation theory and we must have omitted several With all of them he is at once the technical scientist and the philosophical critic and analyst When writing of decisions and actions he is at the interface of philosophy of science decision theory philosophy of the specific social sciences and inventory theory itself for him at the interface of economic theory production engineering and information theory When writing on causality he is at the interface of methodology metaphysics logic and philosophy of physics systems theory and so on Not that the interdisciplinary is his orthodoxy we are delighted that he has chosen to include in this book both his early and little appreciated treatment of straightforward philosophy of physics the axioms of Newtonian mechanics and also his fine papers on pure confirmation theory Making Minds Henry M. Wellman, 2014 Developmental psychologists coined the term theory of mind to describe how we understand our shifting mental states in daily life Over the past twenty years researchers have provided rich provocative data showing that from an early age children develop a sophisticated and consistent theory of mind by attributing their desires beliefs and emotions to themselves and to others Building on his pioneering research in The Child's Theory of Mind 1990 Henry M Wellman pulls together all that we have learned in the past twenty years to shine new light on how theory of mind develops *Ouantified Representation of* Uncertainty and Imprecision Dov M. Gabbay, Philippe Smets, 2013-11-11 We are happy to present the first volume of the Handbook of Defeasible Reasoning and Uncertainty Management Systems Uncertainty pervades the real world and must therefore be addressed by every system that attempts to represent reality The representation of uncertainty is a major

concern of philosophers logicians artificial intelligence researchers and com puter sciencists psychologists statisticians economists and engineers The present Handbook volumes provide frontline coverage of this area This Handbook was produced in the style of previous handbook series like the Handbook of Philosoph ical Logic the Handbook of Logic in Computer Science the Handbook of Logic in Artificial Intelligence and Logic Programming and can be seen as a companion to them in covering the wide applications of logic and reasoning We hope it will answer the needs for adequate representations of uncertainty This Handbook series grew out of the ESPRIT Basic Research Project DRUMS II where the acronym is made out of the Handbook series title This project was financially supported by the European Union and regroups 20 major European research teams working in the general domain of uncertainty As a fringe benefit of the DRUMS project the research community was able to create this Hand book series relying on the DRUMS participants as the core of the authors for the Handbook together with external international experts **Latent Variable Path Modeling with Partial** Least Squares Jan-Bernd Lohmöller, 2013-11-11 Partial Least Squares PLS is an estimation method and an algorithm for latent variable path LVP models PLS is a component technique and estimates the latent variables as weighted aggregates The implications of this choice are considered and compared to covariance structure techniques like LISREL COSAN and EQS The properties of special cases of PLS regression factor scores structural equations principal components canonical correlation hierarchical components correspondence analysis three mode path and component analysis are examined step by step and contribute to the understanding of the general PLS technique The proof of the convergence of the PLS algorithm is extended beyond two block models Some 10 computer programs and 100 applications of PLS are referenced The book gives the statistical underpinning for the computer programs PLS 1 8 which is in use in some 100 university computer centers and for PLS PC It is intended to be the background reference for the users of PLS 1 8 not as textbook or program manual

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