Probabilistic Graphical Models Principles And Techniques Solution

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This book constitutes the thoroughly refereed post-conference proceedings of the 5th International Workshop on Graph Structures for Knowledge Representation and Reasoning, GKR 2017, held in Melbourne, VIC, Australia, in August 2017, associated with IJCAI 2017, the 26th International Joint Conference on Artificial Intelligence. The 7 revised full papers presented were reviewed and selected from 9 submissions. The contributions address various issues for knowledge representation and reasoning and the common graph-theoretic background allows to bridge the gap between the different communities.

This volume conveys some of the surprises, puzzles and success stories in high-dimensional and complex data analysis and related fields. Its peer-reviewed contributions showcase recent advances in variable selection, estimation and prediction strategies for a host of useful models, as well as essential new developments in the field. The continued and rapid advancement of modern technology now allows scientists to collect data of increasingly unprecedented size and complexity. Examples include epigenomic data, genomic data, proteomic data, high-resolution image data, high-frequency financial data, functional and longitudinal data, and network data. Simultaneous variable selection and estimation is one of the key statistical problems involved in analyzing such big and complex data. The purpose of this book is to stimulate research and foster interaction between researchers in the area of high-dimensional data analysis. More concretely, its goals are to: 1) highlight and expand the breadth of existing methods in big data and high-dimensional data analysis and their potential for the advancement of both the mathematical and statistical sciences; 2) identify important directions for future research in the theory of regularization methods, in algorithmic development, and in methodologies for different application areas; and 3) facilitate collaboration between theoretical and subject-specific researchers.

Annotation Graphical models (e.g., Bayesian and constraint networks, influence diagrams, and Markov decision processes) have become a central paradigm for knowledge representation and reasoning in both artificial intelligence and computer science in general. These models are used to perform many reasoning tasks, such as scheduling, planning and learning, diagnosis and prediction, design, hardware and software verification, and bioinformatics. These problems can be stated as the formal tasks of constraint satisfaction and satisfiability, combinatorial optimization, and probabilistic inference. It is well known that the tasks are computationally hard, but research during the past three decades has yielded a variety of principles and techniques that significantly advanced the state of the art. In this book we provide comprehensive coverage of the primary exact algorithms for reasoning with such models. The main feature exploited by the algorithms is the model's graph. We present inference-based, message-passing schemes (e.g., variable-elimination) and search-based, conditioning schemes (e.g., cycle-cutset conditioning and AND/OR search). Each class possesses distinguished characteristics and in particular has different time vs. space behavior. We emphasize the dependence of both schemes on few graph parameters such as the treewidth, cycle-cutset, and (the pseudo-tree) height. We believe the principles outlined here would serve well in moving forward to approximation and anytime-based schemes. The target audience of this book is researchers and students in the artificial intelligence and machine learning area, and beyond.

This book constitutes the proceedings of the 17th International Conference on Quantitative Evaluation Systems, QEST 2020, held in Vienna, Austria, in August/September 2020. The 12 full papers presented together with 7 short papers were carefully reviewed and selected from

42 submissions. The papers cover topics such as classic measures involving performance and reliability, quantification of properties that are classically qualitative, such as safety, correctness, and security as well as analytic studies, diversity in the model formalisms and methodologies employed, and development of new formalisms and methodologies.

Markov networks and other probabilistic graphical modes have recently received an upsurge in attention from Evolutionary computation community, particularly in the area of Estimation of distribution algorithms (EDAs). EDAs have arisen as one of the most successful experiences in the application of machine learning methods in optimization, mainly due to their efficiency to solve complex real-world optimization problems and their suitability for theoretical analysis. This book focuses on the different steps involved in the conception, implementation and application of EDAs that use Markov networks, and undirected models in general. It can serve as a general introduction to EDAs but covers also an important current void in the study of these algorithms by explaining the specificities and benefits of modeling optimization problems by means of undirected probabilistic models. All major developments to date in the progressive introduction of Markov networks based EDAs are reviewed in the book. Hot current research trends and future perspectives in the enhancement and applicability of EDAs are also covered. The contributions included in the book address topics as relevant as the application of probabilistic-based fitness models, the use of belief propagation algorithms in EDAs and the application of Markov network based EDAs to real-world optimization problems. The book should be of interest to researchers and practitioners from areas such as optimization, evolutionary computation, and machine learning.

Machine Learning, a vital and core area of artificial intelligence (AI), is propelling the AI field ever further and making it one of the most compelling areas of computer science research. This textbook offers a comprehensive and unbiased introduction to almost all aspects of machine learning, from the fundamentals to advanced topics. It consists of 16 chapters divided into three parts: Part 1 (Chapters 1-3) introduces the fundamentals of machine learning, including terminology, basic principles, evaluation, and linear models; Part 2 (Chapters 4-10) presents classic and commonly used machine learning methods, such as decision trees, neural networks, support vector machines, Bayesian classifiers, ensemble methods, clustering, dimension reduction and metric learning; Part 3 (Chapters 11-16) introduces some advanced topics, covering feature selection and sparse learning, computational learning theory, semi-supervised learning, probabilistic graphical models, rule learning, and reinforcement learning. Each chapter includes exercises and further reading, so that readers can explore areas of interest. The book can be used as an undergraduate or postgraduate textbook for computer science, computer engineering, electrical engineering, data science, and related majors. It is also a useful reference resource for researchers and practitioners of machine learning.

This book constitutes the refereed proceedings of the 16th European Conference on Symbolic and Quantitative Approaches to Reasoning with Uncertainty, ECSQARU 2021, held in Prague, Czech Republic, in September 2021. The 48 full papers presented in this volume were carefully reviewed and selected from 63 submissions. The papers are organized in topical sections about argumentation and analogical reasoning, Bayesian networks and graphical models, belief functions, imprecise probability, inconsistency handling and preferences, possibility theory and fuzzy approaches, and probability logic.

The three volume set LNAI 9284, 9285, and 9286 constitutes the refereed proceedings of the European Conference on Machine Learning and Knowledge Discovery in Databases, ECML PKDD 2015, held in Porto, Portugal, in September 2015. The 131 papers presented in these proceedings were carefully reviewed and selected from a total of 483 submissions. These include 89 research papers, 11 industrial papers, 14 nectar papers, 17 demo papers. They

were organized in topical sections named: classification, regression and supervised learning; clustering and unsupervised learning; data preprocessing; data streams and online learning; deep learning; distance and metric learning; large scale learning and big data; matrix and tensor analysis; pattern and sequence mining; preference learning and label ranking; probabilistic, statistical, and graphical approaches; rich data; and social and graphs. Part III is structured in industrial track, nectar track, and demo track.

One of the goals of artificial intelligence (AI) is creating autonomous agents that must make decisions based on uncertain and incomplete information. The goal is to design rational agents that must take the best action given the information available and their goals. Decision Theory Models for Applications in Artificial Intelligence: Concepts and Solutions provides an introduction to different types of decision theory techniques, including MDPs, POMDPs, Influence Diagrams, and Reinforcement Learning, and illustrates their application in artificial intelligence. This book provides insights into the advantages and challenges of using decision theory models for developing intelligent systems.

This book constitutes the thoroughly refereed post-conference proceedings of the 9th International Conference on Quantum Interaction, QI 2015, held in Filzbach, Switzerland, in July 2015. The 20 papers together with 2 invited keynotes presented in this book were carefully selected from 27 submissions. Quantum Interaction has developed into an emerging interdisciplinary area of science combining research topics in mathematics, physics, psychology, economics, cognitive science, and computer science.

The purpose of this book is to provide an overview of AI research, ranging from basic work to interfaces and applications, with as much emphasis on results as on current issues. It is aimed at an audience of master students and Ph.D. students, and can be of interest as well for researchers and engineers who want to know more about AI. The book is split into three volumes: - the first volume brings together twenty-three chapters dealing with the foundations of knowledge representation and the formalization of reasoning and learning (Volume 1. Knowledge representation, reasoning and learning) - the second volume offers a view of AI, in fourteen chapters, from the side of the algorithms (Volume 2. AI Algorithms) - the third volume, composed of sixteen chapters, describes the main interfaces and applications of AI (Volume 3. Interfaces and applications of AI). This second volume presents the main families of algorithms developed or used in AI to learn, to infer, to decide. Generic approaches to problem solving are presented: ordered heuristic search, as well as metaheuristics are considered. Algorithms for processing logic-based representations of various types (first-order formulae, propositional formulae, logic programs, etc.) and graphical models of various types (standard constraint networks, valued ones, Bayes nets, Markov random fields, etc.) are presented. The volume also focuses on algorithms which have been developed to simulate specific 'intelligent" processes such as planning, playing, learning, and extracting knowledge from data. Finally, an

afterword draws a parallel between algorithmic problems in operation research and in AI.

This accessible text/reference provides a general introduction to probabilistic graphical models (PGMs) from an engineering perspective. The book covers the fundamentals for each of the main classes of PGMs, including representation, inference and learning principles, and reviews real-world applications for each type of model. These applications are drawn from a broad range of disciplines, highlighting the many uses of Bayesian classifiers, hidden Markov models, Bayesian networks, dynamic and temporal Bayesian networks, Markov random fields, influence diagrams, and Markov decision processes. Features: presents a unified framework encompassing all of the main classes of PGMs; describes the practical application of the different techniques; examines the latest developments in the field, covering multidimensional Bayesian classifiers, relational graphical models and causal models; provides exercises, suggestions for further reading, and ideas for research or programming projects at the end of each chapter.

Bayesian Belief Networks are a powerful tool for combining different knowledge sources with various degrees of uncertainty in a mathematically sound and computationally efficient way. A Bayesian network is a graphical model that encodes probabilistic relationships among variables of interest. When used in conjunction with statistical techniques, the graphical model has several advantages for data modeling. First, because the model encodes dependencies among all variables, it readily handles situations where some data entries are missing. Second, a Bayesian network can be used to learn causal relationships, and hence can be used to gain an understanding about a problem domain and to predict the consequences of intervention. Third, because the model has both causal and probabilistic semantics, it is an ideal representation for combining prior knowledge (which often comes in a causal form) and data. Fourth, Bayesian statistical methods in conjunction with Bayesian networks offer an efficient and principled approach to avoid the over fitting of data.

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This book is a collection of all papers presented at the 2015 International Workshop on Wireless Communication and Network (IWWCN 2015), which was held on August 21–23, 2015 in Kunming, Yunnan, China. The book provides cutting-edge development and signification contributions to all major fields of wireless communication and network. The book will benefit global researchers and practitioners in the field. Contents: Meta Heuristics and Data MiningIntelligent Sensors and Actuators Vision Systems & Multi Media Applications4G Communication & NetworksCloud Computing Readership: Graduate students, academics and researchers in the field of wireless communication and network. Keywords:PHY and Fundamentals;MAC and Cross-Layer Design;Mobile and Wireless Networks;Services;Applications;Business
This book presents an exciting new synthesis of directed and undirected, discrete and

continuous graphical models. Combining elements of Bayesian networks and Markov random fields, the newly introduced hybrid random fields are an interesting approach to get the best of both these worlds, with an added promise of modularity and scalability. The authors have written an enjoyable book---rigorous in the treatment of the mathematical background, but also enlivened by interesting and original historical and philosophical perspectives. -- Manfred Jaeger, Aalborg Universitet The book not only marks an effective direction of investigation with significant experimental advances, but it is also---and perhaps primarily---a guide for the reader through an original trip in the space of probabilistic modeling. While digesting the book, one is enriched with a very open view of the field, with full of stimulating connections. [...] Everyone specifically interested in Bayesian networks and Markov random fields should not miss it. -- Marco Gori, Università degli Studi di Siena Graphical models are sometimes regarded---incorrectly---as an impractical approach to machine learning, assuming that they only work well for low-dimensional applications and discrete-valued domains. While guiding the reader through the major achievements of this research area in a technically detailed yet accessible way, the book is concerned with the presentation and thorough (mathematical and experimental) investigation of a novel paradigm for probabilistic graphical modeling, the hybrid random field. This model subsumes and extends both Bayesian networks and Markov random fields. Moreover, it comes with well-defined learning algorithms, both for discrete and continuous-valued domains, which fit the needs of real-world applications involving large-scale, high-dimensional data.
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Classical computer science textbooks tell us that some problems are 'hard'. Yet many areas, from machine learning and computer vision to theorem proving and software verification, have defined their own set of tools for effectively solving complex problems. Tractability provides an overview of these different techniques, and of the fundamental concepts and properties used to tame intractability. This book will help you understand what to do when facing a hard computational problem. Can the problem be modelled by convex, or submodular functions? Will the instances arising in practice be of low treewidth, or exhibit another specific graph structure that makes them easy? Is it acceptable to use scalable, but approximate algorithms? A wide range of approaches is presented through self-contained chapters written by authoritative researchers on each topic. As a reference on a core problem in computer science, this book will appeal to theoreticians and practitioners alike.
A general framework for constructing and using probabilistic models of complex systems that would enable a computer to use available information for making decisions. Most tasks require a person or an automated system to reason—to reach conclusions based on available information. The framework of probabilistic graphical models, presented in this book, provides a general approach for this task. The approach is model-based, allowing interpretable models to be constructed and then manipulated by reasoning algorithms. These models can also be learned automatically from data, allowing the approach to be used in cases where manually constructing a model is difficult or even impossible. Because uncertainty is an inescapable aspect of most real-world applications, the book focuses on probabilistic models, which make the

uncertainty explicit and provide models that are more faithful to reality. Probabilistic Graphical Models discusses a variety of models, spanning Bayesian networks, undirected Markov networks, discrete and continuous models, and extensions to deal with dynamical systems and relational data. For each class of models, the text describes the three fundamental cornerstones: representation, inference, and learning, presenting both basic concepts and advanced techniques. Finally, the book considers the use of the proposed framework for causal reasoning and decision making under uncertainty. The main text in each chapter provides the detailed technical development of the key ideas. Most chapters also include boxes with additional material: skill boxes, which describe techniques; case study boxes, which discuss empirical cases related to the approach described in the text, including applications in computer vision, robotics, natural language understanding, and computational biology; and concept boxes, which present significant concepts drawn from the material in the chapter. Instructors (and readers) can group chapters in various combinations, from core topics to more technically advanced material, to suit their particular needs.

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Probabilistic Graphical ModelsPrinciples and TechniquesMIT Press

At the crossroads between statistics and machine learning, probabilistic graphical models provide a powerful formal framework to model complex data. For instance, Bayesian networks and Markov random fields are two of the most popular probabilistic graphical models. With the rapid advance of high-throughput technologies and their ever decreasing costs, a fast-growing volume of biological data of various types - the so-called "omics" - is in need of accurate andefficient methods for modeling, prior to further downstream analysis. As probabilistic graphical models are able to deal with high-dimensional data, it is foreseeable that such models will have aprominent role to play in advances in genome-wide data analyses. Currently, few people are specialists in the design of cutting-edge methods using probabilistic graphical models for genetics, genomics and postgenomics. This seriously hinders the diffusion of such methods. The prime aim of the book is therefore to bring the concepts underlying these advanced models within reach of scientists who are not specialists of these models, but with no concession on theinformativeness of the book. The target readers include researchers and engineers who have to design novel methods for postgenomics data analysis, as well as graduate students starting a Masters or a PhD. Inaddition to an introductory chapter on probabilistic graphical models, a thorough review chapter focusing on selected domains in genetics and fourteen chapters illustrate the design of such advanced approaches in various domains: gene network inference, inference of causal phenotype networks, association genetics, epigenetics, detection of copy number variations, and prediction of outcomes from high-dimensional genomic data. Notably, most examples also illustrate that probabilistic graphicalmodels are well suited for integrative biology and systems biology, hot topics guaranteed to be of lasting interest. Many of the concepts and terminology surrounding modern causal inference can be quite intimidating to the novice. Judea Pearl presents a book ideal for beginners in statistics, providing a comprehensive introduction to the field of causality. Examples from classical statistics are presented throughout to demonstrate the need for causality in resolving decision-making dilemmas posed by data. Causal methods are also compared to traditional statistical methods, whilst questions are provided at the end of

each section to aid student learning.
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Familiarize yourself with probabilistic graphical models through real-world problems and illustrative code examples in RAbout This Book- Predict and use a probabilistic graphical models (PGM) as an expert system- Comprehend how your computer can learn Bayesian modeling to solve real-world problems- Know how to prepare data and feed the models by using the appropriate algorithms from the appropriate R packageWho This Book Is ForThis book is for anyone who has to deal with lots of data and draw conclusions from it, especially when the data is noisy or uncertain. Data scientists, machine learning enthusiasts, engineers, and those who curious about the latest advances in machine learning will find PGM interesting.What You Will Learn- Understand the concepts of PGM and which type of PGM to use for which problem- Tune the model's parameters and explore new models automatically- Understand the basic principles of Bayesian models, from simple to advanced- Transform the old linear regression model into a powerful probabilistic model- Use standard industry models but with the power of PGM- Understand the advanced models used throughout today's industry- See how to compute posterior distribution with exact and approximate inference algorithmsIn DetailProbabilistic graphical models (PGM, also known as graphical models) are a marriage between probability theory and graph theory. Generally, PGMs use a graph-based representation. Two branches of graphical representations of distributions are commonly used, namely Bayesian networks and Markov networks. R has many packages to implement graphical models.We'll start by showing you how to transform a classical statistical model into a modern PGM and then look at how to do exact inference in graphical models. Proceeding, we'll introduce you to many modern R packages that will help you to perform inference on the models. We will then run a Bayesian linear regression and you'll see the advantage of going probabilistic when you want to do prediction.Next, you'll master using R packages and implementing its techniques. Finally, you'll be presented with machine learning applications that have a direct impact in many fields. Here, we'll cover clustering and the discovery of hidden information in big data, as well as two important methods, PCA and ICA, to reduce the size of big problems.Style and approach This book gives you a detailed and step-by-step explanation of each mathematical concept, which will help you build and analyze your own machine learning models and apply them to real-world problems. The mathematics is kept simple and each formula is explained thoroughly.

This book systematically discusses the basic concepts, theories, research and latest trends in image fusion. It focuses on three image fusion categories – pixel, feature and decision – presenting various applications, such as medical imaging, remote sensing, night vision, robotics and autonomous vehicles. Further, it introduces readers to a new category: edge-preserving-based image fusion, and provides an overview of image fusion based on machine learning and deep learning. As such, it is a valuable resource for graduate students and scientists in the field of digital image processing and information fusion.

This research monograph is highly contextual in the present era of spatial/spatio-

temporal data explosion. The overall text contains many interesting results that are worth applying in practice, while it is also a source of intriguing and motivating questions for advanced research on spatial data science. The monograph is primarily prepared for graduate students of Computer Science, who wish to employ probabilistic graphical models, especially Bayesian networks (BNs), for applied research on spatial/spatio-temporal data. Students of any other discipline of engineering, science, and technology, will also find this monograph useful. Research students looking for a suitable problem for their MS or PhD thesis will also find this monograph beneficial. The open research problems as discussed with sufficient references in Chapter-8 and Chapter-9 can immensely help graduate researchers to identify topics of their own choice. The various illustrations and proofs presented throughout the monograph may help them to better understand the working principles of the models. The present monograph, containing sufficient description of the parameter learning and inference generation process for each enhanced BN model, can also serve as an algorithmic cookbook for the relevant system developers.

This first volume, edited and authored by world leading experts, gives a review of the principles, methods and techniques of important and emerging research topics and technologies in machine learning and advanced signal processing theory. With this reference source you will: Quickly grasp a new area of research Understand the underlying principles of a topic and its application Ascertain how a topic relates to other areas and learn of the research issues yet to be resolved Quick tutorial reviews of important and emerging topics of research in machine learning Presents core principles in signal processing theory and shows their applications Reference content on core principles, technologies, algorithms and applications Comprehensive references to journal articles and other literature on which to build further, more specific and detailed knowledge Edited by leading people in the field who, through their reputation, have been able to commission experts to write on a particular topic

This book brings together important topics of current research in probabilistic graphical modeling, learning from data and probabilistic inference. Coverage includes such topics as the characterization of conditional independence, the learning of graphical models with latent variables, and extensions to the influence diagram formalism as well as important application fields, such as the control of vehicles, bioinformatics and medicine.

This book discusses how to combine type-2 fuzzy sets and graphical models to solve a range of real-world pattern recognition problems such as speech recognition, handwritten Chinese character recognition, topic modeling as well as human action recognition. It covers these recent developments while also providing a comprehensive introduction to the fields of type-2 fuzzy sets and graphical models. Though primarily intended for graduate students, researchers and practitioners in fuzzy logic and pattern recognition, the book can also serve as a valuable reference work for researchers without any previous knowledge of these fields. Dr. Jia Zeng is a Professor at the School of Computer Science and Technology, Soochow University, China. Dr. Zhi-Qiang Liu is a Professor at the School of Creative Media, City University of Hong Kong, China.

As the age of Big Data emerges, it becomes necessary to take the five dimensions of Big Data- volume, variety, velocity, volatility, and veracity- and focus these dimensions

towards one critical emphasis - value. The Encyclopedia of Business Analytics and Optimization confronts the challenges of information retrieval in the age of Big Data by exploring recent advances in the areas of knowledge management, data visualization, interdisciplinary communication, and others. Through its critical approach and practical application, this book will be a must-have reference for any professional, leader, analyst, or manager interested in making the most of the knowledge resources at their disposal.

This book constitutes the refereed proceedings of the 7th International Workshop on Probabilistic Graphical Models, PGM 2014, held in Utrecht, The Netherlands, in September 2014. The 38 revised full papers presented in this book were carefully reviewed and selected from 44 submissions. The papers cover all aspects of graphical models for probabilistic reasoning, decision making, and learning.

An introduction to decision making under uncertainty from a computational perspective, covering both theory and applications ranging from speech recognition to airborne collision avoidance. Many important problems involve decision making under uncertainty—that is, choosing actions based on often imperfect observations, with unknown outcomes. Designers of automated decision support systems must take into account the various sources of uncertainty while balancing the multiple objectives of the system. This book provides an introduction to the challenges of decision making under uncertainty from a computational perspective. It presents both the theory behind decision making models and algorithms and a collection of example applications that range from speech recognition to aircraft collision avoidance. Focusing on two methods for designing decision agents, planning and reinforcement learning, the book covers probabilistic models, introducing Bayesian networks as a graphical model that captures probabilistic relationships between variables; utility theory as a framework for understanding optimal decision making under uncertainty; Markov decision processes as a method for modeling sequential problems; model uncertainty; state uncertainty; and cooperative decision making involving multiple interacting agents. A series of applications shows how the theoretical concepts can be applied to systems for attribute-based person search, speech applications, collision avoidance, and unmanned aircraft persistent surveillance. Decision Making Under Uncertainty unifies research from different communities using consistent notation, and is accessible to students and researchers across engineering disciplines who have some prior exposure to probability theory and calculus. It can be used as a text for advanced undergraduate and graduate students in fields including computer science, aerospace and electrical engineering, and management science. It will also be a valuable professional reference for researchers in a variety of disciplines.

The monographic volume addresses, in a systematic and comprehensive way, the state-of-the-art dependability (reliability, availability, risk and safety, security) of systems, using the Artificial Intelligence framework of Probabilistic Graphical Models (PGM). After a survey about the main concepts and methodologies adopted in dependability analysis, the book discusses the main features of PGM formalisms (like Bayesian and Decision Networks) and the advantages, both in terms of modeling and analysis, with respect to classical formalisms and model languages. Methodologies for deriving PGMs from standard dependability formalisms will be introduced, by pointing out tools able to support such a process. Several case studies will be presented and analyzed to

support the suitability of the use of PGMs in the study of dependable systems. Contents:Dependability and ReliabilityProbabilistic Graphical ModelsFrom Fault Trees to Bayesian NetworksFrom Dynamic Fault Tree to Dynamic Bayesian NetworksDecision Theoretic DependabilityThe RADyBaN Tool: Supporting DependabilityCase Study 1: Cascading FailuresCase Study 2: Autonomous Fault Detection, Identification and RecoveryCase Study 3: Security Assessment in Critical InfrastructuresCase Study 4: Dynamic Reliability Keywords:Dependability;Reliability;Probabilistic Graphical Models;Bayesian Networks;Fault Detection Identification and Recovery
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This volume contains lecture notes of the 14th Reasoning Web Summer School (RW 2018), held in Esch-sur-Alzette, Luxembourg, in September 2018. The research areas of Semantic Web, Linked Data, and Knowledge Graphs have recently received a lot of attention in academia and industry. Since its inception in 2001, the Semantic Web has aimed at enriching the existing Web with meta-data and processing methods, so as to provide Web-based systems with intelligent capabilities such as context awareness and decision support. The Semantic Web vision has been driving many community efforts which have invested a lot of resources in developing vocabularies and ontologies for annotating their resources semantically. Besides ontologies, rules have long been a central part of the Semantic Web framework and are available as one of its fundamental representation tools, with logic serving as a unifying foundation. Linked Data is a related research area which studies how one can make RDF data available on the Web and interconnect it with other data with the aim of increasing its value for everybody. Knowledge Graphs have been shown useful not only for Web search (as demonstrated by Google, Bing, etc.) but also in many application domains.
This book presents a contemporary view of the role of information quality in information fusion and decision making, and provides a formal foundation and the implementation strategies required for dealing with insufficient information quality in building fusion systems for decision making. Information fusion is the process of gathering, processing, and combining large amounts of information from multiple and diverse sources, including physical sensors to human intelligence reports and social media. That data and information may be unreliable, of low fidelity, insufficient resolution, contradictory, fake and/or redundant. Sources may provide unverified reports obtained from other sources resulting in correlations and biases. The success of the fusion processing depends on how well knowledge produced by the processing chain represents reality,

which in turn depends on how adequate data are, how good and adequate are the models used, and how accurate, appropriate or applicable prior and contextual knowledge is. By offering contributions by leading experts, this book provides an unparalleled understanding of the problem of information quality in information fusion and decision-making for researchers and professionals in the field.

Bayesian decision analysis supports principled decision making in complex domains. This textbook takes the reader from a formal analysis of simple decision problems to a careful analysis of the sometimes very complex and data rich structures confronted by practitioners. The book contains basic material on subjective probability theory and multi-attribute utility theory, event and decision trees, Bayesian networks, influence diagrams and causal Bayesian networks. The author demonstrates when and how the theory can be successfully applied to a given decision problem, how data can be sampled and expert judgements elicited to support this analysis, and when and how an effective Bayesian decision analysis can be implemented. Evolving from a third-year undergraduate course taught by the author over many years, all of the material in this book will be accessible to a student who has completed introductory courses in probability and mathematical statistics.

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