

## Article

# Investigations of Symmetrical Incomplete Information Spreading in the Evidential Reasoning Algorithm and the Evidential Reasoning Rule via Partial Derivative Analysis

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**Abstract:** Incomplete information causes great uncertainty in decision making. It is a critical task to understand how incomplete information spreads symmetrically in order to make comprehensive and balanced decisions. A better understanding of the spreading of incomplete information can also be used for accurately locating limited resources to reduce incomplete information in the input for the final purpose of reducing incomplete information in the result. In this study, the way in which incomplete information spreads is studied via the evidential reasoning (ER) algorithm and the evidential reasoning rule (the ER rule), which are known for their transparent analytical procedures. Specifically, the partial derivative analysis is conducted using the steps of ER and the ER rule for calculating the contributions made by the beliefs, weights, and reliability to the incomplete information in the result. The major theoretical contribution of this study is the calculation of the contribution of the input to the incomplete information in the output based on partial derivative analysis. A numerical case is studied to demonstrate the proposed derivative analysis, the contribution calculation, and the consequential results.

**Keywords:** symmetrical incomplete information; information spreading; evidential reasoning algorithm; evidential reasoning rule; partial derivative analysis



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## 1. Introduction

Incomplete information brings uncertainty to traditional decision making, which however, is almost unavoidable under many conditions [1,2]. There are many causes for incomplete information, e.g., degraded sensors [3], inaccurate recording and transferring of data [4], or human knowledge ignorance [5]. Generally existent incomplete information produces challenges in complex systems modeling.

Many traditional machine learning approaches, e.g., the neural network (NN), the support vector machine (SVM), etc., are effective in complex systems modeling, yet they cannot effectively handle incomplete information [1,6,7]. There are several methods for handling incomplete information [8]. When there is a large quantity of data, the data with incomplete information would be deleted or omitted from the later modeling procedure. Alternatively, incomplete information could be imputed using prior information or according to statistical data. Furthermore, the imputed information could be used either in a single value or as a distribution to provide a holistic picture of the problem, if required. Recently, machine learning approaches have been used for inferring the missing information, leading to superior performance. However, those endeavors are all indirect means, i.e., the missing information is either deleted or filled in, becoming complete information which traditional machine learning approaches can handle.

Therefore, the presence of incomplete information remains a challenge in decision-making, leading to the requirement of eliminating or at least reducing it. [9]. For example, there may be ambiguity regarding a patient's assessment of pain, or the X-rays or CT scans may be blurred [10,11], all of which are sources of incomplete information in the input.

# Reasoning With Incomplete Information

**Philippe Codognet**



## **Reasoning With Incomplete Information:**

*Reasoning with Incomplete Information* David W. Etherington, 1988      *Answer Set Programming* Vladimir Lifschitz, 2019-08-29 Answer set programming ASP is a programming methodology oriented towards combinatorial search problems In such a problem the goal is to find a solution among a large but finite number of possibilities The idea of ASP came from research on artificial intelligence and computational logic ASP is a form of declarative programming an ASP program describes what is counted as a solution to the problem but does not specify an algorithm for solving it Search is performed by sophisticated software systems called answer set solvers Combinatorial search problems often arise in science and technology and ASP has found applications in diverse areas in historical linguistic in bioinformatics in robotics in space exploration in oil and gas industry and many others The importance of this programming method was recognized by the Association for the Advancement of Artificial Intelligence in 2016 when AI Magazine published a special issue on answer set programming The book introduces the reader to the theory and practice of ASP It describes the input language of the answer set solver CLINGO which was designed at the University of Potsdam in Germany and is used today by ASP programmers in many countries It includes numerous examples of ASP programs and present the mathematical theory that ASP is based on There are many exercises with complete solutions      **Incomplete Information: Rough Set Analysis** Ewa

Orlowska, 1997-11-27 In 1982 Professor Pawlak published his seminal paper on what he called rough sets a work which opened a new direction in the development of theories of incomplete information Today a decade and a half later the theory of rough sets has evolved into a far reaching methodology for dealing with a wide variety of issues centering on incompleteness and imprecision of information issues which play a key role in the conception and design of intelligent information systems *Incomplete Information Rough Set Analysis* or RSA for short presents an up to date and highly authoritative account of the current status of the basic theory its many extensions and wide ranging applications Edited by Professor Ewa Orlowska one of the leading contributors to the theory of rough sets RSA is a collection of nineteen well integrated chapters authored by experts in rough set theory and related fields A common thread that runs through these chapters ties the concept of incompleteness of information to those of indiscernibility and similarity      *The Many Valued and Nonmonotonic Turn in Logic* Dov M. Gabbay, John Woods, 2007-08-13 The present volume of the *Handbook of the History of Logic* brings together two of the most important developments in 20th century non classical logic These are many valuedness and non monotonicity On the one approach in deference to vagueness temporal or quantum indeterminacy or reference failure sentences that are classically non bivalent are allowed as inputs and outputs to consequence relations Many valued dialethic fuzzy and quantum logics are among other things principled attempts to regulate the flow through of sentences that are neither true nor false On the second or non monotonic approach constraints are placed on inputs and sometimes on outputs of a classical consequence relation with a view to producing a notion of consequence that serves in a more realistic

way the requirements of real life inference Many valued logics produce an interesting problem Non bivalent inputs produce classically valid consequence statements for any choice of outputs A major task of many valued logics of all stripes is to fashion an appropriately non classical relation of consequence The chief preoccupation of non monotonic and default logicians is how to constrain inputs and outputs of the consequence relation In what is called left non monotonicity it is forbidden to add new sentences to the inputs of true consequence statements The restriction takes notice of the fact that new information will sometimes override an antecedently and reasonably derived consequence In what is called right non monotonicity limitations are imposed on outputs of the consequence relation Most notably perhaps is the requirement that the rule of introduction not be given free sway on outputs Also prominent is the effort of paraconsistent logicians both preservationist and dialetheic to limit the outputs of inconsistent inputs which in classical contexts are wholly unconstrained In some instances our two themes coincide Dialetheic logics are a case in point Dialetheic logics allow certain selected sentences to have as a third truth value the classical values of truth and falsity together So such logics also admit classically inconsistent inputs A central task is to construct a right non monotonic consequence relation that allows for these many valued and inconsistent inputs The Many Valued and Non Monotonic Turn in Logic is an indispensable research tool for anyone interested in the development of logic including researchers graduate and senior undergraduate students in logic history of logic mathematics history of mathematics computer science AI linguistics cognitive science argumentation theory and the history of ideas Detailed and comprehensive chapters covering the entire range of modal logic Contains the latest scholarly discoveries and interpretative insights that answers many questions in the field of logic

*Probabilistic Reasoning in Intelligent Systems* Judea Pearl, 2014-06-28 Probabilistic Reasoning in Intelligent Systems is a complete and accessible account of the theoretical foundations and computational methods that underlie plausible reasoning under uncertainty The author provides a coherent explication of probability as a language for reasoning with partial belief and offers a unifying perspective on other AI approaches to uncertainty such as the Dempster Shafer formalism truth maintenance systems and nonmonotonic logic The author distinguishes syntactic and semantic approaches to uncertainty and offers techniques based on belief networks that provide a mechanism for making semantics based systems operational Specifically network propagation techniques serve as a mechanism for combining the theoretical coherence of probability theory with modern demands of reasoning systems technology modular declarative inputs conceptually meaningful inferences and parallel distributed computation Application areas include diagnosis forecasting image interpretation multi sensor fusion decision support systems plan recognition planning speech recognition in short almost every task requiring that conclusions be drawn from uncertain clues and incomplete information Probabilistic Reasoning in Intelligent Systems will be of special interest to scholars and researchers in AI decision theory statistics logic philosophy cognitive psychology and the management sciences Professionals in the areas of knowledge based systems operations research engineering and statistics will find theoretical

and computational tools of immediate practical use The book can also be used as an excellent text for graduate level courses in AI operations research or applied probability

**COMADEM 89 International** Raj B. K. N. Rao, A. D. Hope, 2012-12-06  
 Raj B. K. N. Rao Conference Director Birmingham Polytechnic Condition Monitoring and Diagnostic Engineering Management

COMADEM is a relatively new field that has already made its mark in a wide range of industries But all the signs are that even more will be required of researchers in the field over the next decade for COMADEM directly addresses a whole range of issues that are likely to become increasingly important to companies as competitiveness increases along with the uncertainties resulting from rapid technological change Already for example businesses are having to scrutinize the economics of plant and machinery in greater detail than ever before reliability is becoming a crucial factor as the costs of unscheduled breakdowns rise and there is increasing pressure on companies to demonstrate and assure improved health and safety conditions especially in light of the growing number of catastrophic accidents that have occurred throughout the world Because it offers solutions to these and similar problems COMADEM is now gaining an international reputation as a problem solving user friendly and financially beneficial multi discipline with immense potential Many people at the senior management level are now convinced that COMADEM has much to offer and are wasting no time in reaping maximum benefit from the latest developments The fact that the first UK informal seminar on COMADEM COMADEM 88 proved to be a great success and had a truly international flavour reflected this growing interest in the new field

*ECAI 2014* T. Schaub, G. Friedrich, B. O'Sullivan, 2014-08 The role of artificial intelligence AI applications in fields as diverse as medicine economics linguistics logical analysis and industry continues to grow in scope and importance AI has become integral to the effective functioning of much of the technical infrastructure we all now take for granted as part of our daily lives This book presents the papers from the 21st biennial European Conference on Artificial Intelligence ECAI 2014 held in Prague Czech Republic in August 2014 The ECAI conference remains Europe's principal opportunity for researchers and practitioners of Artificial Intelligence to gather and to discuss the latest trends and challenges in all subfields of AI as well as to demonstrate innovative applications and uses of advanced AI technology Included here are the 158 long papers and 94 short papers selected for presentation at the conference Many of the papers cover the fields of knowledge representation reasoning and logic as well as agent based and multi agent systems machine learning and data mining The proceedings of PAIS 2014 and the PAIS System Demonstrations are also included in this volume which will be of interest to all those wishing to keep abreast of the latest developments in the field of AI

**FGCS '92**, 1992 **Intellectics and Computational Logic** Steffen Hölldobler, 2013-04-18 Intellectics seeks to understand the functions structure and operation of the human intellect and to test artificial systems to see the extent to which they can substitute or complement such functions The word itself was introduced in the early 1980s by Wolfgang Bibel to describe the united fields of artificial intelligence and cognitive science The book collects papers by distinguished researchers colleagues and former students of Bibel's all of whom have worked

together with him and who present their work to him here to mark his 60th birthday The papers discuss significant issues in intellectics and computational logic ranging across automated deduction logic programming the logic based approach to intellectics cognitive robotics knowledge representation and reasoning Each paper contains new previously unpublished reviewed results The collection is a state of the art account of the current capabilities and limitations of a computational logic based approach to intellectics Readership Researchers who are convinced that the intelligent behaviour of machines should be based on a rigid formal treatment of knowledge representation and reasoning

**SIGMA** Takashi Matsuyama, Vincent Shang-Shouq Hwang, 2013-06-29 It has long been a dream to realize machines with flexible visual perception capability Research on digital image processing by computers was initiated about 30 years ago and since then a wide variety of image processing algorithms have been devised Using such image processing algorithms and advanced hardware technologies many practical machines with visual recognition capability have been implemented and are used in various fields optical character readers and design chart readers in offices position sensing and inspection systems in factories computer tomography and medical X ray and microscope examination systems in hospitals and so on Although these machines are useful for specific tasks their capabilities are limited That is they can analyze only simple images which are recorded under very carefully adjusted photographic conditions objects to be recognized are isolated against a uniform background and under well controlled artificial lighting In the late 1970s many image understanding systems were developed to study the automatic interpretation of complex natural scenes They introduced artificial intelligence techniques to represent the knowledge about scenes and to realize flexible control structures The first author developed an automatic aerial photograph interpretation system based on the blackboard model Naga1980 Although these systems could analyze fairly complex scenes their capabilities were still limited the types of recognizable objects were limited and various recognition errors occurred due to noise and the imperfection of segmentation algorithms

**Logic, Language and Computation S.** Akama, 2012-12-06 The editors of the Applied Logic Series are happy to present to the reader the fifth volume in the series a collection of papers on Logic Language and Computation One very striking feature of the application of logic to language and to computation is that it requires the combination the integration and the use of many diverse systems and methodologies all in the same single application The papers in this volume will give the reader a glimpse into the problems of this active frontier of logic The Editors CONTENTS Preface IX 1 S AKAMA Recent Issues in Logic Language and Computation 1 2 M J CRESSWELL Restricted Quantification 27 3 B H SLATER The Epsilon Calculus Problematic 39 4 K VON HEUSINGER Definite Descriptions and Choice Functions 61 5 N ASHER Spatio Temporal Structure in Text 93 6 Y NAKAYAMA DRT and Many Valued Logics 131 7 S AKAMA On Constructive Modality 143 8 H W ANSING Displaying as Temporalizing Sequent Systems for Subintuitionistic Logics 159 9 L FARINAS DEL CERRO AND V LUGARDON 179 Quantification and Dependence Logics 10 R SYLVAN Relevant Conditionals and Relevant Application Thereof 191 Index 245 Preface This is a collection of

papers by distinguished researchers on Logic Linguistics Philosophy and Computer Science The aim of this book is to address a broad picture of the recent research on related areas In particular the contributions focus on natural language semantics and non classical logics from different viewpoints

### **An Introduction to Default Logic** Philippe

Besnard,2013-04-17 This book is written for those who are interested in a formalization of human reasoning especially in order to build intelligent computer systems Thus it is mainly designed for the Artificial Intelligence community both students and researchers although it can be useful for people working in related fields like cognitive psychology The major theme is not Artificial Intelligence applications although these are discussed throughout in sketch form Rather the book places a heavy emphasis on the formal development of default logic results and problems Default logic provides a formalism for an important part of human reasoning Default logic is specifically concerned with common sense reasoning which has recently been recognized in the Artificial Intelligence literature to be of fundamental importance for knowledge representation Previously formalized reasoning systems failed in real world environments though succeeding with an acceptable ratio in well defined environments This situation enabled empirical explorations and the design of systems without theoretical justification In particular they could not be compared since there was no basis to judge their respective merits Default logic turned out to be very fruitful by proving the correctness of some of them We hope that this book will initiate other successful developments in default logic

*A Guided Tour of Relational Databases and Beyond* Mark Levene,George Loizou,2012-09-18 Database theory

is now in a mature state and this book addresses important extensions of the relational database model such as deductive temporal and object oriented databases It provides an overview of database modelling with the Entity Relationship ER model and the relational model providing the pivot on which the material revolves The main body of the book focuses on the primary achievements of relational database theory including query languages integrity constraints database design computable queries and concurrency control The most important extensions of the relational model are covered in separate chapters This book will be useful to third year computer science undergraduates and postgraduates studying database theory and will also be of interest to researchers and database practitioners who would like to know more about the ideas underlying relational database management systems and the problems that confront database researchers

### **Logic Programming**

Philippe Codognet,2001-11-14 This book constitutes the refereed proceedings of the 17th International Conference on Logic Programming ICLP 2001 held in Paphos Cyprus in November December 2001 The 23 revised full papers presented were carefully reviewed and selected from 64 submissions All current aspects of logic programming and computational logics are addressed

### **AALIANCE Ambient Assisted Living Roadmap** Seventh Framework Programme (European

Commission),2010 Title page AALIANCE The European Ambient Assisted Living Innovation Platform Foreword Executive Summary Table of contents List of Roadmaps List of Scenarios List of Figures List of Tables Introduction Structure of the Roadmap Roadmapping Process Scope of AAL Technological trends and barriers in AAL Technological trends Technological

barriers AAL for persons AAL for health rehabilitation and care Support for chronic disease management Biorobotics for neuro rehabilitation Support for multi disciplinary care teams Consolidated view Coping with impairments and disabilities Motor disabilities Personal activity management and monitoring Physical activity Mental activity Consolidated view Personal and home safety and security Open issues Safety in the face of specific threats Activities of Daily Life oriented support Other common activities Shopping Eat and drink Social interaction and communication AAL in the community Social inclusion Participation in community activities Creativity hobbies and sports Cultural and experience exchanges Entertainment and leisure Training the brain Exercise and gaming Mobility Supporting individual physical mobility AA driving cars private vehicles Public transport AAL at work Background Work ability Employers attitudes to older workers Training in and for the workplace Issues of work life balance Needs of older workers in the workplace Access to working space Assuring environmental working conditions Support for working Prevention of diseases and injuries Safety and health regulations Enabling Technologies Sensing Sensors for safety and security in the environments Sensors for monitoring persons Sensor networks

The Cognitive Approach to Conscious Machines Pentti O. Haikonen, 2015-11-30 Could a machine have an immaterial mind The author argues that true conscious machines can be built but rejects artificial intelligence and classical neural networks in favour of the emulation of the cognitive processes of the brain the flow of inner speech inner imagery and emotions This results in a non numeric meaning processing machine with distributed information representation and system reactions It is argued that this machine would be conscious it would be aware of its own existence and its mental content and perceive this as immaterial Novel views on consciousness and the mind body problem are presented This book is a must for anyone interested in consciousness research and the latest ideas in the forthcoming technology of mind

*Dynamic Fuzzy Logic and Its Applications* Fanzhang Li, 2008 Dynamic fuzzy problem are problems that are universally focused by academics Mathematicians and cybernetic experts have used fuzzy logic to developed theories and solve static problems in so called subjective and objective worlds This book includes 12 chapters Chapter 1 is about basic conceptions of Dynamic Fuzzy Sets DFS Chapter 2 introduces Dynamic Fuzzy DF decomposition theorem Chapter 3 is about L form of DFS module structure Chapter 4 is about representation theorem of DFS Chapter 5 introduces extension theorem of DFS Chapter 6 is about DF measure theory In chapter 7 it is Dynamic Fuzzy Logic DFL Chapter 8 is about reasoning methods of DFL Chapter 9 is about bases of DFL programming language Chapter 10 introduces multi agent learning model based on DFL Chapter 11 is about autonomic computing model based on DFL The last Chapter introduces application of DFL in machine learning

**The Automation of Reasoning with Incomplete Information** Torsten Schaub, 1997 Reasoning with incomplete information constitutes a major challenge for any intelligent system In fact we expect such systems not to become paralyzed by missing information but rather to arrive at plausible results by bridging the gaps in the information available A versatile way of reasoning in the absence of information is to reason by default This book aims at providing formal and practical means for



automating reasoning with incomplete information by starting from the approach taken by the framework of default logic For this endeavor a bridge is spanned between formal semantics over systems for default reasoning to efficient implementation

**Features and Fluents** Erik Sandewall,1994 Techniques for reasoning about actions and change in the physical world are among the classic research topics in artificial intelligence motivated by the needs of autonomous robots which must be able to anticipate future developments and analyze problems This monograph presents a novel methodology for such reasoning It is based on a systematic approach for identifying the exact range of applicability of a given logic as opposed to traditional methods based on proposing new logic variants supported by episodic examples For a number of previously proposed logics as well as for some new ones this work characterizes exactly the class of those reasoning tasks where the logic results in the intended set of conclusions and the class where it does not The book will be a necessary resource for researchers in knowledge representation cognitive robotics and intelligent control It can also be recommended as a graduate level text in these fields especially in light of its emphasis on a strict and systematic methodology

**Multisensor Fusion and Integration in the Wake of Big Data, Deep Learning and Cyber Physical System** Sukhan Lee,Hanseok Ko,Songhwai Oh,2018-07-04 This book includes selected papers from the 13th IEEE International Conference on Multisensor Integration and Fusion for Intelligent Systems MFI 2017 held in Daegu Korea November 16 22 2017 It covers various topics including sensor actuator networks distributed and cloud architectures bio inspired systems and evolutionary approaches methods of cognitive sensor fusion Bayesian approaches fuzzy systems and neural networks biomedical applications autonomous land sea and air vehicles localization tracking SLAM 3D perception manipulation with multifinger hands robotics micro nano systems information fusion and sensors and multimodal integration in HCI and HRI The book is intended for robotics scientists data and information fusion scientists researchers and professionals at universities research institutes and laboratories

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## **Table of Contents Reasoning With Incomplete Information**

1. Understanding the eBook Reasoning With Incomplete Information
  - The Rise of Digital Reading Reasoning With Incomplete Information
  - Advantages of eBooks Over Traditional Books
2. Identifying Reasoning With Incomplete Information
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Reasoning With Incomplete Information
  - User-Friendly Interface
4. Exploring eBook Recommendations from Reasoning With Incomplete Information
  - Personalized Recommendations
  - Reasoning With Incomplete Information User Reviews and Ratings
  - Reasoning With Incomplete Information and Bestseller Lists
5. Accessing Reasoning With Incomplete Information Free and Paid eBooks

- Reasoning With Incomplete Information Public Domain eBooks
- Reasoning With Incomplete Information eBook Subscription Services
- Reasoning With Incomplete Information Budget-Friendly Options
- 6. Navigating Reasoning With Incomplete Information eBook Formats
  - ePub, PDF, MOBI, and More
  - Reasoning With Incomplete Information Compatibility with Devices
  - Reasoning With Incomplete Information Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Reasoning With Incomplete Information
  - Highlighting and Note-Taking Reasoning With Incomplete Information
  - Interactive Elements Reasoning With Incomplete Information
- 8. Staying Engaged with Reasoning With Incomplete Information
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Reasoning With Incomplete Information
- 9. Balancing eBooks and Physical Books Reasoning With Incomplete Information
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Reasoning With Incomplete Information
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Reasoning With Incomplete Information
  - Setting Reading Goals Reasoning With Incomplete Information
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Reasoning With Incomplete Information
  - Fact-Checking eBook Content of Reasoning With Incomplete Information
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development

- Exploring Educational eBooks

#### 14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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