

# Qualitative Temporal Representation and Reasoning about Points, Intervals and Durations

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## Abstract

*Recently, an elegant framework called  $\mathcal{N}^2\mathcal{TL}$  [8] has been proposed for representing qualitative information about time intervals and durations.  $\mathcal{N}^2\mathcal{TL}$  is a single network, therefore it avoids typical problems of bi-networks, and in addition it has interesting computational properties. In this paper, we extend  $\mathcal{N}^2\mathcal{TL}$  in two directions: we enrich its expressive power by including points and introducing the same computational properties, and we provide it with an automatic theory able to handle qualitative temporal information about points, intervals and durations in a unified framework. This theory is based on general interval axioms and two relations: general meets and not longer than.*

## 1. Introduction

In many domains, it is more important to consider the relative information concerning the durations of two temporal intervals instead of considering the absolute knowledge about a single interval. If durations are taken as distances between endpoints of intervals then qualitative constraints as "the duration of the interval  $I$  is shorter than the duration of the interval  $J$ " cannot be represented in a binary constraint network since they concern four points. This problem is usually overcome encoding duration information in a network orthogonal to the interval relationship network, but this strategy presents some limits. In the  $\mathcal{IA}$  framework [1] it does not guarantee the total consistency

of the network [7]. In the same line, there are other bi-network based works proposed for representing information about durations:  $\mathcal{PDN}$  [2] and  $\mathcal{APDN}$  [12].  $\mathcal{PDN}$  is a point duration network defined as a structure based by two point algebra networks, separately but not independently, as binary constraints are introduced for relating point and duration information.  $\mathcal{APDN}$  extends  $\mathcal{PDN}$  where only qualitative information is considered, by representing both qualitative and quantitative information about point events. Like other point-based approaches, they do not handle the disjointness of interval algebras.

The  $\mathcal{PIDN}$  framework [9] considers a single network able to handle both qualitative and quantitative temporal information about points, intervals and durations, but its high expressive power is achieved at the price of its computational properties.

Recently, an elegant subframework of  $\mathcal{PIDN}$  called  $\mathcal{N}^2\mathcal{TV}$  [3] has been proposed.  $\mathcal{N}^2\mathcal{TV}$  represents only qualitative information about time intervals and durations and it has interesting computational properties. The set of interval relations considered is an extension of 13 Allen's relations [1] integrated with qualitative information about durations  $\{<, =, >\}$ . For example, the relation  $k$  is extended to the three relations  $\{k^<, k^=, k^>\}$ , while other relations such as  $\{rc, s, al, d, dl, f, fi\}$  which include implicit information about interval durations, are left unchanged. Thus, 25 basic relations between pairs of intervals are considered. The  $\mathcal{N}^2\mathcal{TV}$  network exhibits similar characteristics as the  $\mathcal{IA}$ -network concerning tractable subclasses ( $\mathcal{C}ommet$  as well as  $\mathcal{P}ro-commet$ ), but the level of local consistency to achieve global consistency is  $\mathcal{B}$ -consistency [4].

# Temporal Representation And Reasoning Time 00 Proceedings

**Vasco Brattka,Hannes Diener,Dieter  
Spreen**



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Qualitative Spatial and Temporal Reasoning Gérard Ligozat, 2013-05-21 Starting with an updated description of Allen's calculus the book proceeds with a description of the main qualitative calculi which have been developed over the last two decades It describes the connection of complexity issues to geometric properties Models of the formalisms are described using the algebraic notion of weak representations of the associated algebras The book also includes a presentation of fuzzy extensions of qualitative calculi and a description of the study of complexity in terms of clones of operations *Logic,*

*Computation, Hierarchies* Vasco Brattka, Hannes Diener, Dieter Spreen, 2014-09-04 Published in honor of Victor L Selivanov the 17 articles collected in this volume inform on the latest developments in computability theory and its applications in computable analysis descriptive set theory and topology and the theory of omega languages as well as non classical logics such as temporal logic and paraconsistent logic This volume will be of interest to mathematicians and logicians as well as theoretical computer scientists Qualitative Spatio-Temporal Representation and Reasoning: Trends and Future Directions

Hazarika, Shyamanta M., 2012-05-31 Space and time are inextricably linked Reasoning about space often involves reasoning about change in spatial configurations Qualitative spatial information theory encompasses spatial as well as temporal representation and reasoning Qualitative Spatio Temporal Representation and Reasoning Trends and Future Directions is a contribution to the emerging discipline of qualitative spatial information theory within artificial intelligence This collection of research covers both theory and application centric research and provides a comprehensive perspective on the emerging area of qualitative spatio temporal representation and reasoning This revolutionary new field is increasingly becoming a core issue within mobile computing GIS spatial information systems databases computer vision as well as knowledge discovery and data mining **Mobility, Data Mining and Privacy** Fosca Giannotti, Dino Pedreschi, 2008-01-12 Mobile

communications and ubiquitous computing generate large volumes of data Mining this data can produce useful knowledge yet individual privacy is at risk This book investigates the various scientific and technological issues of mobility data open problems and roadmap The editors manage a research project called GeoPKDD Geographic Privacy Aware Knowledge Discovery and Delivery and this book relates their findings in 13 chapters covering all related subjects **Environmental**

**Modelling, Software and Decision Support** Anthony J. Jakeman, Alexey A. Voinov, Andrea E. Rizzoli, Serena H. Chen, 2008-09-11 The complex and multidisciplinary nature of environmental problems requires that they are dealt with in an integrated manner Modeling and software have become key instruments used to promote sustainability and improve environmental decision processes especially through systematic integration of various knowledge and data and their ability to foster learning and help make predictions This book presents the current state of the art in environmental modeling and software and identifies the future challenges in the field State of the art in environmental modeling and software theory and practice for integrated assessment and management serves as a starting point for researchers Identifies the areas of

research and practice required for advancing the requisite knowledge base and tools and their wider usage Best practices of environmental modeling enables the reader to select appropriate software and gives the reader tools to integrate natural system dynamics with human dimensions

**Logics in Artificial Intelligence** Michael Fisher, Wiebe van der Hoek, Boris Konev, Alexei Lisitsa, 2006-09-14 This book constitutes the refereed proceedings of the 10th European Conference on Logics in Artificial Intelligence JELIA 2006 The 34 revised full papers and 12 revised tool description papers presented together with 3 invited talks were carefully reviewed and selected from 96 submissions The papers cover a range of topics within the remit of the Conference such as logic programming description logics non monotonic reasoning agent theories automated reasoning and machine learning

**Handbook of Temporal Reasoning in Artificial Intelligence** Michael David Fisher, Dov M. Gabbay, Lluís Vila, 2005-03-01 This collection represents the primary reference work for researchers and students in the area of Temporal Reasoning in Artificial Intelligence Temporal reasoning has a vital role to play in many areas particularly Artificial Intelligence Yet until now there has been no single volume collecting together the breadth of work in this area This collection brings together the leading researchers in a range of relevant areas and provides an coherent description of the breadth of activity concerning temporal reasoning in the field of Artificial Intelligence Key Features Broad range foundations techniques and applications Leading researchers around the world have written the chapters Covers many vital applications Source book for Artificial Intelligence temporal reasoning Approaches provide foundation for many future software systems Broad range foundations techniques and applications Leading researchers around the world have written the chapters Covers many vital applications Source book for Artificial Intelligence temporal reasoning Approaches provide foundation for many future software systems

Temporal Data Mining Theophano Mitsa, 2010-03-10 From basic data mining concepts to state of the art advances this book covers the theory of the subject as well as its application in a variety of fields It discusses the incorporation of temporality in databases as well as temporal data representation similarity computation data classification clustering pattern discovery and prediction The book also explores the use of temporal data mining in medicine and biomedical informatics business and industrial applications web usage mining and spatiotemporal data mining Along with various state of the art algorithms each chapter includes detailed references and short descriptions of relevant algorithms and techniques described in other references

*Handbook of Research on Embedded Systems Design* Bagnato, Alessandra, Indrusiak, Leandro Soares, Quadri, Imran Rafiq, Rossi, Matteo, 2014-06-30 As real time and integrated systems become increasingly sophisticated issues related to development life cycles non recurring engineering costs and poor synergy between development teams will arise The Handbook of Research on Embedded Systems Design provides insights from the computer science community on integrated systems research projects taking place in the European region This premier references work takes a look at the diverse range of design principles covered by these projects from specification at high abstraction levels using standards such as UML and related profiles to intermediate design phases This

work will be invaluable to designers of embedded software academicians students practitioners professionals and researchers working in the computer science industry

**WEBKDD 2002 - Mining Web Data for Discovering Usage Patterns and Profiles** Osmar Zaiane, 2003-10-13 This book constitutes the thoroughly refereed post proceedings of the 4th International Workshop on Mining Web Data WEBKDD 2002 held in Edmonton Canada in July 2002 The 10 revised full papers presented together with a detailed preface went through two rounds of reviewing and improvement and were selected from 23 submissions The papers are organized in topical sections on categorization of users and usage prediction and recommendation and evaluation of algorithms

*Proceedings of the Sixth SIAM International Conference on Data Mining* Joydeep Ghosh, 2006-04-01 The Sixth SIAM International Conference on Data Mining continues the tradition of presenting approaches tools and systems for data mining in fields such as science engineering industrial processes healthcare and medicine The datasets in these fields are large complex and often noisy Extracting knowledge requires the use of sophisticated high performance and principled analysis techniques and algorithms based on sound statistical foundations These techniques in turn require powerful visualization technologies implementations that must be carefully tuned for performance software systems that are usable by scientists engineers and physicians as well as researchers and infrastructures that support them

**Behaviour Monitoring and Interpretation - BMI** Björn Gottfried, Hamid K. Aghajan, 2009 Focuses on behaviour monitoring and interpretation with regard to two main areas of focus investigation of motion patterns and ambient assisted living This book presents contributions on research in both these areas It includes chapters discussing developments in monitoring and representing behaviours with a focus on movement based behaviour

**Spatial Cognition III** Christian Freksa, Wilfried Brauer, Christopher Habel, Karl F. Wender, 2003-08-03 This third volume documents the results achieved within a priority program on spatial cognition funded by the German Science Foundation DFG The 23 revised full papers presented went through two rounds of reviewing and improvement and reflect the increased interdisciplinary cooperation in the area The papers are organized in topical sections on routes and navigation human memory and learning spatial representation and spatial reasoning

**ECAI 2020** Giuseppe De Giacomo, Bistra Dilkina, Michela Milano, Senén Barro, Alberto Bugarín, Jérôme Lang, 2020-09-15 This book presents the proceedings of the 24th European Conference on Artificial Intelligence ECAI 2020 held in Santiago de Compostela Spain from 29 August to 8 September 2020 The conference was postponed from June and much of it conducted online due to the COVID 19 restrictions The conference is one of the principal occasions for researchers and practitioners of AI to meet and discuss the latest trends and challenges in all fields of AI and to demonstrate innovative applications and uses of advanced AI technology The book also includes the proceedings of the 10th Conference on Prestigious Applications of Artificial Intelligence PAIS 2020 held at the same time A record number of more than 1 700 submissions was received for ECAI 2020 of which 1 443 were reviewed Of these 361 full papers and 36 highlight papers were accepted an acceptance rate of 25% for full papers and 45% for

highlight papers The book is divided into three sections ECAI full papers ECAI highlight papers and PAIS papers The topics of these papers cover all aspects of AI including Agent based and Multi agent Systems Computational Intelligence Constraints and Satisfiability Games and Virtual Environments Heuristic Search Human Aspects in AI Information Retrieval and Filtering Knowledge Representation and Reasoning Machine Learning Multidisciplinary Topics and Applications Natural Language Processing Planning and Scheduling Robotics Safe Explainable and Trustworthy AI Semantic Technologies Uncertainty in AI and Vision The book will be of interest to all those whose work involves the use of AI technology [AI\\*IA 2015 Advances in Artificial Intelligence](#) Marco Gavanelli, Evelina Lamma, Fabrizio Riguzzi, 2015-09-09 This book constitutes the refereed proceedings of the 14th International Conference of the Italian Association for Artificial Intelligence AIAA 2015 held in Ferrara Italy in September 2015 The 35 full papers presented were carefully reviewed and selected from 44 submissions The papers are organized in topical sections on swarm intelligence and genetic algorithms computer vision multi agents systems knowledge representation and reasoning machine learning semantic Web natural language and scheduling planning and robotics

**MEDINFO 2019: Health and Wellbeing e-Networks for All** Lucila Ohno-Machado, 2019-11-15 Combining and integrating cross institutional data remains a challenge for both researchers and those involved in patient care Patient generated data can contribute precious information to healthcare professionals by enabling monitoring under normal life conditions and also helping patients play a more active role in their own care This book presents the proceedings of MEDINFO 2019 the 17th World Congress on Medical and Health Informatics held in Lyon France from 25 to 30 August 2019 The theme of this year's conference was Health and Wellbeing E Networks for All stressing the increasing importance of networks in healthcare on the one hand and the patient centered perspective on the other Over 1100 manuscripts were submitted to the conference and after a thorough review process by at least three reviewers and assessment by a scientific program committee member 285 papers and 296 posters were accepted together with 47 podium abstracts 7 demonstrations 45 panels 21 workshops and 9 tutorials All accepted paper and poster contributions are included in these proceedings The papers are grouped under four thematic tracks interpreting health and biomedical data supporting care delivery enabling precision medicine and public health and the human element in medical informatics The posters are divided into the same four groups The book presents an overview of state of the art informatics projects from multiple regions of the world it will be of interest to anyone working in the field of medical informatics

**Knowledge Management for Health Care Procedures** David Riano, 2009-07-21 The intersection between knowledge management computer science and health care defines a technological area of great interest that has not been operated properly Within this area medical procedures on preventive diagnostic therapeutic or prognostic tasks in health care play an outstanding role The management of this type of knowledge at the point of care includes four technological scopes at least The first one establishes the languages and structures to represent health care procedural knowledge and the integration of these structures with medical information

systems The second consists of the development of algorithms and computer science technologies for the operation of this knowledge The third scope is concerned with the development of methodologies to minimize the benefit of these algorithms and methodologies The fourth concerns the integration of the previous algorithms technologies and methodologies in computer science systems that allow the application of this knowledge at the point of need harnessing health care of greater quality and efficiency

**Computer Aided Systems Theory - EUROCAST 2003** Roberto Moreno Diaz, Franz Pichler, 2004-04-14 The concept of CAST as Computer Aided Systems Theory was introduced by F Pichler of Linz in the late 80 s to include those computer theoretical and practical developments as tools to solve problems in System Science It was considered as the third component the other two being CAD and CAM that will provide for a complete picture of the path from Computer and Systems Sciences to practical developments in Science and Engineering The University of Linz organized the first CAST workshop in April 1988 which demonstrated the acceptance of the concepts by the scientific and technical community Next the University of Las Palmas de Gran Canaria joined the University of Linz to organize the first international meeting on CAST Las Palmas February 1989 under the name EUROCAST 89 that was a very successful gathering of systems theorists computer scientists and engineers from most of European countries North America and Japan It was agreed that EUROCAST international conferences would be organized every two years Thus the following EUROCAST meetings took place in Krems 1991 Las Palmas 1993 Innsbruck 1995 Las Palmas 1997 Vienna 1999 and Las Palmas 2001 in addition to an extra European CAST Conference in Ottawa in 1994

Selected papers from those meetings were published by Springer Verlag Lecture Notes in Computer Science nos 410 585 763 1030 1333 1728 and 2178 and in several special issues of Cybernetics and Systems an International Journal EUROCAST and CAST meetings are definitely consolidated as it is demonstrated by the number and quality of the contributions over the years

*The Handbook of Geographic Information Science* John P. Wilson, A. Stewart Fotheringham, 2008-04-15 This Handbook is an essential reference and a guide to the rapidly expanding field of Geographic Information Science Designed for students and researchers who want an in depth treatment of the subject including background information Comprises around 40 substantial essays each written by a recognized expert in a particular area Covers the full spectrum of research in GIS

Surveys the increasing number of applications of GIS Predicts how GIS is likely to evolve in the near future

**The Logic of Software. A Tasting Menu of Formal Methods** Wolfgang Ahrendt, Bernhard Beckert, Richard Bubel, Einar Broch

Johnsen, 2022-07-04 This Festschrift dedicated to Reiner Hähnle on the occasion of his 60th birthday contains papers written by many of his closest collaborators After positions at Karlsruhe Institute of Technology and Chalmers University of Technology since 2011 Reiner has been the chaired professor of Software Engineering at Technische Universität Darmstadt where his team focuses on the formal verification of object oriented software the formal modeling and specification of highly adaptive software systems and formal modeling and analysis in domains such as biological systems and railroad operations

His work is characterized by achievements in theory and in practical implementations significant collaborations include the KeY project and the development of the ABS language He has served as chair and editor of important related academic conferences and coauthored almost 200 academic publications The contributions in this volume reflect Reiner s main research focus formal methods in particular applied to software verification

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