

Normative MAS and the Law: Norm Languages, Mining and Reasoning with Legal Texts

Introduction

GUIDO GOVERNATORI, LIVIO ROBALDO, ANTONINO ROTOLO, LEON VAN
DER TORRE

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Aims of this tutorial

1. Understand why there is no app for legal advice yet
2. Present the main challenges of legal informatics

Layout of the tutorial

1. Introduction
 2. Legal interpretation, Antonino Rotolo
 3. Legal norm mining, Livio Robaldo
 4. Legal compliance, Guido Governatori
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Which representation and reasoning?

Sergot *et al.*, 1986

THE BRITISH NATIONALITY ACT AS A LOGIC PROGRAM

The formalization of legislation and the development of computer systems to assist with legal problem solving provide a rich domain for developing and testing artificial-intelligence technology.

M. J. SERGOT, F. SADRI, R. A. KOWALSKI, F. KRIWACZEK, P. HAMMOND, and H. T. CORY

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g legal reasoning. Rather, we
the limited objective of imple-
mentations with the purpose of
applying to individual cases. The
act 1981 was chosen because it
the accomplishment of this more
an application for which
foundation in logic, proved to
sufficient. However, we do not wish
a computer-executable formal-
ism of achieving similar results.
In the article, we illustrate our
how Prolog might be used to
the first clause of the act, and then
the general structure of the act.
The methodology by which the formal-
ized, we examine the first three
in greater detail, discuss some ap-
lications, and detail some of

- 1.-(1) A person born in the United Kingdom after com-
mencement shall be a British citizen if at the time
of birth his father or mother is
- (a) a British citizen; or
 - (b) settled in the United Kingdom.

The act states that “after commencement” means
after or on the date on which the act comes into
force.

As a first approximation, 1.-(1)(a) can be repre-
sented by the rule

```
x is a British citizen
if x was born in the U.K.
and x was born on date y
and y is after or on commencement
and z is a parent of x
and z is a British citizen on date y
```

Here x , y , and z are *variables*, which can have any
value. For example, the common knowledge that

R. Lee and Y. Ryu, DX: deontic expert system, 1995

Example (Mild Dilemma). The university library has a policy that students with outstanding fines may not use copiers on campus.

```
assess:      Chen : USE-COPIER

rule :       PERMIT (X : USE-COPIER)  IF
              STUDENT (X) .

rule :       FORBID (X : USE-COPIER)  IF
              STUDENT (X)  AND
              OUTSTANDING-FINE (X) .

fact:        STUDENT (Chen) .

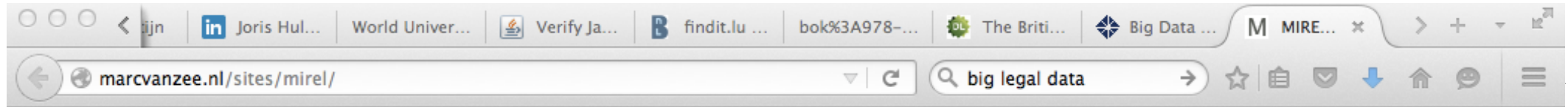
fact:        OUTSTANDING-FINE (Chen) .

response:    PERMIT (Chen : USE-COPIER)
              FORBID (Chen : USE-COPIER)
```

Example (Deadlock Dilemma). Teaching assistants must make use of the copier to prepare

Which data is relevant for the law?

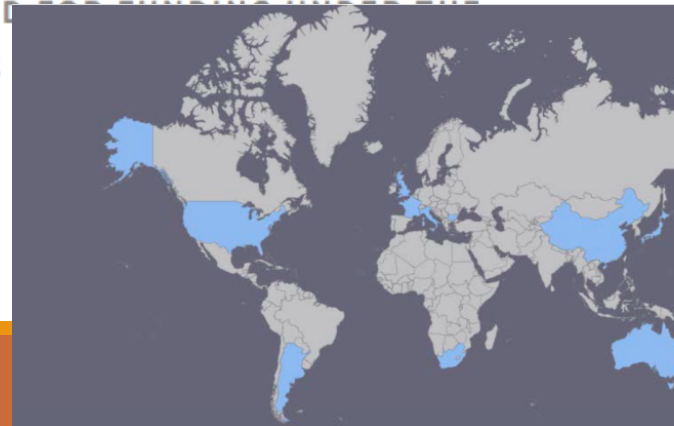
Our approach: combining mining and reasoning



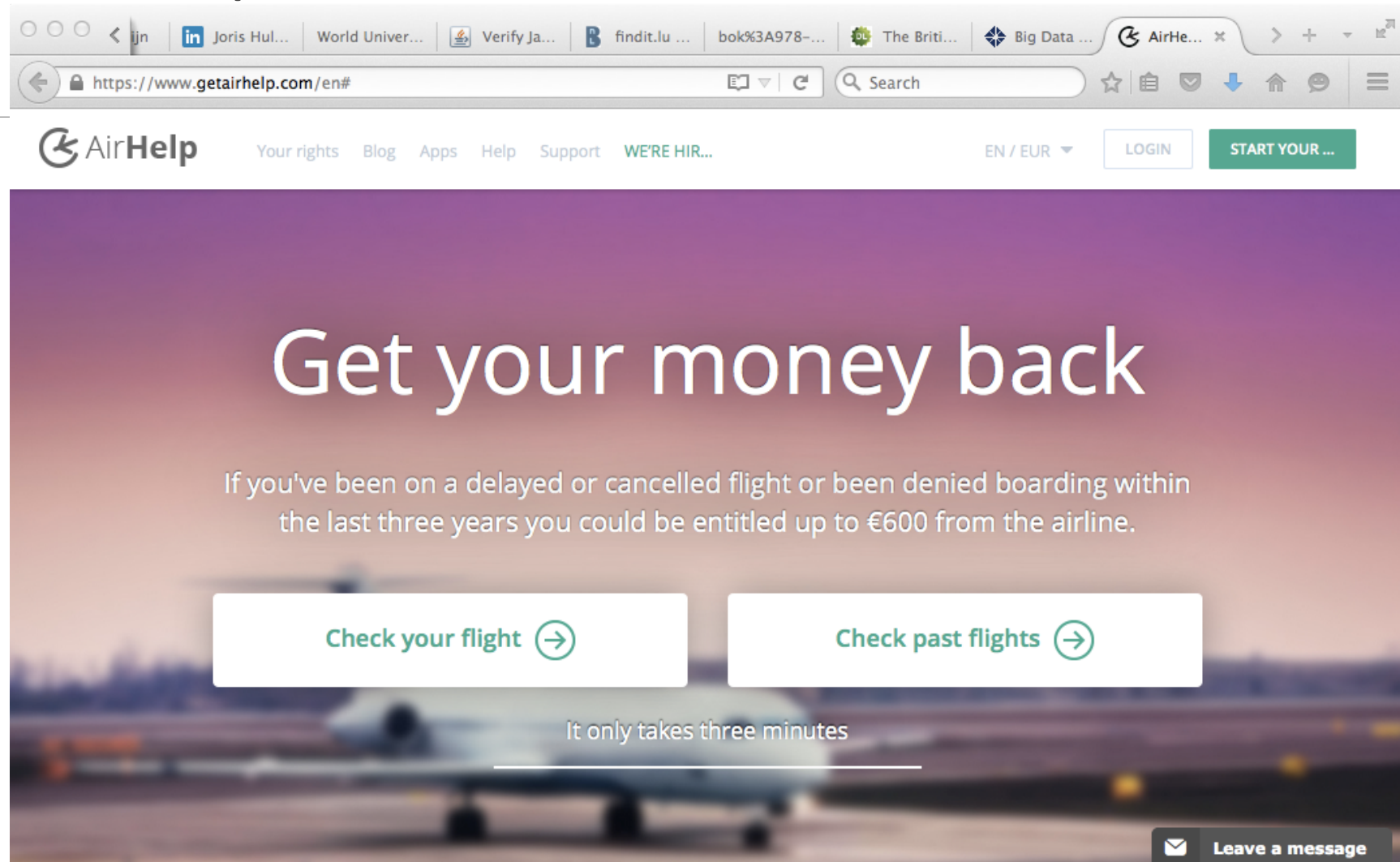
MIREL

MINING AND REASONING WITH LEGAL TEXTS.

MIREL (MINING AND REASONING WITH LEGAL TEXT) IS MARIE SKŁODOWSKA-CURIE RESEARCH AND INNOVATION STAFF EXCHANGE (RISE) PROJECT ([HTTP://EC.EUROPA.EU/RESEARCH/MARIECURIEACTIONS/ABOUT-MSCA/ACTIONS/RIASE/INDEX_EN.HTM](http://ec.europa.eu/research/mariecurieactions/about-msca/actions/riase/index_en.htm)), WHICH HAS BEEN EVALUATED AND RETAINED FOR FUNDING UNDER THE WORK PROGRAMME FOR RESEARCH AND INNOVATION WITH THE OVERALL SCORE OF 97.20%. IT INVOLVES



An example



Regulation (EC) No 261/2004

REGULATION (EC) No 261/2004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 11 February 2004

establishing common rules on compensation and assistance to passengers in the event of denied boarding and of cancellation or long delay of flights, and repealing Regulation (EEC) No 295/91

(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE
EUROPEAN UNION,

Having regard to the Treaty establishing the European
Community, and in particular Article 80(2) thereof,

Having regard to the proposal from the Commission ⁽¹⁾,

Having regard to the opinion of the European Economic and
Social Committee ⁽²⁾,

(4) The Community should therefore raise the standards of
protection set by that Regulation both to strengthen the
rights of passengers and to ensure that air carriers
operate under harmonised conditions in a liberalised
market.

(5) Since the distinction between scheduled and non-sched
uled air services is weakening, such protection should
apply to passengers not only on scheduled but also o
non-scheduled flights, including those forming part of

Regulation (EC) No 261/2004

Article 1

Subject

1. This Regulation establishes, under the conditions specified herein, minimum rights for passengers when:

- (a) they are denied boarding against their will;
 - (b) their flight is cancelled;
 - (c) their flight is delayed.
- 

Regulation (EC) No [261/2004](#)

17.2.2004

EN

Official Journal of the

2. Application of this Regulation to Gibraltar airport is understood to be without prejudice to the respective legal positions of the Kingdom of Spain and the United Kingdom with regard to the dispute over sovereignty over the territory in which the airport is situated.

3. Application of this Regulation to Gibraltar airport shall be suspended until the arrangements in the Joint Declaration made by the Foreign Ministers of the Kingdom of Spain and the United Kingdom on 2 December 1987 enter into operation. The Governments of Spain and the United Kingdom will inform the Council of such date of entry into operation.

Regulation (EC) No 261/2004

Article 2

Definitions

For the purposes of this Regulation:

- (a) 'air carrier' means an air transport undertaking with a valid operating licence;
- (b) 'operating air carrier' means an air carrier that performs or intends to perform a flight under a contract with a passenger or on behalf of another person, legal or natural, having a contract with that passenger;
- (c) 'Community carrier' means an air carrier with a valid operating licence granted by a Member State in accordance with the provisions of Council Regulation (EEC) No 2407/92 of 23 July 1992 on licensing of air carriers ⁽¹⁾;
- (d) 'tour operator' means, with the exception of an air carrier, an organiser within the meaning of Article 2, point 2, of

BENEFITS.

- (l) 'cancellation' means the non-operation of a flight which was previously planned and on which at least one place was reserved.

Article 3

Scope

1. This Regulation shall apply:
 - (a) to passengers departing from an airport located in the territory of a Member State to which the Treaty applies;
 - (b) to passengers departing from an airport located in a third country to an airport situated in the territory of a Member State to which the Treaty applies, unless they received benefits or compensation and were given assistance in that

Regulation (EC) No 261/2004

Article 4

Denied boarding

1. When an operating air carrier reasonably expects to deny boarding on a flight, it shall first call for volunteers to surrender their reservations in exchange for benefits under conditions to be agreed between the passenger concerned and the operating air carrier. Volunteers shall be assisted in accordance with Article 8, such assistance being additional to the benefits mentioned in this paragraph.

2. If an insufficient number of volunteers comes forward to allow the remaining passengers with reservations to board the flight, the operating air carrier may then deny boarding to passengers against their will.

3. If boarding is denied to passengers against their will, the operating air carrier shall immediately compensate them in accordance with Article 7 and assist them in accordance with

3. An operating air carrier shall not be obliged to pay compensation in accordance with Article 7, if it can prove that the cancellation is caused by extraordinary circumstances which could not have been avoided even if all reasonable measures had been taken.

4. The burden of proof concerning the questions as to whether and when the passenger has been informed of the cancellation of the flight shall rest with the operating air carrier.

Article 6

Delay

Regulation (EC) No 261/2004

Article 7

Right to compensation

1. Where reference is made to this Article, passengers shall receive compensation amounting to:

- (a) EUR 250 for all flights of 1 500 kilometres or less;
- (b) EUR 400 for all intra-Community flights of more than 1 500 kilometres, and for all other flights between 1 500 and 3 500 kilometres;
- (c) EUR 600 for all flights not falling under (a) or (b).

In determining the distance, the basis shall be the last destination at which the denial of boarding or cancellation will delay the passenger's arrival after the scheduled time.

2. When passengers are offered re-routing to their final

(c) re-routing, under comparable transport conditions, to their final destination at a later date at the passenger's convenience, subject to availability of seats.

2. Paragraph 1(a) shall also apply to passengers whose flights form part of a package, except for the right to reimbursement where such right arises under Directive 90/314/EEC.

3. When, in the case where a town, city or region is served by several airports, an operating air carrier offers a passenger a flight to an airport alternative to that for which the booking was made, the operating air carrier shall bear the cost of transferring the passenger from that alternative airport either to that for which the booking was made, or to another close-by destination agreed with the passenger.

Article 9

Regulation (EC) No 261/2004

Article 8

Right to reimbursement or re-routing

Where reference is made to this Article, passengers shall be offered the choice between:

- a) — reimbursement within seven days, by the means provided for in Article 7(3), of the full cost of the ticket at the price at which it was bought, for the part or parts of the journey not made, and for the part or parts already made if the flight is no longer serving any purpose in relation to the passenger's original travel plan, together with, when relevant,
 - a return flight to the first point of departure, at the earliest opportunity;
- b) re-routing, under comparable transport conditions, to their final destination at the earliest opportunity; or

needs of unaccompanied children.

Article 10

Upgrading and downgrading

1. If an operating air carrier places a passenger in a class higher than that for which the ticket was purchased, it may not request any supplementary payment.
2. If an operating air carrier places a passenger in a class lower than that for which the ticket was purchased, it shall within seven days, by the means provided for in Article 7(3), reimburse
 - (a) 30 % of the price of the ticket for all flights of 1 500 kilometres or less, or

Regulation (EC) No 261/2004

Whereas:

to those leaving an airport located in a third country or one situated in a Member State, when a Community carrier operates the flight.

- 1) Action by the Community in the field of air transport should aim, among other things, at ensuring a high level of protection for passengers. Moreover, full account should be taken of the requirements of consumer protection in general.
- 2) Denied boarding and cancellation or long delay of flights cause serious trouble and inconvenience to passengers.
- 3) While Council Regulation (EEC) No 295/91 of 4 February 1991 establishing common rules for a denied boarding compensation system in scheduled air transport⁽⁴⁾ created basic protection for passengers, the number of passengers denied boarding against their will remains too high, as does that affected by cancellations without prior warning and that affected by long delays.
- (7) In order to ensure the effective application of this Regulation, the obligations that it creates should rest with the operating air carrier who performs or intends to perform a flight, whether with owned aircraft, under wet lease, or on any other basis.
- (8) This Regulation should not restrict the rights of the operating air carrier to seek compensation from any person, including third parties, in accordance with the law applicable.

Regulation (EC) No 261/2004

an airport in a Member State.

As under the Montreal Convention, obligations on operating air carriers should be limited or excluded in cases where an event has been caused by extraordinary circumstances which could not have been avoided even if all reasonable measures had been taken. Such circumstances may, in particular, occur in cases of political instability, meteorological conditions incompatible with the operation of the flight concerned, security risks, unexpected flight safety shortcomings and strikes that affect the operation of an operating air carrier.

Extraordinary circumstances should be deemed to exist where the impact of an air traffic management decision in relation to a particular aircraft on a particular day gives rise to a long delay, an overnight delay, or the cancellation of one or more flights by that aircraft, even though all reasonable measures had been taken by the air carrier concerned to avoid the delays or cancellations.

(24) Arrangements for greater cooperation over the use of Gibraltar airport were agreed in London on 2 December 1987 by the Kingdom of Spain and the United Kingdom in a joint declaration by the Ministers of Foreign Affairs of the two countries. Such arrangements have yet to enter into operation.

(25) Regulation (EEC) No 295/91 should accordingly be repealed,

HAVE ADOPTED THIS REGULATION:

Article 1

Challenges: interpretation

1. Definitions
2. When relevant
3. Extraordinary circumstances
4. ...

Challenges: mining

1. Cross references
2. Case law to interpret legal terms
 - Handling named identities
3. Soft law and other legal sources
4. ...

Challenges: reasoning

1. Legal ontologies, space and time
 2. Aims in recitals
 3. Implicit and explicit exceptions
 4. Rights (e.g. to be informed) without sanctions
 5. Legal decision making, legal compliance
 6. ...
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Home

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Previous
NorMAS

Steering
Committee

Roadmap

Normative systems are systems in the behavior of which norms play a role and which need normative concepts in order to be described or specified. A normative multi-agent system combines models for normative systems (dealing for example with obligations, permissions and prohibitions) with models for multi-agent systems.

Norms have been proposed in multi-agent systems and computer science to deal with issues of coordination, security, electronic commerce, electronic institutions and agent organization. However, due to the lack of a unified theory, many multi-agent system researchers are presently developing their own ad hoc concepts and applications.

**NorMAS 2015 will be held in Dagstuhl, Germany.
(from Monday, March 23 to Friday, March 27, 2015)**

The NorMAS Roadmap is now available

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Vol. 4

Normative Multi-Agent Systems

Andrighetto and Guido Governatori and Pablo Noriega and Leendert W. N. van der Torre (Eds.)



978-3-939897-51-4

ISSN 1868-8977

General Information

Full volume (PDF, 5 MB)

Publication Server

Frontmatter, Table of Contents, Preface, List of Authors

Authors: Andrighetto, Giulia ; Governatori, Guido ; Noriega, Pablo ; van der Torre, Leendert W. N.

[Abstract](#) | [Document \(312 KB\)](#) | [BibTeX](#)

Norms in MAS: Definitions and Related Concepts

Authors: Balke, Tina ; da Costa Pereira, Célia ; Dignum, Frank ; Lorini, Emiliano ; Rotolo, Antonino ; Vasconcelos, Wamberto ; Villata, Serena

[Abstract](#) | [Document \(524 KB\)](#) | [BibTeX](#)

Normative Reasoning and Consequence

Authors: Broersen, Jan ; Craneffeld, Stephen ; Elrakaiby, Yehia ; Gabbay, Dov ; Grossi, Davide ; Lorini, Emiliano ; Parent, Xavier ; van der Torre, Leendert W. N. ; Tummolini, Luca ; Turrini, Paolo ; Schwarzentruher, François

[Abstract](#) | [Document \(865 KB\)](#) | [BibTeX](#)

Computational Models for Normative Multi-Agent Systems

Authors: Alechina, Natasha ; Bassiliades, Nick ; Dastani, Mehdi ; De Vos, Marina ; Logan, Brian ; Mera, Sergio ; Martin, Andreea ; Schapachnik, Fernando

Norms in MAS: Definitions and Related Concepts

<i>Tina Balke, Célia da Costa Pereira, Frank Dignum, Emiliano Lorini, Antonino Rotolo, Wamberto Vasconcelos, and Serena Villata</i>	1
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Normative Reasoning and Consequence

<i>Jan Broersen, Stephen Cranefield, Yehia Elrakaiby, Dov Gabbay, Davide Grossi, Emiliano Lorini, Xavier Parent, Leendert W. N. van der Torre, Luca Tummolini, Paolo Turrini, and François Schwarzentruher</i>	33
--	----

Computational Models for Normative Multi-Agent Systems

<i>Natasha Alechina, Nick Bassiliades, Mehdi Dastani, Marina De Vos, Brian Logan, Sergio Mera, Andreea Morris-Martin, and Fernando Schapachnik</i>	71
--	----

Regulated MAS: Social Perspective

<i>Pablo Noriega, Amit K. Chopra, Nicoletta Fornara, Henrique Lopes Cardoso, and Munindar P. Singh</i>	93
--	----

(Social) Norm Dynamics

<i>Giulia Andrighetto, Cristiano Castelfranchi, Eunata Mayor, John McBreen, Maite Lopez-Sanchez, and Simon Parsons</i>	135
--	-----

Simulation and NorMAS

<i>Tina Balke, Stephen Cranefield, Gennaro Di Tosto, Samhar Mahmoud, Mario Paolucci, Bastin Tony Roy Savarimuthu, and Harko Verhagen</i>	171
--	-----

The Uses of Norms

<i>Munindar P. Singh, Matthew Arrott, Tina Balke, Amit Chopra, Rob Christiaan, Stephen Cranefield, Frank Dignum, Davide Eynard, Emilia Farcas, Nicoletta Fornara, Fabien Gandon, Guido Governatori, Hoa Khanh Dam, Joris Hulstijn, Ingolf Krueger, Ho-Pun Lam, Michael Meisinger, Pablo Noriega, Bastin Tony Roy Savarimuthu, Kartik Tadanki, Harko Verhagen, and Serena Villata</i>	191
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Norms in MAS: Definitions and Related Concepts

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Abstract

In this chapter we provide an introductory presentation of normative multi-agent systems (nMAS). The key idea of the chapter is that any definition of nMAS should preliminarily clarify meaning, scope, and function of the concept of norm. On account of this idea, we focus on three definitions and some related requirements for nMAS. For each of such definitions we propose some guidelines for developing nMAS. Second, we suggest how to relate the concept of nMAS to different conceptions of norms and how norms can be used within the systems. Finally, we identify some specific issues that open research questions or that exhibit interesting overlaps with other disciplines.

1998 ACM Subject Classification I.2.11 Distributed Artificial Intelligence

Keywords and phrases Norms, MAS

Digital Object Identifier 10.4230/DFU.Vol4.12111.1

Normative Reasoning and Consequence

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Abstract

In this chapter we first provide a general introduction to the research area methodology and relevance, then we discuss normative reasoning for multi-agent systems, and finally we discuss current research challenges. We cover the main issues in modern deontic logic, which is much broader than the traditional modal logic framework of deontic logic, with an emphasis to our intended audience. To emphasize this broadness, we typically refer to “deontic logic and normative systems” rather than deontic logic only.

1998 ACM Subject Classification I.2.11 Distributed Artificial Intelligence

Keywords and phrases Norms, MAS

Digital Object Identifier 10.4230/DFU.Vol4.12111.33

Computational Models for Normative Multi-Agent Systems

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Abstract

This chapter takes a closer look at computational logic approaches for the design, verification and the implementation of normative multi-agent systems. After a short overview of existing formalisms, architectures and implementation languages, an overview of current research challenges is provided.

Regulated MAS: Social Perspective

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Abstract

This chapter addresses the problem of building normative multi-agent systems in terms of regulatory mechanisms. It describes a static conceptual model through which one can specify normative multi-agent systems along with a dynamic model to capture their operation and evolution. The chapter proposes a typology of applications and presents some open problems. In the last section, the authors express their individual views on these matters.

1998 ACM Subject Classification I.2.11 Distributed Artificial Intelligence

Keywords and phrases NormMAS, Norms, Open Interaction

Digital Object Identifier 10.4230/DFU.Vol4.12111.93



(Social) Norm Dynamics

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Abstract

This chapter is concerned with the *dynamics* of social norms. In particular the chapter concentrates on the lifecycle that social norms go through, focusing on the generation of norms, the way that norms spread and stabilize, and finally evolve. We also discuss the cognitive mechanisms behind norm compliance, the role of culture in norm dynamics, and the way that trust affects norm dynamics.

1998 ACM Subject Classification I.2.11 Intelligent agents, Multi-agent systems

Keywords and phrases Social norms, Norm generation, Norm spreading, Norm evolution, Trust, Culture

Simulation and NorMAS

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Abstract

In this chapter, we discuss state of the art and future perspective of the study of norms with simulative methodologies, in particular employing agent-based simulation. After presenting the state of the art and framing the simulative research on norms in a norm life-cycle schema, we list those research challenges that we feel more apt to be tackled by the simulative approach. We conclude the chapter with the indications for the realization of a NorMAS simulation platform, illustrated by selected scenarios.

1998 ACM Subject Classification I.2.11 Distributed Artificial Intelligence

Keywords and phrases Simulation, Norms, MAS

The Uses of Norms

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- 9 INRIA Sophia Antipolis, France
- 10 NICTA, Australia
- 11 University of Wollongong, Australia
- 12 Delft University of Technology, The Netherlands
- 13 IIIA-CSIC, Spain
- 14 Deutsche Bank, USA
- 15 Stockholm University, Sweden
- 16 University of Luxembourg, Luxembourg

Abstract

This chapter presents a variety of applications of norms. These applications include governance in sociotechnical systems, data licensing and data collection, understanding software development teams, requirements engineering, assurance, natural resource allocation, wireless grids, autonomous vehicles, serious games, and virtual worlds.

1998 ACM Subject Classification I.2.11 Distributed Artificial Intelligence

Keywords and phrases Norms, MAS, Governance, Requirements engineering

Preface

Research in Multi-Agent Systems (MAS) has been expanding its focus from from the individual, cognitive focussed, agent models to models of socially situated agents, MAS. Researchers have been showing rising interest in social theories. Particular attention has been given to normative concepts because it is expected that norms could play as key a role in articulating agent interactions as the one norms play in human social intelligence. Thus, the label of “normative multi-agent system” has been attached to systems where individual and collective behaviour is affected by norms. This book is not a state of the art of normative multi-agent systems, nor a systematic description of the key concepts, or a compendium of the most salient challenges. However, the reader will find in its chapters something of each of these three contents because *Normative Multi-Agent Systems* is an effort to clarify the ideas behind the label and to put in perspective the work that is being done in this area.

Normative Multi-Agent Systems is the outcome of the 2012 Schloss Dagstuhl Seminar on Normative Multi-Agent Systems¹, the third in a series of Schloss Dagstuhl seminars on Normative Multi-Agent Systems. The first seminar (07122)², in 2007, had the aim of identifying common definitions, ontologies, research problems and applications in the field. The second seminar (09121)³, in 2009, had instead the aim of discussing these fundamental concepts in relation to the use of norms as a regulatory mechanism in human and artificial systems. Building on the work of these two workshops, the 2012 seminar was convened to produce a forward-looking account of current research in the area. Some forty specialists were

Preface

Research in Multi-Agent Systems (MAS) has been expanding its focus from from the individual, cognitive focussed, agent models to models of socially situated agents, MAS. Researchers have been showing rising interest in social theories. Particular attention has been given to normative concepts because it is expected that norms could play as key a role in articulating agent interactions as the one norms play in human social intelligence. Thus, the

collective behaviour is affected by norms. This book is not a state of the art of normative multi-agent systems, nor a systematic description of the key concepts, or a compendium of the most salient challenges. However, the reader will find in its chapters something of each of these three contents because *Normative Multi-Agent Systems* is an effort to clarify the ideas behind the label and to put in perspective the work that is being done in this area.

In *Normative Multi-Agent Systems*¹, the third in a series of Schloss Dagstuhl seminars on Normative Multi-Agent Systems. The first seminar (07122)², in 2007, had the aim of identifying common definitions, ontologies, research problems and applications in the field. The second seminar (09121)³, in 2009, had instead the aim of discussing these fundamental concepts in relation to the use of norms as a regulatory mechanism in human and artificial systems. Building on the work of these two workshops, the 2012 seminar was convened to produce a forward-looking account of current research in the area. Some forty specialists were

Layout of the Tutorial

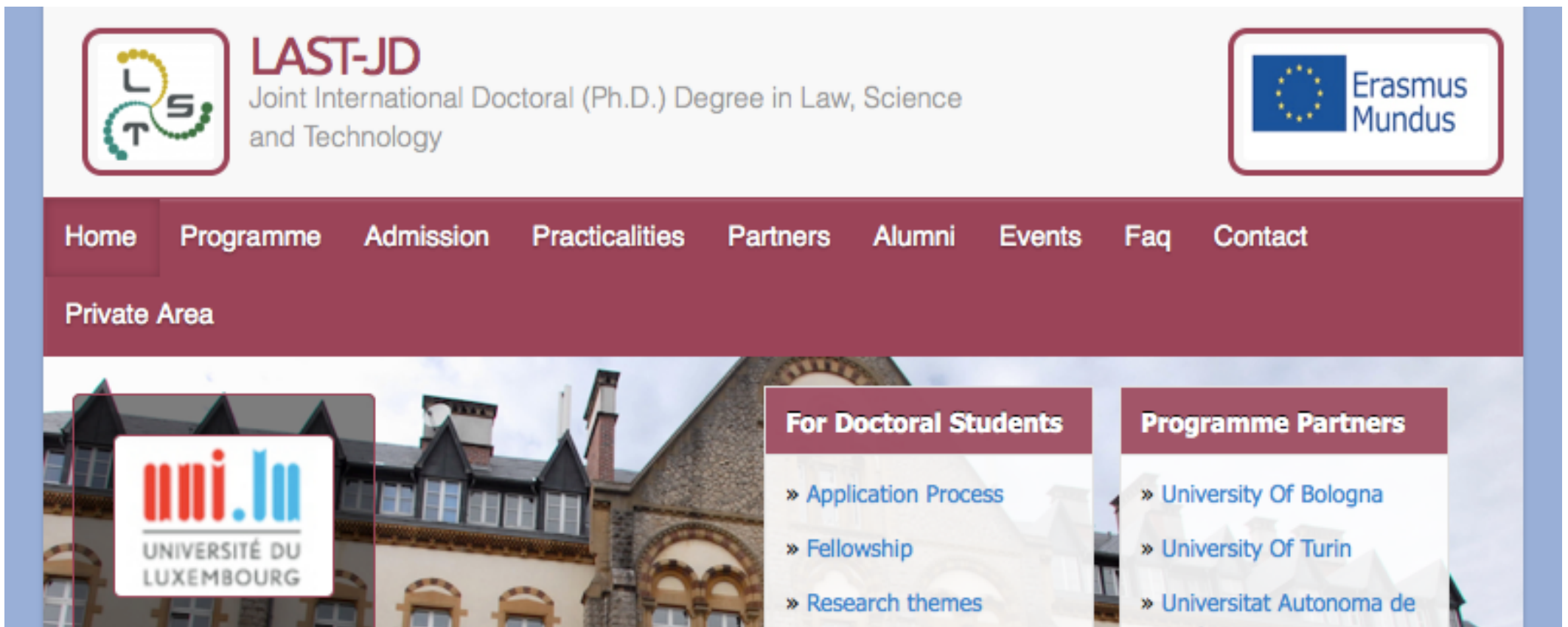
1. Introduction

2. Legal interpretation, Antonino Rotolo

3. Legal norm mining, Livio Robaldo

4. Legal compliance, Guido Governatori

<http://www.last-jd.eu/>



The screenshot shows the top section of the LAST-JD website. At the top left is the LAST-JD logo, which consists of the letters L, S, and T in a stylized, interconnected green and yellow font. To its right is the text "LAST-JD" in a bold, dark red font, followed by "Joint International Doctoral (Ph.D.) Degree in Law, Science and Technology" in a smaller, grey font. On the top right is the Erasmus Mundus logo, featuring the European Union flag and the text "Erasmus Mundus". Below these is a dark red navigation bar with white text links: "Home", "Programme", "Admission", "Practicalities", "Partners", "Alumni", "Events", "Faq", and "Contact". Below the navigation bar is a "Private Area" link. The main content area features a background image of a historic building. On the left is a logo for "uni.lu UNIVERSITÉ DU LUXEMBOURG". On the right are two white boxes with dark red headers. The first box, "For Doctoral Students", contains links for "Application Process", "Fellowship", and "Research themes". The second box, "Programme Partners", contains links for "University Of Bologna", "University Of Turin", and "Universitat Autònoma de Barcelona".

LAST-JD
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<http://deonticlogic.org/>

DeonticLogic.org

Welcome to deontic logic

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News

Handbook

Vol 1 out now!

DEON 2014

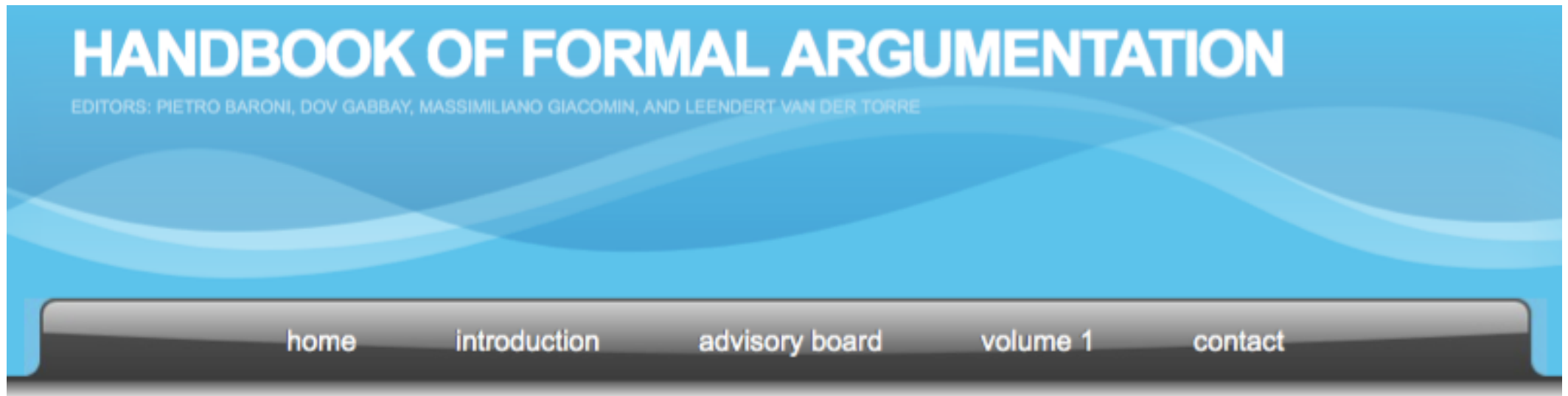
The **Society of Deontic Logic and Normative Systems** is concerned with fostering research and communication on deontic logic and normative systems, and aims to build bridges between disciplines like ethics, law, linguistics, philosophy, computer science, game theory, the social sciences, artificial intelligence, and mathematics.

Its primary activities include organizing a series of prestigious conferences, the International Conferences on Deontic Logic and Normative Systems (DEON), cooperating with workshops on related topics, maintaining informational materials at <http://deonticlogic.org>, and maintaining a DEON-related mailing list.

The DEON series originated within computer science, and has been held biannually since 1991.

DEON 2014, the **12th International Conference on Deontic Logic and Normative Systems**, was held

<http://formalargumentation.org/>



Handbook Of Formal Argumentation (HOFA)

The HOFA initiative aims at producing a series of volumes providing a comprehensive coverage of both the state of the art and future research perspectives in the highly interdisciplinary field of formal

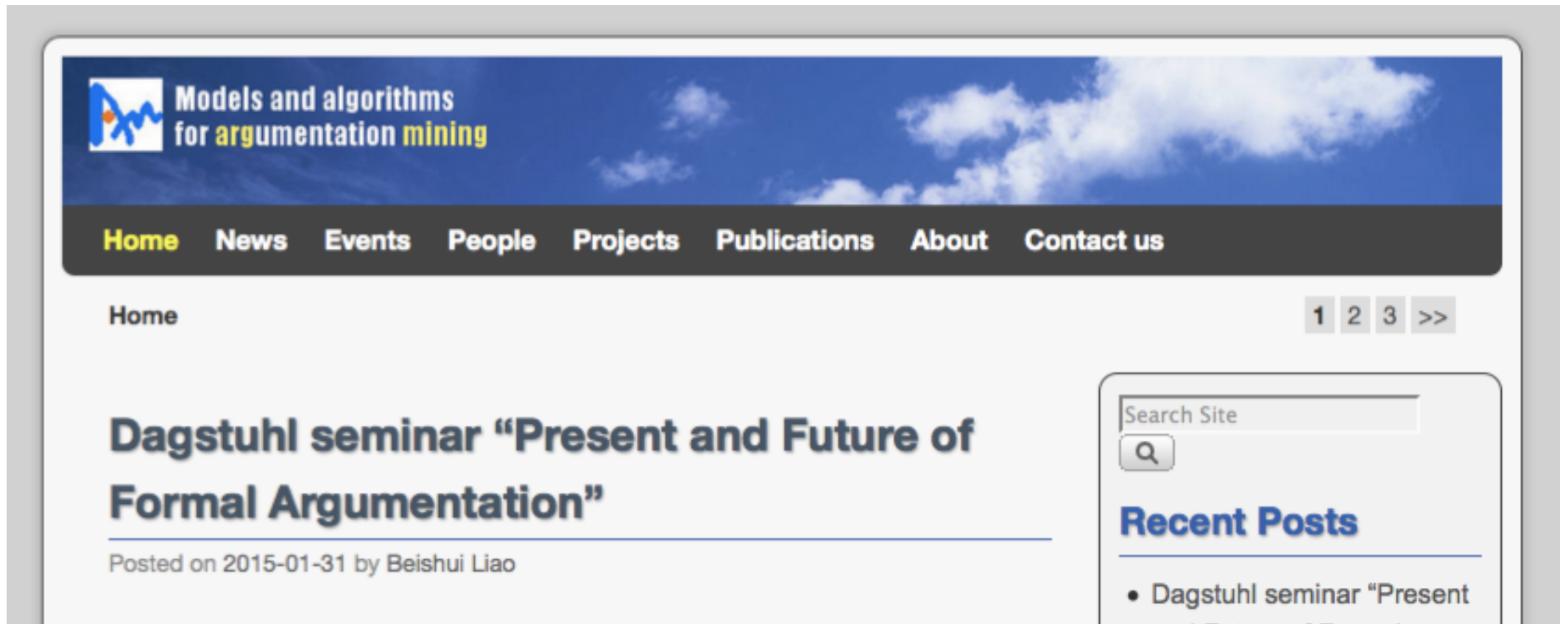
ESSLI 2014 and 2016



Deontic Modality: Linguistic and Logical Perspectives

Cleo Condoravdi & Leon van der Torre

<http://www.argmining.org/>



Leon van der Torre, University of Luxembourg Individual and Collective Reasoning

<http://deonticlogic.org/>

<http://www.formalargumentation.org/>

Norms

Argument

<http://www.last-jd.eu/>

**Natural
Language**

ESSLI 2014

26th European Summer School in Logic, Language and Information

Modality: Linguistic and Logical Perspectives

Horavdi & Leon van der Torre

logic

00-10.30 - Level: I

HANDBOOK OF FORMAL ARGUMENTATION

EDITORS: PIETRO BARONI, DOV GABBAY, MASSIMILIANO GIACOMINI, AND LEENDERT VAN DER TORRE

home introduction advisory board volume 1 contact

For Doctoral Students

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» Models and algorithms
» Argumentation mining

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Home

Dagstuhl seminar "Present and Future of Formal Argumentation"

on 2015-01-31 by Beishui Liao

<http://www.dagstuhl.de/15362>

August 30 – September 4, 2015, Dagstuhl Perspectives Workshop 15362

Present and Future of Formal Argumentation

Organized by:
Dov M. Gabbay (King's College London, GB)

<http://www.argmining.org/>

Reasoning in Legal Interpretation

Antonino Rotolo

CIRSFID - University of Bologna, Italy

Tutorial *Normative MAS and the Law: Norm Languages, Mining and Reasoning with Legal Texts*
PRIMA 2015, Bertinoro, Italy



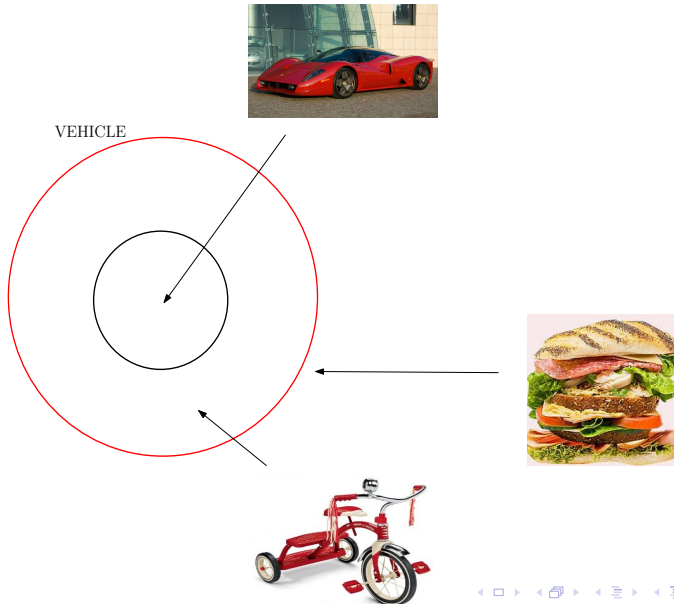
- Why legal interpretation?
- Legal interpretation and interpretive canons
- Interpretation as activity or outcome
- Canons as defeasible rules: competing arguments and interpretive conflicts
- Preferences over interpretations
- Deontic qualification of interpretation
- Abstract or structured provisions



Why Interpret? The open texture of the legal language



Why Interpret? The open texture of the legal language



The Open Texture of the Legal Language

- A general concept is *characterized* by those items to which it *clearly* applies: a car is a vehicle
- A general term is *not characterized* by those items beyond the penumbra to which it *clearly* does not apply: a sandwich is not a vehicle
- Is a bike a vehicle?



Applying norms and arguing about legal concepts

- reasoning about legal norms in order to determine what actual obligations obtain in a given situation



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- reasoning about broadening or restricting the legal concept (change the core meaning): expand or restrict the core meaning depending on the context



Applying norms and arguing about legal concepts

- reasoning about legal norms in order to determine what actual obligations obtain in a given situation
- reasoning about broadening or restricting the legal concept (change the core meaning): expand or restrict the core meaning depending on the context
- reasoning about the goals of legal norms: the broadening and restricting processes are often goal-driven



A legal case: Italian Legislative Act 40/2004 on "Medically assisted reproduction"

Art. 4

The recourse to medically assisted reproduction techniques is allowed only [...] in the cases of sterility [...]



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Question: Has this couple the right to the recourse of techniques?



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Question: Has this couple the right to the recourse of techniques?

$$\begin{aligned} \text{Theory} = \{ & r_1 : \neg \text{Embryo} \Rightarrow \text{Sterility}, \\ & r_2 : \text{Embryo} \Rightarrow \neg \text{Sterility}, \\ & r_3 : \text{Embryo} \Rightarrow \text{Life}, \\ & r_4 : \text{Life} \Rightarrow \neg \text{Sterility}, \\ & r_5 : \neg \text{Sterility} \Rightarrow \text{Life} \} \end{aligned}$$



Interpreting by broadening the concept of *Sterility*

- 1 According to Art. 1 of the Italian Legislative Act 40/2004 the goals to be promoted are *Life* and *Health*;



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Interpreting by broadening the concept of *Sterility*

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- ④ The theory suggests that such genetic anomalies **may** count as sterility
- ⑤ extending the concept of sterility requires to revise the theory
- ⑥ this revision is compatible with the promotion of other goals



Legal interpretation and interpretive canons



Legal interpretation and interpretive canons

Definition

Legal interpretation is sometimes defined as the process through which we ascribe a meaning to one or more legal provisions (a piece of authoritative legal text)



Legal interpretation and interpretive canons

Definition

Legal interpretation is made by acts that map a piece of legal text into a meaning (possibly, a sentence paraphrasing the interpreted text)



Legal interpretation and interpretive canons

Canons are arguments (ways for) supporting a certain meaning ascription. In statutory interpretation, e.g., among others (MacCormick and Summers 1991 identified 11 canons):

Argument from ordinary (or literal) meaning: a statutory provision should be interpreted according to the (literal) meaning a native speaker of a given language would ascribe to it.

Argument from contextual harmonisation: a statutory provision should be interpreted in light of the whole statute it is part of, or in light of other statutes it is related to.

Argument from precedent: a statutory provision should be interpreted in conformity with previous interpretations.

Argument from analogy: a statutory provision is similar to provisions of other statutes, then it should be interpreted to preserve the similarity of meaning.

Argument from substantive reasons: if a fundamental goal can be promoted by one rather than another interpretation of a statutory provision, then the provision should be interpreted in accord with the goal.

Argument from intention: if a legislative intention concerning a statutory provision can be identified, the provision should be interpreted in line with that intention.



Interpretation as activity or as outcome (Ross 1958)



Interpretation as activity or as outcome (Ross 1958)

Definition

We assume the distinction between interpretation as activity and as outcome:

- interpretation as activity (*A-interpretation*) (literal or from ordinary language, by coherence, etc.) views any argumentative canon as a means through which a certain meaning is ascribed to a legal provision and thus obtained, and
- interpretation as outcome (*O-interpretation*) is precisely the meaning obtained through a certain interpretive act and ascribed to the provision.

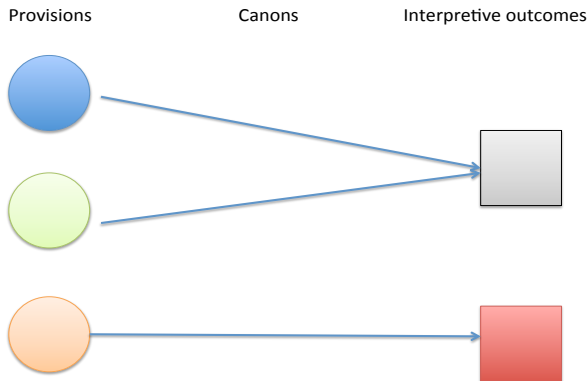


Interpretation as activity or as outcome (Ross 1958)

Provisions



Interpretation as activity or as outcome (Ross 1958)



Canons as defeasible rules



Art. 575 Italian Penal Code. Homicide. Whoever causes the death of a man [uomo] is punishable by no less than 21 years in prison.



Are you safe if you kill your wife in Italy?



Art. 575 Italian Penal Code. Homicide. Whoever causes the death of a man [uomo] is punishable by no less than 21 years in prison.

Art. 3 Italian Constitution. All citizens have equal social status and are equal before the law, without regard to their sex, race, language, religion, political opinions, and personal or social conditions.



Canons as defeasible rules

IF

art. 3 ought to be interpreted literally as d , AND
art. 3 is related with art. 575

THEN

art. 575 is interpreted by coherence as b .

where $b =$

Whoever causes the death of a human being is punishable by no less than 21



$r : \mathbf{Obl}_I(\text{art. } 3, d), \text{related} \Rightarrow^I \mathbf{I}_c(\text{art. } 575, b)$



Interpretive conflicts (competing canons and beyond)



Interpretive conflicts (competing canons and beyond)

$$r : \mathbf{Obl}_I(\text{art. } 3, d), \text{related} \Rightarrow^I \mathbf{I}_c(\text{art. } 575, b)$$
$$s : \neg \text{citizen} \Rightarrow^I \mathbf{I}_I(\text{art. } 575, b')$$

where b and b' are legally incompatible (e.g., $b = \neg b'$ or even simply $b \neq b'$).



Interpretive conflicts (competing canons and beyond)

$\text{Obl}_I(\text{art. } 3, d), \text{related} \Rightarrow^I \text{I}_c(\text{art. } 575, b)$

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where $b \neq b'$.



Preferences over interpretations



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$r > s$



Preferences over interpretations

Preferences are employed as usual in defeasible reasoning to solve conflicts



Deontic qualification of interpretations



Deontic qualification of interpretations

General provisions of the Italian civil code, art. 12 (simplified):

In applying the law judges ought to ascribe to statutes their literal meaning, an ascription that can be done by also considering to the intent of the legislator. If a case cannot be solved in this way, judges have to employ arguments by analogy and, when this does not remove all doubts, the decision ought to be based on the general principles of the legal system.



Definition

An interpretation can be *admissible* or *obligatory*. In the case of A-interpretations, for instance, an interpretive act I of n (A-interpretation of n) is admissible, if it is provable using a defeasible interpretation rule; it is obligatory, if this interpretation of n is the only one admissible. Similarly for O-interpretations.



Beyond abstract norms....



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Interpretation manipulates elements of rules like

art.575 : *kill_man* $\Rightarrow^{Obl}$ *atLeast_21y*



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Beyond abstract norms....

Interpretation acts map into new versions of the same provision by replacing some elements

$I_s(\text{art.575}, \langle \text{kill_man}, \text{atLeast_21y} \rangle, \langle \text{kill_human}, \text{atLeast_21y} \rangle)$



Beyond abstract norms....

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$I_s(\text{art.575}, \langle \text{kill_man}, \text{atLeast_21y} \rangle, \langle \text{kill_human}, \text{atLeast_21y} \rangle)$

takes

$\text{art.575} : \text{kill_man} \Rightarrow^{\text{Obl}} \text{atLeast_21y}$



Beyond abstract norms....

Interpretation acts map into new versions of the same provision by replacing some elements

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takes

$\text{art.575} : \text{kill_man} \Rightarrow^{\text{Obl}} \text{atLeast_21y}$

and returns

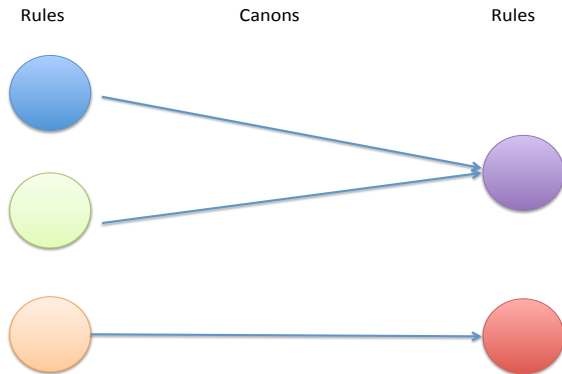
$\text{art.575} : \text{kill_human} \Rightarrow^{\text{Obl}} \text{atLeast_21y}$



Interpretation as norm change? (From the logical viewpoint....)



Beyond abstract norms....



Conclusions

- interpretation as a process to assign meaning
- interpretive canons are represented by defeasible rules
- different reasoning patterns can be identified depending on whether we work on interpretations as activities or as outcomes
- preferences are important
- canons license deontic interpretive claims
- abstract vs structured provisions



Thanks!



Natural Language Processing and Natural Language Semantics for Representation and Processing of legal Text

LIVIO ROBALDO, POST-DOC AT UNIVERSITY OF LUXEMBOURG, UNDER
THE MARIE SKŁODOWSKA-CURIE IF PROJECT: "PROLEMAS: PROCESSING
LEGAL LANGUAGE IN NORMATIVE MULTI-AGENT SYSTEMS"

Natural Language Processing

for processing legal text

A broad term referring to several sub-topics. The specific NLP task used for legal text is NLU (Natural Language Understanding), i.e. the task of deriving meaning from natural language input (legal documents such as legislation and case law).

Two main techniques are used for NLU on legal text (but also in general...)

- **Statistical techniques**, used to look for *general information* in the documents. For instance, for associating a document, an article, a paragraph, etc. with certain labels (from a finite set of available label) that describes the topic it is about (classification).
- **Rule-based techniques**, used to look for *specific information* in the documents. For instance, for extracting the dates, the locations, the names of the lawyers/judges/parties/ etc. involved in a case law, etc. as well as certain relevant concepts, i.e. the roles of the actors with respect to the norms they are involved in.

Statistical NLP techniques

for processing legal text

Used for classifying and clustering legal documents wrt a fixed set of labels, e.g. the set of classes of EuroVoc (<http://eurovoc.europa.eu>), the EU multi-lingua thesaurus.

E.g. [Boella et al, 2013a] G. Boella, L. Di Caro, D. Rispoli, L. Robaldo: **A System for Classifying Multi-label Text into EuroVoc**, *In proc. of 14th International Conference on Artificial Intelligence and Law (ICAIL2013)*. Rome, Italy, 2013.

A multi-label classifier has been implemented and trained on EuroVoc data. Then, by executing it on new text, it is able to associate the text with some EuroVoc labels

Demo available at:

http://legal-informatics.di.unito.it/classification/index_exp.html



Rule-based NLP techniques

for processing legal text

The term “rule-based techniques” generally refers to a *production-rules system*, i.e. an unordered set of if-then rules that trigger each on certain keyword and produce certain results (which, in turn, can trigger other if-then rules).

R1: If the word “in” is followed by a noun proper, tag the noun as “location”
 R2: If the word “via” is followed by a noun proper, tag the noun as “street”
 R3: If the word “22” is followed by a noun proper, tag the noun as “quantity”
 R4: If there is the word “avvocato” followed by a noun proper, tag the noun as “lawyer”



... *elettivamente domiciliata in ROMA, VIA GRADOLI 22, presso l'avvocato VAGNONI FEDERICO, che la rappresenta e difende ...*

Rule-based NLP techniques

for processing legal text

The result is an XML file (preferably in Akoma 'Ntoso) where all named entities are tagged and can be indexed with respect to an ontology to inter-link the documents:

```
<p>...elettivamente domiciliata in</p>
<p><location>ROMA</location></p>
<p>,</p>
<p><location refersTo="#street">VIA GRADOLI</location></p>
<p><quantity refersTo="#civicNumber">22</quantity></p>
<p>,</p>
<p>presso l'avvocato</p>
<p><lawyer for="#appellant">VAGNONI FEDERICO</lawyer></p>
<p>,</p>
<p>che la rappresenta e difende...</p>
```

Rule-based NLP techniques

for processing legal text

In order to apply the rules, we need to associate the words with PosTagging and Parsing information, via NLP basic software, in order to recognize proper nouns, numbers, etc:

```
<line>36 in (IN PREP) [35 MOD]</line>
<line>37 ROMA (ROMA NOUN PROPER) [36 ARG] {geoEntity}</line>
<line>38 , (, PUNCT) [37 SEPARATOR]</line>
<line>39 VIA (VIA NOUN COMMON F S) [37 MOD]</line>
<line>40 GRADOLI (GRADOLI NOUN PROPER) [39 MOD] {street}</line>
<line>41 22 (22 PRON CARDIN N N P) [40 MOD]</line>
<line>42 , (, PUNCT) [43 OPENASIDE]</line>
<line>43 presso (PRESSO PREP) [39 MOD]</line>
<line>44 l' (IL ART DEF M S) [43 ARG]</line>
<line>45 avvocato (AVVOCATO NOUN COMMON M S) [44 ARG]</line>
<line>46 VAGNONI (VAGNONI NOUN PROPER) [45 MOD] {person}</line>
<line>47 FEDERICO (FEDERICO NOUN PROPER) [46 PROPER]</line>
<line>48 , (, PUNCT) [43 CLOSEASIDE]</line>
```

Natural Language Semantics

for processing legal text

NLS is defined as the formal study of meaning expressed by elements of a language. Concerning the design of a proper semantics for legal text, two aspects must be kept in mind:

- **Operational Semantics**, and not truth-conditional semantics. We need to talk about norms even in scenarios where some of them have been already violated.
- **Expressivity VS complexity**, our logic should be able to represent all aspect of (standard) natural language semantics, but we must take into account that legislation is huge. If the logic is too complex, the final systems can take ages to answer a query or to perform other legal reasoning tasks. First order logic is needed, but first order logic is semi-decidable!

Input/Output Logic

The semantics is operational. The following formula calculates whether according to normative system N and in the input context A , a formula x is obligatory

$$x \in \text{out}(N; A)$$

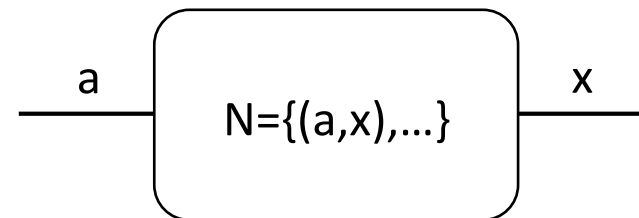
Factual detachment (i.e. Modus Ponens):

- (i) If a is the case, then x is obligatory
- (ii) a is the case
- (iii) So, x is obligatory

If $(a, x) \in N$ then $x \in \text{out}(N, a)$

N : a set of pairs of propositional wffs (cond. norms)

$\text{out}(N; a)$: output of a under N .



Input/Output Logic

The cottage should not have a fence or a dog; if it has a dog it must have both a fence and a warning sign. Suppose further that we are in the situation that the cottage has a dog, thus violating the first norm. Still, we want to know what are our current obligations.

$$N = \{ (T, \neg(f \vee d)), (d, f \wedge w) \}$$

$$A = \{d\}$$

$$\text{maxfamily}(N, A) = \{(d, f \wedge w)\} \quad \text{outfamily}(N, A) = \{Cn(f \wedge w)\}$$

maxfamily(N, A) is the family of all *maximal* subsets $N' \subseteq N$ such that $\text{out}(N', A)$ is consistent with A. **outfamily**(N, A) is the family of outputs $\text{out}(N', A)$ for N' in the maxfamily.

A possible solution: I/O logic + Hobbs

Hobbs logic is based on the notion of *reification* (Davidson, 1967). Reification allows to explicitly talk about events and states by introducing first-order terms referring to them

From “(give a b c)” to “(give’ e a b c)”, where “e” is called ‘eventuality’

John believes that Jack wants to eat an ice cream:

$$\exists e \exists e_1 \exists e_2 [(\text{Rexist } e) \wedge (\text{believe' } e \text{ John } e_1) \wedge (\text{want' } e_1 \text{ Jack } e_2) \wedge (\text{eat' } e_2 \text{ Jack } Ic) \wedge (\text{iceCream } Ic)]$$

Each lawyer must run:

$$\forall x (\text{lawyer}(x), \exists e_r [(\text{Rexist } e_r) \wedge \text{run}(e_r) \wedge \text{agent}(e_r, x)]) \in N$$

The last formula is an attempt to combine I/O logic an Hobbs’ logic (accepted in JURISIN2015)

A possible solution: I/O logic + Hobbs

Other Reification-based solutions have been proposed in deontic logic. The crucial difference between Hobbs and the other approaches is that **the formulae are always conjunctions of atomic predicates**.

- No embedding of sub-formulae within complex operators: this allows to easily scale the approach towards complex NL phenomena (anaphora, NL quantifiers, etc.), if needed.
 - Complex operators are modeled in terms of predicates that applies to eventualities reified in a recursive fashion.
 - The operators are defined in terms of axioms in the ontology, from which we can make new inferences. We can keep complexity under strict control by limiting the expressivity of the axioms.
- 



Norms, Processes and Compliance

Guido Governatori

26 October 2015

www.data61.csiro.au



A Privacy Act



Section 1: (Prohibition to collect personal medical information)

Offence: It is an offence to collect personal medical information.

Defence: It is a defence to the prohibition of collecting personal medical information, if an entity immediately destroys the illegally collected personal medical information before making any use of the personal medical information

Section 2: An entity is permitted to collect personal medical information if the entity acts under a Court Order authorising the collection of personal medical information.

Section 3: (Prohibition to collect personal information) It is forbidden to collect personal information unless an entity is permitted to collect personal medical information.

Offence: an entity collected personal information

Defence: an entity being permitted to collect personal medical information.

A Privacy Act



Section 1: (Prohibition to collect personal medical information)

Offence: It is an offence to collect personal medical information.

Defence: It is a defence to the prohibition of collecting personal medical information, if an entity immediately destroys the illegally collected personal medical information before making any use of the personal medical information

Section 2: An entity is permitted to collect personal medical information if the entity acts under a Court Order authorising the collection of personal medical information.

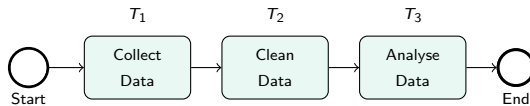
Section 3: (Prohibition to collect personal information) It is forbidden to collect personal information unless an entity is permitted to collect personal medical information.

Offence: an entity collected personal information

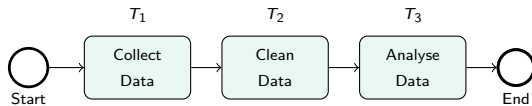
Defence: an entity being permitted to collect personal medical information.

Is the act complied with?

A Business Process



A Business Process



is the process compliant?

Definition of Compliance



Definition of Compliance



Compliance is a relationship between two sets of specifications

Definition of Compliance



Compliance is a relationship between two sets of specifications

Alignment of formal specifications for business processes and formal specifications for prescriptive (legal) documents.

Definition of Compliance



Compliance is a relationship between two sets of specifications

Alignment of formal specifications for business processes and formal specifications for prescriptive (legal) documents.

- Conceptually sound representation of processes

Definition of Compliance

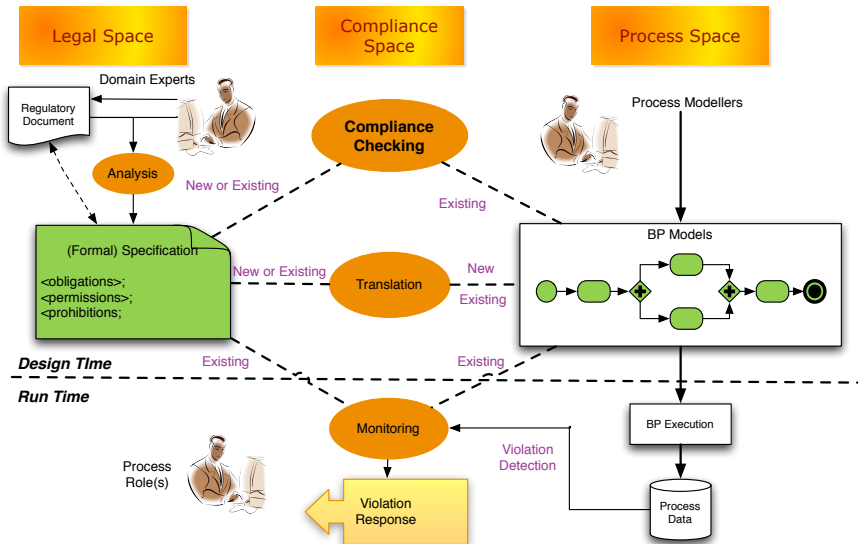


Compliance is a relationship between two sets of specifications

Alignment of formal specifications for business processes and formal specifications for prescriptive (legal) documents.

- Conceptually sound representation of processes
- Conceptually sound representation of and reasoning with norms

Compliance Ecosystem



Compliance Recipe



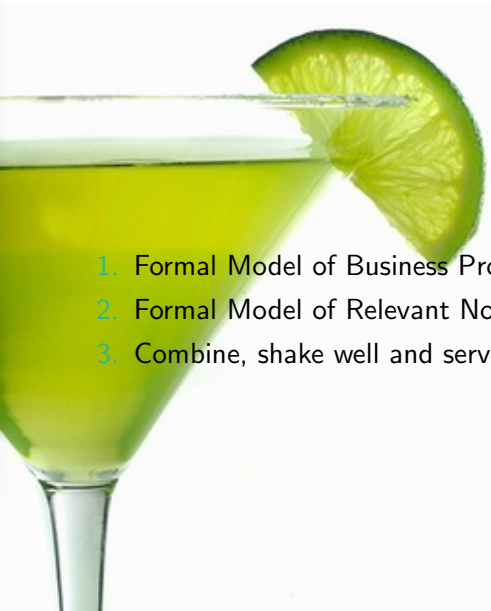
1. Formal Model of Business Processes

Compliance Recipe

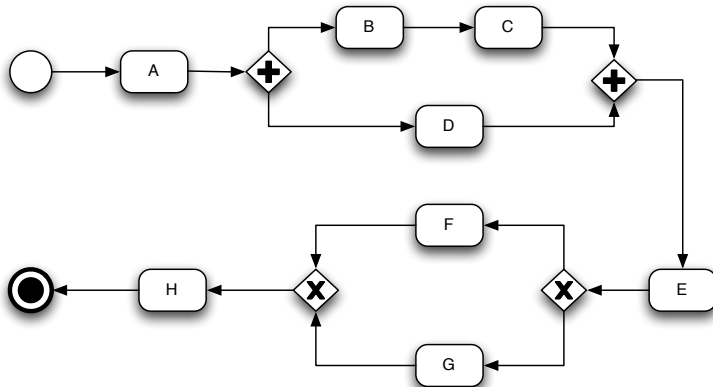


- 
- A close-up photograph of a glass filled with a bright yellow liquid, likely a cocktail or juice. A wedge of lime is perched on the rim of the glass, with a small droplet of liquid visible on its surface. The background is plain white.
1. Formal Model of Business Processes
 2. Formal Model of Relevant Norms/Normative Frameworks

Compliance Recipe

- 
- A close-up photograph of a glass filled with a bright yellow liquid, likely a cocktail or juice. A fresh lime wedge is perched on the rim of the glass, partially submerged in the liquid. The background is plain white.
1. Formal Model of Business Processes
 2. Formal Model of Relevant Norms/Normative Frameworks
 3. Combine, shake well and serve!

Modelling Processes



$t_1: A, B, C, D, E, F, H$
 $t_2: A, B, D, C, E, F, H$
 $t_3: A, D, B, C, E, F, H$

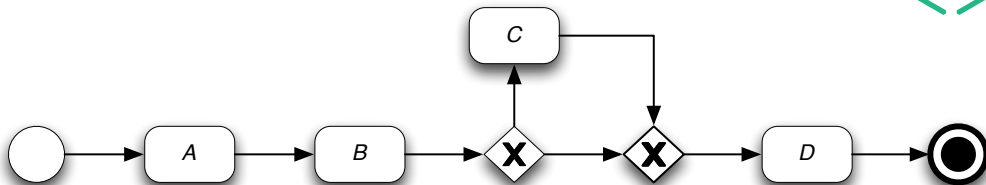
$t_4: A, B, C, D, E, G, H$
 $t_5: A, B, D, C, E, G, H$
 $t_6: A, D, B, C, E, G, H$

Let Lit be a set of literals, T be the set of traces of a process and $\mathbb{N}$ be the set of natural numbers

$$State: T \times \mathbb{N} \mapsto 2^{Lit}$$

The function $State$ returns the set of literals describing “what’s going on in a trace t after the execution of the n -th task in the process”.

Example



Tasks

- A: “turn the light on”
- B: “check if glass is empty”
- C: “fill glass with water”
- D: “turn glass upside-down”

Propositions

- p : “the light is on”
- q : “the glass is full”

Trace 1: $\langle A, B, D \rangle$

Trace 2: $\langle A, B, C, D \rangle$

- $State(i, 1) = \{p\}, i \in \{1, 2\}$
- $State(1, 2) = \{p, q\}$
- $State(2, 2) = \{p, \neg q\}$
- $State(2, 3) = \{p, q\}$
- $State(1, 3) = \{p, \neg q\}$
- $State(2, 4) = \{p, \neg q\}$

Norms are modelled as **if ... then ...** rules

- norms are defeasible (handling exceptions)
- two types of norms
 - ▶ constitutive rules: defining terms used in a legal context

$$A_1, \dots, A_n \Rightarrow C$$

- ▶ prescriptive rules: defining “normative effects” (i.e., obligations, permissions, prohibitions ...)

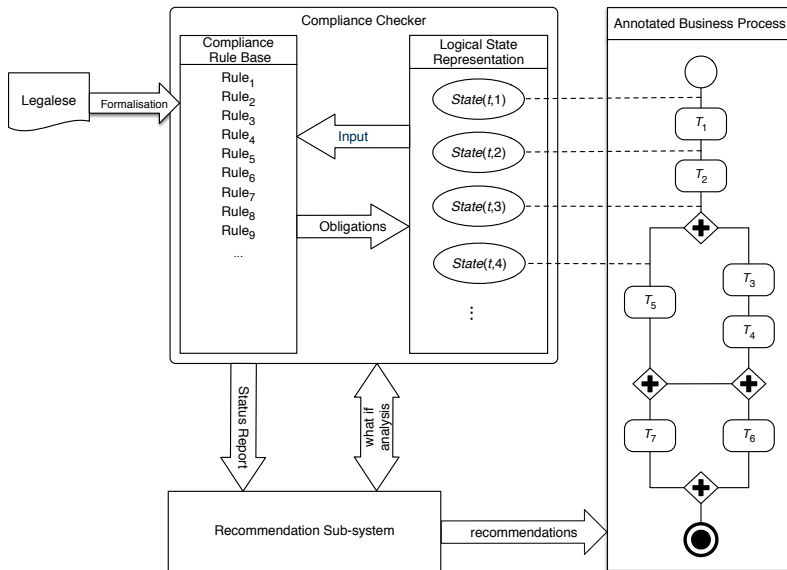
$$A_1, \dots, A_n \Rightarrow [O]C_1 \otimes [O]C_2 \otimes \dots \otimes [O]C_m$$
$$A_1, \dots, A_n \Rightarrow [P]C$$

Reasoning with Norms



1. A is a fact; or
2. there is an applicable rule for A , and either
 1. all the rules for $\neg A$ are discarded (i.e., not applicable) or
 2. every applicable rule for $\neg A$ is weaker than an applicable rule for A .

Compliance Architecture



Making Sense of the Act



- Collection of medical information is forbidden.
- Destruction of the illegally collected medical information excuses the illegal collection.
- Collection of medical information is permitted if there is an authorising court order.
- Collection of personal information is forbidden.
- Collection of personal information is permitted if the collection of medical information is permitted

Formalisation of the Privacy Act



- collection of medical information is forbidden
 - ▶ c destruction of medical information compensates the illegal collection

$$r_1: \Rightarrow [O] \neg medicalInfo \otimes [O] destroy$$

- collection of medical information is permitted if acting under a court order

$$r_2: courtOrder \Rightarrow [P] medicalInfo$$

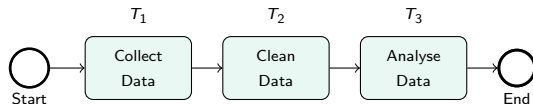
- collection of personal information is forbidden

$$r_3: \Rightarrow [O] \neg personalInfo$$

- collection personal information is permitted if collection of medical information is permitted

$$r_4: [P] medicalInfo \Rightarrow [P] personalInfo$$

Are We Compliant?



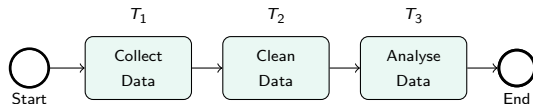
$r_1: \Rightarrow [O] \neg medicalInfo \otimes [O] destroy$

$r_2: courtOrder \Rightarrow [P] medicalInfo$

$r_3: \Rightarrow [O] \neg personalInfo$

$r_4: [P] medicalInfo \Rightarrow [P] personalInfo$

Are We Compliant?



$State(start) : \neg courtOrder$

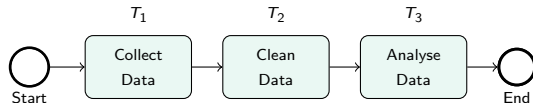
$r_1 : \Rightarrow [O] \neg medicalInfo \otimes [O] destroy$

$r_2 : courtOrder \Rightarrow [P] medicalInfo$

$r_3 : \Rightarrow [O] \neg personalInfo$

$r_4 : [P] medicalInfo \Rightarrow [P] personalInfo$

Are We Compliant?



$r_1 : \Rightarrow [O] \neg medicalInfo \otimes [O] destroy$

$r_2 : courtOrder \Rightarrow [P] medicalInfo$

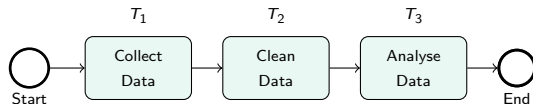
$r_3 : \Rightarrow [O] \neg personallInfo$

$r_4 : [P] medicalInfo \Rightarrow [P] personallInfo$

$State(start) : \neg courtOrder$

$Force(T_1) : [O] \neg medicalInfo$
 $[O] \neg personallInfo$

Are We Compliant?



$r_1: \Rightarrow [O] \neg medicalInfo \otimes [O] destroy$

$r_2: courtOrder \Rightarrow [P] medicalInfo$

$r_3: \Rightarrow [O] \neg personallInfo$

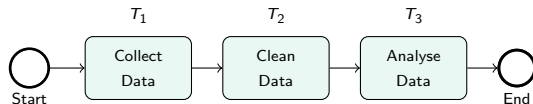
$r_4: [P] medicalInfo \Rightarrow [P] personallInfo$

$State(start) : \neg courtOrder$

$Force(T_1) : [O] \neg medicalInfo$
 $[O] \neg personallInfo$

$State(T_1) : medicalInfo$

Are We Compliant?



$r_1 : \Rightarrow [O] \neg medicalInfo \otimes [O] destroy$

$r_2 : courtOrder \Rightarrow [P] medicalInfo$

$r_3 : \Rightarrow [O] \neg personallInfo$

$r_4 : [P] medicalInfo \Rightarrow [P] personallInfo$

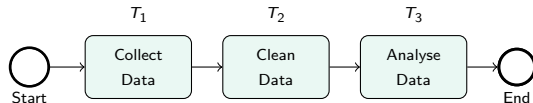
$State(start) : \neg courtOrder$

$Force(T_1) : [O] \neg medicalInfo$
 $[O] \neg personallInfo$

$State(T_1) : medicalInfo$

$Violated(T_1) : [O] \neg medicalInfo$

Are We Compliant?



$r_1 : \Rightarrow [O] \neg medicalInfo \otimes [O] destroy$

$r_2 : courtOrder \Rightarrow [P] medicalInfo$

$r_3 : \Rightarrow [O] \neg personallInfo$

$r_4 : [P] medicalInfo \Rightarrow [P] personallInfo$

$State(start) : \neg courtOrder$

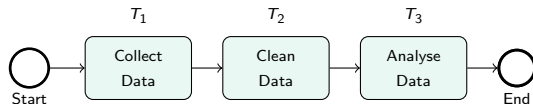
$Force(T_1) : [O] \neg medicalInfo$
 $[O] \neg personallInfo$

$State(T_1) : medicalInfo$

$Violated(T_1) : [O] \neg medicalInfo$

$Force(T_2) : [O] destroy$

Are We Compliant?



$r_1 : \Rightarrow [O] \neg medicalInfo \otimes [O] destroy$

$r_2 : courtOrder \Rightarrow [P] medicalInfo$

$r_3 : \Rightarrow [O] \neg personallInfo$

$r_4 : [P] medicalInfo \Rightarrow [P] personallInfo$

$State(start) : \neg courtOrder$

$Force(T_1) : [O] \neg medicalInfo$
 $[O] \neg personallInfo$

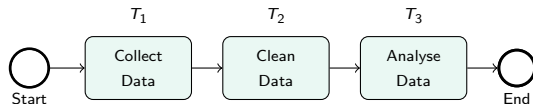
$State(T_1) : medicalInfo$

$Violated(T_1) : [O] \neg medicalInfo$

$Force(T_2) : [O] destroy$

$State(T_2) : personallInfo$

Are We Compliant?



$r_1 : \Rightarrow [O] \neg medicalInfo \otimes [O] destroy$

$r_2 : courtOrder \Rightarrow [P] medicalInfo$

$r_3 : \Rightarrow [O] \neg personalInfo$

$r_4 : [P] medicalInfo \Rightarrow [P] personalInfo$

$State(start) : \neg courtOrder$

$Force(T_1) : [O] \neg medicalInfo$
 $[O] \neg personalInfo$

$State(T_1) : medicalInfo$

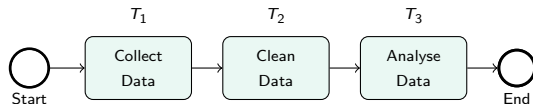
$Violated(T_1) : [O] \neg medicalInfo$

$Force(T_2) : [O] destroy$

$State(T_2) : personalInfo$

$Violated(T_2) : [O] \neg personalInfo$

Are We Compliant?



$r_1 : \Rightarrow [O] \neg medicalInfo \otimes [O] destroy$

$r_2 : courtOrder \Rightarrow [P] medicalInfo$

$r_3 : \Rightarrow [O] \neg personalInfo$

$r_4 : [P] medicalInfo \Rightarrow [P] personalInfo$

$State(start) : \neg courtOrder$

$Force(T_1) : [O] \neg medicalInfo$
 $[O] \neg personalInfo$

$State(T_1) : medicalInfo$

$Violated(T_1) : [O] \neg medicalInfo$

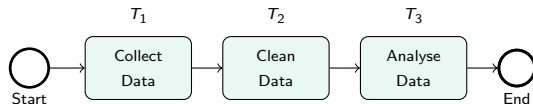
$Force(T_2) : [O] destroy$

$State(T_2) : personalInfo$

$Violated(T_2) : [O] \neg personalInfo$

$State(T_3) : destroy$

Are We Compliant?



$r_1 : \Rightarrow [O] \neg medicalInfo \otimes [O] destroy$

$r_2 : courtOrder \Rightarrow [P] medicalInfo$

$r_3 : \Rightarrow [O] \neg personalInfo$

$r_4 : [P] medicalInfo \Rightarrow [P] personalInfo$

$State(start) : \neg courtOrder$

$Force(T_1) : [O] \neg medicalInfo$
 $[O] \neg personalInfo$

$State(T_1) : medicalInfo$

$Violated(T_1) : [O] \neg medicalInfo$

$Force(T_2) : [O] destroy$

$State(T_2) : personalInfo$

$Violated(T_2) : [O] \neg personalInfo$

$State(T_3) : destroy$

$Compensated(T_3) : [O] \neg medicalInfo$

Questions?