Rules, Agents and Norms

Introduction to Track

Antonino Rotolo

Leon van der Torre

Norms are Rules

- Tight and fruitful connections between rule-based systems and MAS (see today-morning session and the track paper by Badica, Braubach, and Paschke)

- WG5: “Trust”
- WG4: “Argumentation and Negotiation”
- WG3: “Organizations”
- WG2: “**Norms**”
- WG1: “Semantics” e.g. RuleML

Some Norms

- You are obliged to return the book in 2 weeks
- Role X is permitted to access resource Y
- Actions of agent X count as actions of agent Y
- Advocates should act in the interest of their clients
- Violations should be sanctioned
- Don’t do to them what you don’t want them to do to you
- People should know the law
- Every adult has the right to vote
- Make your homework!
- We start at 09:00

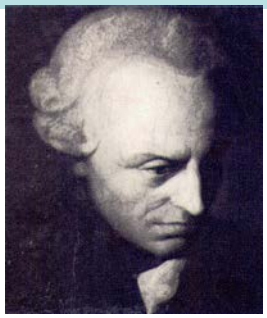
Norms are Peculiar Types of Rules

$$a_1, \ldots, a_n \Rightarrow b$$

where b can be, among others,

- Evaluative: “Human dignity is valuable"
- Qualificatory: “*x* is a citizen"
- Definitional: “An adult is a person aged 18 or older"
- Deontic: “x has the obligation to do *A*"
- Potestative: “x has the power to terminate his work contract"
- Evidentiary: “It is presumed that dismissal was discriminatory"
- Existential: “The company ceases to exist"
- Norm-concerning effects: “Norm *A* is repealed"

Philosophical Foundations





period	tradition	main issue
50s	monadic modal logic	relation O and P
60s	dyadic modal logic	relation O and facts, violations, sub-ideality and optimality, CTD
70s	temporal deontic logic	relation O and time
80s	action deontic logic	relation O and actions
90s	defeasible deontic logic	dilemmas, CTD
00s	imperatives, normative systems	Jorgensen's dilemma

Table 4. A schematic reconstruction of deontic logic

Normative Systems (1993)

- 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”

J.-J. Meyer and R. Wieringa. Deontic Logic in Computer Science: Normative System Specification. John Wiley & Sons, Chichester, England, 1993.

- Many distinct notions of “normative systems”
  - Social expectation, legal law, linguistic imperative…
- Role of norms in computer science is changing
  - Solutions based on multiagent systems increasing

AgentLink RoadMap

	Short Term	Medium Term	Long Term
oftware	Peer to peer Better development tools Agent UML Service oriented computing	Generic designs for coordination Libraries for agent-oriented development	Best practice in agent systems design
Agreed Standards	FIPA ACL Peer to peer Better development tools Service oriented computing Semantic description	Flexible business/trading languages Libraries of interaction protocols	Tools for evolutions of communications languages and protocols
Infrastructure for Open Communities	Web mining Data integration and Semantic Web Metadata	Semantic interaction Agent-enabled semantic web (services) Dynamic norms, roles, laws, organisations	Shared, improved ontologies
Reasoning in Open Environments	Organisational views of agent systems	Enhanced understanding of agent society dynamics Theory and practice of argumentation strategies Norms and social structure Theory and practice of negotiation strategies	Automated eScience systems and other application domains
Learning Technologies	Adaptation Personalisation Hybrid technologies	Evolving Agents Self organisation Distributed learning	Run-time reconfiguration and re-design
Trust and Reputation	Security and verifiability for agents Reliability testing for agents Self-enforcing protocols	Norms and social structures mechanisms Formal methods for open agent systems Electronic contracts	Trust techniques for coping with malicious agents

Figure 7.1: Agent technology comprises areas that will be addressed over different timescales

2005: Normative MultiAgent Systems

- are multiagent systems with normative systems
- in which agents can decide whether to follow the explicitly represented norms, and
- the normative systems specify how and in which extent the agents can modify the norms.’’

“The NormChange definition”

G. Boella, L. van der Torre, H. Verhagen, Introduction to normative multiagent systems. *Computational and Mathematical Organization Theory, double special issue on normative multiagent systems,* 12(2-3):71–79, 2006.

Guideline 1

Motivate which definition of NMAS:

1. Norms explicit in system (‘strong’),
2. Norms explicit in specification (‘weak’),
   - Problem 1 (Norm compliance). How to check whether a NMAS complies with relevant norms?
   - Problem 2 (Norm implementation). How can we design a system such that it complies with norms?
3. none of the above interpretations.

Guideline 2

2. Make explicit why norms are a kind of (soft) constraints deserving special analysis.

- Ways to deal with violations, representation of permissive norms, the evolution of norms over time (in deontic logic), the relation between the cognitive abilities of agents and the global properties of norms, how agents can acquire norms, how agents can violate norms, how an agent can be autonomous (in normative agent architectures and decision making), how norms are created by legislator, emerge spontaneously or are negotiated among agents, how norms are enforced, how constitutive or counts-as norms are used to describe institutions, how norms are related to social and legal concepts, how norms structure organizations, how norms coordinate groups and societies, how contracts are related to contract frames & contract law, how legal courts are related, how normative systems interact?

Guideline 3

3. Explain why and how norms can be changed at runtime.

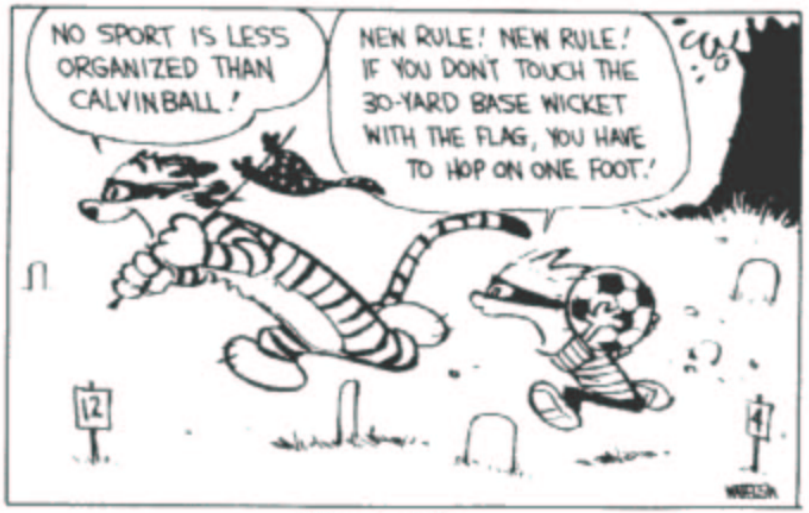
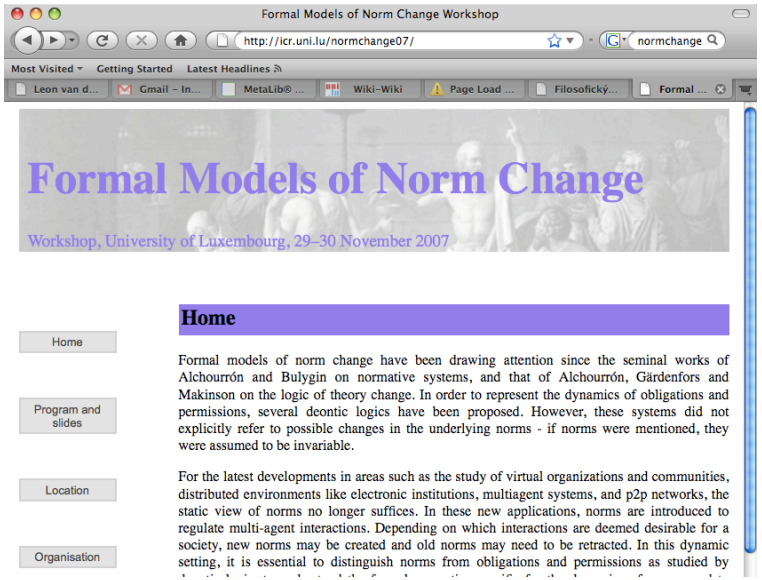


Figure 1.2



- E.g., legislators and voting on acceptance, observe behavior and violations to modify…

NORMAS 2007

2007: Normative MultiAgent System

- “is a multiagent system organized by means of mechanisms to represent, communicate, distribute, detect, create, modify, and enforce norms, and mechanisms to deliberate about norms and detect norm violation and fulfillment.”

“The mechanism design definition”

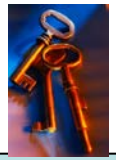
G. Boella, L. van der Torre, and H. Verhagen, Introduction to the special issue on normative multiagent systems. *Autonomous Agents and MultiAgent Systems,* 17(1):1–10, 2008.

Guideline 4

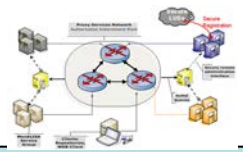
4. Discuss the use and role of norms as a mechanism in a game-theoretic setting.

- D. Lewis “master and slave” game
- E. Bulygin “rex, minister and subject” game
- G. Boella c.s.: violation games, institutionalized games, negotiation games, norm creation games, control games

Norms are rules specifying violation games.






Guideline 5

5. Clarify role of norms in the organization
   - Isomorphism formal & units of natural language
   - Rule semantics computing the legal effects
   - Defeasibility
     - Conflicts: lex specialis, superior, posterior
     - Exclusionary rules explicitly undercut other rules
   - Contributory reasons or factors
   - Rule validity annulment abrogation
   - Legal procedures, persistence, values
- Consider regulative norms in relation to other kinds of norms and concepts.

Ten Challenges for NorMAS

1. Tools for agents supporting communities in their task of recognizing, creating, and communicating norms to agents.
2. Tools for agents to simplify normative systems, recognize when norms have become redundant, and to remove norms.
3. Tools for agents to enforce norms. In a distributed approach, roles should be defined for agents in charge of monitoring and sanctioning.
4. Tools for agents to preserve their autonomy.
5. Tools for agents to construct organizations.
6. Tools for agents to create intermediate concepts and normative ontology, for example to decide about normative gaps.
7. Tools for agents to decide about norm conflicts.
8. Tools for agents to voluntarily give up some norm autonomy by allowing automated norm processing in agent acting and decision making
9. Tools for conviviality.
10. Tools for legal responsibility of the agents and their principals.

G. Boella, L. van der Torre, H. Verhagen, Introduction to the special issue on normative multiagent systems. *Autonomous Agents and MultiAgent Systems,* Aug 2008.

Normative MAS and agent compliance

- compliance amounts to ensuring that agents' behavior is in accordance with given prescriptive rules

$$a_1, \ldots, a_n \Rightarrow_{\mathbf{Obl}} b$$

$$a_1, \ldots, a_n$$

$$b$$

- in cognitive agents, for example,
  - **deliberative compliance**: agents have intentions which do not violate norms
  - **plan compliance**: agents generate or execute plans which do not violate norms

Normative MAS and agent compliance (cont'd)

- **Checking compliance runtime and allowing agents to violate norms:** Agents' behavior can be checked at the end of the deliberation or of the plan execution, or step by step (e.g., after each intention is obtained or after each atomic action is executed).
- **Enforcing compliance at design time:** Compliance should fundamentally have a preventative focus: MAS are designed in such a way as agents cannot violate norms.
- **Hybrid models:** Enforcing compliance but allowing to some extent agents to violate norms but also to recover from their violations

In normative MAS norms are supposed to be soft constraints

Normative MAS and agent compliance (cont'd)

Enforcing compliance at design time can be hard

- chains of reparative norms
- rich ontology of norms and normative effects
- complexity issues
  - when plans require the execution of parallel actions which are regulated by obligations, there are cases where we have to handle the combinatorial explosion of the number of possible execution paths to be verified
  - compliance by design can be obtained when obligations will always prevail over conflicting intentions, but if the system allows for inferences like

    $$\mathbf{Int}\mathit{GoToBarcelona},\ \mathit{GoToBarcelona} \Rightarrow_{\mathbf{Bel}} \mathit{GoToSpain} \vdash \mathbf{Int}\mathit{GoToSpain}$$

    then achieving compliance by design is an NP-complete problem