

Computable Law as Argumentation-based MAS

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- 1 Context & Contribution
- 2 Motivating Scenario: self-driving cars
- 3 Computable law in MAS
- 4 Enabling technologies
- 5 Conclusion & Further Work



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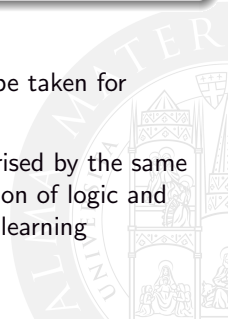
Context

Computable law research field [Sartor et al., 2008]

- norms, terms and conditions to be represented in a machine-understandable way
- enable machine and software agents to process, and reason about, legal abstractions

Two key factors to be considered

- single or unique way of modelling legal knowledge cannot be taken for granted → heterogeneous “legal ontologies”
- application scenarios for computable law strongly characterised by the same “symbolic vs sub-symbolic” dichotomy → try a reconciliation of logic and argumentation (i.e., symbolic approaches) and of machine learning algorithms (i.e., sub-symbolic approaches)



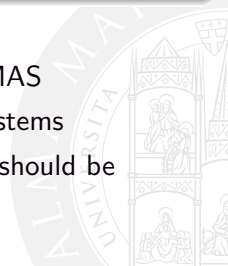
Contribution

Computable law as an argumentation-based multi-agent system

- agent architecture reference for the design of intelligent systems
[Wooldridge and Jennings, 1995, Calegari et al., 2020, Xhafa et al., 2020]
- expanding MAS abstractions and architecture
 - norms and argumentation [Andrighetto et al., 2013, Vasconcelos et al., 2002]
 - integration between symbolic and sub-symbolic techniques.

The contributions of the paper are the following:

- concept of computable law as argumentation based MAS
- show how they affect the engineering of intelligent systems
- investigate a number of approaches and technologies should be involved



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Analysis & requirements

- Cars capable of communicating
- Cities and roads enriched with sensors and virtual traffic signs

→ natural fit for computable law: need real-time control and feedback
→ capability to converse with the surrounding environment to address the goal (i.e., reach a destination)

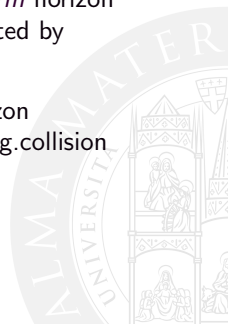
System requirements

- (i) exhibit some degree of intelligence for taking autonomous decisions
- (ii) converse with the context that surrounds them
- (iii) have humans in the loop
- (iv) be intertwined with the law setting (environment and society)

Requirements in detail

undertake complex decision-making process in compliance with norms and social rules → actions (and perceptions) at different levelsm

- **global knowledge** macro level of the system, *mid / long term* horizon
→ universal norms and legal conventions, possibly modulated by commonsense reasoning
- **local knowledge** micro level of the system, *short term* horizon
→ intersection management, intertwined sub-problems—e.g. collision avoidance, minimisation of average delay,



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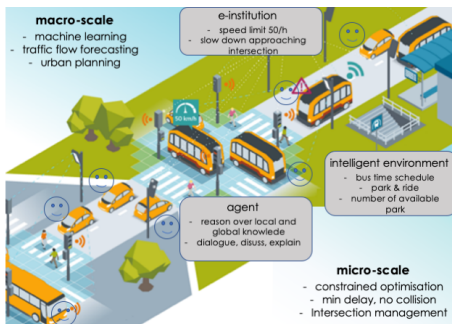
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Computable law vision

Computable law vision

- based on the fundamental roles of MAS [Omicini, 2001] A&A meta-model [Omicini et al., 2008]
- norms and e-institutions
- micro-intelligence



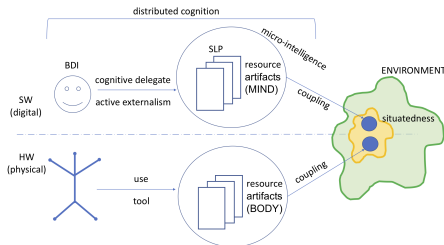
e-institution I

electronic-institution (e-institution) [Andrighetto et al., 2013] and deliberative agents [Rubino et al., 2005]

- norms and laws are the basic bricks upon which to build the concept of computable law
- suitable coordination artefacts exploited as normative abstractions
- agents' normative autonomy



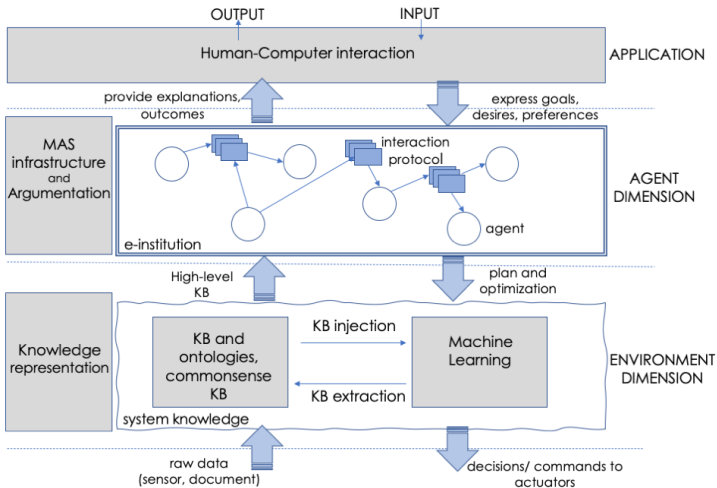
Micro-intelligence



Micro-intelligence

- *externalised rationality* of cognitive agents, complementing their own (Clark and Chambers' *active externalism* [Clark and Chalmers, 1998])
- Hutchins' *distributed cognition* [Hollan et al., 2000]
- *external* → not strictly belong to agents
- *rational* → convey a sound inference and argumentation

Overall vision



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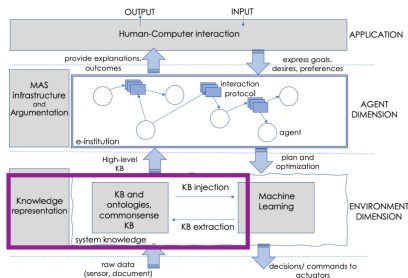
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Enabling technologies I

Knowledge representation

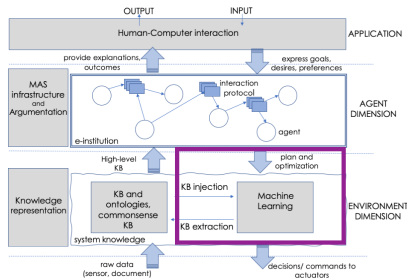
- domain-specific knowledge and large-scale ontologies as repositories
- modification, adaptation according to experience, perception
- two main sources: ontologies and hand-crafted rules & rules learned from big data → hybrid approach: integration symbolic / sub-symbolic



Enabling technologies II

Machine learning

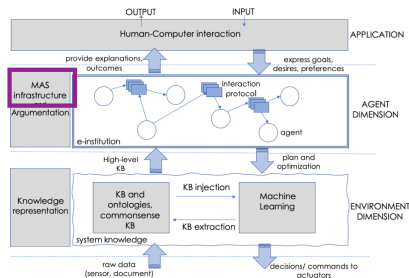
- data processing & rule learning
- planning



Enabling technologies III

MAS & Normative MAS - middleware infrastructure

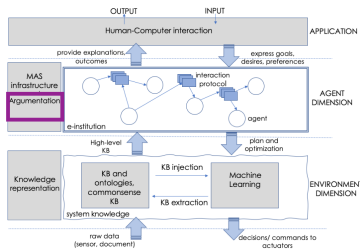
- coordination among system actors
- customisable and reactive artefacts, capable of incorporating regulation, norms, micro-intelligence
- support for discussions via an open and shared discussion space



Enabling technologies IV

Argumentation & logical reasoning

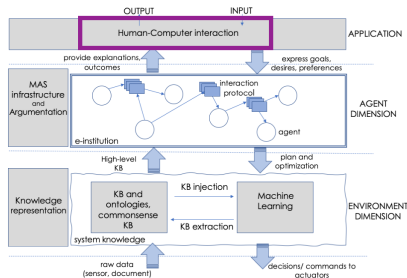
- ready-to-use technology
- integration with contingency situation and situated reasoning to achieve a blended integration
- challenging preserving external judge enacting some form of control over the argumentation process



Enabling technologies V

Human-Computer interaction

- techniques coming from natural language processing
- computer vision speech recognition



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Conclusion

- we sketch a vision of computable law as argumentation-based MAS
- MAS based on argumentation, dialogue, and conversation is, in this vision, the basis for making the law computable
- MAS methodologies and technologies starting point to achieve computable law → adapted, extended
- build upon some readily available technologies → open research question



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