Governing Communities of Autonomous Agents and People on the Web using Social Norms

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Social norms are the informal rules that govern behavior in groups and societies[1]. They are inherently based on humans or agents relations and are fundamental for governing communities of autonomous agents and people on the Web. An important aspect of these social norms is that they can be violated, i.e. their enforcement is not regimented. In certain models the notion of norm is considered similar to the notion of *policy*. Different research communities are focused on different types of norms/policies and on different services that it is useful to provide regarding norms.

The Multiagent Systems (MAS) community has been focused on the following problems: (i) propose application independent models for the formal specification of social norms and contracts able to express different types of norms [12] and normative concepts, e.g. obligations, prohibitions, and permissions; (ii) definition of frameworks for reasoning about norms. Automatic reasoning can be used to provide various services related to norms: detecting the activation of norms, reasoning about the performance or not of actions regulated by norms (i.e. detecting violations) and sanctioning the violations; performing what-if analysis (i.e. what are the active norms in a given moment? what are the obligations of an agent?); detection of inconsistencies and conflicts among norms (i.e. can it happen that an agent is obliged to perform an action that is prohibited to it?).

A very important connection between the MAS and the Semantic Web communities is represented by those norm models that use semantic web technologies (e.g. OWL or RDF ontologies) for defining some components of the norms, for expressing the state of the world, and for defining the operational semantics of norms (e.g. using rule-based programming, SPARQL queries, Shapes Constraint Language (SHACL) conditions). The first norm models to use semantic technologies were the KAoS framework [14], the REI [9] policy language, and the PRovisional TrUst NEgotiation framework Protune [2]. Those approaches are summarized and compared in [3]. More recent proposals of a policy/norm model and framework, which are based on semantic web technologies, are the OWL-POLAR framework [13] and the T-Norm model [7, 8].

A model of policies that represents a bridge between the MAS, the Semantic Web and the Web community is the Open Digital Rights Language ODRL 2.2 [2], which is based on semantic web technologies and is a W3C Recommendation since 15 February 2018. It is a policy expression language that can be used to represent permitted, prohibited, and obliged actions over a certain asset. Its focus is on digital assets and the standard set of generic actions that may be used in ODRL policies is defined in the ODRL Common Vocabulary[3]. ORDL 2.2 is a Policy Language formalized in RDF with an abstract information model specified by an ontology. It has no formal semantics, so compliance checking of policies written with this language cannot be performed automatically. Some extensions of ODRL has been proposed to overcome to some of its limits. In particular, in [6] an extension of the ODRL Information Model has been proposed together with a set of state machines used for describing the evolution in time of the deontic state of obligations, prohibitions, and permissions. Another extension of ODRL is presented in [4] to model both regulatory policies (in the form of nested permissions, prohibitions, obligations and dispnesations), and business policies via discrete permissions. A policy written with that extension of the ODRL language is then translated into an Institutional Action Language (InstAL) policy and thanks to its formal semantics, expressed in Answer Set Programming, it is possible to automatically check compliance and also provide an explanation of the aspects of the policy that brings to the non-compliance. I am currently cooperating as a one of the co-chairs of the ODRL Community Group with other members for defining the Semantics of Permission, Prohibition, and Obligation expressed using ODRL[4]. Interesting use cases have been developed around ODRL for the definition of various profiles of the language[5], for example the Big Data Profile and the Market Data Profile[6], other use cases are described in the POE Use Cases and Requirements web page[7]. It is probably unthinkable that we would reach an agreement on a common model for specifying norms and policies for all web applications, perhaps it is more reasonable to take the path of studying which norms can be formalised with which languages and how to translate norms from one formalisation to

[1] https://plato.stanford.edu/entries/social-norms/
[2] https://www.w3.org/TR/odrl-model/
[3] https://www.w3.org/TR/odrl-vocab/
[4] https://w3c.github.io/odrl/formal-semantics/#section3
[5] https://w3c.github.io/odrl/profile-bp/
[6] https://www.w3.org/2021/md-odrl-profile/v1/
[7] https://www.w3.org/TR/poe-ucr/

another. An initial study in this direction is [12].

It is difficult to imagine that people not specially trained could formalise the norms and policies governing the use of their data, of their digital assets or of their interactions with human and software agents. So methods have to be devised that can assist such formalisation or vice versa that can describe in natural language the content of norms written in a formal language so that humans can understand them.

Other research communities are focused on particular types of norms. For example privacy policies are a statement or a legal document (like for example the GDPR[8] privacy law) that regulate how a party can use, manage or disclose a customer's data. Interesting attempts to model privacy policies using semantic web technologies are the PrivOnto ontology [10] used to analyze a corpus of annotated data practices, extracted from a set of privacy policies of US-based companies. In this frameworks the goal is not monitoring norms but analyse them and being able to query them by searching for policies having certain characteristics. Another interesting privacy ontology for legal reasoning is PrOnto [11] it supports legal reasoning and compliance checking using defeasible logic theory by means of the LegalRuleML standard[1].

Another example of a specific type of norms is represented by access control policies, which are used to determine access by users or software agents to digital resources. They are relevant for regulating access to decentralized personal data stores (called Pods) based on the idea of user control of data and interoperability using linked data and web standards proposed by the SOLID specification[9]. Currently access to data in SOLID is regulated by Web Access Control[10] (WAC) specifications and there is a proposal to formalize them using ODRL [5].

All these studies can be a starting point for the engineering and development of mechanisms for governing autonomous agents on the web even if a significant limitation of existing norm models is the fact that there is a lack of evaluation of the scalability of the mechanisms used to monitor the fulfilment or violation of norms. Another limitation is the lack of a repository in which there is a formalisation of a large number of norms and policies expressed in a language with a formal semantics. Another limitation of the proposed norm models is due to the difficulty, in a distributed and decentralized system like the Web, of assuming that all agents agree on a sharable representation of the state of the world or the state of interaction among agents.

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