

Shared knowledge and interpretation of norms in multi-agent systems

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1 Introduction

The representation of norms is a central challenge in AI&LAW and in normative multi-agent systems [1]. Two requirements from AI&LAW are that the representation is realistic in the sense of being founded in legal practice¹, and to build more realistic agents. In particular, the representation of norms has to address the following questions:

1. How to represent the ontological status of norms?
2. How to represent open norms and vagueness?
3. How to represent agent's interpretation of norms?

In multi-agent systems, norms are usually considered rules that can be violated by agents. The reasons for norm violation are usually bounded to agents utility evaluation - gain versus possible fee - but with our proposal we depict a scenario in which norms are open or vague. Agent's can interpret norms in different ways, according to their knowledge but also according with their own interpretation theory of general concepts, norm goal, etc.

The rest of the paper is organized as follows. In Section 2, we introduce our methodology, Section 3 shows the features of norms as social objects. In Section 4, we discuss the ontological status of norms and their interpretation process. Finally in Section 5 we present some final remarks.

2 The problem: beyond the rule representation of norms

Part of the current research in AI&Law is based on the strong assumption that norms can be model as rules and that such rules can be extracted from the legal text only. Thus, rules are typically considered as given and from this assumption a formal theory of law in terms of rule reasoning has been given with the formal means at disposal up to now. Researchers in AI&Law are aware that "law is not a matter of simply applying rules to facts via modus ponens" [2] but most of the current techniques continue to be based on the same assumptions [3, 4]. Despite the advances in logic and case-based systems, "these ideas have not achieved their full potential" [5].

Looking at legal norms in legal practice, norms are not exhausted by rules extracted from the legislative texts, norms emerge from the whole legislative system and society.

¹In order to answer to the current request of transparency of law processes.

2.1 Social objects

As methodology in our ontological analysis we use the concept of social object in the sense of Ferraris [6]. A social object in this sense represents both the physical and immaterial side of the social constructs, the inscriptions but also a set of shared beliefs.

A social object [6] is a class of entities between concepts and physical objects. A social object follows the rule *Object = Inscribed² Action* that represents the transformation of an agent's action into an independent object. Those objects are accessible by inscriptions, like papers, drawings, digital or human memory, their interpretations are shared by a group of people and detached from the will of their creators. A social object is an instance of a common model (like documents) that defines the expected/required content, a communicative [7] speech act [8], within a context, i.e. within an existing system of relations and references.

A public and communicative action can create a new social object in each context it is posed, i.g., each event in which an act is performed can create a new social object. A social object is shattered in all participants' mind, it depends on the memories of the event (shared) and on the interpretation they elaborate (personal). Social objects possess both physical and intangible features: the structure of their inscriptions (physical objects) and the structure of their meaning (mind images and connections of concepts). For that reason, every social object is unique even if they are instance of known models. To give an intuition of social object models, we can consider as example the features of "personal statements": any personal statement involves several things like the author mental state, the declaration body, the knowledge shared by the recipes, a time and place of the statement, the traces left, pragmatic games and social behaviour, the social status of anyone involved and their mutual expectations.

Agents' actions creating social objects are communicative and public. Those communications can be represented as graph of relations among entities like common concepts and physical objects [9]. The meaning of those objects is given by their interpretation: the manipulation their graphs using agent's assumptions.

The references of physical and ideal objects (from now on concepts) in social objects is represented with relations extracted from their content³. Concepts are represented by their use as references to external descriptions or definitions, e.g. domain ontologies. The distinction between use and definitions catch the meaning of social objects as instances of shared models: a graph represents the specific use of general concepts⁴.

3 Norms as social constructs

Norms are social objects and legal texts are one of their inscriptions. A legal text is an accessible reminders (media) leading agents to similar interpretations⁵ of norm mean-

²Inscribed stand for written down or recorded in some retrievable media like paper or even brain memory.

³E.g. a semantic network of a document text.

⁴The technical solution can be found in [9].

⁵The use is vague but not necessary the meaning of norms.

ing. Norms are connected to agents' beliefs like common and legal concepts, interpretations, judgements and common behaviour. The effectiveness of law is bounded to community's interpretation of norms and related to common principles/concepts such as "to not bring harm to someone"⁶. Boella and van der Torre [10] showed the dependency of normative systems to agents' actions. In detail, they exposed how the (regulative, constitutive, procedural) aspects of norms requires specific behaviours from agents. For instance, the regulative effect needs the agents desire to avoid potential sanctions caused by their actions. Rules emerge from the society in a process of definition of shared goals and acceptable norms [11]. Those two works show the entanglement between norms, institutional agents and society but are still based on the same limiting assumption that norms can be represented as rules, norms are dynamic, vague and part of a greater social or normative context.

Represent norms as social objects goes a step further in this direction. The notion of social object allows us to model the requirements mentioned in Section 1:

1. Norms are different than their inscriptions and their life cycle depends only partly on their inscriptions.
2. As social objects, norms meaning can evolve for other reasons than their inscriptions.
3. Norms can depend to other norms as other social objects.
4. As social objects, norms meaning depend to the related concepts meaning.
5. As social objects, norms depend on the shared beliefs of the agents of the society (even the very status of norms depends to agents' agreement).

We want to discuss a methodology to build norm representations that holds those features.

3.1 Structure and interpretation of norms

In real life, norms have more than one inscription (copies, versions, public documents, etc.), several authors (legislators, commissions) for each part or aspect, formal and informal goals, implicit assumptions, implicit and explicit scenarios, explicit and implicit connections with other norms, related groups that give support (as the parliament) with formal or informal actions, and a constitutive action (like X count as Norm in Italy) creating the new norm from the legal texts and the other sources. Norms are complex objects, made of components, partially defined and bounded to groups' shared beliefs and convergent interpretation.

If norm contents depends to agents' beliefs and goal they are partially inaccessible and so impossible to represent fully. Furthermore, a norm context and content is inevitable vague, concepts cannot be universally defined: their are sensible to society, language and use dynamics. Considering human communication, open concepts and vagueness are important aspect of communication that do not need to be resolved to archive mutual understanding. For the sake of norms representation, all a priori attempts of disambiguation of norm vagueness as introduced by legislators makes norms representations unacceptable by practitioners and applications unreliable.

⁶Norms containing general or undefined concepts are called "open norms".

3.2 Norm dynamics

A norm representation should catch the real-life dynamics of norms and not just the dynamic of the legal text [12]. Even the legal text dynamics is more complex than the life-cycle of legal text⁷.

Norm dynamics includes all elements that contribute to norm meaning. For instance, norms are affected by the current status of the whole normative system and not only from their legal texts. Those elements have different time so a norm representation should be incrementally extended. Furthermore, a norm representation cannot be finite and self-explanatory but a shared starting point for agent's interpretation [13].

4 The ontological impact of interpretation and vagueness

Interpretation hide always ontological assumptions. For instance, for an interpretation theory norms evolve or not with society or language. We want distinguish norm as social social objects to norm meaning as result of agent's interpretation. We'll discuss interpretation in legal practice to give an intuition of norm representation as shared state of affairs and interpretation as reasoning on shared norm representations.

In order to clarify the differences between ontological status of norms and interpretation, we briefly recall the ontological analysis of the four canonical interpretations of legal norms [13]:

- a) The grammatical interpretation: norm meaning should be found in legal texts.
- b) The systematic interpretation: norms meaning emerge from the state of the normative system.
- c) The historical interpretation: norm meaning is within the original context of norms and in the legislator's will.
- d) The teleological interpretation: norm meaning change with the current state of society.

The ontological assumptions in the first two interpretations limits what is part of a norm representation. The historical and teleological interpretations involve the norm evolution: how to use the timing of norm components. In order to take in account all interpretation, the best strategy is to build a widest possible representation and postpone components selections and time interpretation.

4.1 Norm representation and explicit interpretation

The four interpretations presented in the previous section are all used in legal practice. An objective representation of norms is required to derive all four interpretations from the same representation. In general, a norm representation should preserve its original meaning and all external references considering their timing. A norm can be represented as a stratified graph, like in Figure 1, in a network with other social objects and ontologies for common concepts.

⁷As text revisions, versions, etc.

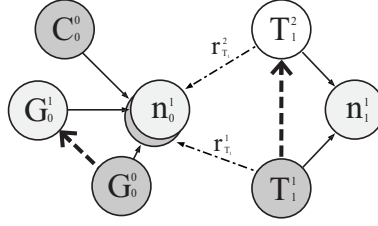


Fig. 1: References between norms n_0 and n_1 with different timing.

The norm in Figure 1 has a unique identifier (the node n_0) and its components are labelled with the creation time⁸.

An interpretation as uses external information extracts more than the original content from a norms. For instance, considering figure 1 the first two interpretation theories can be implemented as selection of nodes by type (like references). The historical (left) and teleological (right) interpretations, figure 2, can be calculated selecting the nodes by time.

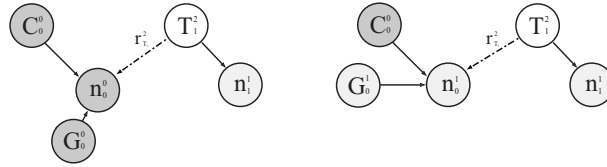


Fig. 2: Two interpretations of norm n_0 in Figure 1 extracted by selection by time attributes of nodes.

The previous example of interpretation is extremely simplified but even in this interpretation require agent's parameters: the node type and a time window. Interpretation mechanism can also include graph traversing and combination of norm graphs.

5 Concluding remarks

In this contribution we depicted a methodology to represent shared knowledge and agent's interpretation. In particular, we answered the following questions:

1. How to represent the ontological status of norms? With an incremental representation of social facts and norm context, and excluding all interpretation assumptions.
2. How to represent open norms and vagueness? It is done avoiding a priori interpretation and representing only the outcome of agent's actions.

⁸To simply the example we annotate time as parameters of nodes avoiding the representation of time node

3. How to represent agent's interpretation of norms? The norm representation is the ontological status of norms, even if it not so informative it can be interpreted using agent's assumptions as parameters of the interpretation mechanisms.

Our methodology requires to define the level of detail of the representation, it is not exhaustive but can be used also with incomplete information. knowledge graph of norms with existing tools, like text analysers, it is necessary to map the output of the tools to a meta-model of norms. That will require, for each tool, the analysis of the embedded ontological assumptions.

For future work, we want to address the integration between norm representations of norms and society structures like organizations and roles.

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