On Temporal Regulations and Commitment Protocols

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Abstract

The proposal of Elisa Marengo's thesis is to extend commitment protocols in order to (i) allow for expressing commitments to temporal regulations, and (ii) to supply a tool for expressing laws, conventions and the like, in order to specify legal interactions. These two aspects will be deeply investigated in the proposal of a unified framework. This proposal is part of ongoing work that will be included in the thesis.

1 Commitment Protocols: Strengths and Shortcomings

The issues of communication and cooperation are crucial in the area of Multiagent systems (MAS). The common solution is to rely on agent interaction protocols. Among different proposals, *commitment protocols* [Singh, 1999] have been widely adopted. All agents involved in an interaction ruled by a commitment protocol share the semantics of a set of actions which affect the social state. Semantics is based on the notion of *social commitment*. The idea is that if an agent takes a commitment towards another agent to bring about a condition, then, it will behave in such a way to fulfill the engagement sooner or later. In this respect, commitment protocols have a *deontic nature*, because a commitment introduces a social expectation on the responsibility of some agent towards some other agent to perform something or to achieve some result. Commitment protocols suit well open MAS because they are respectful of the agents' autonomy, since no introspections to the agents' mental states is required; they are dynamic because commitments can be created, released, deleted and suchlike, and they are flexible because agents are free to take advantage of opportunities or to follow shortcuts.

Commitment protocols have fundamentally changed the process of protocol specification from a procedural approach (i.e., prescribing *how* an interaction is to be executed) to a declarative one (i.e., describing *what* interaction is to take place) [Winikoff *et al.*, 2005]. However, in many practical situations it is necessary to express some hints on how the interaction should evolve. This does not mean going back to procedural approaches, but it means reconsidering the *how*. In particular, it could be necessary to express commitments to *temporal regulations* and to represent *legal patterns of interaction*. Temporal regulations are needed to express commitments to achieve something and in a specified order. For instance, an insurance company commits to paying an in-network surgeon for a procedure only after a covered patient has undergone the procedure. Patterns of interaction, instead, can capture conventions, laws, preferences, habits, or rules that, in general, constrain a certain reality. For example, in the context of a democratic assembly, a participant cannot speak if she has not obtained the floor.

The thesis focuses on these lacks, by proposing an extension of commitment protocols. The proposal (i) extends the regulative nature of commitments with the possibility of explicitly committing to temporal regulations, and (ii) supplies a way for expressing patterns of interaction, capturing laws, conventions and whatever constrain the interaction. Until now, these are two disjoint solutions for two different problems. The final step of the thesis will be to investigate the correlations among the two and to propose a unified framework.

2 Temporal Regulations and Commitment Protocols

Commitments have a *regulative* nature in the sense that the debtor is bound to the creditor to make the condition in the commitment become true. However, it is often necessary to specify patterns of interaction and temporal regulations which require a degree of expressiveness that commitments alone do not have.

The first step in this direction is described in [Marengo *et al.*, 2011] and consists in a new formalization of commitments where temporal regulations are incorporated as content of the commitments. In this way regulations assume a normative force which is due to the regulative nature of commitments. For example, the commitment $C(x, y, \top, a \cdot b)$ expresses the engagement of x towards y to make a and b happens and in the given order. Participants to the interaction will be able to guide their actions locally, in order to not violate any commitment they have taken, and to judge the compliance of their counterparties. Indeed, since regulations are placed inside commitments, the debtor will be considered responsible and thus liable for any violation. For this reason it becomes fundamental for an agent to establish, before tak-

ing a commitment, if it has the sufficient support by the other agents. The elements the agent has to consider are both the set of actions it can perform and the cooperations it can get from the others, via the set of commitment of which it is the creditor. To this aim, we formalized the notions of *control* and *safety*. The former captures the capability, for an agent, to bring about a regulation. It depends on the actions a certain agent can perform and on commitments directed towards it. The latter is strictly related to the notion of control: a commitment is safe if its debtor has established sufficient control to guarantee being able to discharge it.

Even though commitment to temporal regulations allows to make some assumptions on how the interaction should evolve, they are not sufficient to express general rules like norms or conventions. For example, it is not possible to express that, in a democratic assembly, a participant has to obtain the floor before speaking, otherwise it will be sanctioned. However, this rule do not impose to a participant to make a question. Norms usually express permissions and prohibitions that basically restrict the legal evolutions of the social state. In order to capture these *patterns of interaction*, the solution described in [Baldoni *et al.*, 2010b] relies on Searle's definition of a social reality [Searle, 1995]. In particular, he identifies a *constitutive* and a *regulative* specification. The former defines a set of actions as foundational of a certain context. In commitment protocols this corresponds to the actions' semantics, given in terms of effects on the social state. The latter, instead, captures how things should be carried on. This aspect is currently missing in commitment protocol specification. The thesis proposes an explicit definition of the regulative specification, given in a declarative way by means of a set of constraints expressed in Linear-time Temporal Logic (LTL). The choice of a declarative representation of constraints allows for the specification of what is mandatory and what is forbidden for a protocol. This is similar, in the aim, to what conventions, laws, contractual obligations and rules in general capture.

3 Ongoing Work

The two proposed solutions allow facing two different lacks of commitment protocols related to temporal regulations and patterns of interaction. The thesis will finally investigate a unified framework in which both aspects can be reconciled. This framework will allow agents to commit to complex conditions, providing them the tools necessary to verify their capability to fulfill the engagements. This can be done thanks to the notions of control and of safety. Moreover, it will allow for the specification of a set of norms, conventions, rules that have to be respected throughout the interaction. Before taking part to an interaction agents can determine if, given this set of constraints, they will be able to reach their goals.

The aim of reconciling these two aspects, however, is motivated by another important point. Indeed, these two kinds of temporal regulations are *strictly connected to one another* [Baldoni *et al.*, 2011]. In particular, a set of norms restricts the set of commitments that can be taken by the agents and that are not in contrast with the constraints. For example, before getting on a train a person has to punch the ticket first.

Only after, she is allowed to travel on the train. However, think to a person that commits to travel to her destination first and, once she reached it, to punch the ticket. In this situation, it is impossible for the person to fulfill her commitment without violating the norm. More generally, in order to propose a unified framework some important questions have to be answered. For example, given a set of norms expressed in terms of patterns of interaction, how can we establish which commitments are compliant and which are incompatible? If norms change, how do these changes affect the set of commitments? Moreover, how can one monitor the interaction of the agents and discover violations? In this respect, a solutions could be to lean on e-institutions. In [Baldoni *et al.*, 2010a] an initial proposal is described, where the idea is to define specific artifacts able to detect agents' violations.

Another important field in which the described proposal can find application is that of business process representations. In this area the trend is currently evolving to consider declarative representations for non-sequential processes. We plan to investigate more deeply these aspects in the line of [Telang and Singh, 2009].

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