Representing and Evaluating Electronic Contracts with Normative Markov Decision Processes[*]

Moser Silva Fagundes[1], Sascha Ossowski[1], Michael Luck[2], and Simon Miles[2]

[1] Centre for Intelligent Information Technologies (CETINIA)
University Rey Juan Carlos, Madrid – Spain
`{moser.fagundes,sascha.ossowski}@urjc.es`
[2] Department of Informatics
King's College, London – UK
`{michael.luck,simon.miles}@kcl.ac.uk`

Abstract. This position paper summarizes the contributions resulting from the short term scientific mission (STSM) of the first author, from University Rey Juan Carlos, to the Kings College London. During this scientific mission, we have studied the impact of norms on the sequential decision making of rational agents, and how they can be modelled and quantitatively assessed. For this purpose, we put forward a framework based on Markov Decision Processes that allows for explicitly representing norms and sanctions. In order to illustrate the usage of the framework, we model an example in a simulated aerospace aftermarket ruled by electronic contracts in terms of norms and sanctions, and present algorithms for reasoning about it.

Keywords: Norms, Electronic Contracts, Normative Reasoning, MDP

1 Introduction

There have been several proposals for enabling agents to reason about norms using the *Belief-Desire-Intention* (BDI) paradigm, acknowledging the advantages of norms as a means to condition agent behavior. However, the emphasis in these proposals has been on the feasibility of such normative reasoning rather than on the ability to quantitatively reason about agent performance, especially in the presence of uncertainty. *Markov Decision Processes* (MDPs) are well suited for quantitatively assess the agent performance under uncertainty, but so far, this framework has never been exploited to reason about norms. There have been some proposals to tackle coordination problems in MDPs, but none of these proposals have employed solutions based on normative systems.

This position paper summarizes the contributions resulting from the short term scientific mission (STSM) of the first author, from University Rey Juan Carlos, to the Kings College London. In this scientific mission, we propose a solution to model norm-aware rational agents that combines the native strengths of the MDPs and norms in order to cover their individual limitations. We combine, on one hand, the analytic advantages of MDPs to model the domain of interaction and agent decision-making under uncertainty, and, on the other, the use of norms to coordinate autonomous agents.

---

[*] AT2012, 15-16 October 2012, Dubrovnik, Croatia. Copyright held by the author(s).

2 Contributions

The contribution resulting from this STSM is threefold[3]:

(i) An extension of the MDPs, referred to as *Normative Markov Decision Processes* (NMDPs), that explicitly represent norms, sanctions and detection probabilities of norm violations. The MDP framework has been extended by an additional component that denotes a set of norms ruling system. A norm is described as a set of states that are prohibited or obliged for the addressee agent, and a sanction consists of a penalty and an enforced state-transition aiming at updating the current state of this agent. The underlying intention of these sanctions is to punish the transgressors by decreasing their utility, and moving them from violating states to states where the norms are obeyed and/or their capabilities are constrained.

(ii) An algorithm for identifying which states of the process violate which norms, and a technique to calculate the risk of violating a set of norms by adopting a particular policy. In this respect, the focus of the approach is on the norms within electronic contracts rather than any other concern.

(iii) To illustrate the application of our approach, we developed a case study in a simulated aerospace aftermarket [2], where an engine manufacturer agent, modeled as an NMDP, represents and evaluates sets of contracts with airline operators and suppliers of engine parts.

3 Future Work

As future work we intend to study the relation between the minimization of norm violations, utility maximization and the agents' reputation. Before signing contracts, the signatories take into account their past experiences, which provide data to construct the reputation of the agents. Our second research direction aims at generating detailed explanations of norm violations within the NMDP framework, identifying their direct and indirect causes as well as the involved agents.

Acknowledgment

References

1. M. S. Fagundes, S. Ossowski, M. Luck and S. Miles, Using Normative Markov Decision Processes for Evaluating Electronic Contracts, *AI Communications*, **25**(1) (2012), 1-17.
2. M. Jakob, M. Pechoucek, S. Miles and M. Luck, Case Studies for Contract-based Systems, in: *AAMAS'08: Industry and Applications Track*, IFAAMAS, Estoril, Portugal, 2008, pp. 55-62.

---

[3] For the sake of space, this position paper does not include technical details, such as formal definitions and algorithms. The complete research is published in Fagundes et. al [1].