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A Normative Agent-based Model for Sharing Data in Secure Trustworthy Digital Market Places

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Abstract

Norms are driving forces in social systems and governing many aspects of individual and group decision-making. Various scholars use agent based models for modeling such social systems, however, the normative component of these models is often neglected or relies on oversimplified probabilistic models. Within the multi-agent research community, the study of norm emergence, compliance and adoption has resulted in new architectures and standards for normative agents. We have extended the N-BDI* architecture by extending the Belief-Desire and Intention (BDI) agents' control loop, for constructing normative agents to model social systems; the aim of our research to create a better basis for studying the effects of norms on a society of agents. In this paper, we focus on how norms can be used to create so-called Secure Trustworthy Digital Marketplaces (STDMPs). We also present a case study showing the usage of our architecture for monitoring the STDMP-members' behavior. As a concrete result, a preliminary implementation of the STDMP framework has been implemented in multi-agent systems based on Jadex.
keywords: Normative Agent Based Model, Beliefs Desire and Intentions Agent, Simulation, Agent Based Modeling, Jadex

1 METHOD

In this paper, a Trusted Electronic Institutions agent (TEI) presented to mimic real-world institutions, by regulating the interactions between agents. The TEI agent concept is a coordination framework that facilitating the establishment of contracts and providing a level of trust by offering an enforceable normative environment. The TEI agent encompasses a set of norms regulating the environment.

This normative environment evolves as a consequence of the establishment of agents' agreements formalized in contractual norms. Therefore, an important role of the TEI agent is to monitor and enforce, through appropriate services, both predefined institutional norms and those formalizing contracts that result from a negotiation process. Agents rely on the TEI agent to monitor their contractual commitments.
This paper describes an extended BDI architecture for constructing and simulating normative effects on a social system such as STDMPs.
The aim of our research is to create a general purpose Agent-Based Modeling (ABM) and simulation system for studying how norms can be used to create STDMPs and how we can monitor the effects of norms on such system where each member's of society are self-governed autonomous entities and pursue their individual goals based only on their beliefs and capabilities (Gouaich, 2003).

2 N-BDI*

In this paper, we introduced N-BDI* architecture. The N-BDI* framework is inspired by the nBDI framework from (Criado et al., 2010). Their framework, like ours, is an extension of the basic BDI agents (Deljoo et al., 2017). The N-BDI* framework consists of two functional contexts: the Plan selection Context (PC), which is responsible for select the most appropriate plan. In our framework we assign utility to each plan and select the one that maximizes the utility; and the Normative Context (NC), which allows agents to consider norms in their decision making processes. In our work, we have a norm representation based upon the work of Hohfeldian (Doesburg and Engers, 2016). In Figure 1 we depict our N-BDI* architecture. The deliberation cycle of the N-BDI* agent model is presented in Algorithm 1. As we mentioned earlier, our

Algorithm 1 Modified control loop for the extended BDI agent (N-BDI*), where O= observation, B= Belief set, G= Goal set, P= Plan set, and A_p= Actions.

Given an agent $\{O,B,G,P,A_p,Norms\}$
repeat
  $O := Observe(O + Norms)$ $B := Revise(B,O)$ $G := Generate\ G\ (B)$ $P := \forall g \in G \rightarrow generate\ P(B,G)$ $P := Calculte\ U_P\ \forall\ p \in P(B,G,P)$ $PrefP := Update\ P\ to\ PrefP(B,G,A_p,P)$ $B := revise(B,Pref)$ $A_p := (norms(Power),Allowed?)\ take\ (A_p)$
until *forever*;

goal to use N-BDI* framework to model and simulate the effect of different norms on STDMPs. Our architecture contains three phases: recognition, adoption and compliance. In the first recognition part, the beliefs of an agent revise and develop. During the adoption, the agent commences actions. The norm violation can happen during the adoption phase (Luck et al., 2013). The compliance phase is used to simulate the situation when the agent really starts executing the action. We add another part to the normative phase in our architecture that called monitoring. In monitoring phase, the agent will reason about the action and consequence of the actions on the society.
To implement the STDMP we used the Java Agent Development Framework based on BDI (Jadex) (Pokahr et al., 2005) platform. In this paper, we show a first implementation of the STDMPs system using Jadex. As example of synthesis, we are now able to

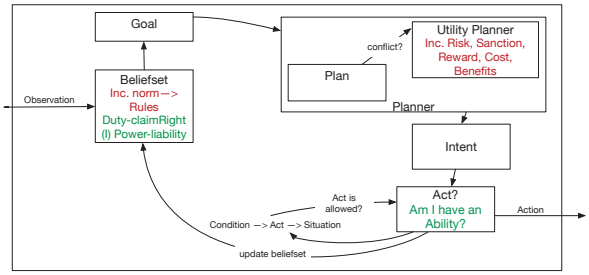

Figure 1: N-BDI* architecture.

implement the N-BDI* model illustrated in Algorithm 1[1].

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[1]The extended version of this paper with the implementation and all technical steps presented in this paper(Deljoo et al., 2018)