Decentralised Runtime Norm Synthesis

Doctoral Consortium

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ABSTRACT

The process of determining the appropriate set of norms, referred to as synthesis, for a multiagent system has predominantly been carried out offline by the designers of the system. Of recent, there have been a few approaches that synthesise norms online utilising a centralised mechanism. The research presented here aims to propose a mechanism for decentralised runtime (online) norm synthesis through the use of agents dedicated to synthesising norms based on participating agents' requests.

KEYWORDS

norm synthesis, online, offline, runtime, decentralised, normative, multiagent systems (MAS)

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1 INTRODUCTION

Multiagent systems (MAS) utilise norms as a means of encouraging coordination and cooperation and to avoid conflict states. Norm synthesis is the process of specifying or updating a set of norms for a system [8, 14]. We will refer to this set of norms as the normative system.

Norm synthesis has normally been implemented at design time, also known as offline, before the MAS is live and typically remains the same throughout the lifetime of the society. Norm synthesis can potentially occur while the system is live, which is referred to as online or runtime .

The main challenge for normative MAS is to remain relevant as environments may change over time and as a result the normative system will over time be unable to properly cope with the new environment. Therefore the normative system should be able to evolve as the society evolves [3] or risk becoming irrelevant. Consequently, it is imperative for norm synthesis to occur at runtime.

Current research portrays norm synthesis with external factors driving norm creation, the norm emergence literature takes the view that norms are created internally taken into account the behaviour of it's participants. The insights from the behaviour of agents in norm emergence provide scope for agents to participate in the norm synthesis process. We argue that the best actors for normative change and therefore dynamic norm synthesis are the participating agents within the MAS.

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2 BACKGROUND AND RELATED WORK

Existing norm synthesis mechanisms primarily employ a centralised approach that relies on global knowledge, for example, [1, 2, 7–11, 13]. To the best of our knowledge, AOCMAS [5] is the only study that employs a decentralised mechanism. AOCMAS [5] operate at runtime where distributed *assistant agents* partially observe the state of the organisation for conflicts, then propose the regulations that avoid these conflicts in the future. Assistant agents first check to see if an existing solution can solve the observed conflict using case-based reasoning(CBR), when none is found a new solution is proposed. Regulations in the proposal are voted on by all assistants and the ones receiving the majority vote becomes the new set of regulations.

Of the proceeding researches cited, tin [1] presents a synthesis mechanism for offline use aimed at designers. Similarly Morales et al. [11] present an offline method coined SENSE - "System for Evolutionary Norm SynthEsis". SENSE [11] builds on a previous online implementation IRON - Intelligent Robust On-line Norm [8, 10] which they reported had limitations reasoning about the interdependence of norms and could result in unstable normative systems.

These existing systems are successful at avoiding conflicts because either of the following occurs (a) agents choose to adopt the norms as they are better off doing so though they can violate them [7–10]; (b) agents are restricted from performing certain actions or achieving certain states [2]; or (c) regulations become more or less restrictive based on whether agents adopt them or not [5]. . With the exception of [5], the normative systems do not appear to be rigorously tested with agents who choose to arbitrarily violate norms leaving the effectiveness of the synthesis mechanisms in question.

3 RESEARCH METHODOLOGY

3.1 Context

As highlighted previously, norm synthesis has been primarily implemented as a centralised mechanism that is usually endowed with global knowledge and it is assumed that the resulting norms will be adhered to by the participating agents. As a consequence we propose that mechanisms for norm synthesis using a distributed approach should be investigated and attempt to achieve this using distributed agents with local knowledge. Further we believe that the participating agents should contribute to the norms that govern them and as such we propose that these agents should be allowed to highlight or recommended changes that affect their participation

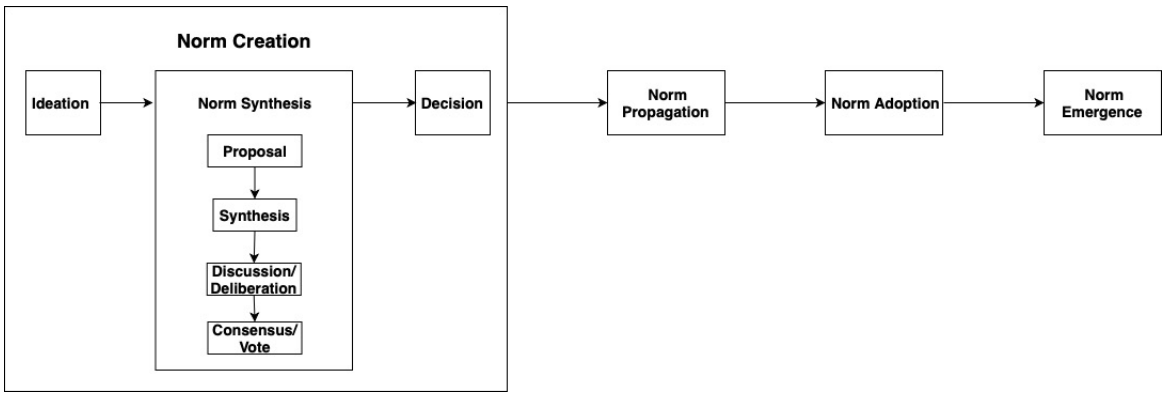

Figure 1: Conceptual Model for norm emergence in normative MAS

in a MAS and see those be rectified as new norms or norm changes to the normative system.

3.2 Research Questions

(1) Can distributed agents with local knowledge synthesise appropriate norms for a MAS at runtime?
(2) Would norms synthesised in response to participating agents' needs be applicable to the entire MAS?

To address our research questions, we conceptualised a model of norm emergence, depicted in Figure 1, that allows participating agents in a MAS to influence the norms that govern them by initiating the synthesis of norms by special-purpose synthesiser agents.

The conceptual model, as depicted in Figure 1, details the process of norms being synthesised, which begins with the initial recognition of the need for a new norm in the society by a participating agent – *Ideation*. This participating agent proposes a norm change or new norm request to its synthesiser agent. The synthesiser agent must then synthesis a norm that can resolve the issue or inform the agent that their issue cannot be resolved – *Norm Synthesis*. The process then continues with a *Decision* where the new or modified norm is accepted or rejected by an *Oracle Decision System* which can be automated or human controlled. The preceding stages all form components of the **norm creation stage** of the model where the output is a norm to be included in the normative system. Finally all agents are informed of the changes to the normative system if any in the **norm propagation stage** after which they reason about adopting any new/modified norm in the **norm adoption stage**. The emergence of the new/modified norm can then be observed in the **Norm Emergence stage**.

3.3 Decentralised Runtime Norm Synthesis

This research focuses mainly on the Norm Synthesis stage that enables us to adequately answer our research questions. The synthesiser agents in this model are inspired by the assistant agents of Campos et al. [5]. Synthesiser agents of our proposed model are reactive, they await a trigger from agents before synthesising a norm. They are conceptualised to contain knowledge of the domain context: goals, actions, conflicting states, and norms. We propose a distributed set of synthesiser agents each with a partial perception of the system as they are only able to perceive the actions and state of the agents for whom they are responsible.

At present we foresee the Norm Synthesis stage to consist of the following sub-processes:

Proposal: The agent after determining that there is something that it wants to change will propose a norm change or new norm to a synthesiser agent specifying the context and reason for the request. Upon receipt, the synthesiser will parse and interpret this request.

Norm Synthesis: The act of synthesising the norm occurs here by the synthesiser agent utilising the request and their perceivable knowledge of the environment.

Discussion/Deliberation: The synthesiser agent must inform other synthesiser agents about the proposed new norm or norm change and solicit a discussion.

Consensus/Vote: A majority vote or some other consensus mechanism will be employed to have agreement among the assistant/supervisor agents on whether the norm should be introduced into the normative system. If a consensus cannot be met, the presenting synthesiser agent must inform the agent that proposed the norm change that it was rejected with a reason for rejection if available.

4 CONCLUSION

The experimental simulation environment has been developed as proof of concept and based on in-house expertise. It utilises JASON[4] for the environment and the agents and InstAL [6] for providing the normative system, and allows for seamless interaction between both. We simulate the rooms institution as defined in [12]. The development of the participatory agents has been completed while the synthesiser agents are in progress.

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