Instrumenting Multi-Agent Organisations with Reputation Artifacts

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COIN@AAAI 2008 – July 2008
Outline

- Context and motivation
- Reputation artifact
- Example
- Conclusion
Multi-Agent Organisations have to

- help the agents to achieve common goals
- deal with agents’ autonomy i.e. controlling their actions while keeping their autonomy

- e.g. when someone adopts the role of master student in a laboratory, she remains autonomous to perform its research but should follow some rules of the laboratory organisation. These rules vary from ‘the access to computers requires an username’ to ‘a master thesis should be written in two years’

The agent is free to adopt the role, but once adopted the organisation expects her to limit her autonomy.
Limiting the autonomy of the agents

- Rules as **regimentations**: the organisation prevents their violation by the agents
  - e.g. the access to computers requires an username
  - e.g. messages that do not follow the protocol are discarded, roles which cardinality is full cannot be adopted
- Rules as **norms**: agents decide to obey or not to them, the organisation lets the agents the possibility to violate them
  - e.g. a master thesis should be written in two years

\(\rightarrow\) Detection of violations, decision about sanctions must be considered
The success of the organisational approach depends on how the compliance to the norms is ensured inside the system.

The objective of this work is to present a first step towards the use of reputation as an instrument to enforce the compliance to norms.
Reputation and Organisation

- Agent and Organisation centred approaches
  - REGRET [Sabater and Sierra, 2002] and FIRE [Huynh et al., 2004] focus on the agent reasoning about target position in an organisation
  - [Silva et al., 2008] considers both an agent and an organisation centred approach:
    - (subjective) evaluation done by the agents is sent to the (centralised) organisation that publishes the results
    - requires evaluation of agents as evaluators
    - considers only obedience to norms

- Reputation as a kind of **Shared voices** [Conte and Paolucci, 2002]
General view of the proposal

1. Our proposal will focus on the organisation (not on the agent): The agent’s behaviour is constantly evaluated by the organisation with respect to the roles it plays and the result of this evaluation is published to other members.

2. This information helps then the agents to construct their reputation of others inside the organisation:
   - it is not a simple label assigned to agents (‘Bob plays editor’) but an evaluation of the performance of the agents in an organisational context
   - it does not depend on a subjective evaluation, but is rather precisely computed

3. Hence the reputation influences decision processes, agents take care of their reputation and behave accordingly

   (this presentation will focus on the first step)
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A&A Model

- Artifacts, Agents, Workspaces [Ricci et al., 2007]
- background in Activity Theory and Distributed Cognition
Organisational artifacts in ORA4MAS

- based on A&A model [Kitio et al., 2008]
- Artifacts in charge of regimentations, detection and evaluation of norms compliance
- Agents are in charge of decisions about sanctions
Instrument to help in the enforcement of norms — *indirect sanction system*

Considers the public character of the reputation process

Provides an evaluation of the agents from the organisation point of view
The **obedience** of an agent is computed by the number of obligated goals an agent achieves.

**Definition (general obedience)**

\[
o(\alpha) = \frac{\{\varphi \mid \text{obligated}(\alpha, \varphi) \land \text{achieved}(\alpha, \varphi)\}}{\{\varphi \mid \text{obligated}(\alpha, \varphi)\}}
\]

**Definition (obedience in the context of a role)**

\[
o_r(\alpha, \rho) = \frac{\{\varphi \mid \text{obligated}(\alpha, \varphi) \land gr(\varphi, \rho) \land \text{achieved}(\alpha, \varphi)\}}{\{\varphi \mid \text{obligated}(\alpha, \varphi) \land gr(\varphi, \rho)\}}
\]

where \(gr\) represents the goals specified as obligations for a role.

\[
gr(\varphi, \rho) \overset{\text{def}}{=} \text{goal\_mission}(\varphi, m) \land \text{obl}(\rho, m)
\]

other contexts could be considered: scheme, mission, ...
The **pro-activeness** of an agent is computed by the number of goals it achieves such that it is not obligated to fulfil that goal in a scheme.

**Definition (general pro-activeness)**

\[ p(\alpha) = \frac{\# \{ \varphi \mid \text{achieved}(\alpha, \varphi) \land \neg \text{obligated}(\alpha, \varphi) \} }{\# \Phi \# S} \]

where \( \# \Phi \# S \) represents the total number of goals in all schemes.

**Definition (pro-activeness in the context of a role)**

\[ p_r(\alpha, \rho) = \frac{\# \{ \varphi \mid \text{achieved}(\alpha, \varphi) \land \neg \text{obligated}(\alpha, \varphi) \land \text{gr}(\varphi, r) \} }{\# \{ \varphi \mid \text{committed}(\alpha, m, \_ ) \land \text{gm}(\varphi, m) \land \text{gr}(\varphi, r) \}} \]
Agent evaluation 3/3 — results

The results produced by an agent is computed by the number of successful execution of scheme where it participates; it means the agent somehow share the success of the scheme execution and likely has helped for that success.

Definition (general results)

\[
r(\alpha) = \frac{\#\{s \mid committed(\alpha, -, s) \land succeeded(s)\}}{\#\{s \mid committed(\alpha, -, s)\}}
\]

- this criteria is collective and
- create a dependence among the agents
- enforce selection of good partners (e.g. by means of reputation)
Agent overall evaluation

Definition (agent overall evaluation)

\[ e(\alpha) = \frac{\gamma o(\alpha) + \delta p(\alpha) + \epsilon r(\alpha)}{\gamma + \delta + \epsilon} \]

\[ e_r(\alpha, \rho) = \frac{\gamma o(\alpha, \rho) + \delta p(\alpha, \rho) + \epsilon r(\alpha, \rho)}{\gamma + \delta + \epsilon} \]

where

- \( \gamma \) is the importance of obedience
- \( \delta \) is the importance of the pro-activeness
- \( \epsilon \) is the importance of results
Example: “writing a paper” — specification

(a) Structural Specification

(b) Functional Specification - “write-paper”

- editor permission mMan
- writer obligation mCol
- writer obligation mBib

(c) Deontic Specification
<table>
<thead>
<tr>
<th>Agent</th>
<th>Role</th>
<th>Mission</th>
<th>Achieved Goals</th>
<th>Unachieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>$s_1$</td>
<td>Bob</td>
<td>editor</td>
<td>mMan</td>
<td>wtitle, wabs, wsectitle, wcon</td>
</tr>
<tr>
<td>ok</td>
<td>Alice</td>
<td>writer</td>
<td>mCol</td>
<td>wsec</td>
</tr>
<tr>
<td></td>
<td>Alice</td>
<td>writer</td>
<td>mBib</td>
<td>wref</td>
</tr>
<tr>
<td>$s_2$</td>
<td>Bob</td>
<td>editor</td>
<td>mMan</td>
<td>wtitle, wabs, wsectitle, wcon</td>
</tr>
<tr>
<td>nok</td>
<td>Marc</td>
<td>writer</td>
<td>mCol</td>
<td>wsec</td>
</tr>
<tr>
<td></td>
<td>Marc</td>
<td>writer</td>
<td>mBib</td>
<td>wref</td>
</tr>
<tr>
<td>$s_3$</td>
<td>Bob</td>
<td>editor</td>
<td>mMan</td>
<td>wtitle, wabs, wsectitle, wcon</td>
</tr>
<tr>
<td>ok</td>
<td>Alice</td>
<td>writer</td>
<td>mCol</td>
<td>wsec, wref</td>
</tr>
<tr>
<td></td>
<td>Marc</td>
<td>writer</td>
<td>mCol</td>
<td>wsec</td>
</tr>
<tr>
<td></td>
<td>Marc</td>
<td>writer</td>
<td>mBib</td>
<td>wref</td>
</tr>
</tbody>
</table>

**Evaluation:**

<table>
<thead>
<tr>
<th>Agent</th>
<th>$o_{editor}$</th>
<th>$o_{writer}$</th>
<th>$o$</th>
<th>$p$</th>
<th>$r$</th>
<th>$e$ ($\gamma = 1$, $\delta = 5$, $\epsilon = 2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bob</td>
<td>12/12</td>
<td>–</td>
<td>12/12</td>
<td>0/18</td>
<td>2/3</td>
<td>0.29</td>
</tr>
<tr>
<td>Alice</td>
<td>–</td>
<td>3/3</td>
<td>3/3</td>
<td>1/18</td>
<td>2/2</td>
<td>0.41</td>
</tr>
<tr>
<td>Marc</td>
<td>–</td>
<td>3/4</td>
<td>3/4</td>
<td>0/18</td>
<td>2/3</td>
<td>0.26</td>
</tr>
</tbody>
</table>
Summary

- Reputation artifact as an instrument to enforce norms — indirect sanction system
- Considers the public character in the reputation process
- Considers obedience, pro-activeness, and results in different contexts (general, role, mission)
  - by pro-activeness and result, we can even support agents that do not achieve their obligations but contribute to the overall system

Future works

- Integrate the ‘agent side’
- Experiment and validate the overall approach


