

Instrumenting Multi-Agent Organisations with Reputation Artifacts

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Outline

- Context and motivation
- Reputation artifact
- Example
- Conclusion

Multi-Agent Organisation

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
- ~> Detection of violations, decision about sanctions must be considered

Objective

- 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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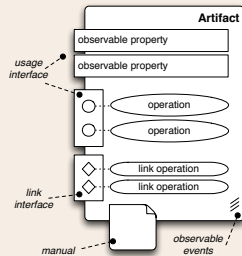
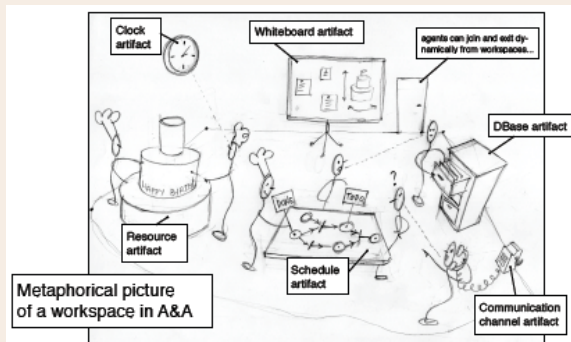
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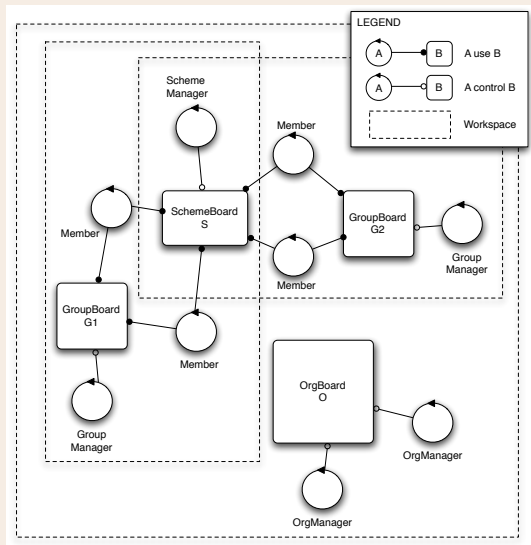
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A&A Model

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

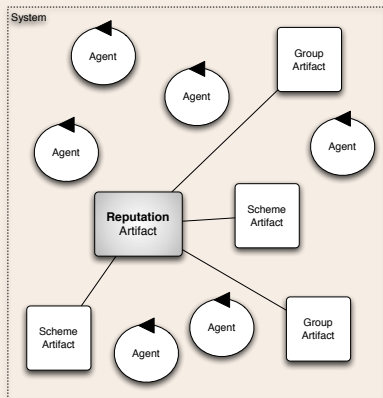


Organisational artifacts in ORA4MAS



- 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

Reputation Artifact



- 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

Agent evaluation 1/3 — obedience

The **obedience** of an agent is computed by the number of obligated goals an agent achieves

Definition (general obedience)

$$o(\alpha) = \frac{\#\{\varphi \mid \text{obligated}(\alpha, \varphi) \wedge \text{achieved}(\alpha, \varphi)\}}{\#\{\varphi \mid \text{obligated}(\alpha, \varphi)\}}$$

Definition (obedience in the context of a role)

$$o_r(\alpha, \rho) = \frac{\#\{\varphi \mid \text{obligated}(\alpha, \varphi) \wedge \text{gr}(\varphi, \rho) \wedge \text{achieved}(\alpha, \varphi)\}}{\#\{\varphi \mid \text{obligated}(\alpha, \varphi) \wedge \text{gr}(\varphi, \rho)\}}$$

where *gr* represents the goals specified as obligations for a role

$$\text{gr}(\varphi, \rho) \stackrel{\text{def}}{=} \text{goal_mission}(\varphi, m) \wedge \text{obl}(\rho, m)$$

other contexts could be considered: scheme, mission, ...

Agent evaluation 2/3 — pro-activeness

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)

$$p(\alpha) = \frac{\#\{\varphi \mid \text{achieved}(\alpha, \varphi) \wedge \neg \text{obligated}(\alpha, \varphi)\}}{\#\Phi \#\mathcal{S}}$$

where $\#\Phi \#\mathcal{S}$ represents the total number of goals in all schemes

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

$$p_r(\alpha, \rho) = \frac{\#\{\varphi \mid \text{achieved}(\alpha, \varphi) \wedge \neg \text{obligated}(\alpha, \varphi) \wedge \text{gr}(\varphi, r)\}}{\#\{\varphi \mid \text{committed}(\alpha, m, -) \wedge \text{gm}(\varphi, m) \wedge \text{gr}(\varphi, r)\}}$$

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)

$$r(\alpha) = \frac{\#\{s \mid \text{committed}(\alpha, -, s) \wedge \text{succeeded}(s)\}}{\#\{s \mid \text{committed}(\alpha, -, s)\}}$$

- 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)

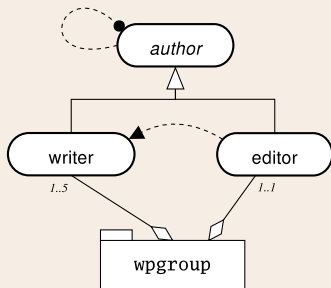
$$e(\alpha) = \frac{\gamma o(\alpha) + \delta p(\alpha) + \epsilon r(\alpha)}{\gamma + \delta + \epsilon}$$

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

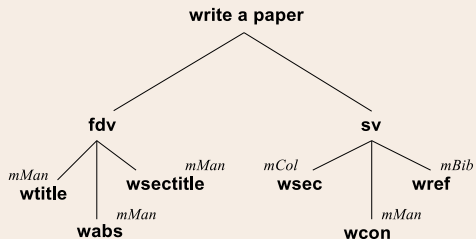
where

- γ is the importance of obedience
- δ is the importance of the pro-activeness
- ϵ is the importance of results

Example: “writing a paper” — specification



(a) Structural Specification



(b) Functional Specification -
“write-paper”

editor	<i>permission</i>	<i>mMan</i>
writer	<i>obligation</i>	<i>mCol</i>
writer	<i>obligation</i>	<i>mBib</i>

(c) Deontic Specification

	Agent	Role	Mission	Achieved Goals	Unachieved
s_1 ok	Bob	editor	mMan	wtitle, wabs, wsectitle, wcon	
	Alice	writer	mCol	wsec	
	Alice	writer	mBib	wref	
s_2 nok	Bob	editor	mMan	wtitle, wabs, wsectitle, wcon	
	Marc	writer	mCol	wsec	
	Marc	writer	mBib	wref	
s_3 ok	Bob	editor	mMan	wtitle, wabs, wsectitle, wcon	
	Alice	writer	mCol	wsec, wref	
	Marc	writer	mCol	wsec	
	Marc	writer	mBib		wref

Evaluation:

Agent	o_{editor}	o_{writer}	o	p	r	$e (\gamma = 1, \delta = 5, \epsilon = 2)$
Bob	12/12	–	12/12	0/18	2/3	0.29
Alice	–	3/3	3/3	1/18	2/2	0.41
Marc	–	3/4	3/4	0/18	2/3	0.26

Conclusion

- 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

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