Programming Open Systems with Agents, Environments and Organizations

Michele Piunti[1] Alessandro Ricci[1] Olivier Boissier[2]
Jomi F. Hübner[3]

[1]Università degli studi di Bologna - DEIS, Bologna - Italy.
{michele.piunti | a.ricci}@unibo.it

[2]Ecole Nationale Superieure des Mines - G2I St-Etienne - France
boissier@emse.fr

[3]Federal University of Santa Catarina - DAS, Florianópolis - Brazil
jomi@das.ufsc.br

9 6 10

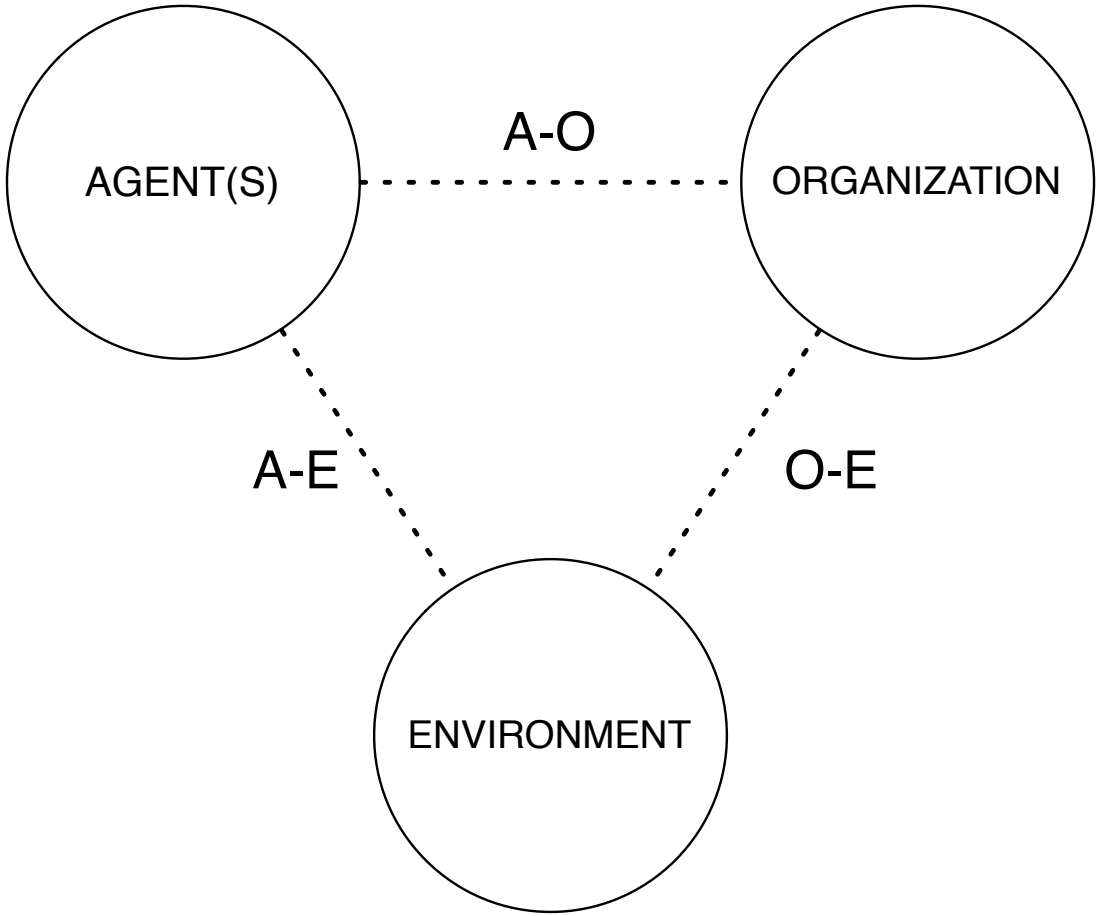
WOA 2010 – Rimini

Outline

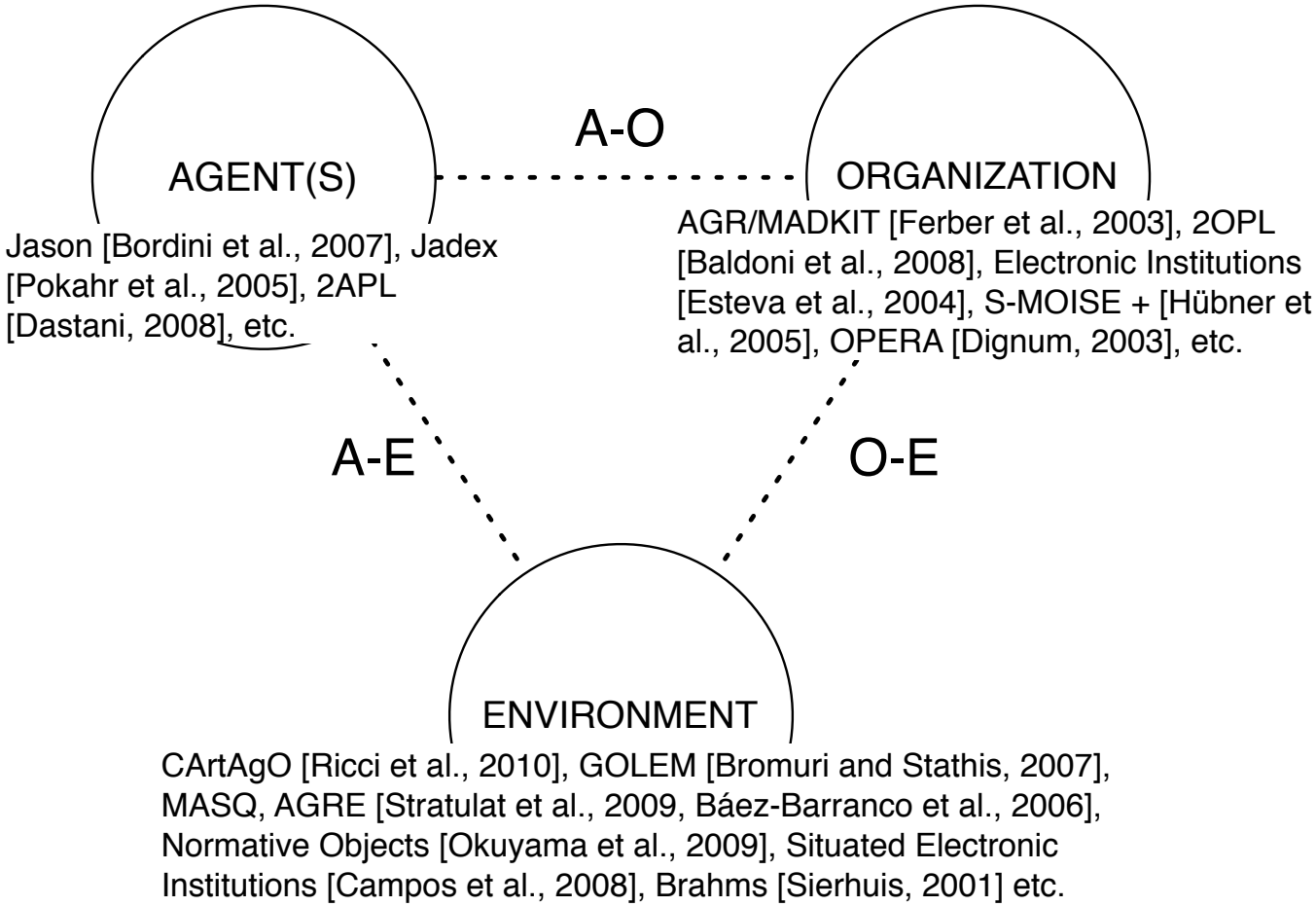
Current Issues in MAS Programming

- Seamless integration of multiple entities and mechanisms
- Interaction, Openness

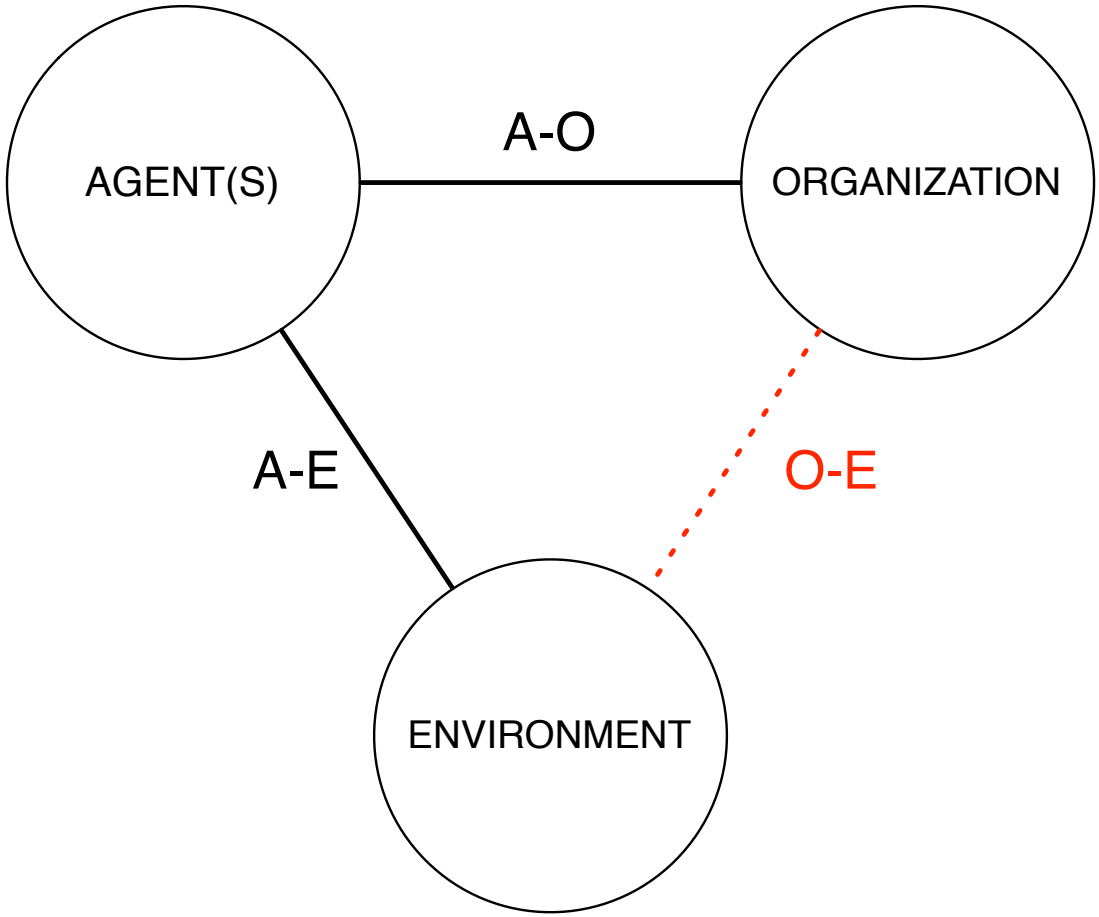
Current Approaches in MAS Programming



Current Approaches in MAS Programming



A-E-O Integrations



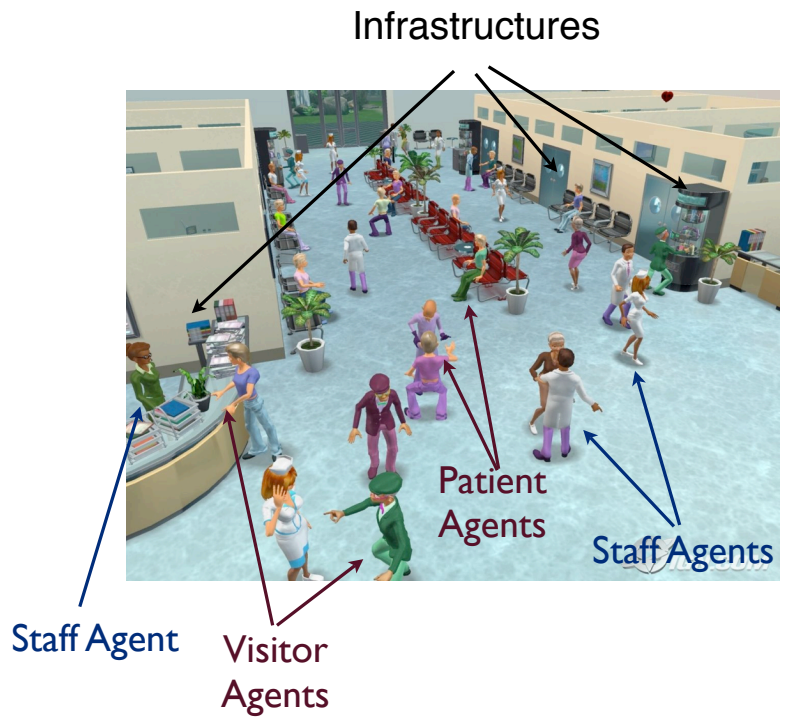
The Idea: *Embodied Organisations*

Human Organisations Analogy

- instrumentation of the environment with specific Infrastructures that are explicitely conceived for easing humans' activities/tasks in organisations [Kirsh, 1995].

Hospital Scenario Example:

- A visitor entering the hospital has not a complete knowledge of the organisation behind
- Visitors (as users) ignore the mechanisms and the structures at the basis of the organisation
- Nonetheless, visitors find those things which they are interested in, means to achieve their goals finally



Expected Outcomes

Integration and Synergy between E and O

- enabling agents to profitably interact with both organisation and other environmental entities;
- enabling organisation to control agents and regiment environmental resources;
- allowing environmental changes to affect both organisation dynamics and agents activities;

⇝ At the application level, possibility:

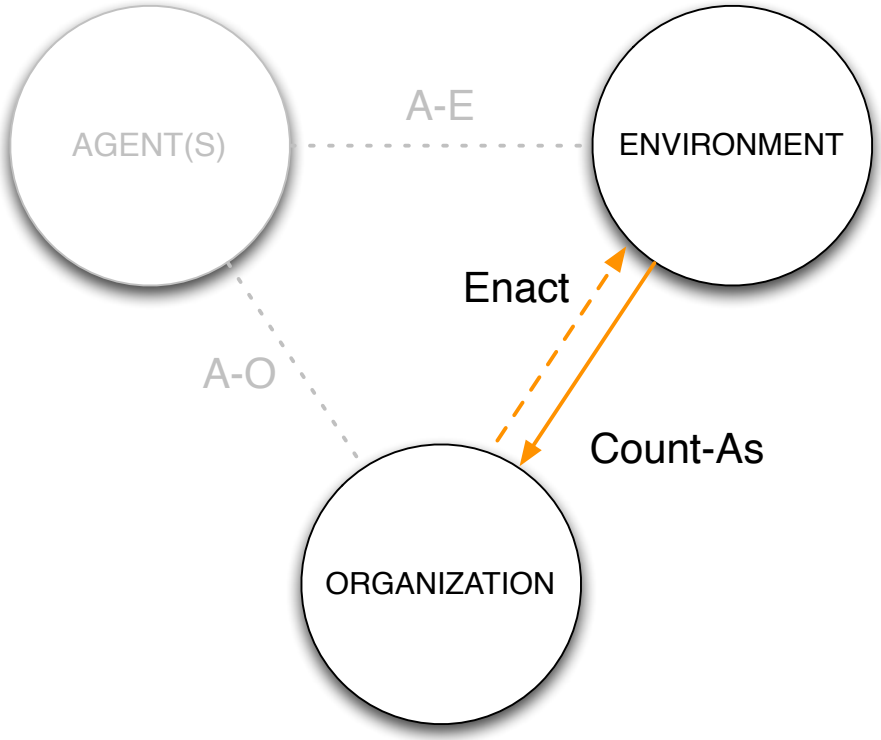
- To reconcile agents and their work environments with institutional dimensions (i.e. organisations);
- To exploit a strong notion of agency, i.e., mental attitudes (purposes, knowledge), events, perception
- To cope with Interoperability and Openness

Outline

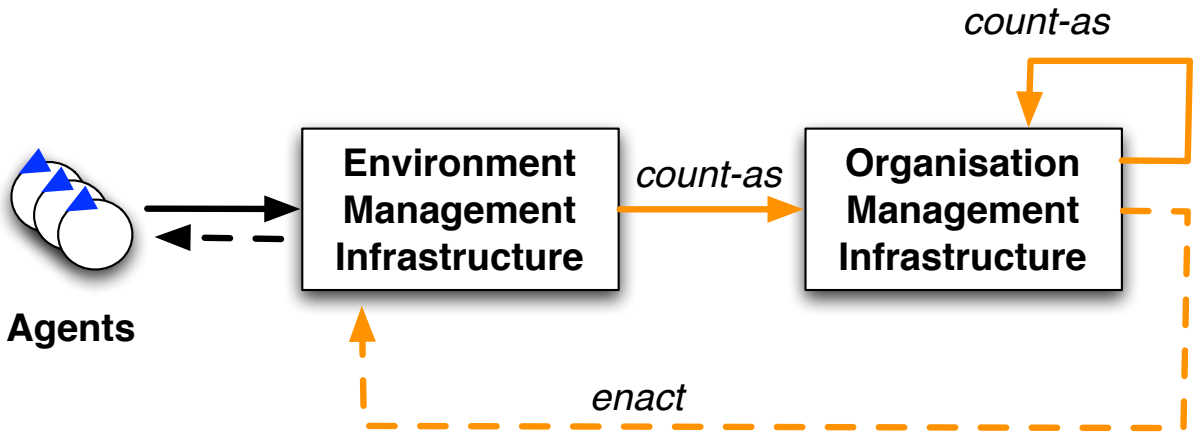
Constitutive Rules

Constitutive Rules [Searle, 1964]

- Typical of human societies (*Social Reality* [Searle, 1997])
- The reification of a state in a particular context may constitute the realization of a particular institutional/organizational fact



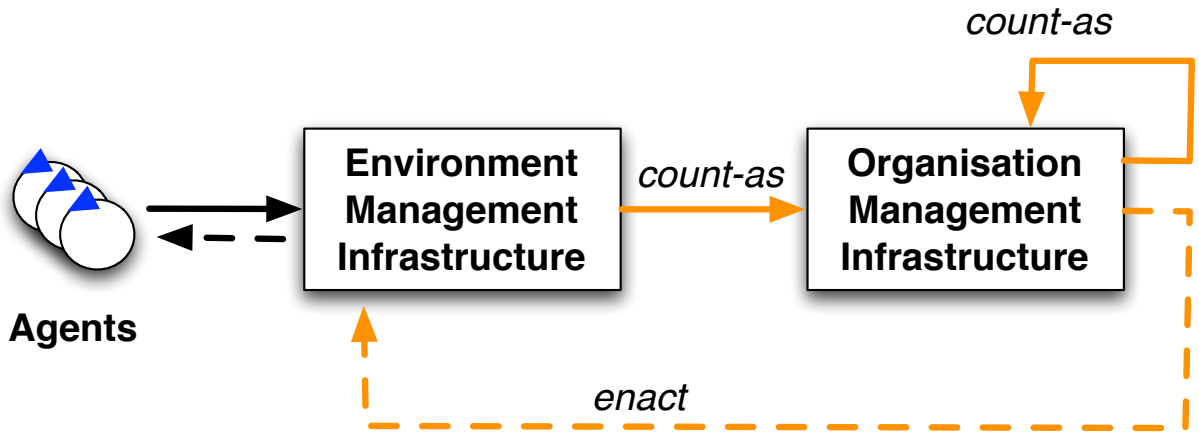
Embodied Organization Rules



Emb-Org-Rules

- Used to automate particular dynamics between E-O:

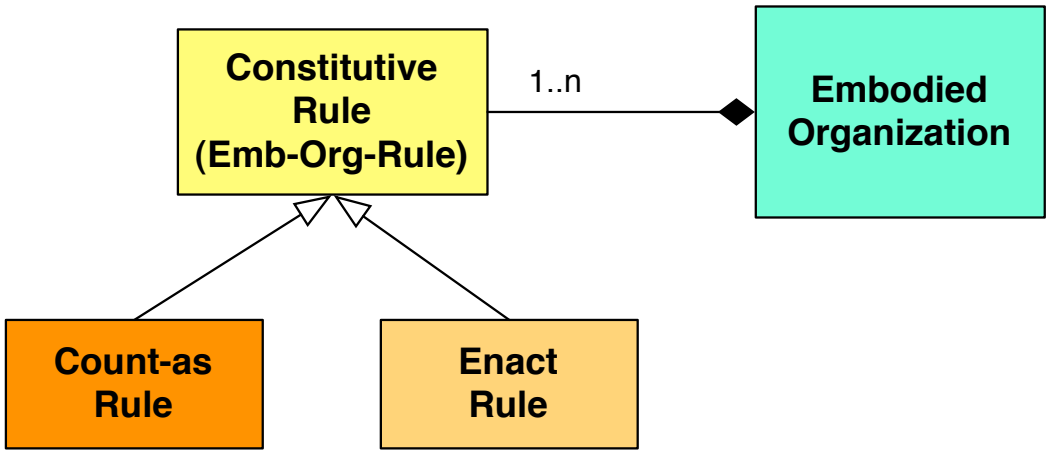
Embodied Organization Rules



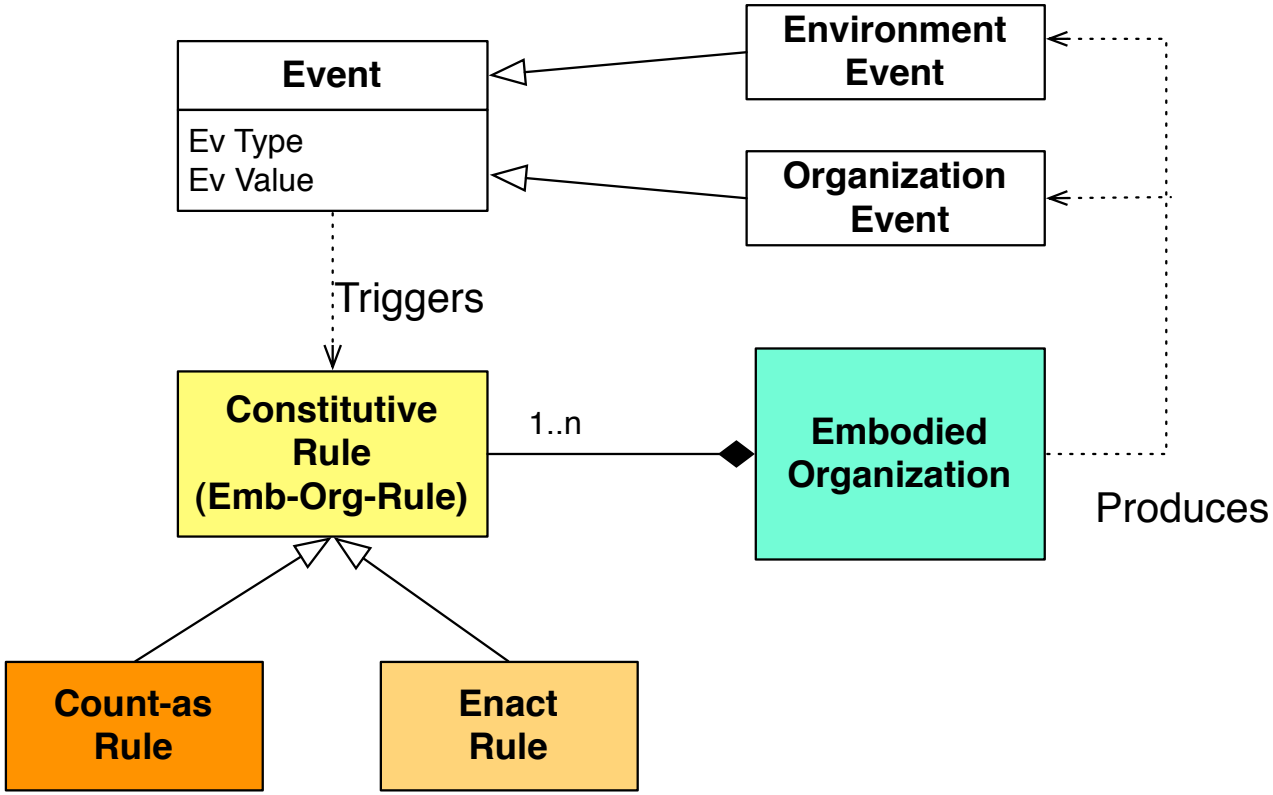
Emb-Org-Rules

- Used to automate particular dynamics between E-O:
  - "Entering an ambulatory room count-as adopting the role patient"
  - "Finalizing the payment operation on the billing machine count-as achieving the goal pay"
  - "A sold out in the visit schedule enact the suspension of the booking service"

Embodied Organisation Meta-Model



Embodied Organisation Meta-Model



Embodied Organisation Rules

Event-Condition-Action (ECA) rules: "when *ev* in the context *c* apply *oeExp*"

- $+ev : c \rightarrow oeExp^*$
- *ev* are organisational event (org-ev) or environment event (env-ev)
- *c* refers to observable states of the Organisation or of the Environment
- *oeExp* refers to organisation embodiement expressions

Embodied Organisation Rules

Event-Condition-Action (ECA) rules: "when *ev* in the context *c* apply *oeExp*"

- $+ev : c \rightarrow oeExp^*$
- *ev* are organisational event (org-ev) or environment event (env-ev)
- *c* refers to observable states of the Organisation or of the Environment
- *oeExp* refers to organisation embodiement expressions

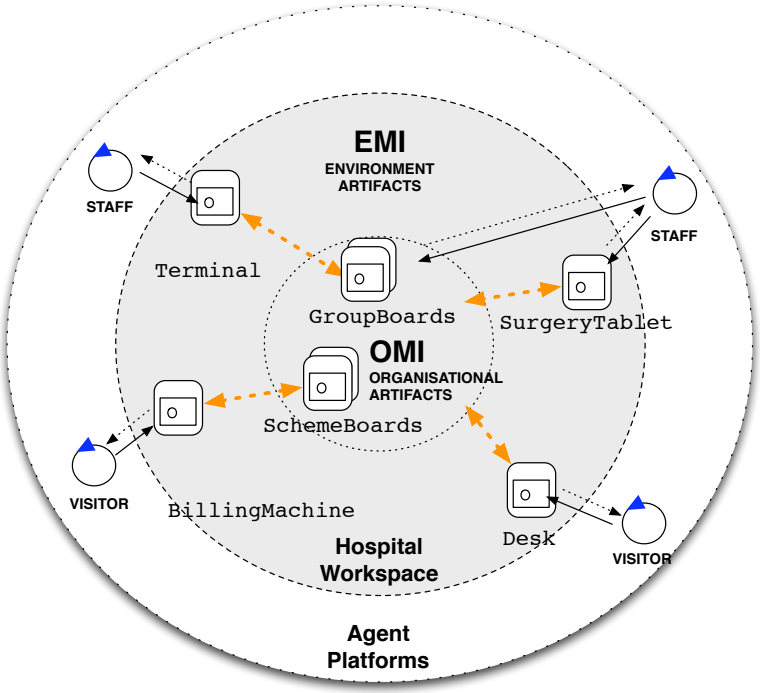
Organisation Embodiement Expressions include workspace operators:

(1)	`applyOp(`$target_{id}, op_{name}$ $[, Params]$`)`
(2)	`applyLop(`$target_{id}, op_{name}$ $[, Params]$`)`
(3)	`disable(`$target_{id}$ $[, ag_{id}]$ $\{, op_{name}\}$`)`
(4)	`enable(`$target_{id}$ $[, ag_{id}]$ $\{, op_{name}\}$`)`
(5)	`make(`$target_{id}, target_n$ $[, Params]$`)`
(6)	`dispose(`$target_{id}$`)`
(7)	`exclude(`ag_{id}`)`
(8)	`include(`ag_{id}`)`

where $target_{id}$ is the management component id, op_{name} is an organisation operation (org-op) or environment operation (env-op)

Outline

A Concrete Embodied Organisation



- EMI: Environment Management Infrastructure
- OMI: Organisation Management Infrastructure

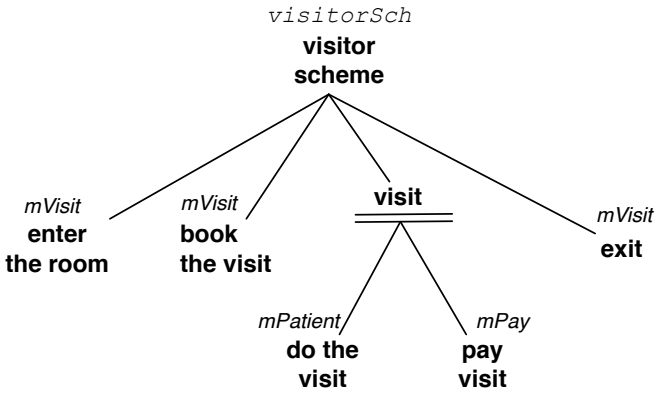
EMI based on CArtAgO Platform [Piunti et al., 2008, Ricci et al., 2009].

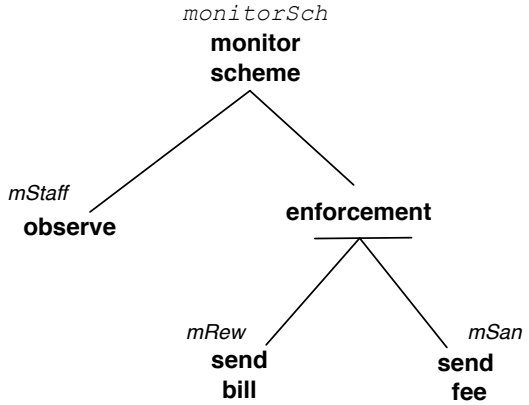
- env-op: operations provided by the “physical” artifacts
- env-ev: change of observable properties, results of operations, ...

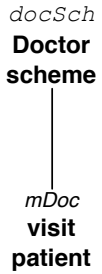
OMI based on ORA4MAS [Hübner et al., 2009]:

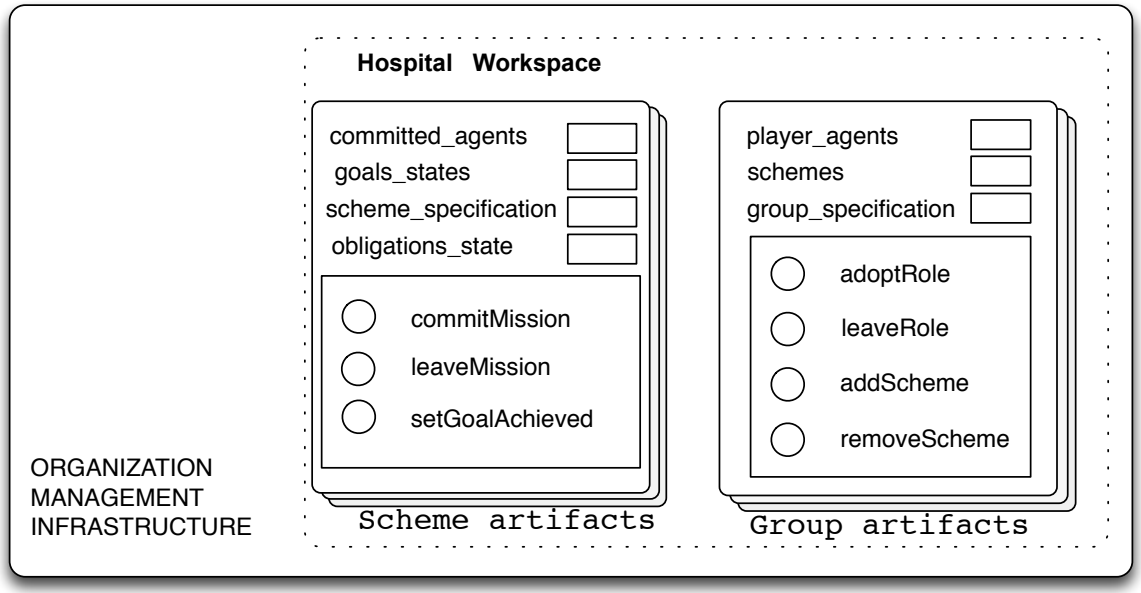
- org-op: adopt-role, commit-mission, achieve-goal, ...
- org-ev: any change of the organisation state

Hospital Scenario

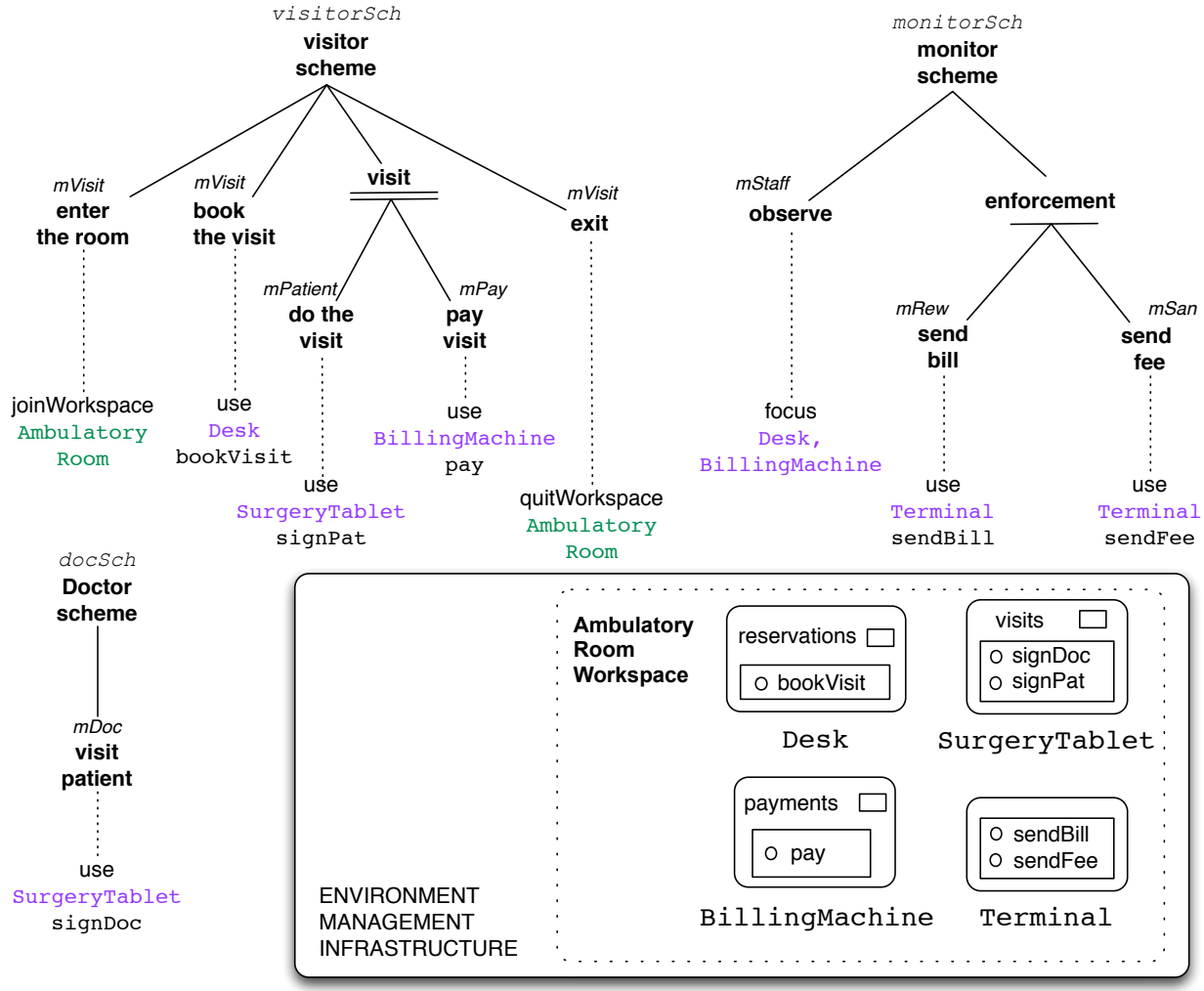








Hospital Scenario



Hospital Scenario
Count-as Rule Example

An event occurring in the system may “count-as” an institutional event and **automatically update** the organisation

```
+join_req(Ag) : true
->  make("visitorGroupBoard",
"OMI.GroupBoard",
["moise/hospital.xml","visitGroup"]);
     make("visitorSchBoard",
"OMI.SchemeBoard",
["moise/hospital.xml","visitorSch"]);
     apply("visitorGroupBoard",
adoptRole(Ag, "patient"));
     include(Ag).

+op_completed("visitorGroupBoard", _,
        adoptRole(Ag, "patient")) : true
-> apply("visitorSchBoard",
commitMission(Ag, "mPat")).
```

```
+ws_leaved(Ag) : true
-> apply("visitorGroupBoard",
         leaveRole(Ag, "patient")).

+op_completed("BillingMachine",
    Ag, pay) : true
-> apply("visitorSchBoard",
    setGoalAchieved(Ag, pay_visit)).


+op_completed("Terminal",
    Ag, sendFee) : true
-> apply("monitorSchBoard",
    setGoalAchieved(Ag, send_fee)).
```

Hospital Scenario
Enact Rule Example

Organisation may produce a control by enacting changes upon the environment (i.e., to promote equilibrium, avoid undesiderable states).

```
+signal("visitorGroupBoard",
  role_cardinality, visitor)
: true
-> disable("Desk", bookVisit).
```

```
+signal("monitorSchBoard",
  goal_non_compliance,
  obligation(Ag,
   ngoa(monitorSch,mRew,send_bill),
   achieved(monitorSch,send_bill,Ag),
   TTF)
: true
-> exclude(Ag).
```

Outline

Conclusions

An unifying approach to MAS programming

- Embodied Organisation;
- No need for agents to bring about organisational notions;
- Environment infrastructures succeed to mediate between agents and organisations;
- Global dynamics shaped on workspace events and transparently handled by the system.

Limitations and Aspects we do not address (yet):

- Complex interaction patterns may result in many relationship to be specified between E-O.
- Direct communication between agents (Agent-Agent interaction) through message passing (i.e. ACL) is not currently under the control of the organisation.

Perspectives

Ongoing and Future Work:

- To generalize the mechanism of *Workspace Laws* and *Embodied Organisation Rules* defining a wide set of inter-system functional relations (i.e. access control, security);
- To provide a general framweork for integrated MAS development

Applications in future ICT:

- Any scenario integrating artificial agents, devices, humans in the same application
- Future Internet, Cloud Computing
- Sociotechnical systems, pervasive computing
- Virtualization, Electronic Marketplaces, etc.

Bibliography I


Hübner, J. F., Boissier, O., Kitio, R., and Ricci, A. (2009).
Instrumenting Multi-Agent Organisations with Organisational Artifacts and Agents.
Journal of Autonomous Agents and Multi-Agent Systems.


Kirsh, D. (1995).
The intelligent use of space.
Artificial Intelligence, 73(1-2):31–68.


Piunti, M., Ricci, A., Braubach, L., and Pokahr, A. (2008).
Goal-directed Interactions in Artifact-Based MAS: Jadex Agents playing in CArtAgO Environments.
In *IEEE/WIC/ACM International Joint Conference on Web Intelligence and Intelligent Agent Technology (WI-IAT 2008)*, Sydney, NSW, Australia.


Ricci, A., Piunti, M., Viroli, M., and Omicini, A. (2009).
Environment programming in CArtAgO.
In *Multi-Agent Programming: Languages, Platforms and Applications, Vol. 2*, pages 259–288. Springer.


Searle, J. R. (1964).
Speech Acts, chapter What is a Speech Act?
Cambridge University Press.

Bibliography II


Searle, J. R. (1997).
The Construction of Social Reality.
Free Press.


Stratulat, T., Ferber, J., and Tranier, J. (2009).
MASQ: Towards an Integral Approach of Agent-Based Interaction.
In *Proc. of 8th Conf. on Agents and Multi Agent Systems (AAMAS-09)*.


Tinnemeier, N., Dastani, M., Meyer, J.-J., and van der Torre, L. (2009).
Programming normative artifacts with declarative obligations and prohibitions.
In *IEEE/WIC/ACM International Joint Conference on Web Intelligence and Intelligent Agent Technology (WI-IAT 2009)*.

Programming Open Systems with Agents, Environments and Organizations

Michele Piunti[1] Alessandro Ricci[1] Olivier Boissier[2]
Jomi F. Hübner[3]

[1]Università degli studi di Bologna - DEIS, Bologna - Italy.
{michele.piunti | a.ricci}@unibo.it

[2]Ecole Nationale Superieure des Mines - G2I St-Etienne - France
boissier@emse.fr

[3]Federal University of Santa Catarina - DAS, Florianópolis - Brazil
jomi@das.ufsc.br

9 6 10

WOA 2010 – Rimini