A Model for the Structural, Functional, and Deontic Specification of Organizations in Multiagent Systems

(the $\mathcal{M}$oise$^+$ model)

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Context

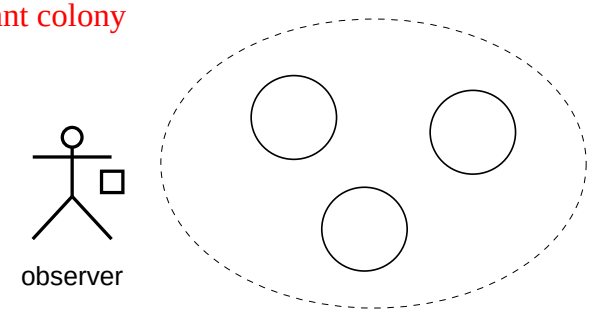
- A MAS has two properties which seems controversial:
  - ⋆ a **global** purpose
  - ⋆ **autonomous** agents

  While the autonomy of the agents is essential for the MAS, it may also cause the looseness of the global congruence/coherence.
- The **organization** of a MAS is used solve this conflict constraining the agents behavior towards its global purpose.
- Example: when an agent adopts a role, it indeed adopts a set of behavioral constraints that collaborates for the global purpose.

Problem

- The MAS organization may become inefficient in case the environment changes.
- **Reorganization** is mandatory.
- However, before tackling this problem, it is necessary to precisely define what is an organization.

Organizational points of view

	agents unable to represent their organization	
agent centered	ant colony  ☐ key: organizational description built by observation	

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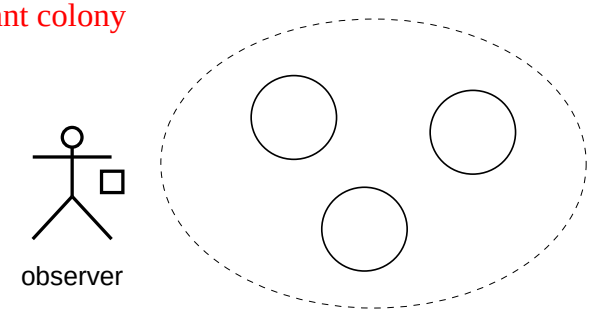
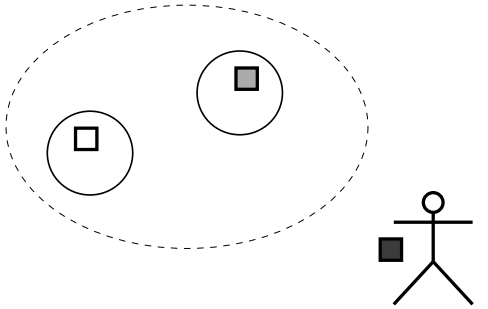
agent centered	ant colony  key: organizational description built by observation	social reasoning  observer

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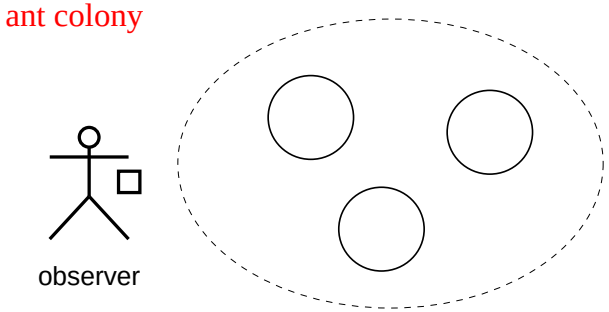
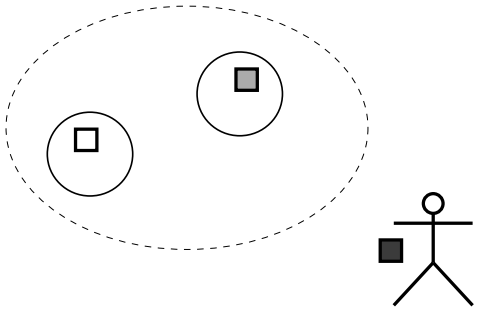
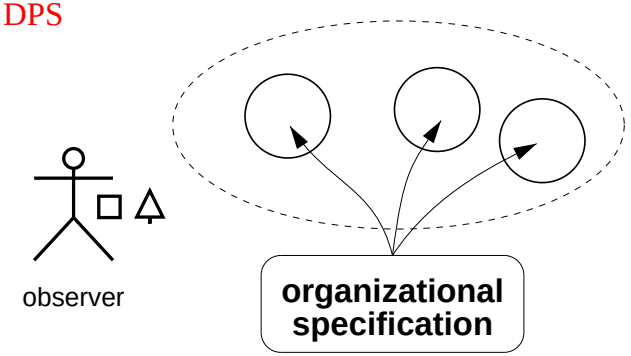
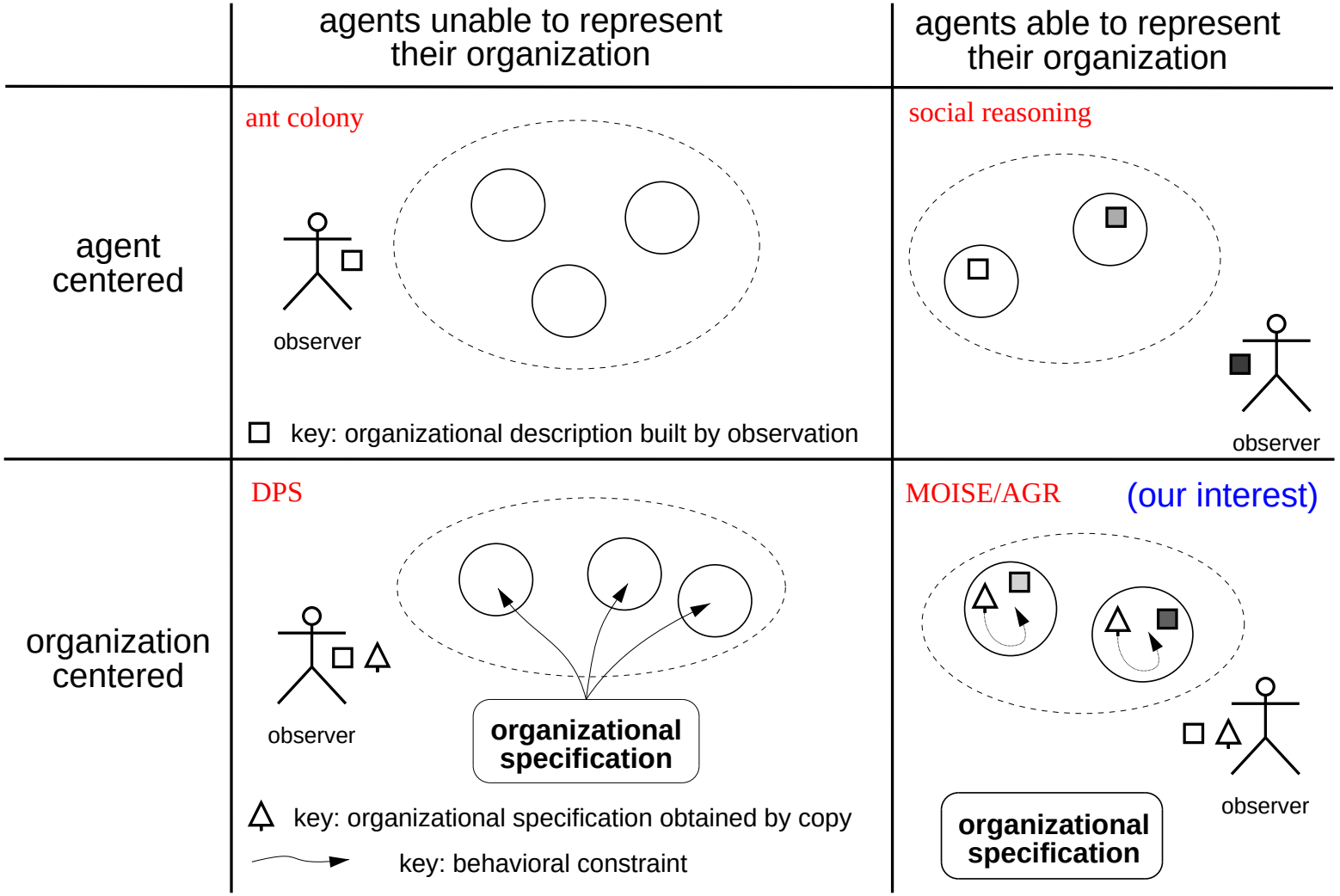
agent centered	ant colony  key: organizational description built by observation	social reasoning 
organization centered	DPS  key: organizational specification obtained by copy key: behavioral constraint	

Organizational points of view



How to describe/specify an organization?

In the case of an organizational centered point of view, there are three dimensions to describe an organization:

- by its structure (roles and groups, e.g. AGR [Ferber and Gutknecht, 1998]),
- by its functioning (global plans and tasks, e.g. TÆMS [Decker and Lesser, 1994], STEAM [Tambe, 1997]), or
- by deontic relations (agents' obligations, norms, . . .)

Addressing these three dimensions is a prolific approach when one wants to design or describe a MAS organization. The **problem** is to define these aspects in such a way that they can be both assembled in a single coherent specification.

The MOISE model

A first attempt to join roles with plans is the MOISE (Model of Organization for multI-agent SystEms) [Hannoun et al., 2000].

The MOISE is structured along three levels:

i) the behaviors that an agent is responsible for when it adopts a role (**individual** level),

ii) the interconnections between roles (**social** level), and

iii) the aggregation of roles in large structures (**collective** level).

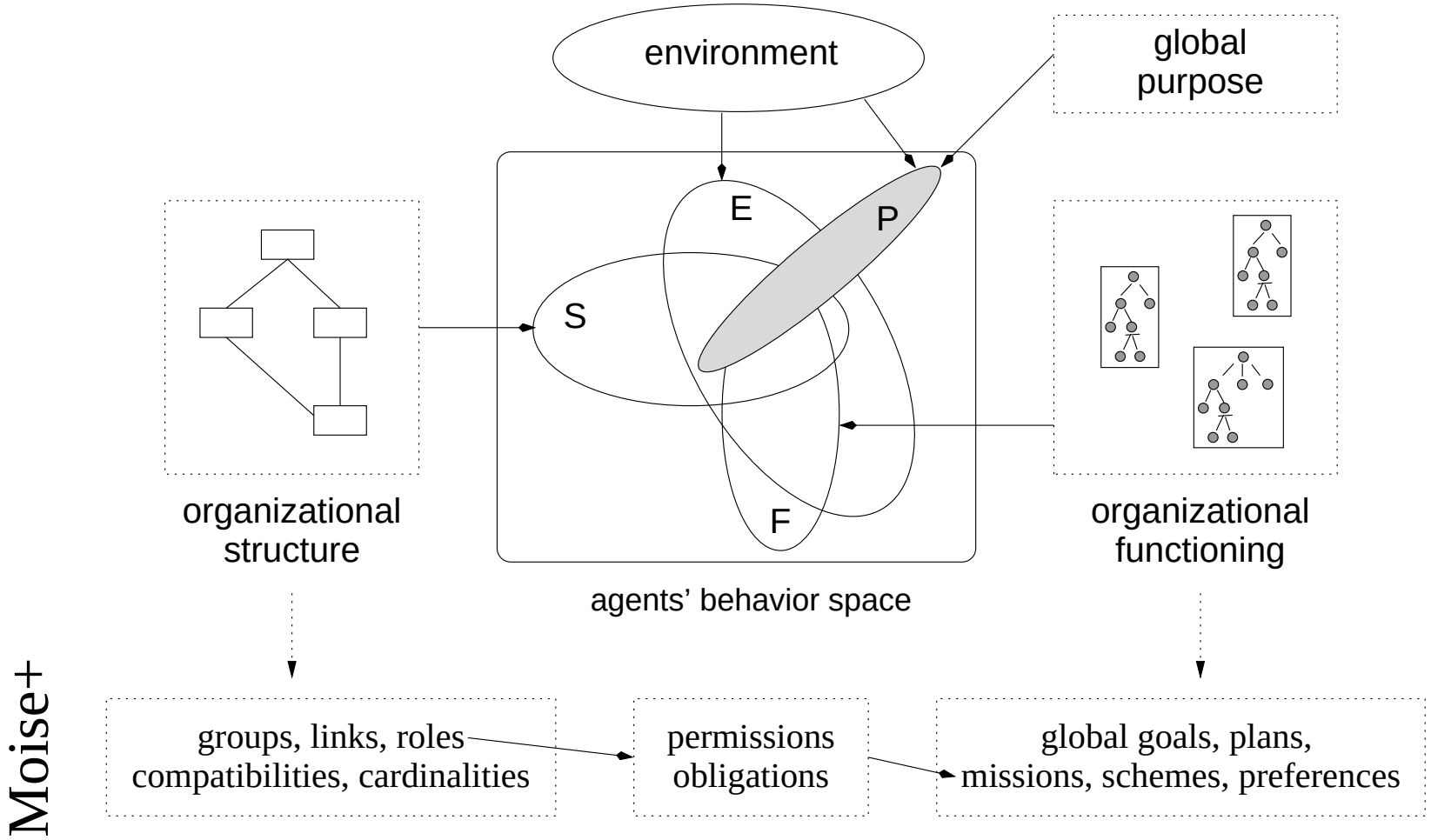
MOISE main shortcomings (concerning reorganization) are

- the lack of the concept of an explicit global plan and
- the strong dependence among the structure and the functioning.

Objective

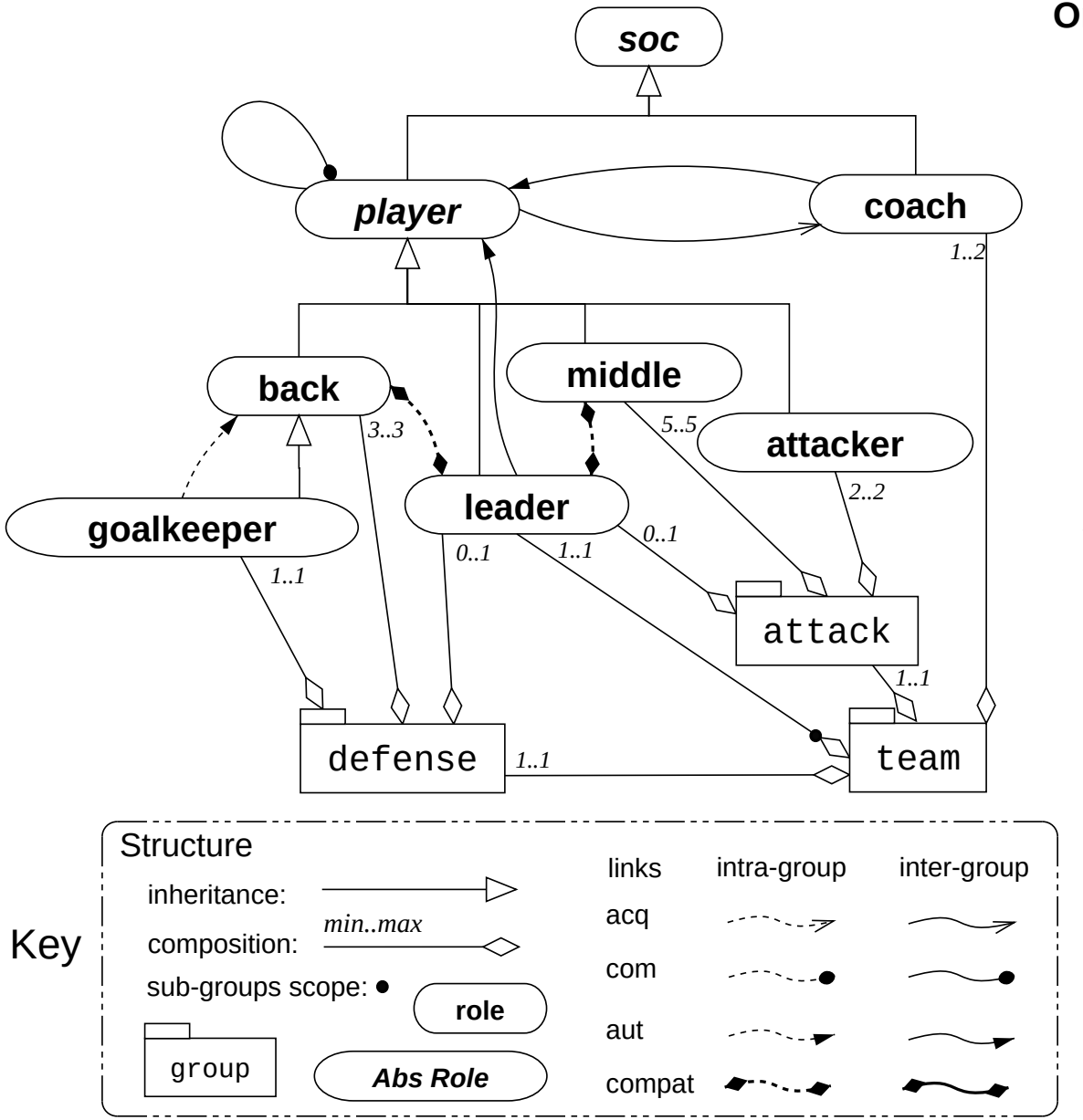
- A model that assembles the three dimensions in a coherent MAS organizational description suitable for the reorganization process (independence among dimensions)

General view of the $\mathcal{M}$oise$^+$ model



Structural dimension

- **Individual** level
  - ⋆ organizational **roles** and
  - ⋆ role inheritance
- **Social** level
  - ⋆ role **links** (authority, communication, . . .)
  - ⋆ representing the social role's relational aspect
- **Collective** level
  - ⋆ **groups** and sub-groups
  - ⋆ well-formation rules (roles' cardinalities and compatibilities)



Organizational Entity

(structure 3-5-2)

Marcos — goalkeeper

Lucio — back

Edmilson — back

Roque Jr. — back

Cafu — leader

Gilberto Silva — middle

Juninho — middle

Ronaldinho — middle

Roberto Carlos — middle

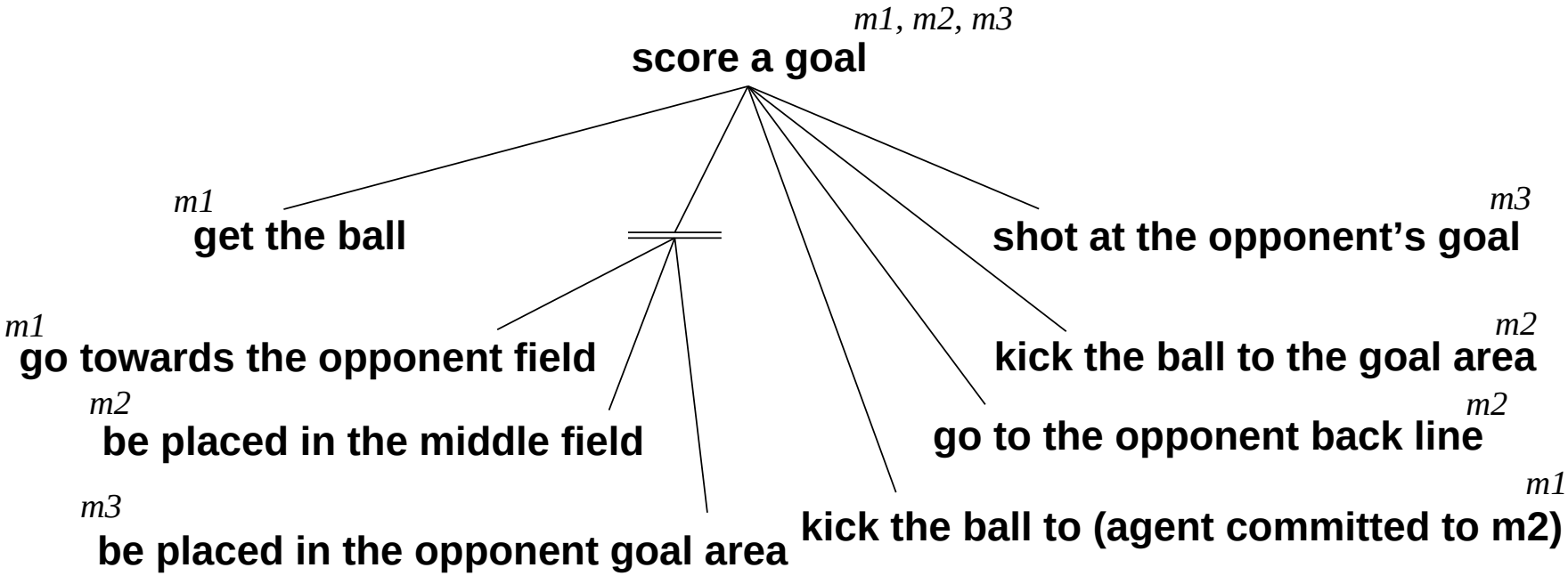
Ronaldo — attacker

Rivaldo — attacker

Functional dimension

Describes how the **global goals** are decomposed by **plans** and distributed to the agents by **missions**

- **Collective** level
  - ⋆ schemes: represents a global plan decomposition
- **Individual** level
  - ⋆ missions: a set of scheme's global goals that an agent may be committed to



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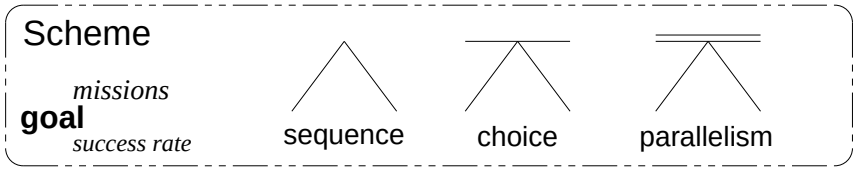
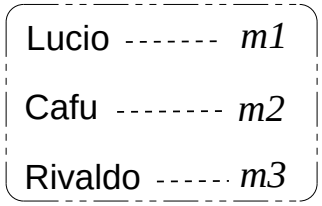


Organizational Entity



Deontic dimension

This dimension relates the structure and the functioning dimensions describing

- the **permissions** and **obligations** from roles to missions
- representing the social role's normative aspect

role	deontic relation	mission	time constraint
back	*per*	m_1	*Any*
middle	*obl*	m_2	*Any*
attacker	*obl*	m_3	*Any*

Conclusions

- The $\mathcal{M}$oise$^+$ model allows us to specify a MAS organization along the structural, functional, and deontic dimension, which are usually expressed separately in MAS organization models.
- The main contribution of this model for the reorganization process is the **independence** design of each one of these dimensions.
- We have used the $\mathcal{M}$oise$^+$ model to specify the three dimensions of a MAS organization in
  - a soccer domain and
  - a B2B (business to business) domain
- An implementation is available at `http://www.lti.pcs.usp.br/moise`

Future work

- grant to the MAS a kind of autonomy regarding its organization: **reorganization**.

  The agents must obey their organization, but they can change it.

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[Tambe, 1997] Tambe, M. (1997). Towards flexible teamwork. *Journal of Artificial Intelligence Reseearch*, 7:8–124.

Organizational Specification and Entity