How to control emergence of behaviours in a holarchy

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Outline

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Statement

- Self-organisation and emergence are common in MAS
- However it is still difficult to engineer
- Few AO methodologies take into account this concept

Motivation

- Self-organisation and emergence need engineering practice
- They require methodological frame to be commonly used

Proposition

- Definition of appropriate concept, namely Capacity, in order to control the emergence of behaviour
- Organisational Holonic framework
- Complete methodology: ASPECS

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Organisation Definition

Definition

An organisation is defined by a collection of roles that take part in systematic institutionalised patterns of interactions with other roles in a common context. This context consists in shared knowledge and social rules/norms, social feel- ings, etc and is defined according to an ontology. The aim of an organisation is to fulfil some requirements.

Role Definition

Definition

An expected behaviour (a set of role tasks ordered by a plan) and a set of rights and obligations in the organisation context. The goal of each Role is to contribute to the fulfilment of (a part of) the requirements of the organisation within which it is defined.

A role can be instantiated either as a Common Role or Boundary Role. A Common Role is a role located inside the designed system and interacting with either Common or Boundary Roles. A Boundary Role is a role located at the boundary between the system and its outside and it is responsible for interactions happening at this border (i.e. GUI, Database, etc).

Group Definition

Definition

An instance in the Agency Domain of an Organisation defined in the Problem Domain. It is used to model an aggregation of Agent Roles played by holons.

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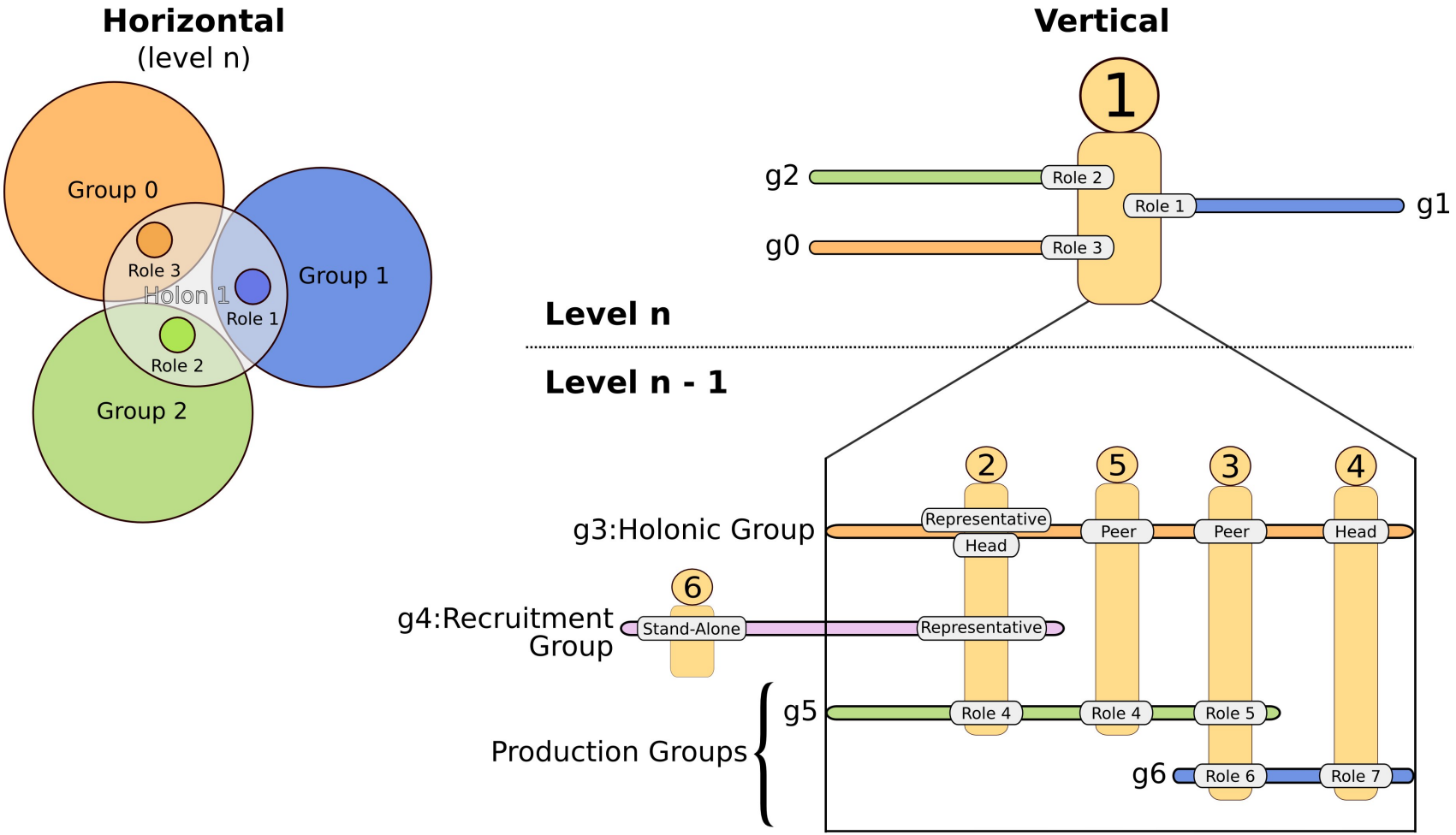
Holon and Holarchy

Definition

A holon is a self-similar structure composed of holons as sub-structures. This hierarchical structure is called a holarchy. A holon may be seen, depending on the level of observation, either as an autonomous "atomic" entity or as a group of interacting holons.

Each holon is an autonomous entity that has collective goals (shared by all members) and may be composed by other holons, called members or sub-holons. A composed holon is called super-holon. A super-holon is not only characterised by its members but also by their interaction patterns. This implies that two super-holons may be created from the same set of sub-holons if the way their members interact differ.

Two perspective of a holon



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Capacity Definition

Definition

A specification of a transformation of a part of the designed system or its environment. This transformation guarantees resulting properties if the system before the transformation satisfies a set of constraints. It may be considered as a specification of the pre- and post-conditions of a goal achievement.

Capacities have a dual aspect.

Heads side

Capacity use

It specifies the result of some role interactions, and consequently it specifies results that an organisation as a whole may achieve with its behaviour. In this sense, it is possible to say that an organisation may exhibit a capacity.

Tails side

Capacity use

Capacities may be used to decompose complex role behaviours by abstracting and externalising (for instance by delegating to other roles) a part of their role tasks into capacities. In this case the capacity may be considered as a behavioural building block that increases modularity and reusability of roles and organisations.

Capacity template

Name : Name of the capacity

Input : The inputs of the capacity

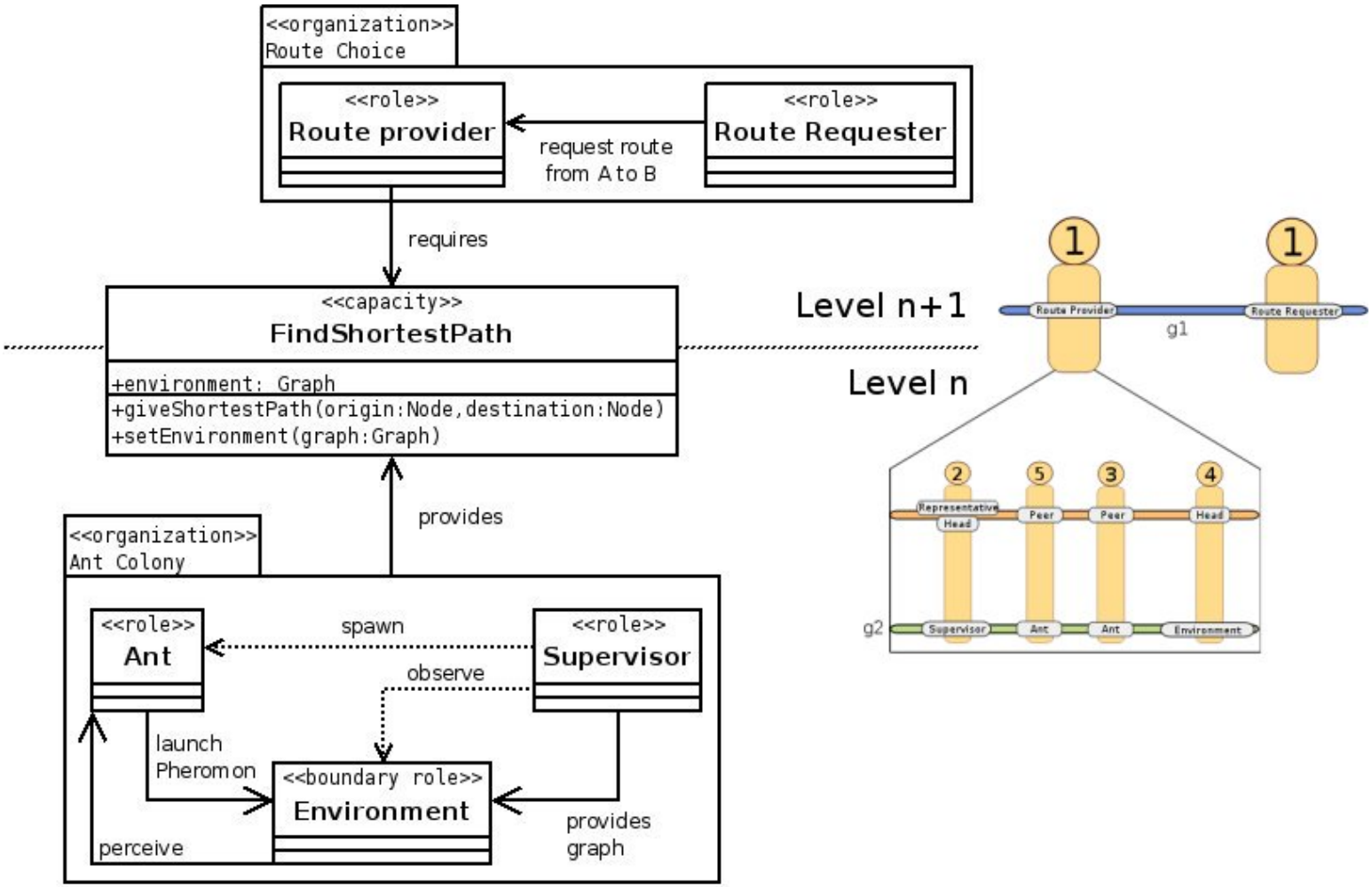
Output : The outputs of the capacity

Requires : What must be true before the capacity is called

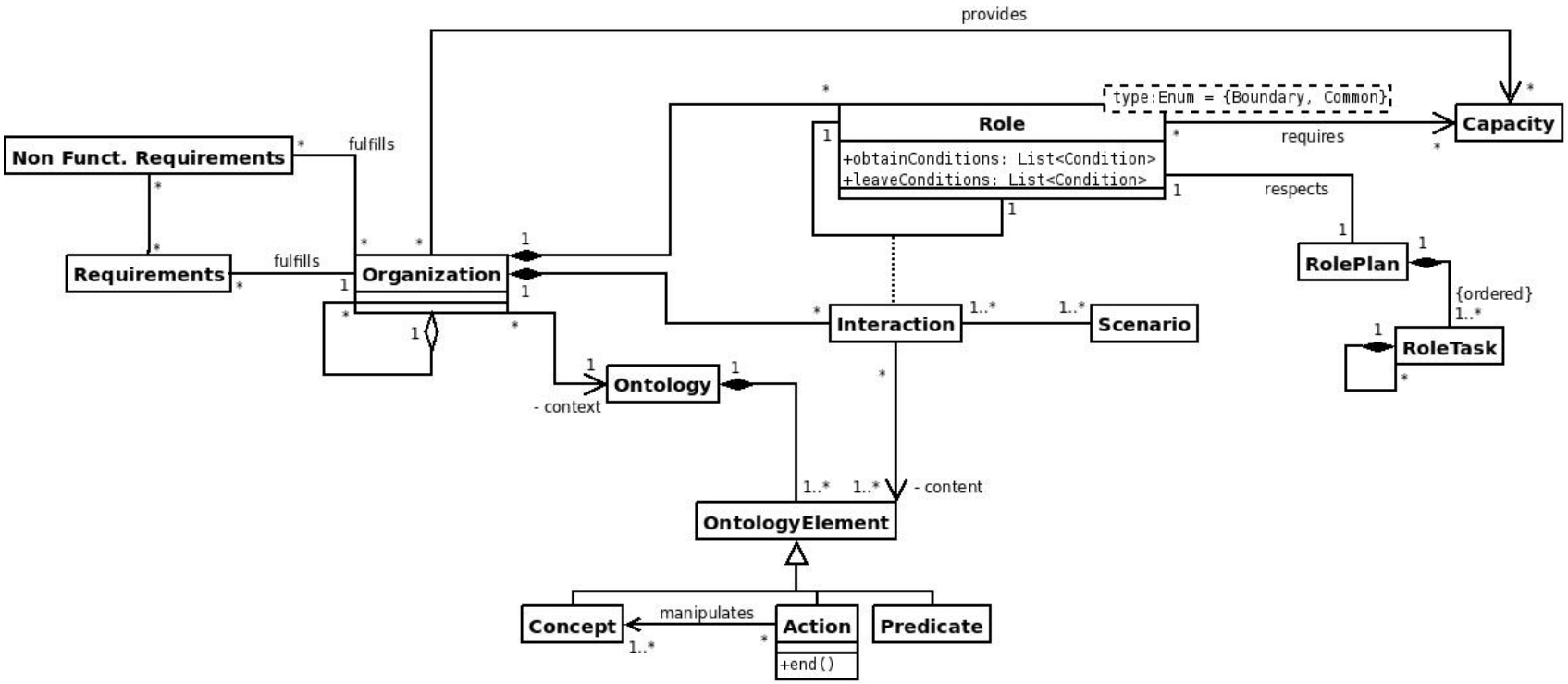
Ensures : The contract of the capacity

Textual Description :

Capacity example



Problem Domain Metamodel



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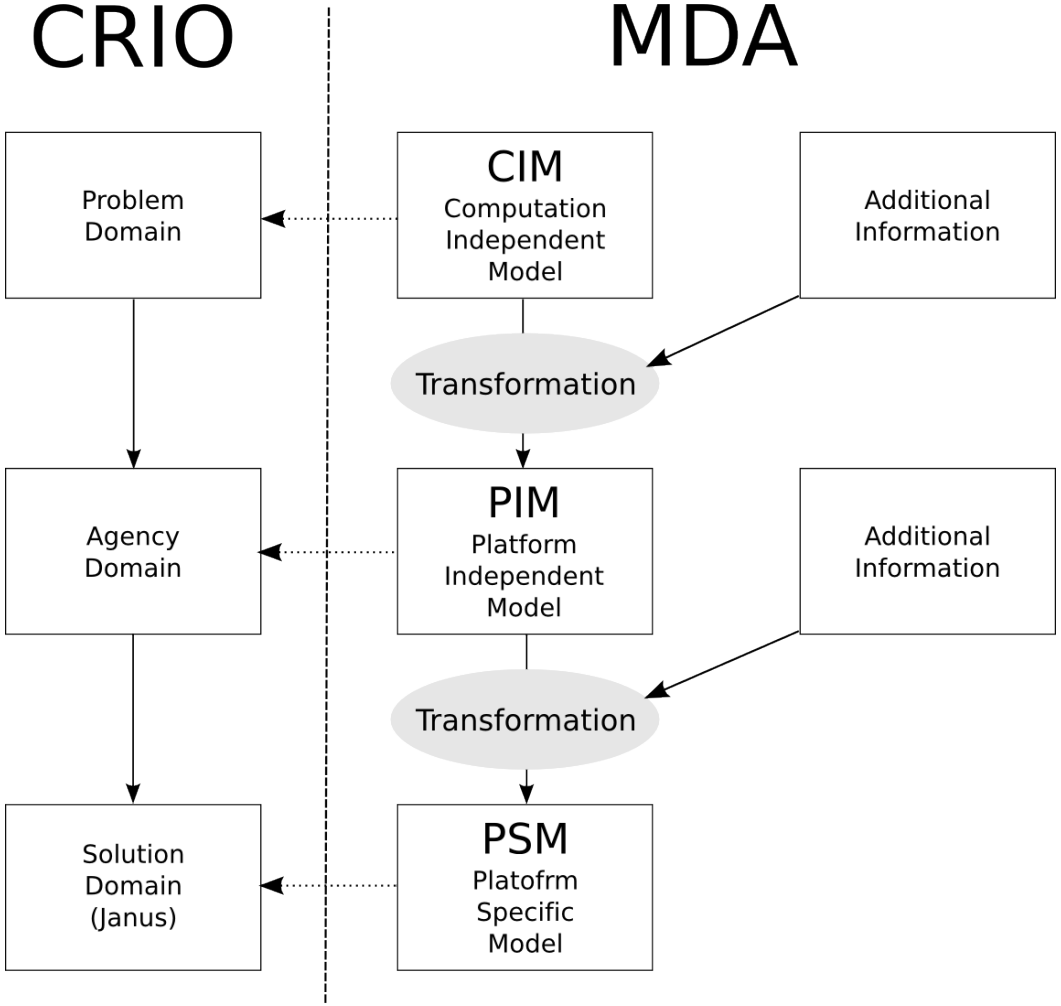
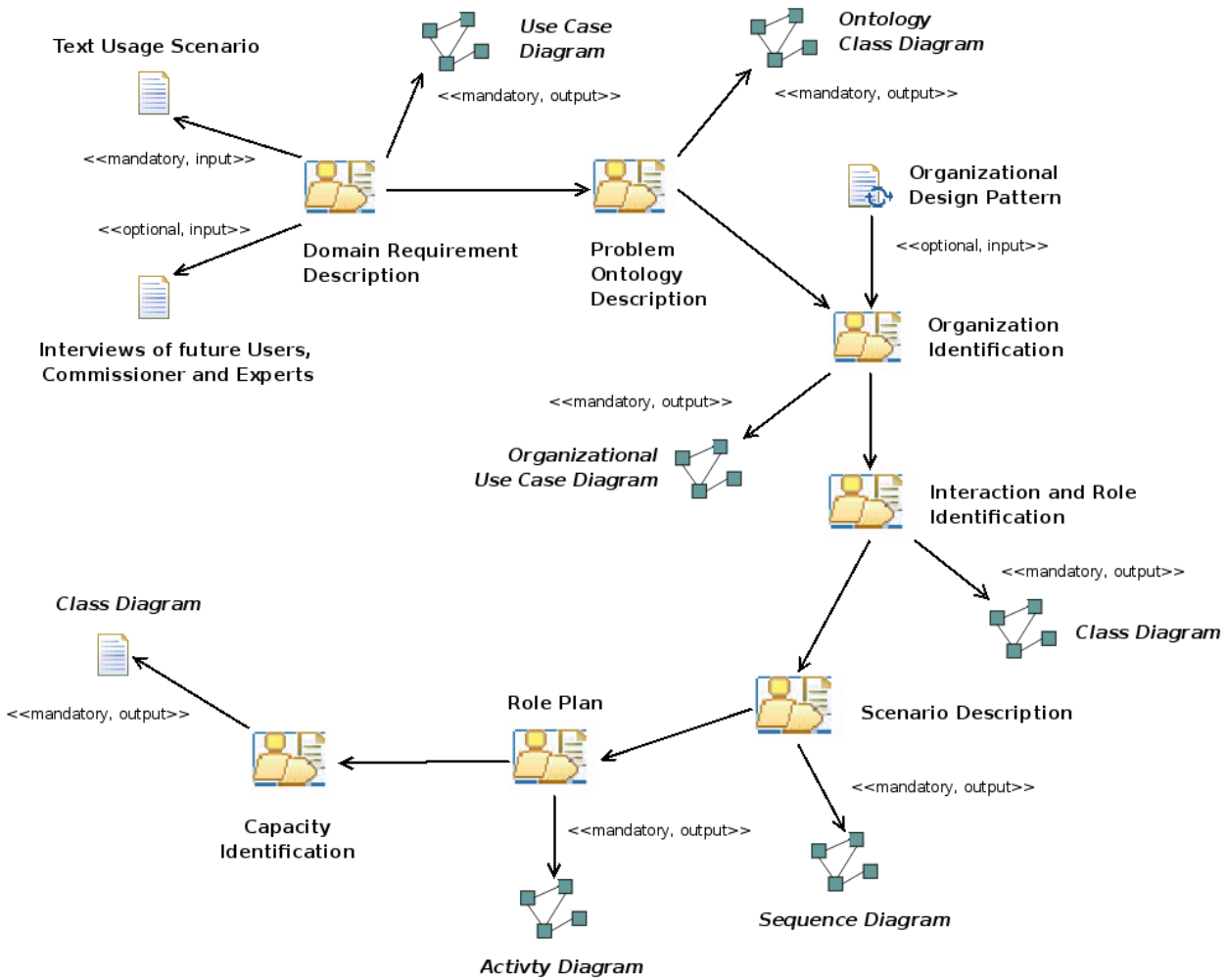
MDA inspired



System requirements phase

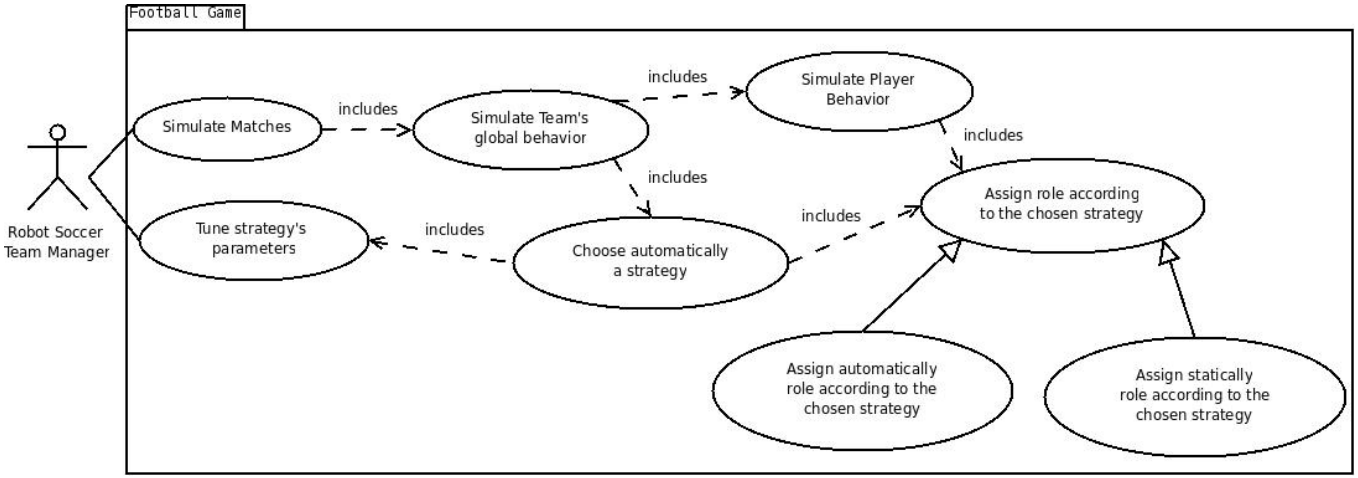


Outline

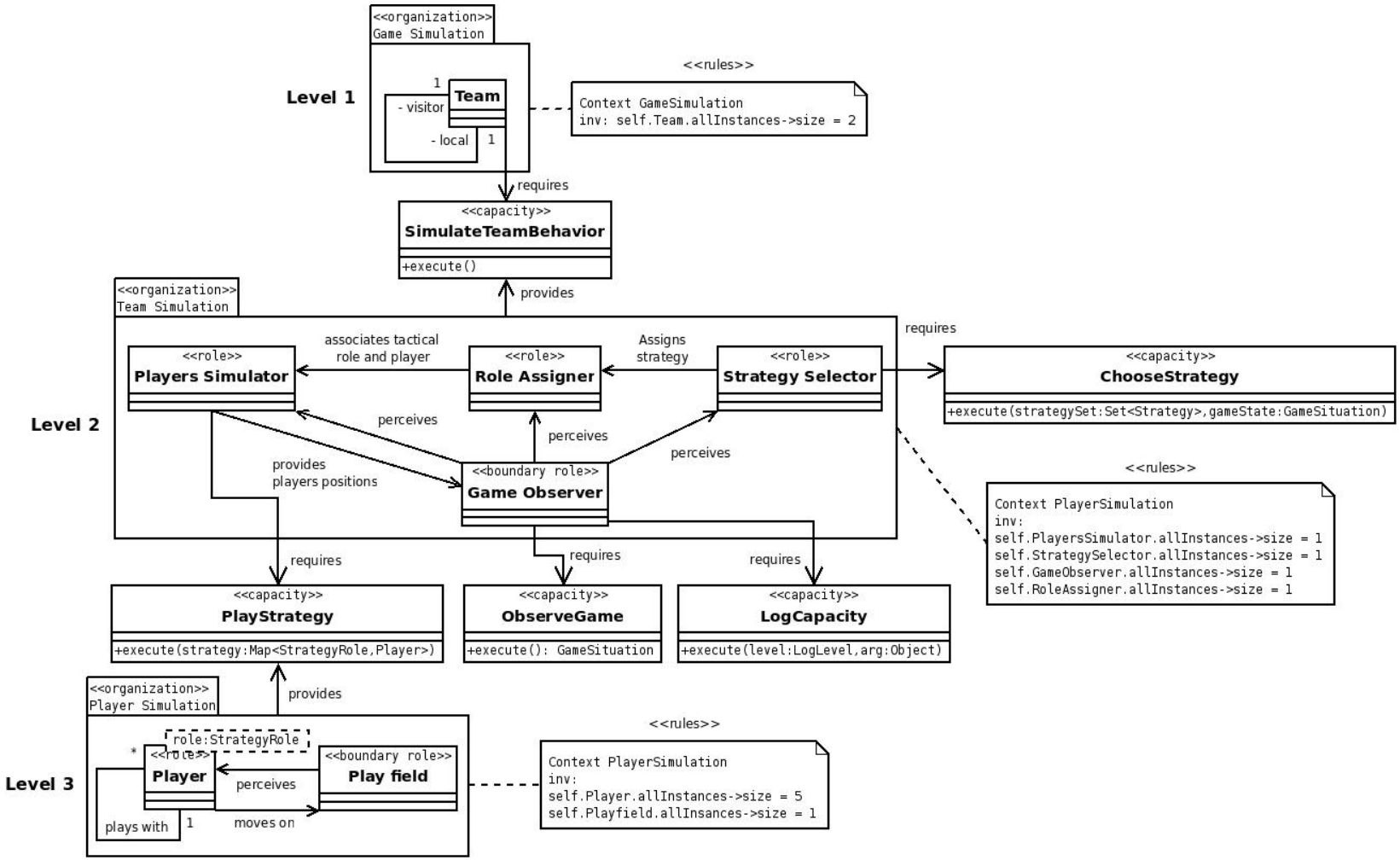
Robot soccers simulator

- The FIRA Robot soccer competitions began in 1996 using real robots and simulators [Kim, 1996]
- The principle consists in two teams of five autonomous robots that play a game similar to human football
- The goal is to develop a simulator based upon HMAS for these games

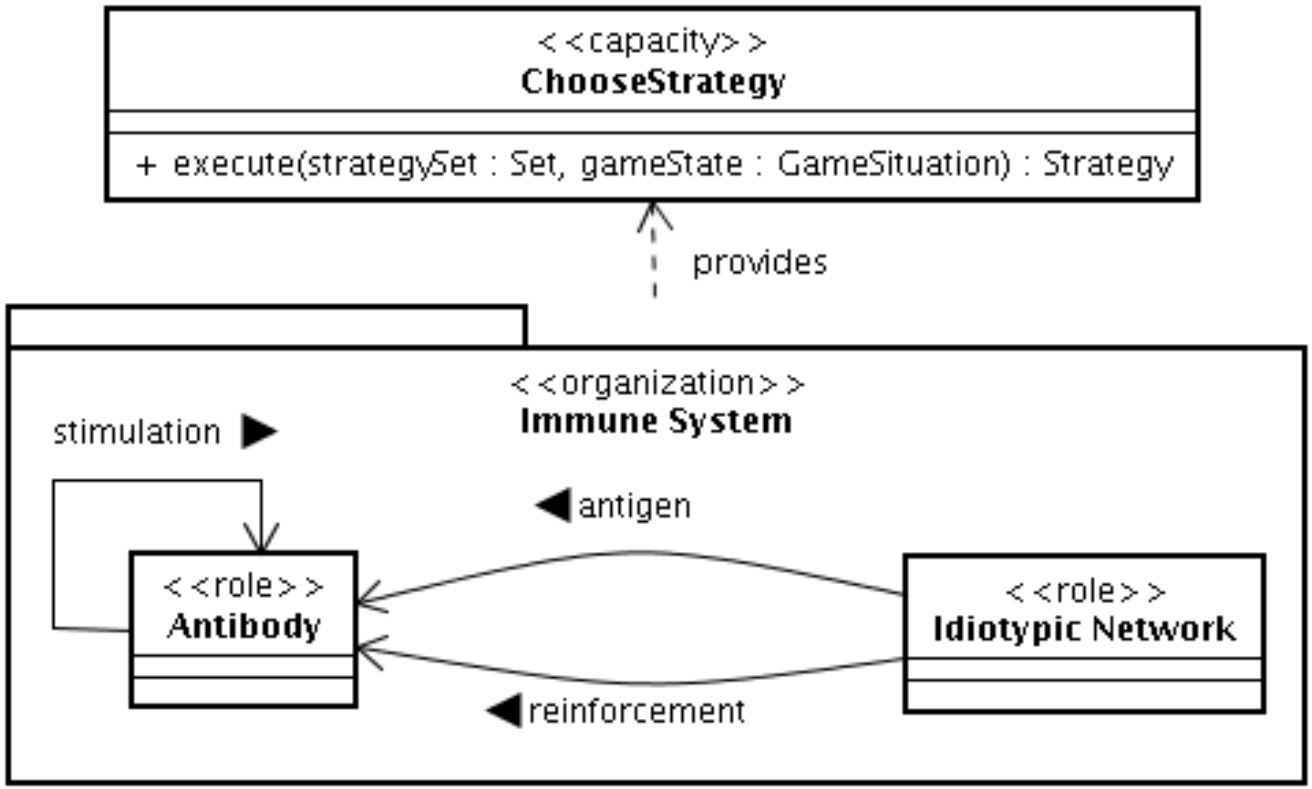
System requirements



Organisation and roles



Choose strategy capacity



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Achievements

We propose an approach based upon the Capacity concept and ASPECS methodology which

- enables to engineer emergence
- allows decomposition and control of emergent behaviours within holarchies
- authorizes and enhance reuse of organizational patterns

Perspectives

- CASE Tool currently in development.
- Specification of other agent and multiagent models.

Thank you for your attention


Kim, Y. H. (1996).
Micro-robot world cup soccer tournament.
KAIST.