SARL

Agent-Oriented Programming Language

www.sarl.io

Sebastian Rodriguez
(On behalf of SARL Team)

Seminar at Universide Federal de Santa Catarina – Florianopolis
May 7^{th}, 2014

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Outline

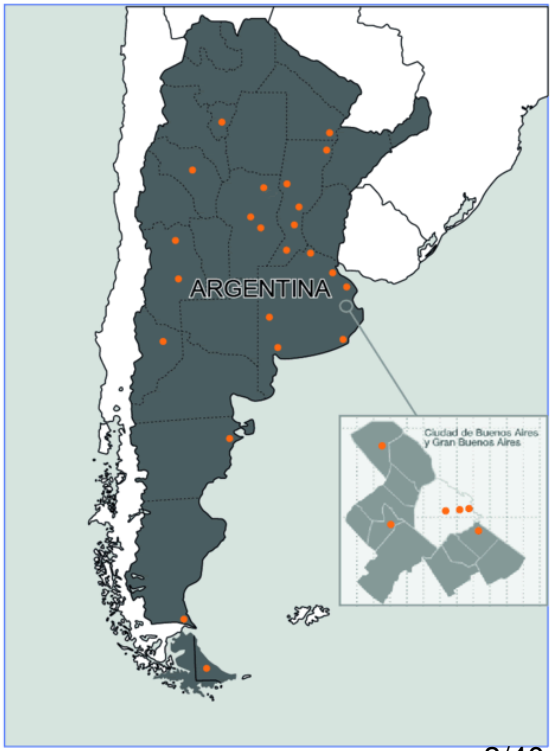
Our University

Universidad Tecnológica Nacional

- 29 Faculties - 75 Degrees (16 Engineering Degrees)
- 75.000 students (2008)
- http://www.utn.edu.ar

Grupo de Investigación en Tecnologías Informaticas Avanzadas (GITIA)

- Team 15 people
- Master in Information Systems Engineering - FRT - UTN



GITIA Research Areas

Agent Oriented Software Engineering

- MAS Meta-models
- Agent Oriented Software Processes
- MAS Development Platforms and Languages
- CASE for MAS

Optimization

- Artificial Neuronal Networks
- Genetic Algorithms
- Genetic Programming

Outline

A whole team

Design & Development

- Nicolas GAUD
- Stéphane GALLAND
- Sebastian RODRIGUEZ

Contributions and Ideas (a lot !!)

- Olivier BOISSIER
- Vincent HILAIRE
- Flavien BALBO
- Gauthier PICARD
- Luk KNAPPEN
- Many others, every contributor is welcome ☺

Contributions and uses during the Young Age

Energy mananagement & simulation

Energy, Transport & LUTI simulation

Environment definition & transport simulation

Transport management & simulation

Outline

Janus Experience

- Janus code base is almost 10 years old.
- Learned a lot of the DO's and DON'Ts.
- API became complex and difficult to maintain.
- Constant need to refactor to include new features.
- New patterns have changed software development (IoC, Event-Driven Communication, Distributed Objects, etc.).

Outline

Design Principles

- Clear separation between Language and Platform related aspects.
- Everything is distributed and it should be transparent.
- Massively parallel.
- Event-driven interactions.
- All agents are holonic.
- Platform- and architecture-independent.
- There is not only one way of interacting but infinite.
- Coding should be fun (Ruby/Scala-like) ☺.

Expectations for SARL

- Stop implementing Agents with Object-Oriented concepts.
- Playground to find minimal Agent-Oriented Programming concepts.
- Agents should be simple to extend.
- Provide the community a common discussion forum. (a testbed)

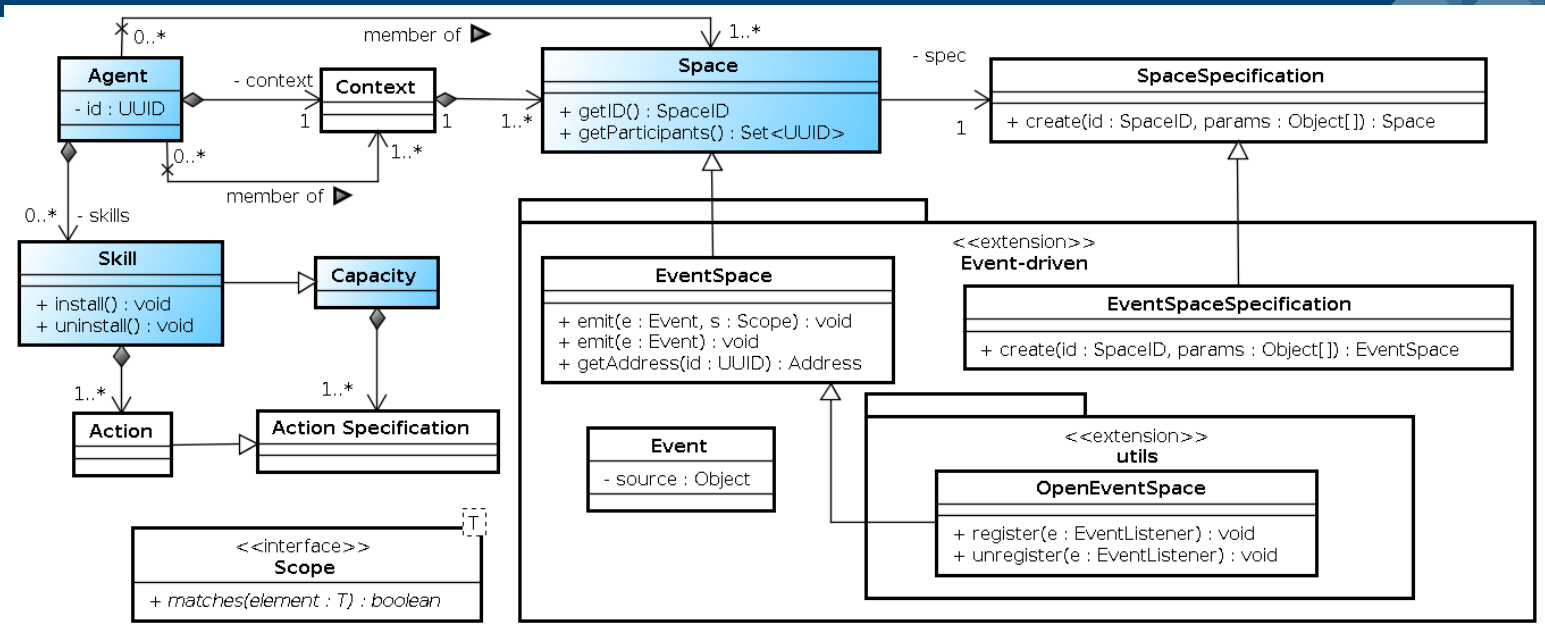
Outline

Multiagent system in SARL

a MAS in SARL

A collection of Agents interacting together in a collection of shared distributed Spaces.

Overview of SARL Concepts



4 main concepts

- Agent
- Capacity
- Skill
- Space

3 main dimensions

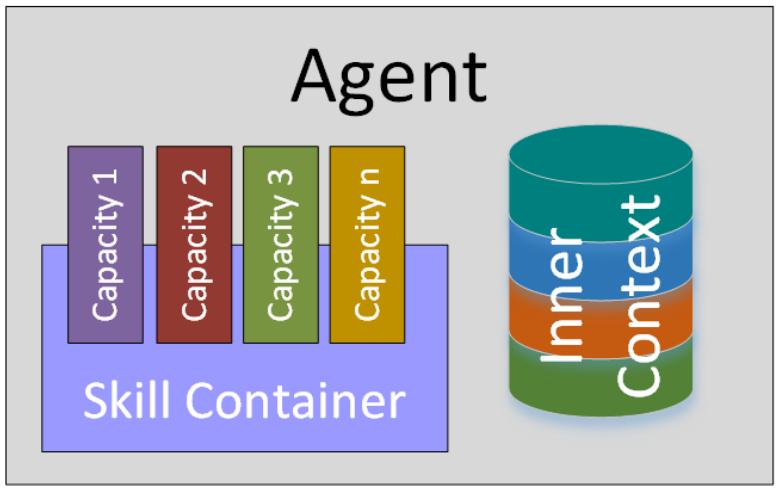
Individual: the Agent abstraction (Agent, Capacity, Skill)

Collective: the Interaction abstraction (Space, Event, etc.)

Hierarchical: the Holon abstraction (Context)

Agent

- An agent is an autonomous entity having some intrinsic skills to implement the capacities it exhibits.
- An agent defines a Context.
- An agent initially owns native capacities called Built-in Capacities.



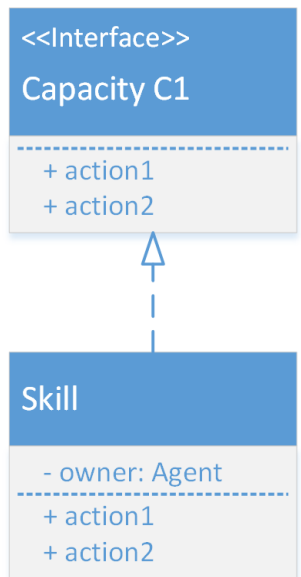
Capacities and Skill

Capacity

Specification of a collection of actions.

Action

- A specification of a transformation of a part of the designed system or its environment.
- Guarantees resulting properties if the system before the transformation satisfies a set of constraints.
- Defined in terms of pre- and post-conditions.



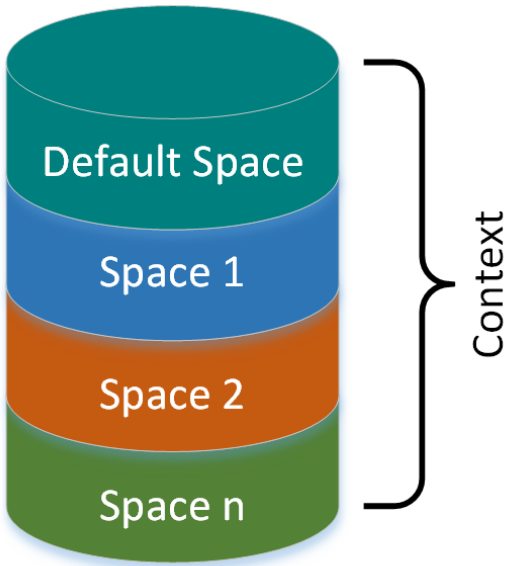
Skill

A possible implementation of a capacity fulfilling all the constraints of its specification.

Context and Interactions

Context

- Defines the boundary of a sub-system.
- Collection of Spaces.
- Every Context has a Default Space.
- Every Agent has a Default Context, the context where it was spawned.



Space

Support of interaction between agents respecting the rules defined in various Space Specifications.

Context and Interactions (cont.)

Space Specification

- Defines the rules (including action and perception) for interacting within a given set of Spaces respecting this specification.
- Defines the way agents are addressed and perceived by other agents in the same space.
- A way for implementing new interaction means.

Use case for organizational approach

Space Specification Organization

Space Group

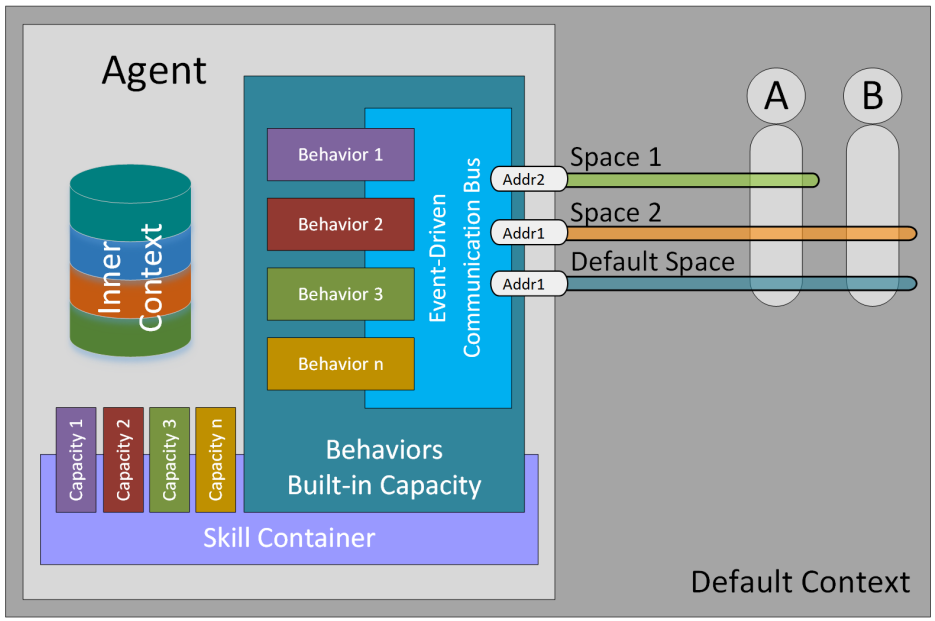
Agent interface Behavior, Role

Addressing Role Address

Context and Interactions (cont.)

Default Space: an Event Space

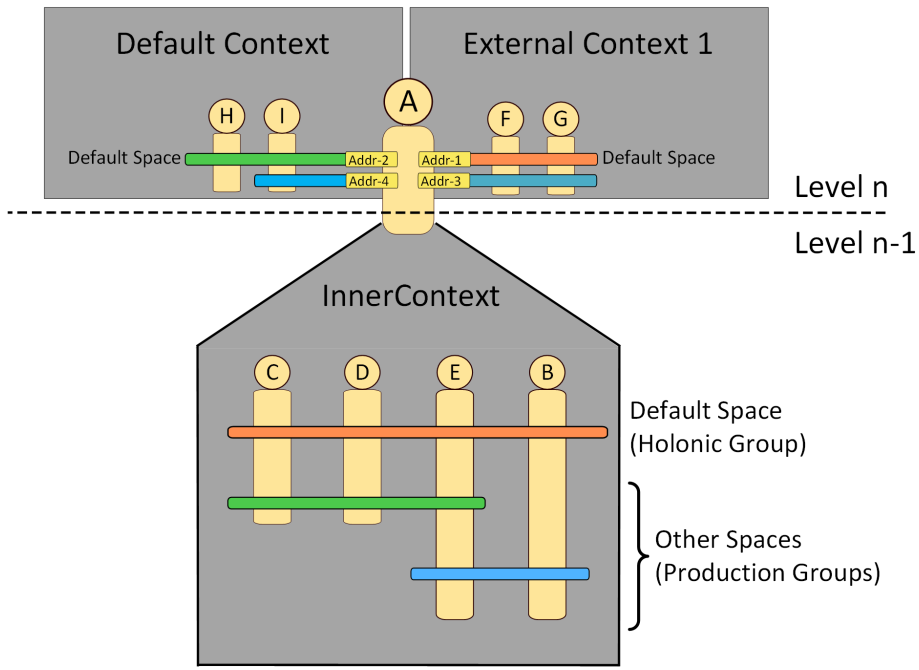
- Event-driven interaction space.
- Default Space of a context, contains all agents of the considered context.
- Event: the specification of some occurrence in a Space that may potentially trigger effects by a participant.



Spaces and Contexts

Contexts and Holonic properties

- All agents have at least one External Context (the default one).
- All agents participate in the Default Space of all Contexts they belong to.
- The Janus Context is omnipresent.

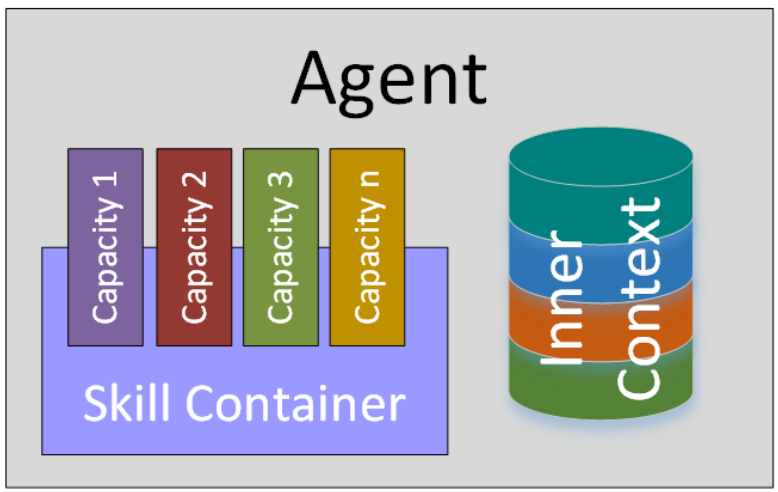


Built-in Capacities

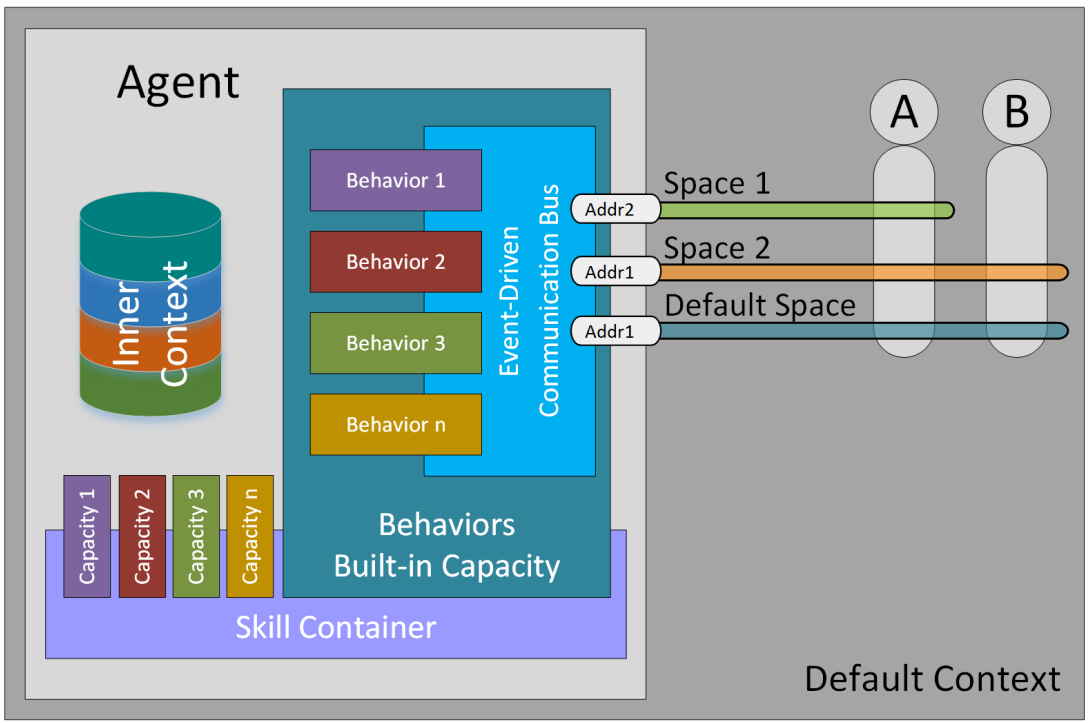
A SARL Agent has inherently a set of Built-in Capacities

Current Built-in Capacities

- ExternalContextAccess
- InnerContextAccess
- Behaviors
- Lifecycle
- Schedules
- DefaultContextInteractions



Behaviors Built-in Capacity



Behavior

Defines the actions to be performed on a given perception (Events) in a Space.

Environment on SARL

Dimensions of the Environment

- Execution
- Physic
- Social

Key Ideas

- It is omnipresent
- Agents can interact with it via Capacities and Spaces
- Manages access to resources and structures

Execution Dimension

Execution Environment requirements

- Handles Agent's Lifecycle
- Provides Built-in Capacities
- Implements SARL concepts
- Handles resources

Janus as SARL Execution Environment

- Fully distributed.
- Dynamic discovery of Kernels.
- Automatic synchronization of kernels' data (easy recovery).
- Micro-Kernel implementation.

Physical Dimension

Physical Environment

Class of real or simulated systems in which agents and objects have an explicit position, and that produce localized actions.

Properties

- Contains all objects
- Agents interact with it via dedicated Capacities
- Agents' Bodies are "managed" by the Environment
- Multiple "Views" of the environment can be implemented (1D, 2D, 3D)
- Enforces Universal Laws (e.g. Laws of physics)

Social Dimension

- Multiple ways of agent interaction
- Supported by Space / SpaceSpecification
- Default Interaction Space: based on events (may be redefined).
- Programmer can create new SpaceSpecifications (and ways of interacting):
  - FIPA
  - Organizational (MOISE, CRIO, etc)
- Social Dimension may influence other dimensions

Integration of the Environment Dimensions

- Enables “communication” between dimensions
  - Constrains of actions/interactions from other dimensions
  - Different perceptions of the same Event according to the dimension
  - Interactions / Perceptions due to interactions in other dimensions
- Seen as Monolithic by Agent accessed by dedicated Capacities and Spaces (Holonic view)
- Should provide a uniform interface of the environment (Simulation vs Real World)

Outline

Show me the Code!

Demo

☺

Outline

Summary

What does SARL currently provide ?

- Defines general agent-technology concepts: Context, Space, Agent, Capacity, Skill.
- All agents are holons.
- Intuitive Syntax (and the associated Eclipse-based IDE).
- Extensible (Capacities and Skill)
- No single way of interacting imposed.
- Janus as SARL platform

Future works

Agent Architectures:

- Capacities for Reasoning Agent: knowledge, plans, goals definition, multiple “reasoning engines”, etc.

Environments:

- Define the organizational extensions firstly based on CRIO then MOISE ☺: static and dynamic (normative).
- Continue work on physical environment integration, and its interaction with the other dimensions.

Language:

- Enforcing Pre- and post-conditions.
- Formal specification.
- Define grammar extensions for describing the environments instances.

Join Us

- Open Source Project - Apache v2 Lincense
- SARL
  - http://www.sarl.io
  - http://www.github.com/sarl
- Janus Project
  - http://www.janusproject.io
  - http://www.github.com/janus-project
- Every contributor is welcome ☺

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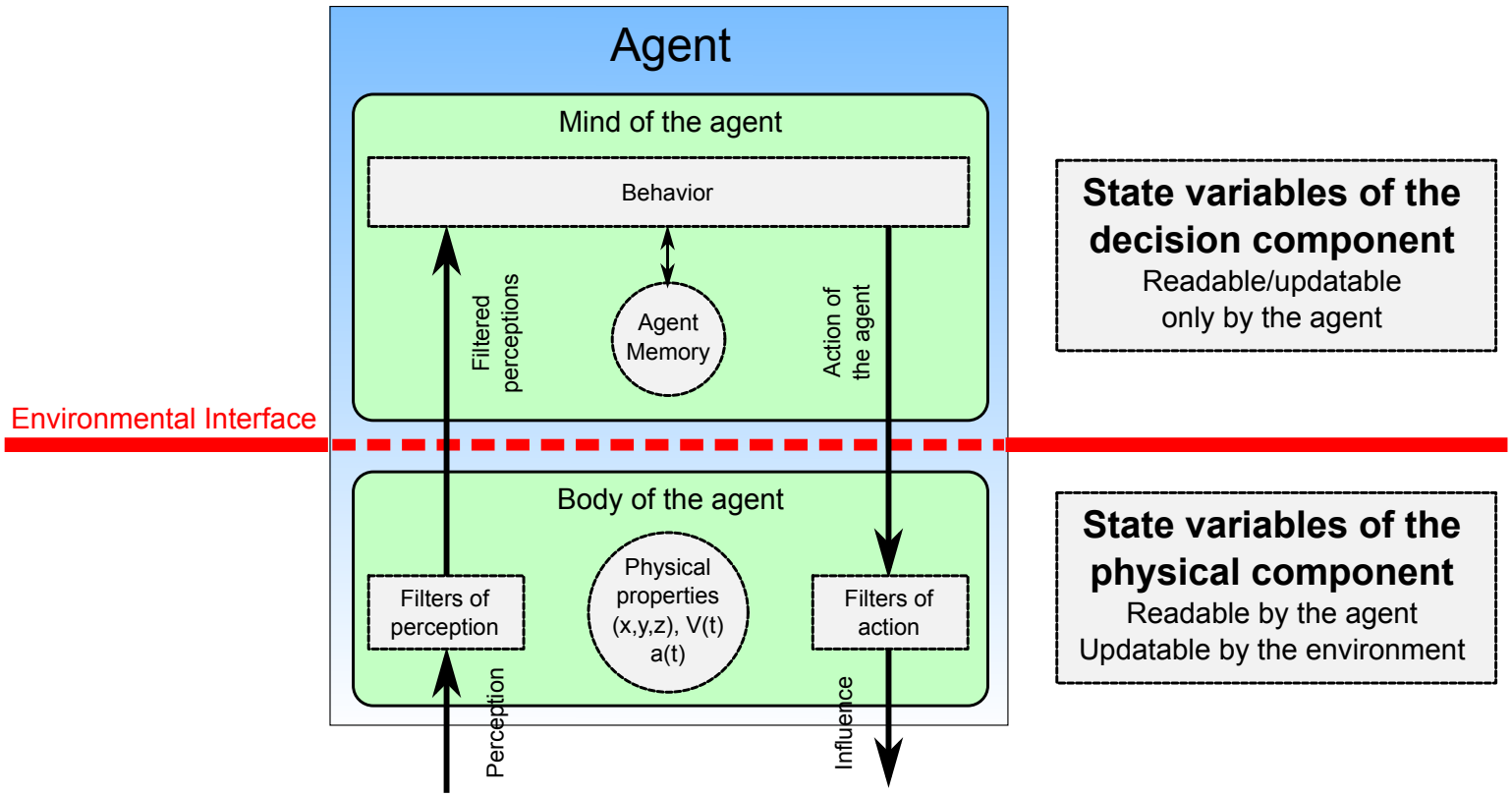
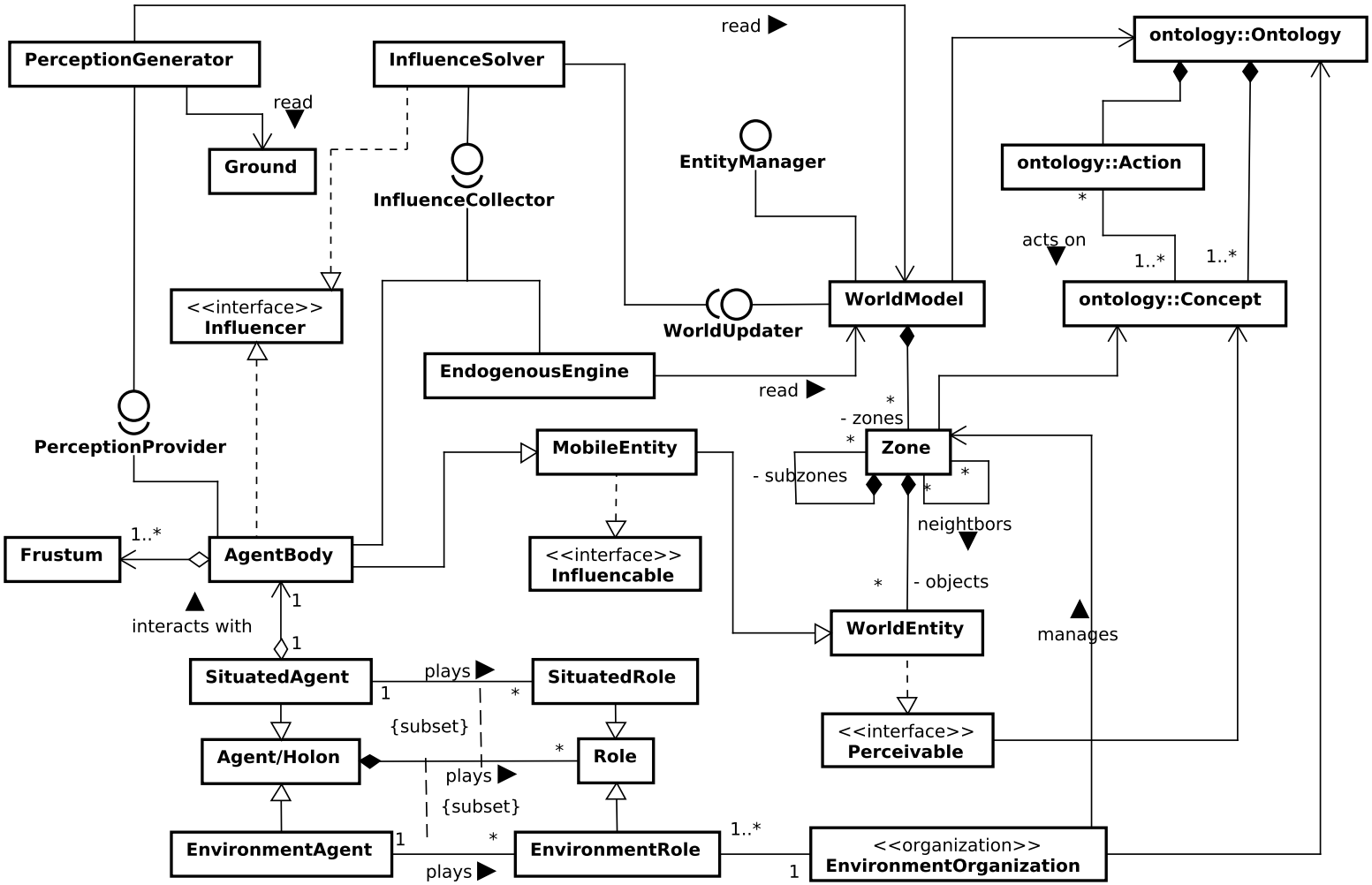
Body-mind separation



[Galland et al., 2009, Galland et al., 2014, Galland and Gaud, 2014]

Simplified model of the physical environment



[Galland et al., 2009, Galland et al., 2014, Galland and Gaud, 2014]

Outline

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