SARL
Agent-Oriented Programming Language
www.sarl.io

Sebastian Rodriguez
(On behalf of SARL Team)

Seminar at Universidade Federal de Santa Catarina – Florianopolis
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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 Informáticas Avanzadas (GITIA)

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

Our University

GITIA - UTN
SARL Team
Motivation
Design Principles
Main Concepts
Definitions
Built-in Capacities
Environment
Show me the Code!
Summary & Future works

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S. Rodriguez

SARL: Agent Programming Language
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

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2. SARL Team
3. Motivation
4. Design Principles
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   - Definitions
   - Built-in Capacities
   - Environment
6. Show me the Code!
7. Summary & Future works
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 management & simulation
- Energy, Transport & LUTI simulation
- Environment definition & transport simulation
- Transport management & simulation
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.).
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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)
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Multiagent system 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

- 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.
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
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.
A SARL Agent has inherently a set of **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 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)
Show me the Code!

Demo

Show me the Code!

Summary & Future works
### 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

The whole is greater than the sum of its parts

Open Source Project - Apache v2 License

SARL

- http://www.sarl.io
- http://www.github.com/sarl

Janus Project

- http://www.janusproject.io
- http://www.github.com/janus-project

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8 Environment Models

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Body-mind separation

[Environment Models

Body of the agent

- Filters of perception
- Physical properties (x,y,z), V(t), a(t)

Mind of the agent

- Agent Memory
- Behavior

Environment Interface

- Perceived
- Influence

Agent

State variables of the decision component
Readable/updatable only by the agent

State variables of the physical component
Readable by the agent
Updatable by the environment

[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]
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