

# Multi-Agent Systems

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<https://jomifred.github.io/mas/>

PósAutomação



from  
**single** agent (AI)  
to  
**multi**-agents (MAS)

# Definitions

- ◆ An MAS is a loosely coupled network of problem solvers that interact to solve problems that are beyond the individual capabilities or knowledge of each problem solver (Durfee and Lesser 1989)
- ◆ These problem solvers, often called agents, are autonomous and can be heterogeneous in nature

# Definitions

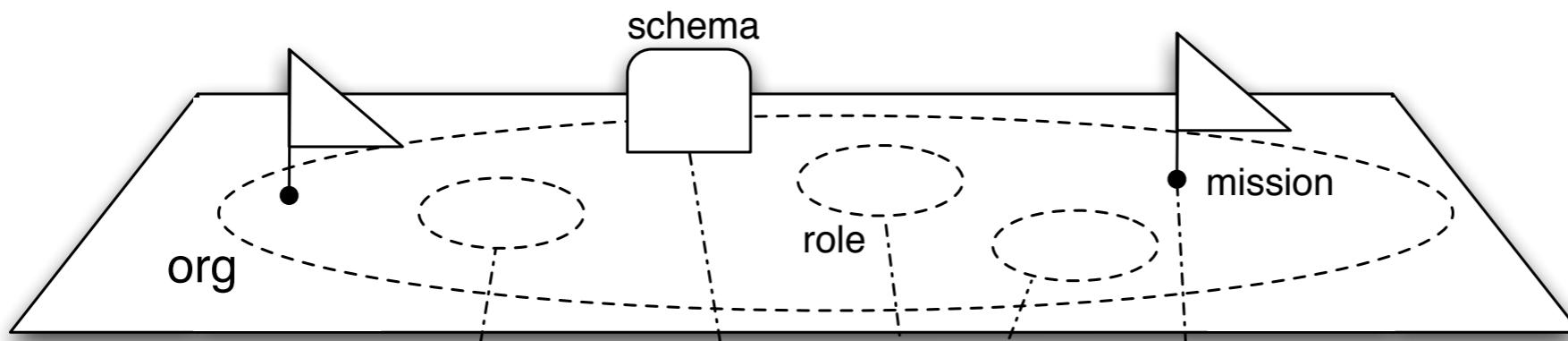
- ◆ An MAS is a loosely coupled collection of problem solvers that interact to solve problems that are beyond the individual agent's capabilities or knowledge base of a single problem solver (Durfee and Lesser, 1990)
- ◆ These problem solvers are autonomous and distributed in nature

## Characteristics

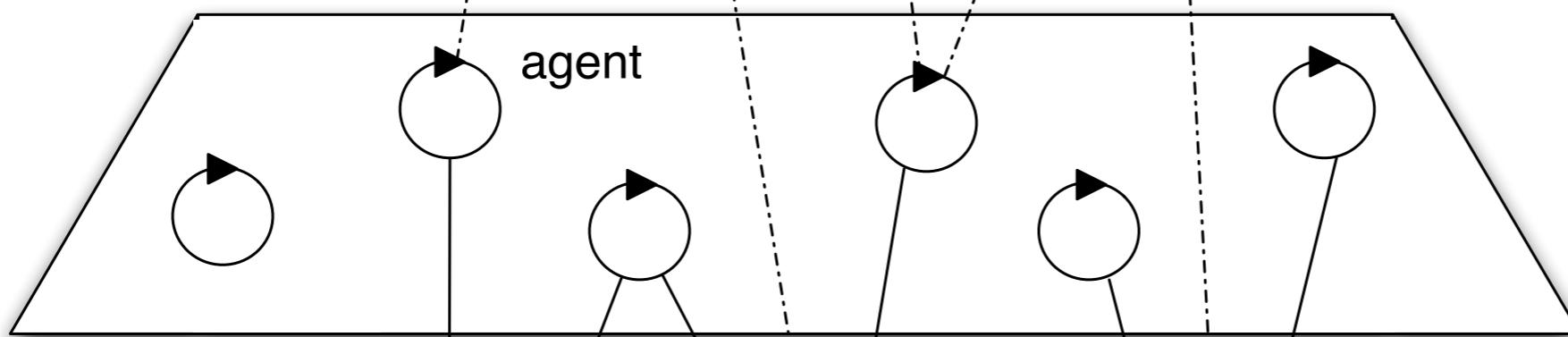
- ◆ agents with incomplete information and limited capabilities
- ◆ distributed
- ◆ decentralised (no global control)
- ◆ computation is asynchronous

# Our definition

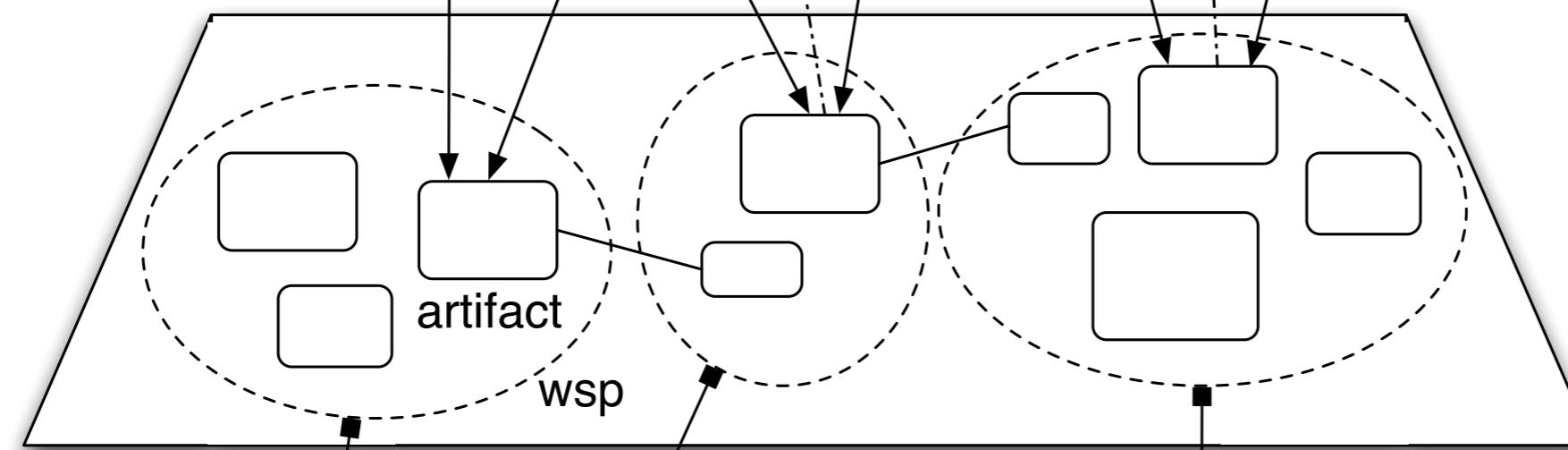
- ◆ an organisation of autonomous agents interacting together within a shared environment
- ◆ conceptual and practical tools to design and implement distributed, complex, huge, open, .... systems



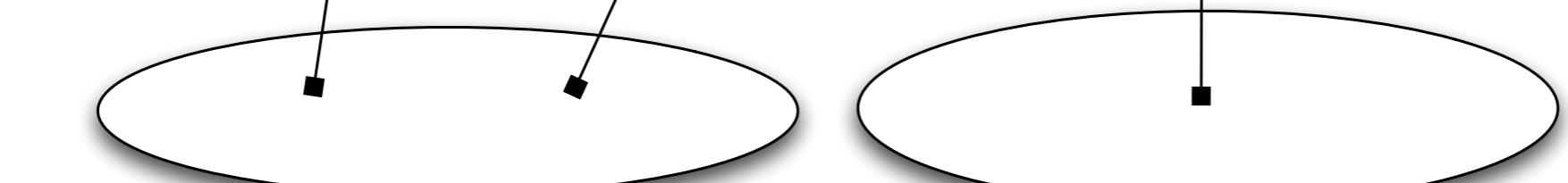
ORGAMISATION  
LEVEL



AGENT  
LEVEL



ENDOGENOUS  
ENVIRONMENT  
LEVEL



EXOGENOUS  
ENVIRONMENT

network node

# Agent programming

- ◆ Autonomous entities of the system
  - ◆ encapsulate state, behaviour, control
- ◆ BDI theory
  - ◆ practical reasoning
  - ◆ reactivity + long term goals

# Agent pro

high level abstraction

beliefs, plans, and  
intentions

- ◆ Autonomous entities

- ◆ encapsulate state, behavior

naturally concurrent,  
distributed, decoupled,  
open, ...

- ◆ BDI theory

- ◆ practical reasoning
  - ◆ reactivity + long term goals

# Environment Programming

- agents inhabit an environment
- interaction model is based on perception and actions
- agents need tools
- tools are not agents and agents are not tools

Agent & Artifacts

# Organisational Programming

- ◆ control [malicious] agents
- ◆ help agents to [cooperatively] achieve goals
- ◆ simplifies reasoning about the organisation

# Our approach

- ◆ programming  
MAS
- ◆ runtime and  
design time

from AOP  
to  
MAOP

# JaCaMo perspective

- ◆ MAS components are first class entities
  - ◆ Agents, Environment, Interactions, Organisation  
[vowels view from Demazeau]
- ◆ Jason + CArtAgO + Moise + ...
- ◆ JaCaMo is a joint work with  
Bordini, Ricci, Santi, and Boissier

# Applications

- ◆ Multi robot systems
  - ◆ group task allocation, team formation, multiagent path planning
- ◆ Games (e.g. Age of Empires)
- ◆ Social Simulation
- ◆ Air Traffic Control
- ◆ Supply chain management
- ◆ RoboCup (rescue)
- ◆ ...

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top down  
or  
bottom up

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MAS used as

- ◆ a conceptual tool to approach the problem
- ◆ a method to specify a system
- ◆ languages to program the system

bottom up

# Bibliography

## MAOP book

