

# Agents and Multi-Agent Systems

M.EIC  
2023/2024

Ana Paula Rocha  
arocha@fe.up.pt

# Course Webpage

- Course webpage in *Moodle*
  - Slides
  - Lesson planning
  - Assignments
  - Resources (software and others)
  - Discussion forum
  - Information

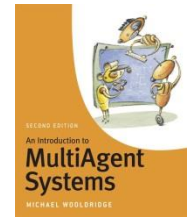
# Syllabus

- **Agent-based computing:** Motivation and goals; Tools for MAS development
- **Intelligent agents:** Definitions; Agents and environments; Agent architectures; Deductive reasoning agents; Practical reasoning: BDI agents; Reactive agents: the subsumption architecture
- **Introduction to agent-based simulation:** Agent-based modeling and simulation (ABMS); Elements of an ABMS tool
- **Multi-agent systems:** Definitions; Communication; ACL; FIPA standards; Interaction protocols; JADE; Agent-Oriented Software Engineering
- **Multi-agent decision making:** Game theory; Cooperative game theory; Mechanism design; Social choice theory; Auctions; Negotiation
- **Reinforcement Learning:** Policies, rewards, and value functions; Bandit problems; Markov decision processes; Temporal-difference learning; Sarsa and Q-learning; Policy gradient methods; Deep reinforcement learning

# Bibliography

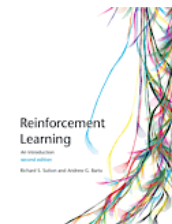
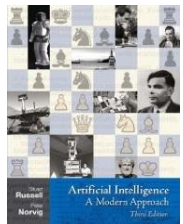
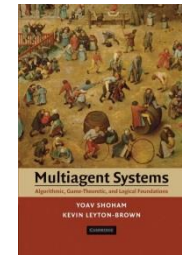
- **Main**

- M. Wooldridge: ***An Introduction to MultiAgent Systems***, 2<sup>nd</sup> ed., John Wiley & Sons, 2009.  
<http://www.cs.ox.ac.uk/people/michael.wooldridge/pubs/imas/IMAS2e.html>



- **Complementary**

- Y. Shoham, K. Leyton-Brown: ***Multiagent systems: Algorithmic, Game-Theoretic, and Logical Foundations***, Cambridge University Press, 2008.  
<http://www.masfoundations.org/>
- S. Russel, P. Norvig: ***Artificial Intelligence: A Modern Approach***, 3<sup>rd</sup> ed., Prentice Hall, 2009.  
<http://aima.cs.berkeley.edu/>
- R. S. Sutton, A. G. Barto: ***Reinforcement Learning: An Introduction***, 2nd ed., MIT Press, 2018.



# Evaluation

- 2 practical group assignments (70%)
  - Assignment 1 (70%)
    - Multi-Agent System
  - Assignment 2 (30%)
    - Agent/Multi-Agent Learning
- Exam (30%)
  - Moodle

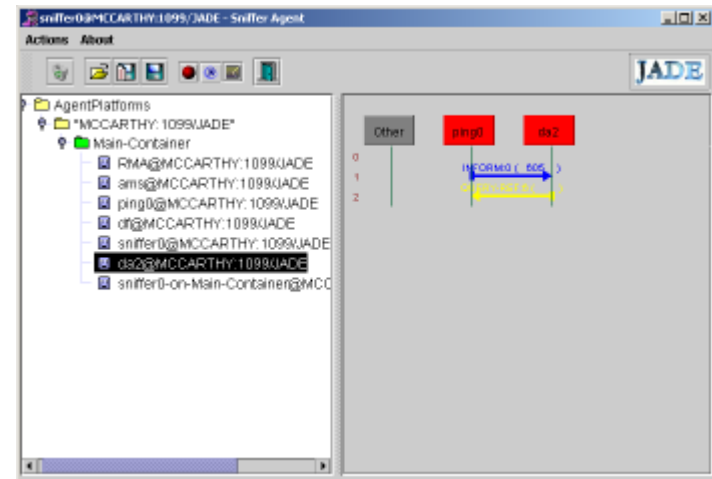
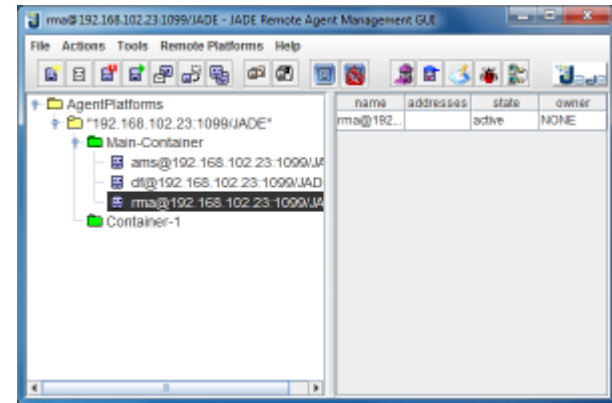
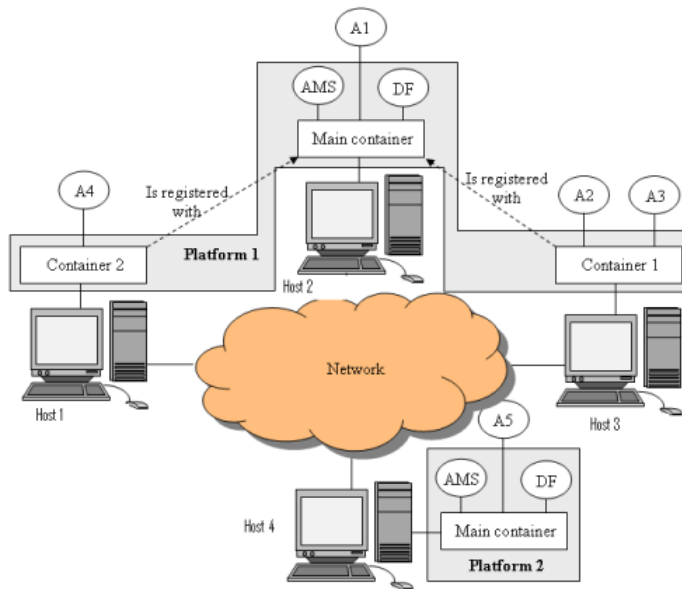
# Important Dates

- Assignment 1
  - Delivery: April 05
  - Presentation: April 08
- Assignment 2
  - Delivery: May 17
  - Presentation: May 20
- Exam
  - June

# Software

## JADE

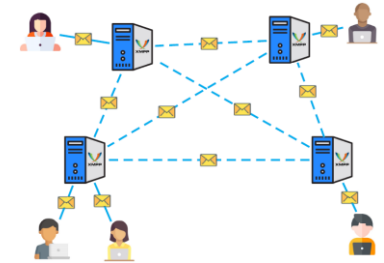
### Java Agent Development Environment



# Software

## SPADE

Smart Python Agent Development Environment



**SPADE** your\_jid Online

Dashboard

Home > Dashboard

**Behaviours**

- CyclicBehaviour/DummyBehav**  
Template: <template to="None" from="agent0@fake\_server" thread="..." Kill
- PeriodicBehaviour/DummyPeriodBehav**  
Template: <template to="None" from="agent1@fake\_server" thread="..." Kill
- TimeoutBehaviour/DummyTimeoutBehav**  
Template: <template to="None" from="agent2@fake\_server" thread="..." Kill
- FSMBehaviour/DummyFSMBehav**  
Template: <template to="None" from="agent3@fake\_server" thread="None" ...

**Contacts**

agent0@fake_se... ONLINE	agent1@fake_se... AWAY	agent2@fake_se... DND	agent4@fake_se... ONLINE
agent3@fake_se... OFFLINE	agent5@fake_se... OFFLINE		

Copyright © 2018 SPADE. Version 3.0.0

**SPADE** your\_jid Online

FSMBehaviour/DummyFSMBehav

4 Mailbox

**True**  
Is killed?

**0**  
Exit Code

**S 1**  
Current State

**Template**  
<template to="None" from="agent3@fake\_server" thread="None" metadata={} ></template>

**Finite State Machine**

```

graph LR
    S_1((S_1)) --> S_2((S_2))
    S_2 --> S_4((S_4))
    S_4 --> S_5((S_5))
    S_1 --> S_3((S_3))
    S_3 --> S_5
  
```

**Chat**

your\_jid 11 minutes ago  
This is my answer.

agent3 11 minutes ago  
Hello from agent3!  
This is a long message.

your\_jid 11 minutes ago  
This is my answer.