

Introduction to the Course

Multiagent Systems LS

Sistemi Multiagente LS

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Ingegneria Due

ALMA MATER STUDIORUM—Università di Bologna a Cesena

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1 Motivations

- Evolution of Computational Systems
- Multiagent Systems

2 Context

- Research in Informatics & Computational Systems
- Research in Informatics in Cesena

3 The Course

- Goal & Structure
- What to Do



Computational Systems

What is a computational system?

- any system with computational capabilities
- how many computational systems today in this room?
 - how many a few years ago?

Interactivity & Interoperability

- Almost any computational system of today comes equipped with TLC technologies for interacting with other computational systems
- We live immersed in a sort of *computational cloud*, where an incredible (and always increasing) number of computations are performed at every instant
 - distributed, concurrent computations
 - either controlled / triggered, or autonomous computations



Pervasiveness of Computational Systems

Nowadays, computational systems. . .

- . . . have become *pervasive*
- . . . are at the core of *most* artificial systems

The physical nature of artificial systems. . .

. . . adds complexity to computational components / systems

- in terms of physical distribution
- in terms of temporal distribution
- in terms of unpredictability of the scenarios



On the Notion of System

No more distinctions between SW & HW systems

- no more *easy* distinctions
- at a given level of abstraction

We consider *artificial systems* in general

either human-made or human-affected natural systems

Abstraction of *system*

to explain complex behaviour in terms of

- components' *behaviour & interaction*
- interaction with the *environment*



On the Notion of Distribution

What is distributed?

- computational units, communication channels. . .
- data, information, knowledge
 - as well as their representations
- sensors, actuators, . . .

Spatio-temporal unity of systems is lost

- there is no longer a notion of *system time*, nor a *location*
- system components, at different level of abstraction, are only partially related
 - temporally & topologically



What is Changed?

A number of assumptions over systems no longer hold

- system events constitute a partially-ordered set
 - generally speaking
- admissible interactions among system components depends on compresence
 - in space / time
 - within a physical / virtual topology



What is Needed?

- New *meta-models* for computational systems
- New *methodologies* for system analysis, design & development
- New *technologies* for system development, implementation & deployment

New abstractions

- to straightforwardly deal with the nature of artificial / computational systems of today
- to capture
 - distribution in space & time
 - the new nature of components and of their interaction
 - complexity & unpredictability of environment



Why Multiagent Systems (MAS)?

MAS first of all address the problem of *distribution*

bringing the principles of encapsulation & locality up to the required level of abstraction

MAS are a suitable source of

- new abstractions
- new meta-models
- new technologies
- new methodologies

for today complex artificial / computational systems
[Zambonelli and Omicini, 2004]



Convergence of Areas on Computational Systems

A number of heterogeneous areas contribute(d) to the MAS field

- Artificial Intelligence, Programming Languages, Distributed Computing, Mobile Computing, Robotics, Software Engineering, Operation Research...

The field of MAS is an independent research area, today
[Omicini and Poggi, 2006]

even though some of the contributing fields claim to contain it from its very beginnings



Convergence of Areas from outside Informatics

From either technological areas. . .

such as Telecommunications, Electronics, Automation, Bioengineering,
...

... and non-technological ones

such as Cognitive sciences, Psychology, Social sciences, Organisational sciences, Biology, Ethology, System sciences, ...



Convergence is not just a Tool for Researchers

- It comes from the pervasiveness of computational devices and technologies. . .
- . . . as well as from the increasing complexity of computational systems

Convergence of heterogeneous research areas is just a matter of fact
the time of specialisation (and specialists) is going to end soon



Research in Informatics and Computer Engineering

aliCE

Agents, languages and infrastructures in Cesena

- physically located in the apiCe Lab, in Via Venezia
- virtually located at <http://www.alice.unibo.it>

People involved

- A. Natali, A. Omicini, *E. Denti*, M. Viroli, A. Ricci
- M. Casadei, L. Gardelli, *A. Molesini*, E. Oliva, G. Piancastelli, *R. Rubino (phd students)*
- A. Benini, C. Buda, M. Cimadamore, G. Quadri di Cardano, G. Venturi, N. Zaghini, ... (*graduated students with research grants*)



(Some of the) Main Research Lines

- Agents & Artifacts: a meta-model for MAS
- Coordination infrastructures for MAS
- AOSE methodologies
- Programming languages for complex systems
 - Generics for Java
 - Multi-paradigm language integration
 - Agent-oriented languages
 - Declarative languages for intelligent distributed systems
- Cognitive stigmergy & self-* MAS
- Systems biology & agent-based simulation
- Simulation for MAS engineering
- Computational Institutions





(Some of the) Main Application Scenarios

- E-learning
- Virtual Enterprises
- Workflow management
- Open Source technologies
- Intelligent portals
- Intelligent development tools
- Complex systems simulation
- ICT in the Automotive



aliCE Projects

<http://www.alice.unibo.it:8080/aliCE/projects.jspx>

- Trust – *Trust in the information society*
- AgentLink III – *European Network for Agent-based Computing*
- OITOS – *Open Source*
- AlmaTwo – *E-learning*
- STIL – *Logistics, virtual enterprises & workflow management*
- EOS – *OO-technologies toward agent-based components & systems*
- Run-time Generics – *Generics for Java with Sun Microsystems*





Products

<http://www.alice.unibo.it:8080/aliCE/products.jspx>

tuProlog

a light-weight, easy deployable Prolog engine, specifically designed to be dynamically configurable and fully interoperable with the Java platform

TuCSon

a model and an infrastructure for MAS coordination

simpA

an extension of OO languages/systems—focussing on Java—toward agents and artifacts as a paradigm for designing and programming concurrent distributed systems

SODA

an agent-oriented methodology for the analysis and design of computational systems as MAS

In the overall, these products are aimed at covering approximately the whole spectrum of agent technologies & methodologies



Goals of the Course

Students of this course should

- Learn the basics of agent-oriented computing
- Experiment with agent-based technologies
- Work with scientific literature



Structure of the Course

Main topics of the course

- Foundations of agent-oriented computing
- Agents and artifacts (A&A): the meta-model
- Programming languages for agents and MAS
- Interaction, communication, coordination, organisation, security
- Agent-oriented Software Engineering (AOSE)
- Agent-oriented simulation of complex systems
- Self-* systems, autonomic computing and MAS



Attitude toward the Course

Attending lessons is important

- The course is new
- Slides are new—made day-by-day
- A lot of “implicit knowledge” is transferred orally

Participating to lessons is important as well

- Just pretending to listen & to agree with professor does not help so much...
- Interacting throughout lessons makes them more effective
- Studying “day by day” more or less ensures a fast “passage”



Registering to the Course

Distribution lists...

- are provided for free by the ALMA MATER STUDIORUM
- they mostly work
- we will use them here

Please register soon...

- to the list ANDREA.OMICINI.SMA-LS-0607
- using password 0607SMALS
- like, say, *today*.



The Exam is an Oral Test

Three questions

- Two questions on issues developed in the course
- The last question is either
 - the discussion of an individual MAS project developed by the student
 - the discussion of an advanced MAS issue based on literature collected by the student
- Students decide when their MAS project / literature issue is ready for prime time

Registering to UniWex lists is required. . .

- . . . in order to be examined



Bibliography



Omicini, A. and Poggi, A. (2006).

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Intelligenza Artificiale, III(1-2):76–83.

Special Issue: The First 50 Years of Artificial Intelligence.



Zambonelli, F. and Omicini, A. (2004).

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Special Issue: Challenges for Agent-Based Computing.



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