

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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Motivations

Evolution of Computational Systems
Multiagent Systems

Context

Research in Informatics & Computational Systems
Research in Informatics in Cesena

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,
Computational Biology, ...

...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 pure 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, M. Cimadamore, L. Gardelli, *A. Molesini*, E. Oliva, G. Piancastelli, *M. Piunti*, *R. Rubino* (*phd students*)
- ▶ M. Cabano, *A. Del Cinque*, *M. Fasanella*, S. Montagna, E. Nardini, G. Venturi, . . . (*graduated students with research grants*)



alice (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
- ▶ E-learning



alice (Some of the) Main Application Scenarios

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



<http://www.alice.unibo.it/alice/?area=Projects>

- ▶ 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 DUE – *Extensible Object Systems for Dynamic and Unpredictable Environments*
- ▶ Run-time Generics – *Generics for Java with Sun Microsystems*
- ▶ MEnSA – *Methodologies for the Engineering of complex Software systems: Agent-based approach*
- ▶ RESET – *Research on E-learning and Social EnviromenTs*



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 a large portion of the range of agent technologies & methodologies

<http://www.alice.unibo.it/alice/?area=Products>



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 2-years new
- ▶ 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



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-0708
- ▶ using password 0708SMALS
- ▶ 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



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