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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Outline

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

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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

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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*

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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

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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

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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]

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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

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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, . . .

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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

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- physically located in the apiCe Lab, in Via Venezia
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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)*
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- 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
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- 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*
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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

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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`

aliCE

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Outline

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

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- 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
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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

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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`
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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

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Introduction to the Course

Multiagent Systems LS

Sistemi Multiagente LS

Andrea Omicini

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Ingegneria Due

Alma Mater Studiorum—Università di Bologna a Cesena

Academic Year 2007/2008