Master Universitario en Inteligencia Artificial

(Bio-inspired) Multiagent Systems

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What is it about

- How does robust behavior arise from the cooperation of vast numbers of unreliable parts? Can we engineer systems with similar properties?

- This class will survey bio-inspired approaches to designing robust multi-agent systems in different domains

Course objectives

- Acquire a general familiarity with multi-agent systems from the perspective of collective intelligence (CI) and pursue a deeper understanding of a number of specific areas of research related to CI

- Give each student some "hands-on" experience doing research and reporting the results of the research activity in the format normally required for submission to an international conference

Course activities

- In class activities
  - Reading assignments
  - In class presentations and/or demos
  - Participation in class discussions
- Peer evaluations
  - In the week following a paper presentation class, each student is required to submit a brief commentary on each of the presentations (one page maximum).
- Course project
  - Implementation of a simulation of a CI system along with a short report (4-5 pages) describing this project
  - All final reports must comply with basic academic ethical standards

Course material

- References to papers and other on-line documents will be provided during the course.

- Most of the material will be made available at the course website:

https://moodle.upm.es/titulaciones/oficiales

Grades

- 5% - Class participation
- 15% - In class presentation
- 20% - Peer evaluations of the presentations
- 50% - Project implementation and final report
- 10% - Demonstration of the implemented system
    - final report 20th of January
    - demos 23rd/24th of January

July exam session

- final report 30th of June
- demo 4th of July

Motivation

- The dynamicity of the ICT environments and the large-scale size of certain systems makes them impossible to be controlled completely by human administrators

- Many researchers and industrials are interested on systems that can "work on their own"
  - autonomous and heterogeneous components
  - decentralized control
  - dynamic adaptation
  - self-organization

- Nature-inspired techniques provide a convenient solution to this problem

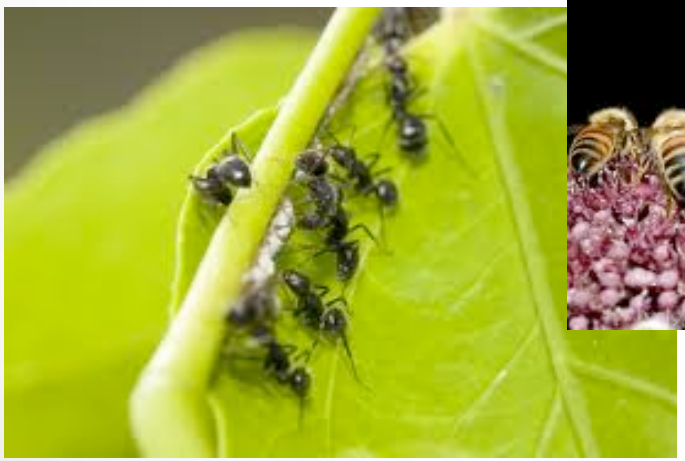
Bio-inspired collective systems

- Collective Intelligence in Nature

  Complex goals can be achieved by collectives of simple and limited individuals

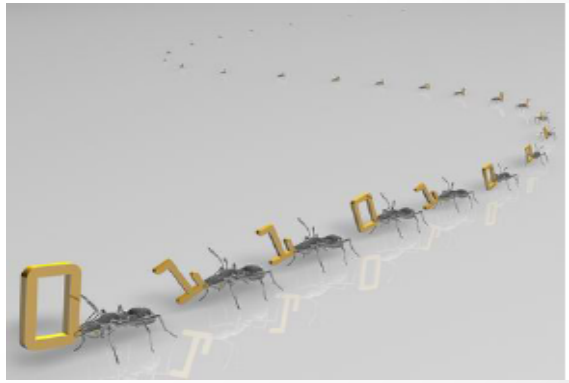
Swarm and collective intelligence

- A social insect colony is:
  - **Flexible**: the colony can respond to internal perturbations and external challenges
  - **Robust**: tasks are completed even if some individuals fail
  - **Decentralized**: there is no central control(ler) in the colony
  - **Self-organized**: paths to solutions are emergent rather than predefined



Swarm intelligence

- A bottom-up approach to controlling and optimizing distributed systems
- Using resilient, decentralized, self-organizing techniques
- Initially inspired by the collective behavior of social insect colonies and other animal societies (Bonabeau et al)



Swarm intelligence

- From swarms to systems:
  - Ant foraging ➔ Routing, Optimization
  - Collective sorting ➔ Clustering data
  - Division of labor ➔ Dynamic task allocation
  - Termite mounds ➔ Automated construction and self-assembly
  - Flocking ➔ Robot coordination, Optimization
  - Collective transport ➔ Robot coordination
- Applications:
  - Self-organizing virtual organizations