Artificial Intelligence II – Multi-Agent Systems

MAS Applications

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When?

- Complex,
- uncertain,
- unknown,
- highly dynamic …

- Agents as natural metaphore

- Physically (spatially) distributed problems

What MAS are expected to do better?

- To solve Problems that are too large for a centralized agent with limited resources
  - distributed computing
- To reduce the risk of failure of a centralized system
  - Disaster mitigation / Urban Search And Rescue
- To keep legacy systems inter-connectable and inter-operational
  - Migration of outdated software
- To solve problems that can naturally be regarded as societies of autonomous components
  - Air-traffic control, Meeting scheduling

Application domains

- Workflow and Business Process Management
- Distributed Sensing
- Information Retrieval and Management
- Electronic Commerce
- Human Computer Interfaces
- Virtual environments
- Social Simulation
- …
- Agents for for X …

- **Multi-robot systems**

Applications of MAS I
Computer Games



Real Time Strategy (e.g. Starcraft, Age of Empires)
→ group task assignment, and multi-agent path planning

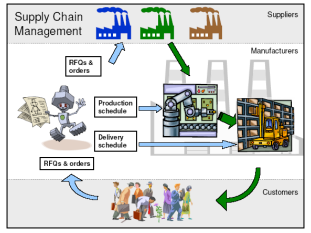

First Person Shooter (e.g. Half Life 2, Splinter Cell)
→character interactions, team formation, limited sensing, path planning, etc...

Simulations (e.g. The Sims)
→character interactions & utility maximization

Applications of MAS II
Supply Chain Management, B2B, Aircraft control

- Supply chain management
- B2B, Logistics

→ coalition formation problem, standardized communications, auctions



- Air traffic control

→ distributed sensing, auctions, …

Applications of MAS III
Urban Search & Rescue

- Urban Search And Rescue (USAR)
  - distributed sensors
  - unmanned vehicles
  - First responder management

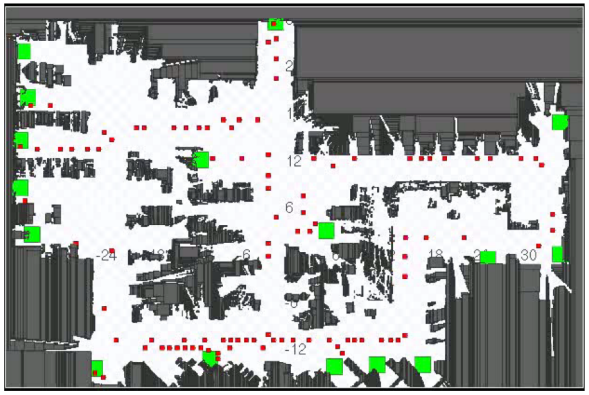
→ Decentralized sensing, task assignment, coalition formation, path planning

Applications of MAS IV
Industry

- Industry
  - factory & ware house management

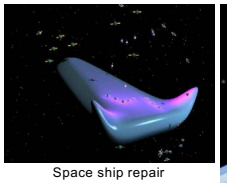
  → Task assignment, coalition formation, path planning
- Project KARIS:
  - Team of 100 decentralized "elements" to accomplish autonomously transportation tasks
- Features:
  - Automatic load and unload at assembly chains
  - Automatic battery recharging via the ground
  - Mechanism to couple with stations or other vehicles
- Challenges:
  - Navigation and coordination of decentralized teams

Applications of MAS IV
Industry

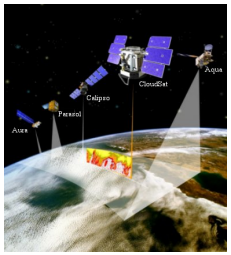


Applications of MAS V
Space

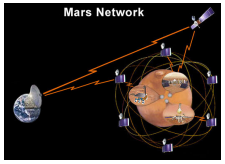
Space Missions with multiple rovers



Space ship repair



Earth orbiters



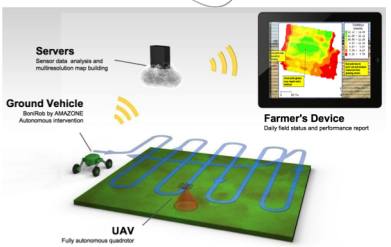
Mars network

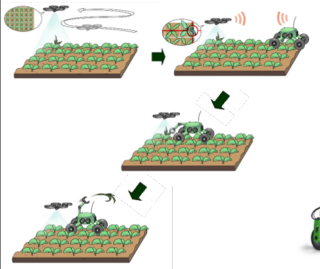
→ Decentralized sensing, task assignment, coalition formation, 3D path planning, and many more challenges ….

Applications of MAS VI
Agriculture

Flourish

Horizon 2020





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Applications of MAS VII
Social Robots

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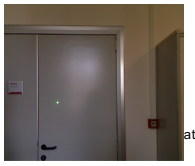
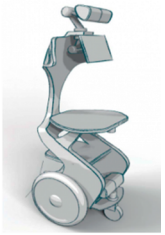
Symbiotic Autonomy



COACHES European Project
Cooperative Autonomous Robots in Complex and Humans Environments



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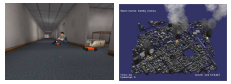
Fully autonomous systems for competitions

Soccer teams (RoboCup)

Rescue robot teams (RoboCup)



Multi Agent Rescue Simulation (RoboCup)

Fast robots (Sick Challenge)

All-terrain navigation (TechX challenge)

Conclusion

- What we can learn about Multi-Agent systems from books only is limited
  - For learning about MAS you have to build them!
  - There exists no ultimate strategy or algorithm (maybe in the future)
  - However, challenges within different domains are very similar
- RoboCup Rescue offers a rich set of problems to MAS-AI
  - Have a look to them!