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Multi-Agent Systems

General point of view from the French MAS College

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Plan

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College SMAA

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French college on MAS

- Part of the AFIA association
- SMAA : $\approx$ 24 teams
- 2 communities : MAS (JFSMA) and AA (ACAI, Artificial Companions, Affects, Interactions)
- collaboration with GDR Robotic, GDR MACS, Simulation (DEVs) group
- $>$ 60 PhD in progress, $>$ 215 PhD completed since 2005
- $>$ 25 HDR completed since 2005
- www.college-smaa.fr

Agents : some definitions

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A computer Science Point of View

- An agent is a software system that is capable of autonomous actions on behalf of its perception of its environment in order to satisfy its objectives.
- A multiagent system is a set of agents that interact (coordinate, cooperate, confront, negociate, decide...) to satisfy a global goal. They can follow specific organizations.

VOWELS approach

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A.E.I.O.U (Demazeau 1995)

List of elements to describe in a MAS:

- **A** Agents: kind of agents, their roles
- **E** Environment: what is perceived by agents; static, dynamic elements
- **I** Interactions: protocoles (negotiation, cooperation, CFP, ...), trust, ...
- **O** Organizations: hierachical, market, society, flat, ...
- **U** Users: type of users, their roles

Depending on the objective, priorities of the elements change
($Simulation \approx EAIOU$, $ManufacturingControl \approx AOIEU$, $Personal\ assistant \approx UAEIO$)

Do not forget the adaptive functions!

Agent: Life Cycle

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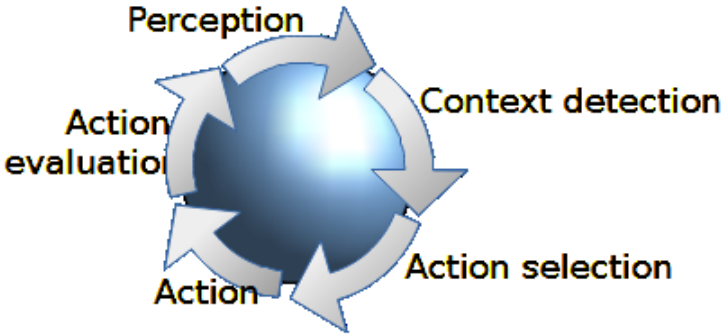

Sort actions	Context C_1	Context C_2	Context
	a_1 [h(a_1, c_1) = 0.8]	a_3 [h(a_3, c_2) = 0.9]	a_4 [h(a_3, c_3)
	a_2 [h(a_2, c_1) = 0.7]	a_5 [h(a_5, c_2) = 0.8]	a_1 [h(a_5, c_3)
	a_3 [h(a_3, c_1) = 0.6]	a_1 [h(a_1, c_2) = 0.3]	a_2 [h(a_1, c_3)
	a_4 [h(a_4, c_1) = 0.5]	a_2 [h(a_2, c_2) = 0.1]	a_5 [h(a_2, c_3)
	a_5 [h(a_5, c_1) = 0.2]	a_4 [h(a_4, c_2) = 0.1]	a_3 [h(a_4, c_3)

Control architectures

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Two main approaches to define the behaviour

- Subsumption: multiple layers of control, where lower levels represent simple and reactive behaviours, and higher levels represent more complex actions.
  Higher-level behaviours can select or "subsume" the lower ones.
- Sequence of behaviours are predefined (and so, easier to understand)
- Adequate for control of systems (hierarchical, holonic, recursive, multi-level architecture)

Control architectures

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Two main approaches to define the behaviour

- BDI: Beliefs, Desires, Intentions.
  Beliefs are representation of their environment, the others,
  Desires are goals to achieve according to a context,
  Intentions are next actions.
- more flexible than predefined plan, more resilient,
  but more complex to foreseen, guarantee the result

Set of agents

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Compositions

AGR : Agent, Groups, Roles (behaviour).

CRIO : Capacity, Role, Interaction, Organisation.

RIO : Role, Interaction, Organisation.

FIPA : Services, sub-services

Reactive : breed, species, ...

MAS: Platforms

Developing MAS

Some platforms build by French teams:

- Application:
  - JaCaMo (EMSE, Saint Etienne, ...): Jason (Agent, interaction), CarTaGo (Environment, artefact), Moïse (Organisation). (BDI / Groups, Roles)
  - SARL: Agent Programming Language (recursion for holonic MAS) JANUS:Agent and Holonic Platform. (Subsumption / CRIO)
  - JADE (Java Agent DEvelopment), some local devpt like Jade UPHF (Valenciennes)
- Simulation:
  - MADKIT (LIRMM , Montpellier). (Reactive / Group, Role)
  - GAMA (Toulouse, Paris, ...). (Reactive, BDI / Species)
  - Mecsyco (Loria, Univ. Lorraine). (Reactive / multilevel)
  - IODA (Univ. Lille). Netlogo extension (Interaction-Oriented Design of Agent simulations)

MAS: key points

Past and current

- cooperation: framework to detect 7 no-cooperation situations (ncs)[IRIT Toulouse]
- DCOP: limit the information shared (Onera Toulouse (position of satellites), UPHF)
- resources/tasks sharing: negotiation (Univ. Lille), vote , auction, ...
- distributed control
  - consensus, cooperatif, résilient (Centrale Lille Institut)
  - auto-organisation (Lyon)
  - cooperative (Toulouse, Paris Saclay, Bourgogne Franche Comté)
- simulations (Toulouse, La Réunion, Brest, Univ. Gustave Effeil, Univ. Lorraine)
- emotions (Univ. Normandie)
- user interactions (cf. ACAI)
- ...

MAS: key points

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Current and future

- MARL (Lyon, Univ Côte d'Azur, Paris Saclay, Montpellier, Toulouse, Renne, Paris Sorbonne)
  since $\approx$ 5 years
- Multi-Agent LLM : **new !**
- IoT, embedded agents (Paris Sorbonne, Univ Grenoble Alpes, Bourgogne Franche Comté)
  since $\approx$ 15 years
- Ethics (Univ Caen Normandie)
  since $\approx$ 10 years
- Humans in the loop !!
  since the beginning (personnal agent), more recent for MAS (CoBot, SmartCities, . . .)

MAS: french projects

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Some recent ANR projects

- Agent conversationnel animé pour favoriser l'interaction sociale dans la schizophrénie. ('Enhancer', 'ANR-22-CE17-0036', 'AAPG2022')
- Processus de décision multi-agent de confiance pour l'Internet des Objets. ('MaestrIoT', 'ANR-21-CE23-0016', 'AAPG2021')
- Multi-agent Agri-food living labs for new supply chain Mediterranean systems; towards more sustainable and competitive farming addressing consumers' preferences and market changes. ('LAB4SUPPLY', 'ANR-21-PRIM-0007', 'PRIMA 2020')
- Emergence de la communication par apprentissage par renforcement guidé par la curiosité en environnement multi-agent. ('ECOCURL', 'ANR-20-CE23-0006', 'AAPG2020')
- An agent-based spatial temporal stochastic framework for modeling of epidemic spread and interventions. ('ABM-EPISPREAD', 'ANR-20-COVI-0029', 'COVID-19')
- Apprentissage adaptatif multi-agent. ('ALIAS', 'ANR-19-CE48-0018', 'AAPG2019')

MAS: french projects

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Other projects

- other regional, national, international projects on the web pages of the teams !

Next rendez-vous

- JFSMA : French days on MAS, 29/07-03/08/26, Arras !!

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Thank you !

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