# Multi Agent Systems Simulations

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INTRODUCTION TO MULTI-AGENT SIMULATION

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# Multi Agent Systems: “BDI” vs “Simulation”??

An important distinction between two main Multi-Agent System (MAS) paradigms:

-multi-agent decision systems : agents participating in the system must make joint decisions as a group. Mechanisms for joint decision-making can be based on economic mechanisms (such as an auction) or alternative mechanisms, such as argumentation.

-multi-agent simulation systems : used as a model to simulate some real-world domain.

# Agents

Agents need to master:

- responsive behaviour (perceiving the environment and respond to changes)
- pro-active behaviour (goal-directed behaviour by taking initiative)
- social behaviour (interacting with other agents and the environment)
- flexible behaviour (having a range of ways to achieve a given goal and being able to recover from failure)

# Agents and the environment

Agents receive information from other agents and the environment and have internal rules that represent the cognitive decision process and determine how they respond.

The rules can be:

- a simple function of the inputs received or
- very complex incorporating various internal state parameters  (a model representing the agent's world view of some part of the environment or even psychological models).

These rules can either be fixed or they can change to represent learning.

# Simulation in MAS

The purpose of simulation is multi agent systems is to better understand how the rules affect a target system and to make predictions about the system:

Simulation would allow you to understand:

- The behaviour to be expected under arbitrarily given parameter combinations
- The behaviour in the future
- The final state of the system in the future?

# ABS

Simulations performed with different methods:

- Discrete Event Simulation (DES)
- System Dynamics (SD)
- Agent Based Simulation (ABS)

In ABS one describes the decision processes of simulated actors at the micro-level. Structures emerge at the macro level as a result of the actions of the agents, and their interactions with other agents and the environment.

ABS is mainly used as a research tool in academia (Social Sciences, Economics, Ecology).

# Applications

- Social Science : Insect societies, group dynamics in fights, growth and decline of ancient societies, group learning, spread of epidemics, civil disobedience
- Economics : Stock market, self organising markets, trade networks, consumer behaviour, deregulated electric power markets
- Ecology : Population dynamics of salmon / trout, land use dynamics, flocking behaviour in fish and birds, rain forest growth
- Political Sciences : Water rights in developing countries, party competition, origins and patterns of political violence, power sharing in multicultural states

# Early applications of MAS

1940s: John von Neumann started to work on cellular automata. A cellular automaton is a set of cells, where each cell can be in one of many pre defined states, such as forest or farmland. Changes in the state of a cell occur based on the prior states of that cell and the history of its neighbouring cells.

1980’s: Robert Axelrod’s prisoner’s dilemma tournaments Some of the strategies submitted were always defect, always cooperate, random etc. The winner of Axelrod's tournament was the TIT FOR TAT strategy. The strategy cooperates on the first move, and then does whatever its opponent has done on the previous move.

# Social science applications

1960s: William McPhee published work on modelling voter behaviour.

1970s: Doran and Scott Moss were using agent-based modelling to address social phenomena such as trade networks, population dynamics, and dynamics of political systems.

1980s: Craig Reynolds was modelling the reality of lively biological agents (e.g. bird flocking behaviour)

# Why multi agent systems?

ABS is suited to systems driven by interactions among their entities and can reveal what appears to be complex emergent behaviour at the system level even when the agents involved have fairly simple behaviour.

It allows modelling of a heterogeneous population where each agent might have personal motivations and incentives, and to represent groups and group interactions.

Multi-agent systems are promising as models of organisations because they are based on the idea that most work in human organisations is done based on intelligence, communication, co-operation, negotiation, and massive parallel processing.

# TP

1. Familiarise yourself with:

https://repast.github.io/docs.html

2. Do the following tutorial:

https://repast.github.io/docs/ReLogoGettingStarted.pdf

3. Get in groups of 4 and start thinking about implementing a simple MAS in Repast over the next two weeks
4. Email croitoru@lirmm.fr with the name of the four students and the proposed MAS simulation by 1st of December @18h the latest.