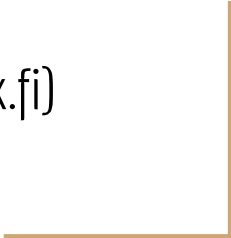


Introduction to Agent-Based Systems

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31.10.16



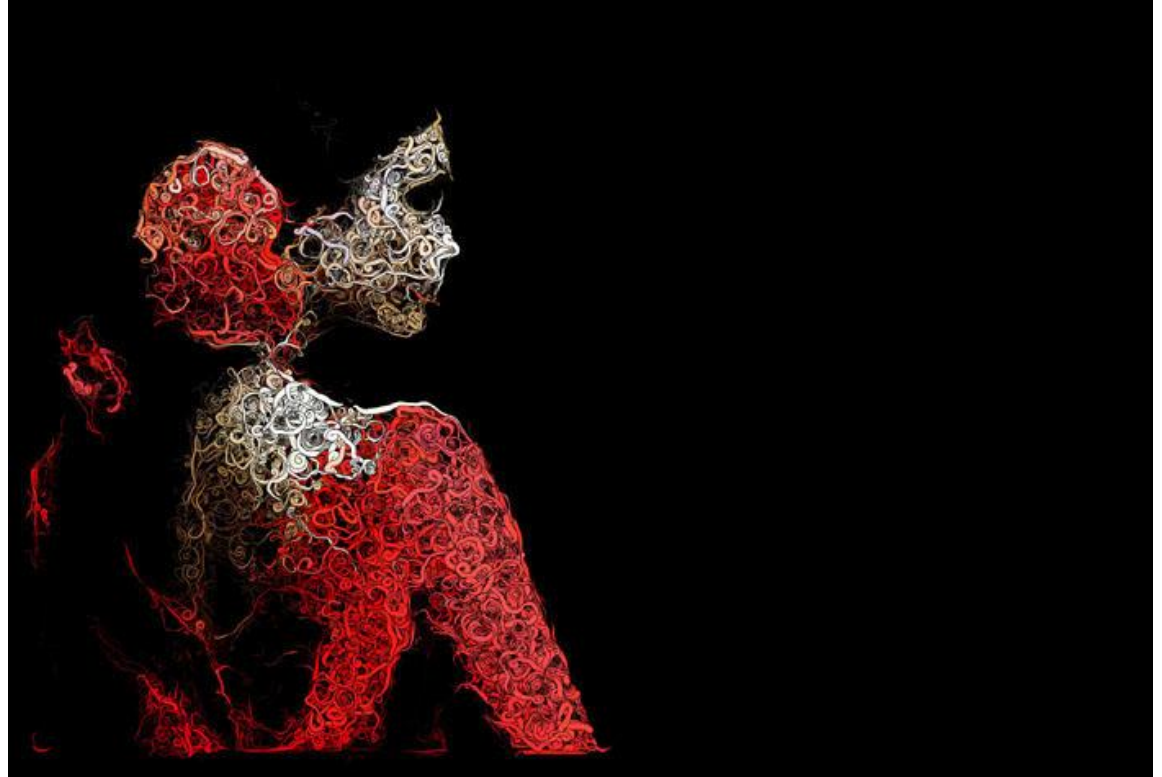
Example: Photogrowth

- Ant colony simulation
- Makes non-photorealistic renderings of images
- Input: an image
- Ants are driven by the image's lightness consuming it
- Output: a rendering of the image

[Video \(2min\)](#)

Outline

1. Terminology
2. Examples
3. Agent Characteristics
4. Environment
5. Interactions

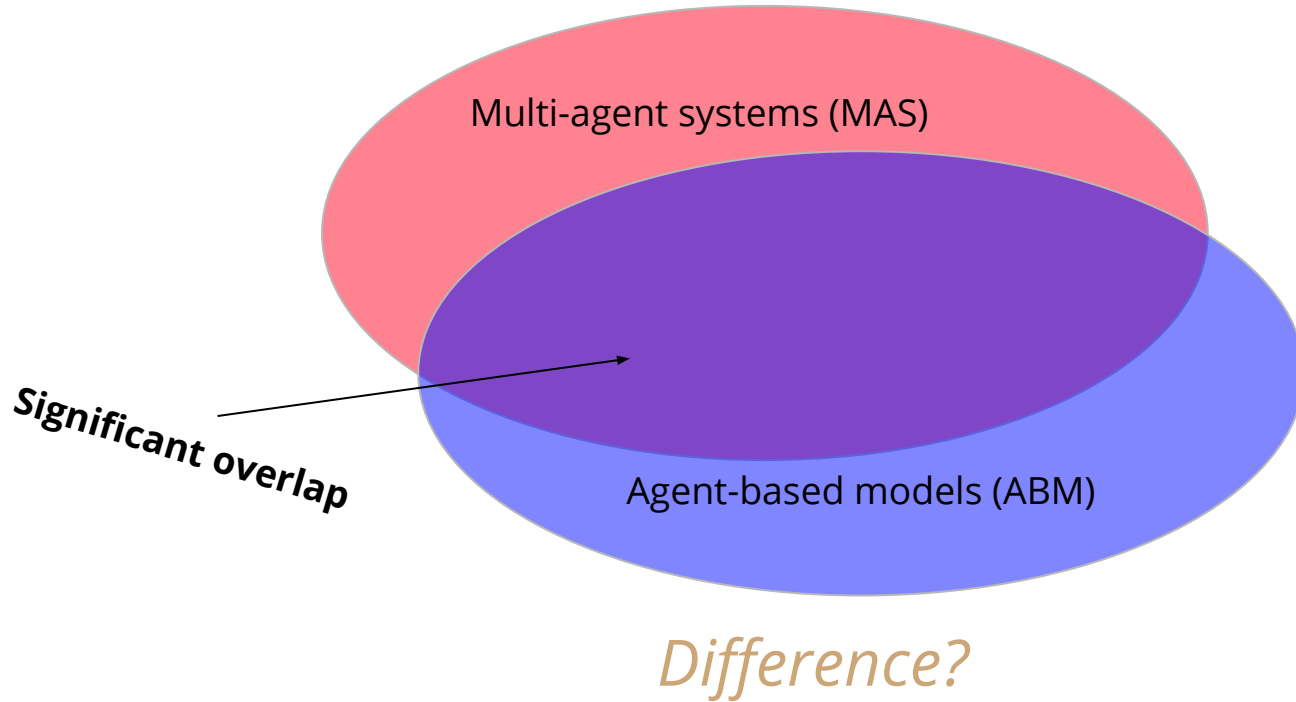


Multi-Agent Systems Are Everywhere

- Transportation
- Sensor networks
- Games
- Industry (e.g. production line)
- etc.



Terminology



What Does the Wikipedia Say?

"A multi-agent system (M.A.S.) is a computerized system composed of multiple interacting intelligent agents within an environment. Multi-agent systems can be used to solve problems that are difficult or impossible for an individual agent or a monolithic system to solve."

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Another Definition

“Multiagent systems are those systems that include multiple autonomous entities with either diverging information or diverging interests, or both.”

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*Maybe more suitable
to our needs.*



Terminology for the Course

You do not have to discriminate between the two terms, therefore:

MAS == ABM

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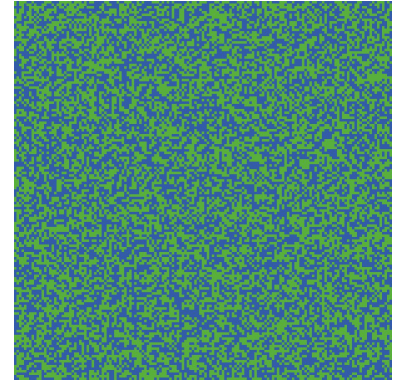
MAS == ABM

However, what matters is the point of view.

*Do we look the system as a whole and its emergent properties,
or do we stress the single agent behavior?*

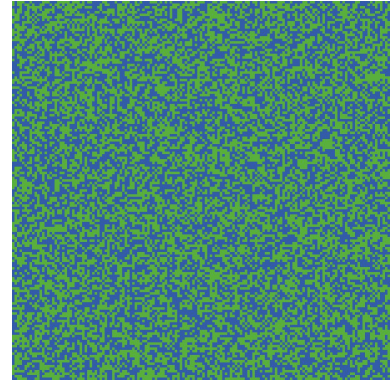
Example: voting

- Agents are initialized in a grid with 8 neighbours
- Two vote options: blue and green
- The starting vote for each agent is random
- Rules:
 - a. An agent votes the same color the majority its neighbours' vote
 - b. In case of tie, do not change the vote
- Optional rules:
 - a. Change the vote on tie
 - b. Award close call to loser (if exactly 3 neighbours vote blue, then vote blue)



Example: voting

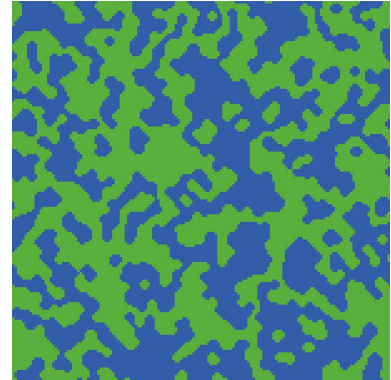
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[Demo time with a NetLogo implementation!](#)

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MAS or ABM?

Objection!

Q: Why is the preceding voting example an agent-based model?

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We can do all the computation with matrices without a single mention about agents.

A: As said, in many cases it is about the point of view, i.e. what characteristics of the model are stressed.

Here the stress was on the voting behavior and its emergent properties, so it is justified to speak about ABM.

Example: A Bot for StarCraft

- RTS game by Blizzard Entertainment (1998)
- Goal in 1v1: destroy the other player
- Player actions:
 - Construct buildings
 - Research technology
 - Gather resources
 - Build (combat) units
 - Attack enemy, etc.
- Three distinct races with their own units requiring different strategies
- SSCAIT: Competitions for bots



Example: A Bot for StarCraft

Modeling example:

- Each unit can be represented as an agent
- Manager agents coordinate large scale behavior:
 - a. Worker management
 - b. Attack orders, etc.

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- Autonomic agents
- No “god agent” deciding everything



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Demo time! A Bot with Multi-agent Potential Fields



Applications and Research Topics

Multi-Agent Systems

- Coordination and cooperation
- Negotiation
- Robotics
- Networking and mobile technologies
- etc.

Agent-Based Models

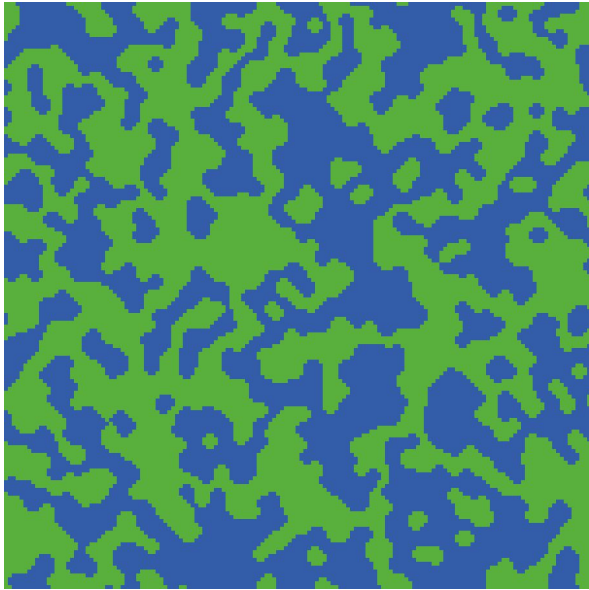
- Re-create and predict the appearance of complex phenomena (emergence)
- Model the spread of epidemics
- Model consumer behavior
- Simulation of other social phenomena
- etc.

Agent Characteristics

- **Autonomy**
 - agents are (at least partially) independent and autonomous
- **Local Views**
 - no agent has a (full) global view of the system
- **Decentralization**
 - no designated controlling agent (or the system is rendered effectively to a monolithic system)

Agent Characteristics

Do the characteristics hold in our examples?

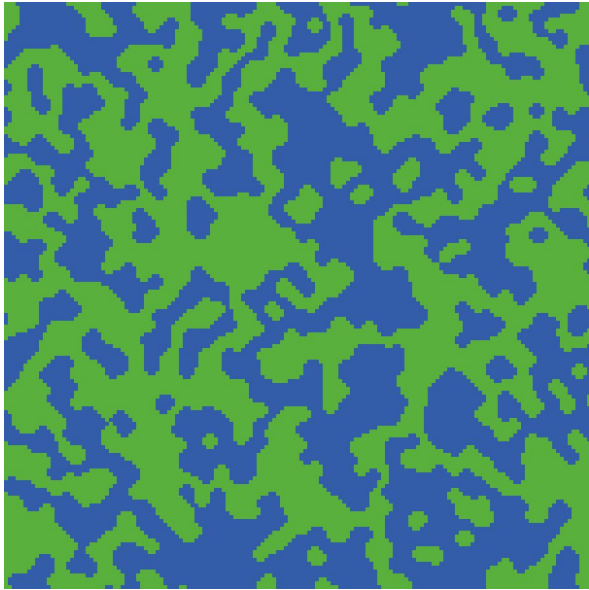


Environment

- All agents live in some environment
- May provide resources, restrictions, etc.
- Agents perceive the environment (with sensors)
- At minimum, the environment provides the platform for inter-agent communication

Environment

What kind of environments do the agents have?

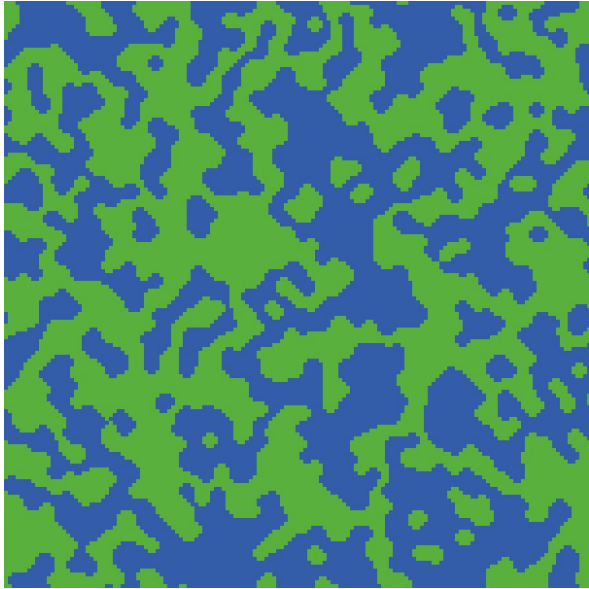


Interaction

- No agent is isolated!
- Agents interact with each other and/or with the environment
- Directly:
 - Asking information
 - Broadcasting/sending information
 - Voting
 - etc.
- Indirectly, through the environment:
 - leaving “pheromones”
 - altering resources (consuming and producing)
 - etc.

Interaction

How do the agents interact in our examples?



Summary

- Two closely related terms: MAS and ABM
- ABM leans towards emergence and large scale behavior
- MAS leans towards intelligent individual agents
- Agents have to be somewhat autonomous
- Environment holds a critical role
- Agent interaction is a central concept

Questions?

