

SWARM INTELLIGENCE

Systems Analysis

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Outline

1 Foundations

2 Artificial Agents

3 Algorithms



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1 Foundations

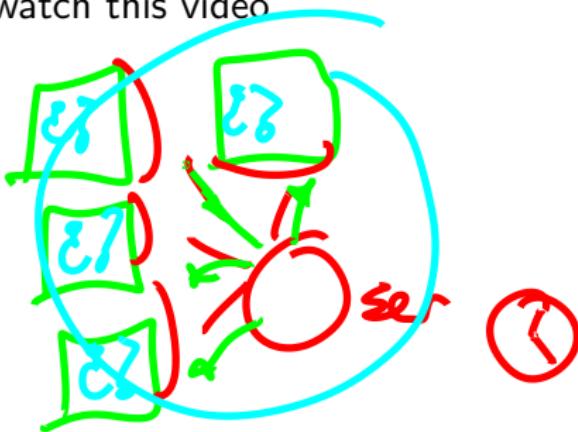
2 Artificial Agents

3 Algorithms



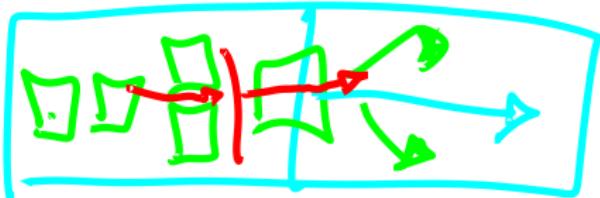
Swarm Intelligence I

- Swarm intelligence is the collective behavior of decentralized, self-organized systems, natural or artificial.
- The concept is employed in work on artificial intelligence.
- The expression was introduced by Gerardo Beni and Jing Wang in 1989, in the context of cellular robotic systems. For example, let's watch this video



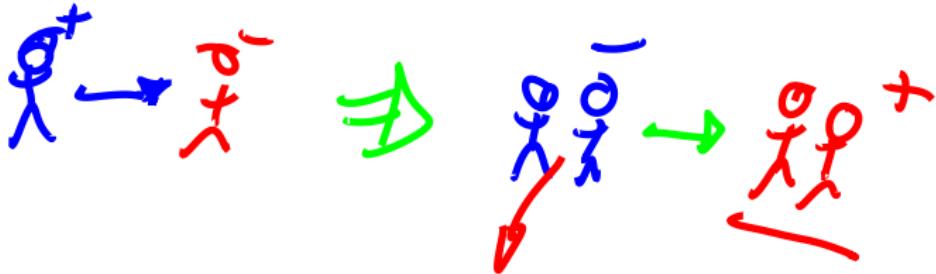
Swarm Intelligence II

- The idea is: if you see an individual, a part, it looks not interesting, even like random; however, several individuals interacting between each other and the environment show pretty smart behaviors.
- Yu Takeuchi said: one colombian guy is most intelligent than a japanese guy, but two japanese guys are smarter than two colombians.
- There is some interesting population behaviors in nature, in special at insects: bees, ants, termites, among others.
- However, in nature there are a lot of examples: school fish, birds, wolfs.



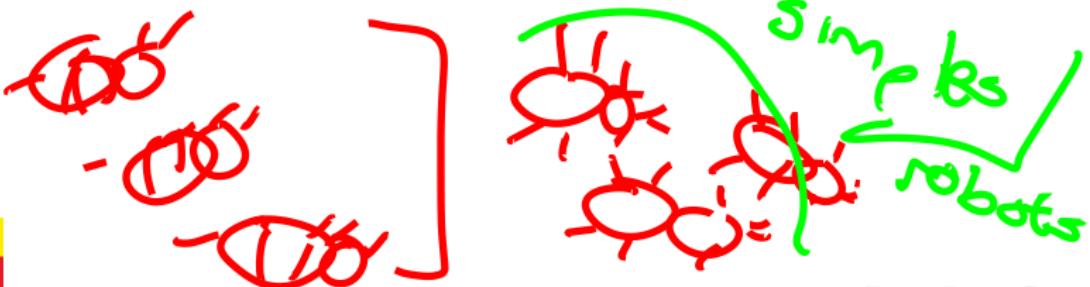
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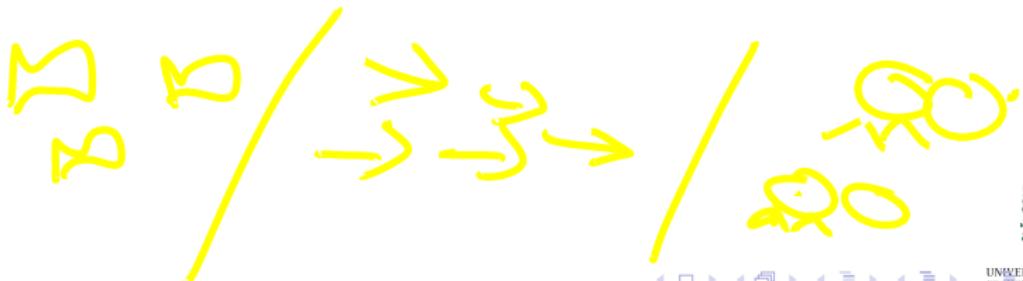
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Emergent Behaviors

- Emergent behavior is the **appearance** of **complex patterns** and behaviors from a **multiplicity** of relatively simple interactions.
- The **emergent behavior** is the **result** of the **collective** behavior of the **individuals** of the system.
- The **emergent behavior** is not planned or **designed** by any individual, but arises from the **interactions** of the individuals.
- The **emergent behavior** is **not** the **sum** of the **individual** behaviors, but something more. In summary: **synergy**.
- Swarm intelligence makes reference to some interesting **emergent** behaviors.



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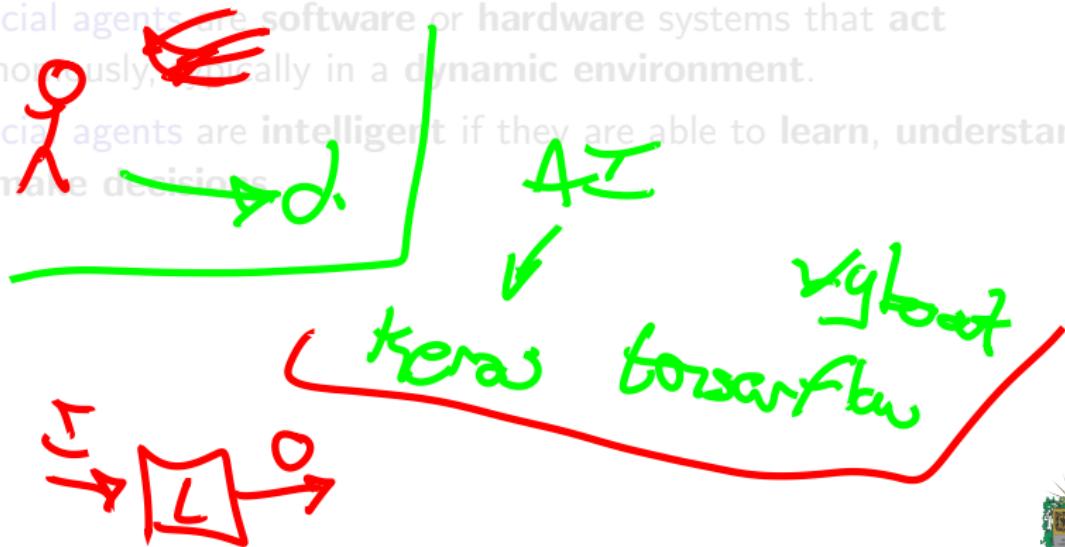
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How is to be intelligent?

- Intelligence is the **ability** to **learn, understand, and make decisions.**
- Artificial intelligence is the simulation of human intelligence in machines.
- Artificial agents are software or hardware systems that act autonomously, **AI**, in a dynamic environment.
- Artificial agents are intelligent if they are able to learn, understand, and make decisions.



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Artificial Reactive Agents

- Reactive agents are simple and fast agents that react to the environment.

- Reactive agents are not able to learn or understand the environment.
- Reactive agents are not able to make decisions based on past experiences.
- Do reactive agents exist in intelligent agents?.
- Swarm intelligence is a way to make reactive agents intelligent.



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~~info~~ \Rightarrow process signals environment



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X historical info \Rightarrow



repeat
errors

own storage
memory



Artificial Reactive Agents

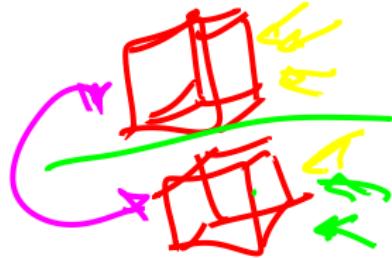
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Learn X Understand ~
decisions ✓



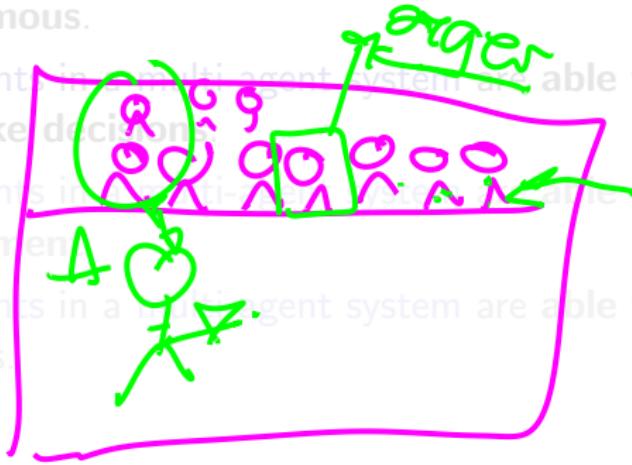
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Multi-Agent Systems

- A **multi-agent system** is a **group of intelligent agents** that **interact** with each other and the **environment**.
- The agents in a multi-agent system are **independent** and **autonomous**.
- The agents in a multi-agent system are **able to learn, understand, and make decisions**.
- The agents in a multi-agent system are **able to adapt to the environment**.
- The agents in a multi-agent system are **able to solve complex problems**.

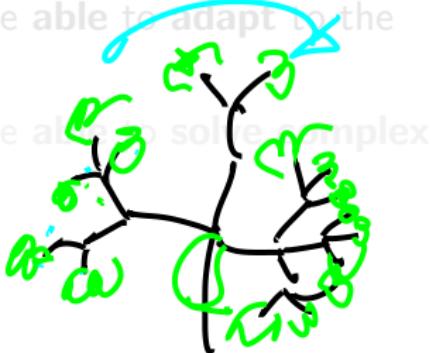
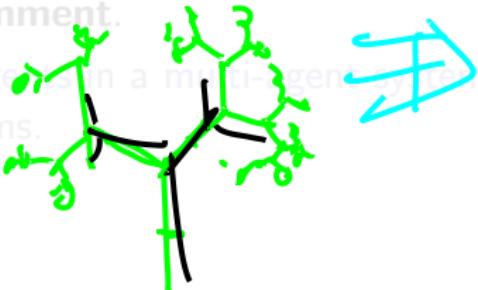


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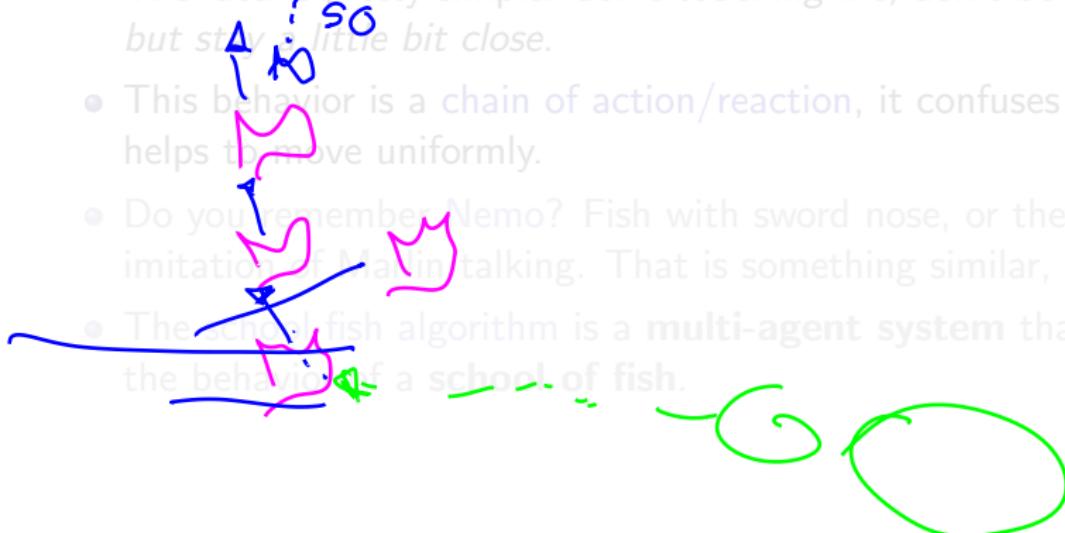
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School Fish Algorithm

- School fish are pretty interesting. When a predator attack, it gets confused by the amount of individuals and the different movements.
- The idea is pretty simple: *don't touching me, don't be so close to me, but stay a little bit close.*
- This behavior is a chain of action/reaction, it confuses predators, helps to move uniformly.
- Do you remember Nemo? Fish with sword nose, or the pirates, or the imitation of Mankind talking. That is something similar, look here.
- The school fish algorithm is a **multi-agent system** that simulates the behavior of a **school of fish**.



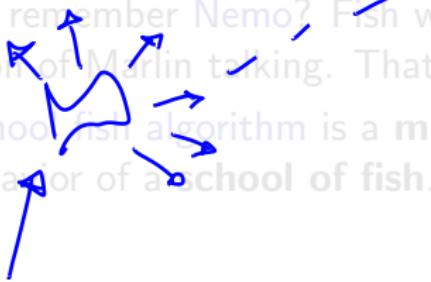
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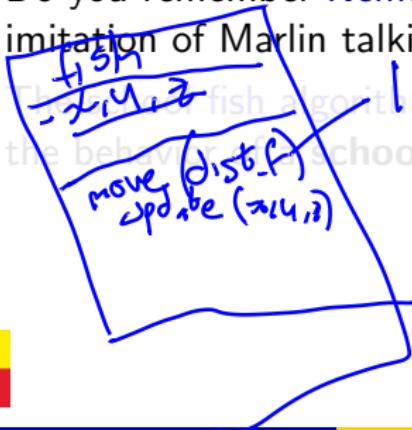
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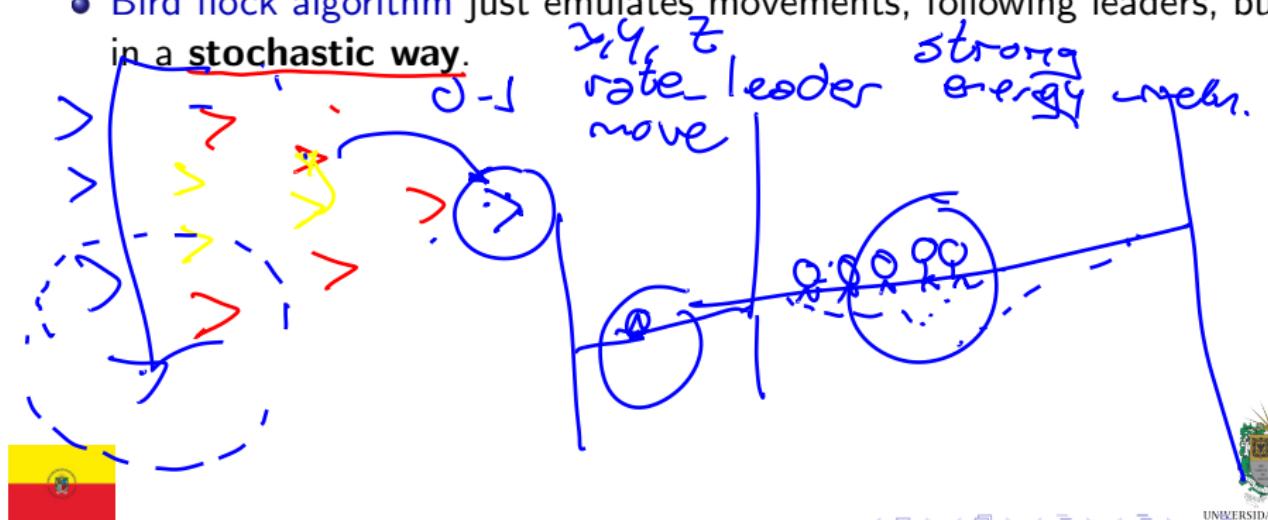
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Bird Flock Algorithm

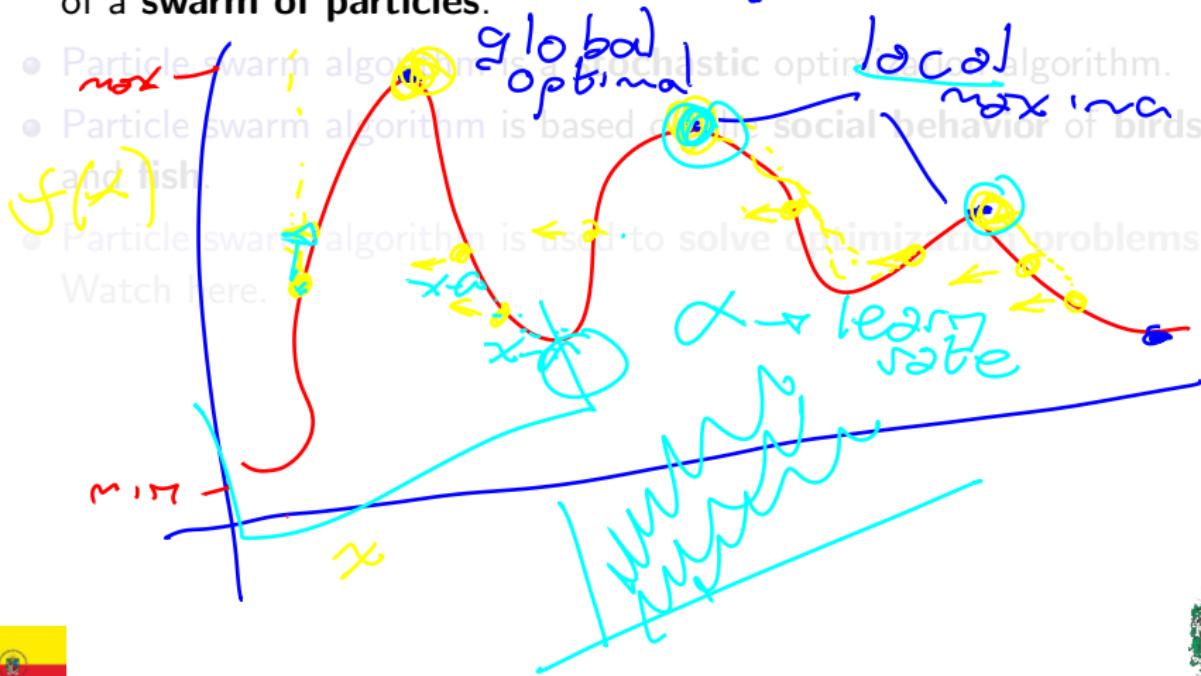
- Birds are pretty interesting. They are able to fly in a **group** without colliding.
 - Bird flock is a **multi-agent system** that **simulates** the behavior of a flock of birds.
 - Bird flock algorithm just emulates movements, following leaders, but in a stochastic way. *with a strong*



Particle Swarm Algorithm

Acco

- **Particle swarm** is a **multi-agent system** that **simulates** the behavior of a **swarm of particles**.
 - Particle swarm algorithm is a stochastic optimization algorithm.
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Thanks!

Questions?



Repo: <https://github.com/EngAndres/ud-public/tree/main/courses/systems-analysis>

