SWARM INTELLIGENCE

Systems Analysis

Author: Eng. Carlos Andrés Sierra, M.Sc.

cavirguezs@udistrital.edu.co

Lecturer
Computer Engineer
School of Engineering
Universidad Distrital Francisco José de Caldas

2024-III

Outline

1. Foundations

2. Artificial Agents

3. Algorithms

Outline

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**.

Auto-Norecotorís
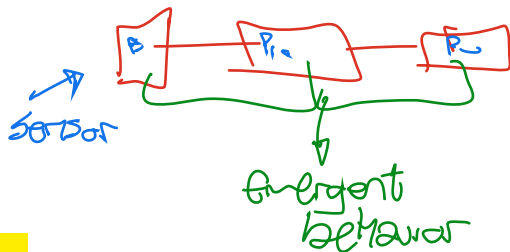
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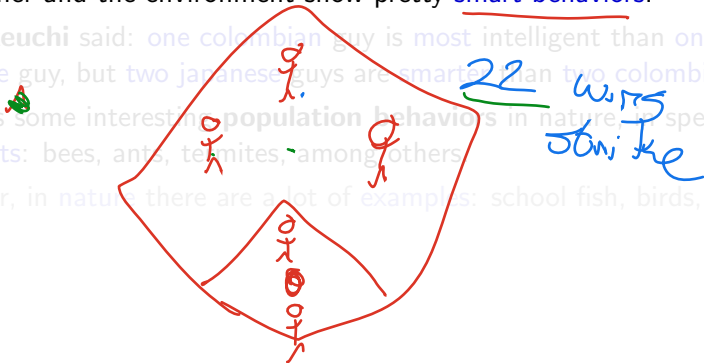- resources
- Knowledgment
+ small world

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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 one japanese guy, but two japanese guys are smarter than two colombians.

- There is some interesting **population behaviors** in nature, is 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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Ants

Bugs

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bio-inspired

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.
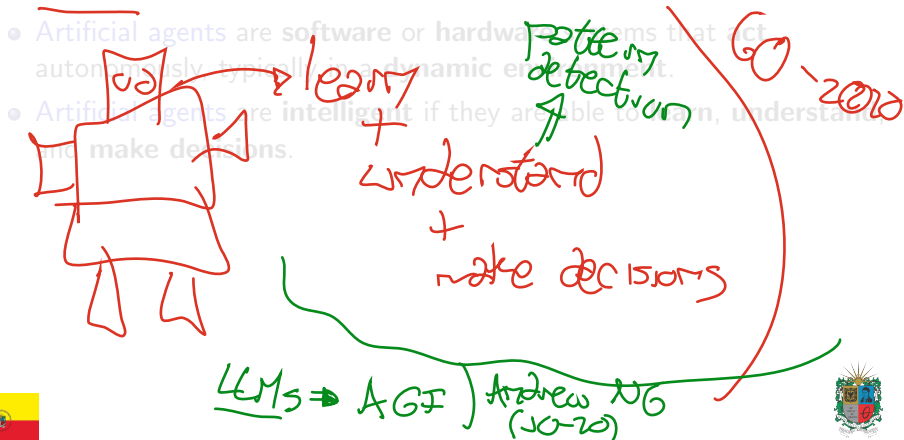
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How is to be intelligent?

- **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, typically in a dynamic environment.
- Artificial agents are intelligent if they are able to learn, understand, and make decisions.

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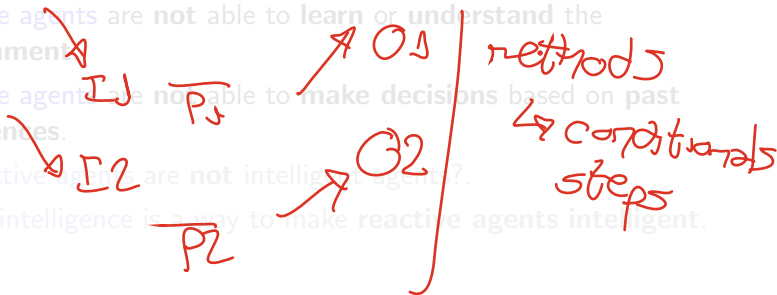
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Artificial Reactive Agents

- **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 are **not** intelligent agents?.

- Swarm intelligence is a way to make **reactive agents intelligent**.

(handwritten annotations) I1, P1, O1, methods → conditionals steps, I2, P2, O2

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Multi-Agent Systems
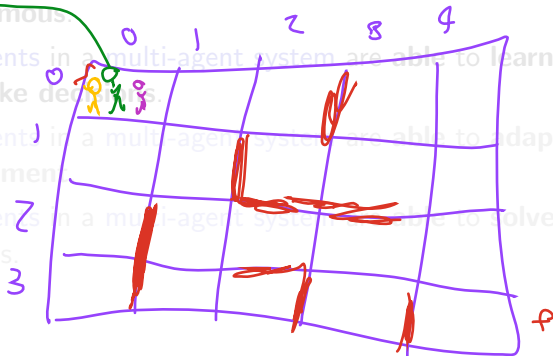
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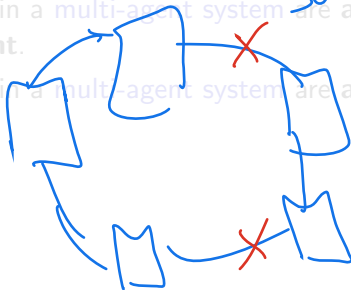
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termites

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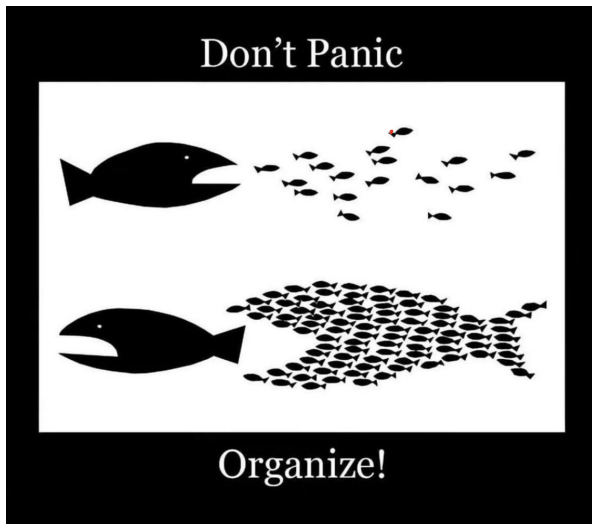- The agents in a multi-agent system are **able** to **solve complex** problems.

Outline

School Fish Algorithm
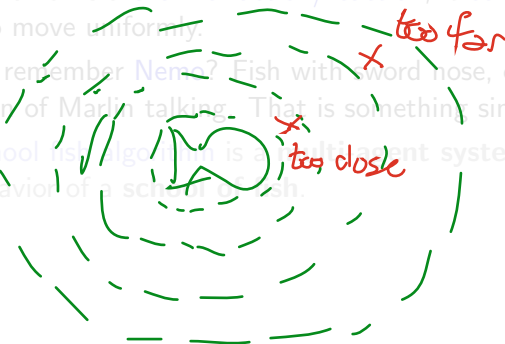
School Fish Algorithm

- **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's Fish with sword nose, or the pirates, or the imitation of Marlin 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**.
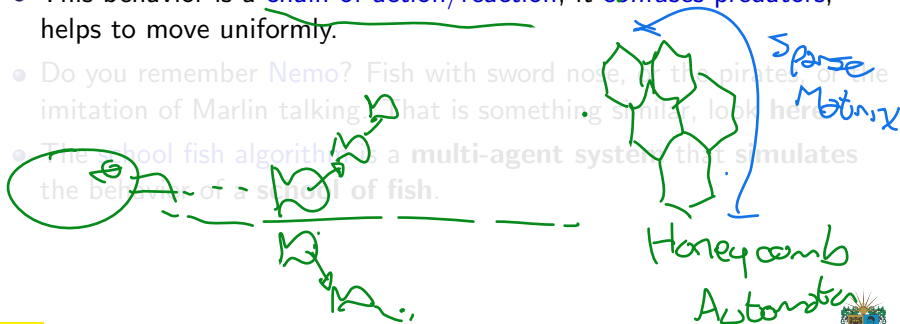
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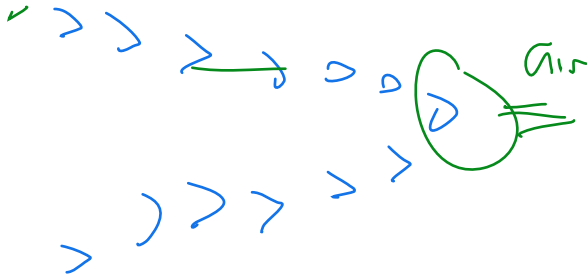- The school fish algorithm is a **multi-agent system** that **simulates** the behavior of a **school of fish**.

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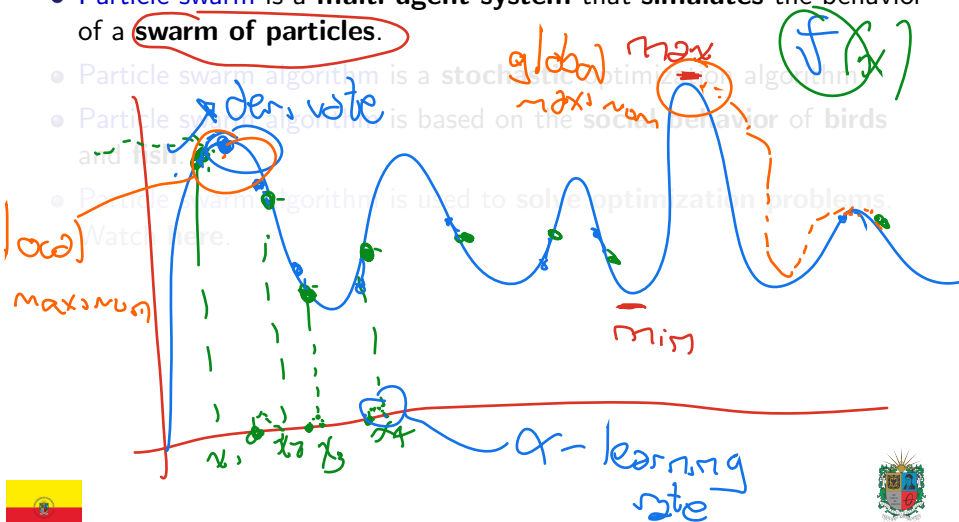
Bird Flock Algorithm

- 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**.

Particle Swarm Algorithm

- Particle swarm is a **multi**-**agent system** that **simulates** the behavior of a **swarm of particles**.

- Particle swarm algorithm is a **stochastic** optimization algorithm.

- Particle swarm algorithm is based on the **social behavior** of **birds** and **fish**.

- Particle swarm algorithm is used to **solve optimization problems**. Watch More.

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Thanks!

Questions?

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