Swarm Intelligence

Systems Analysis

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Outline

1 **Foundations**

2 **Artificial Agents**
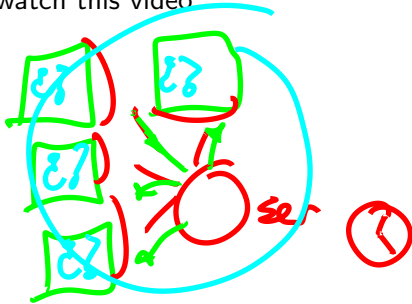
3 **Algorithms**

Outline

1. **Foundations**

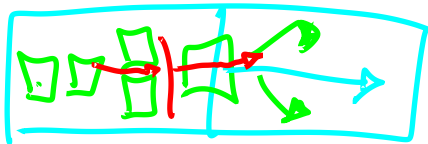2. Artificial Agents

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
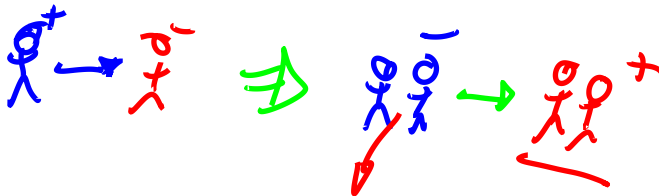
Swarm Intelligence II

- 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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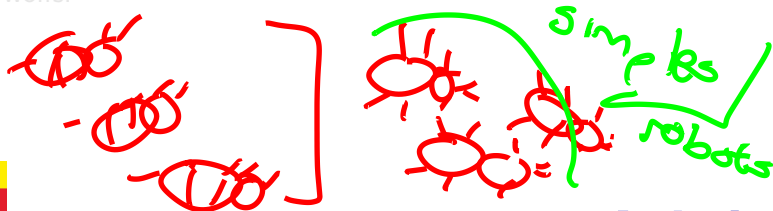- However, in nature there are a lot of examples: school fish, birds, wolfs.

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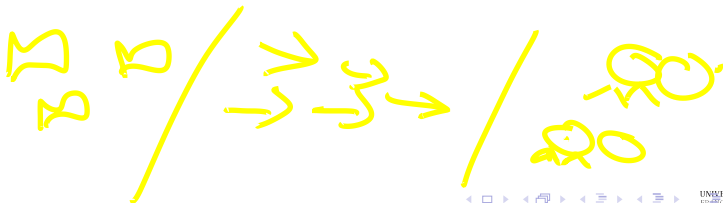- However, in nature there are a lot of examples: school fish, birds, wolfs.

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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**.
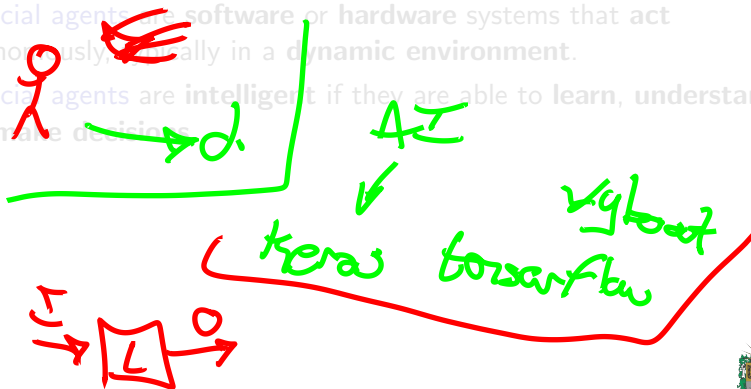- Swarm intelligence makes reference to some interesting emergent behaviors.

Outline

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, usually in a **dynamic environment**.

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class Agent

attr. Info

methods
↳ behaviour

calculate info

make decisions

DB → vectors

Artificial Reactive Agents

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

- Reactive agents are not able or **understand** the environment.

- Reactive agents are not able to **make decisions** based on **past experience**.

- Do reactive agents are not intelligent agents?.

- Swarm intelligence is able to make **reactive agents intelligent**.

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(handwritten annotations)

✗ historical info ⟹ ✓ Own storage memory

↳ repeat errors

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Learn ✗   understand ∿

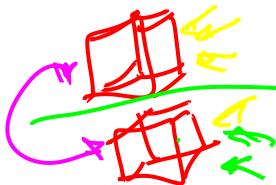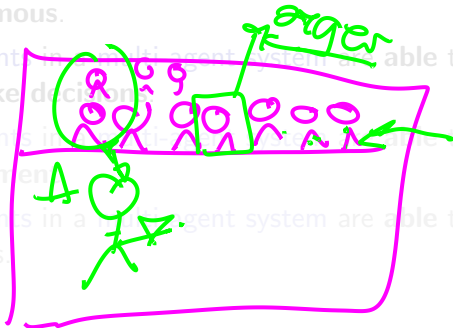decisions ✓

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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**.

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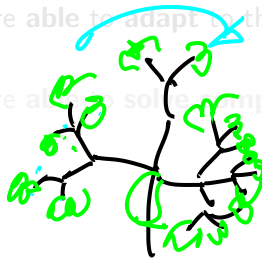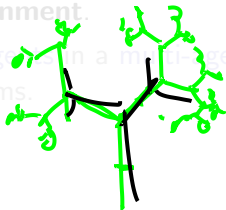
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simple

Outline

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 Marlin talking. That is something similar, look here.

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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**.

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Thanks!

Questions?

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