

SWARM INTELLIGENCE

Systems Analysis

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Outline

- 1 Foundations
- 2 Artificial Agents
- 3 Algorithms



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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**.



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



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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**.
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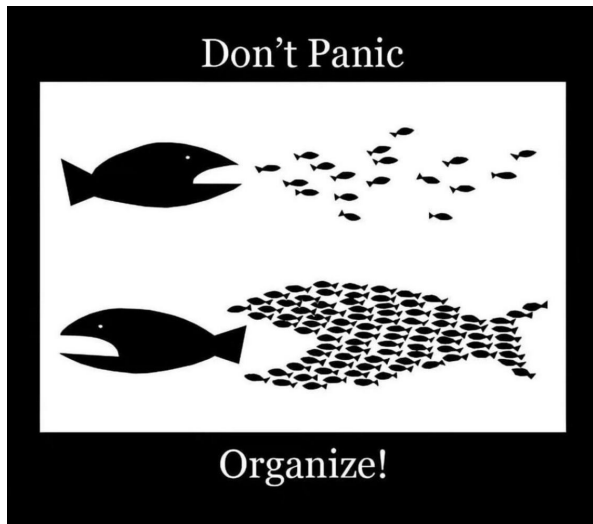


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School Fish Algorithm



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? 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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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**.
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Thanks!

Questions?



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

