Systems Analysis

Systems Analysis & Design

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Outline

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What is a System?

- A **system** is a set of interacting components that work together to achieve a common goal.
- A **system** is a collection of elements that are organized in a specific way.
- A **system** is a structure that is designed to perform a specific function.

Systems Analysis Process

- **Systems analysis** is the process of studying a system in order to identify its components, interactions, and goals.
- **Systems analysis** is the process of understanding how a system works and how it can be improved.
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Systems Development Lifecycle

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- It includes planning, analysis, design, implementation, and maintenance phases.
- It is a structured approach to developing a system that ensures that it meets the needs of its users.

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- **Lateral thinking** is a creative problem-solving technique that involves thinking outside the box.
- It is a non-linear approach to problem-solving that encourages innovation and creativity.
- It is a useful technique for generating new ideas and solving complex problems.
- Examples:
  - How can you improve the design of a product?
  - What are the benefits of failure?
  - Why is ignorance important?
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Lateral Thinking Training

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Complexity and Emergence

- **Complexity** is the degree to which a system is difficult to understand.
- **Emergence** is the appearance of unexpected properties in a system that arise from the interactions of its components.
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What is Chaos?

- **Chaos** is a branch of mathematics that studies the sensitivity of dynamical systems to initial conditions.
- **Chaos** is a non-linear behavior that is highly sensitive to initial conditions.
- **Chaos** is a deterministic behavior that is not predictable in the long term.
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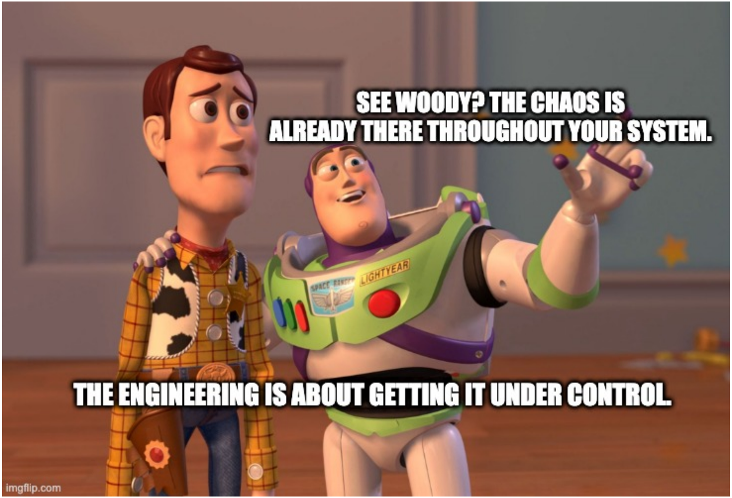
Chaos is Everywhere!



What is a Dynamic System?

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Chaotic Atractors

A **chaotic attractor** is a set of points in a phase space that attracts the trajectory of a dynamical system.

Fractals

- A **fractal** is a complex geometric shape that can be split into parts, each of which is a reduced-scale copy of the whole.
- A **fractal** is a self-similar shape that is infinite in detail.
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Fractals in Nature

Watch this video: https://www.youtube.com/watch?v=kkGeOWYOFoA

Complexity in Dynamic Systems

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- It includes the number of components, the interactions between components, and the emergent properties of a system.

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- 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.

School Fish Algorithm

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- **School fish** are quite interesting. When a predator attacks, they become confused by the large number of individuals and their diverse movements.
- The idea is simple: *"Don't touch me, don't come too close, but stay somewhat close."*
- This behavior is a chain of action and reaction. It confuses predators and helps the school move uniformly.
- Do you remember Nemo? The fish with a sword snout, the pirates, or Marlin's imitation of talking-all are somewhat similar. Watch **here**.
- The school fish algorithm is a **multi-agent system** that **simulates** the behavior of a **school of fish**.

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- Ant colony algorithm is a **multi-agent system** that **simulates** the behavior of an **ant colony**.
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Abstraction and Modularity

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Questions?

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

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