

SYSTEMS ANALYSIS

Systems Analysis & Design

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Outline

- 1 Basic Concepts
- 2 Chaos and Dynamic Systems
- 3 Abstraction and Modularity



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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.
- Systems analysis is the first step in the systems development lifecycle.



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Systems Development Lifecycle

- The **systems development lifecycle** is a **process** that **guides** the **development** of a **system**.
- 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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Systems Analysis Techniques

- **Systems analysis** uses a **variety** of **techniques** to **study** a **system**.
- It includes **interviews**, **surveys**, **observations**, and **document analysis**.
- It also includes **data modeling**, **process modeling**, and **requirements analysis**.



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Lateral Thinking

- **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

- **Lateral thinking** is a **skill** that can be **learned** and **developed** through **training** and **practice**.
- It involves exercises, games, and activities that encourage creative thinking.
- Examples of lateral thinking exercises:
 - Brainstorming sessions.
 - Mind mapping exercises.
 - Role-playing games.
 - Problem-solving activities.



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Uncertainty and Risk

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- **Risk** is the **probability** of a **negative outcome** or **loss** associated with a **decision** or **event**.
- **Uncertainty** and **risk** are **inherent** in **complex systems** and **decisions**.
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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**.
- **Complexity** and **emergence** are **common** in **dynamic** systems that are **non-linear** and **chaotic**.
- They can be studied and understood through systems analysis and modeling.



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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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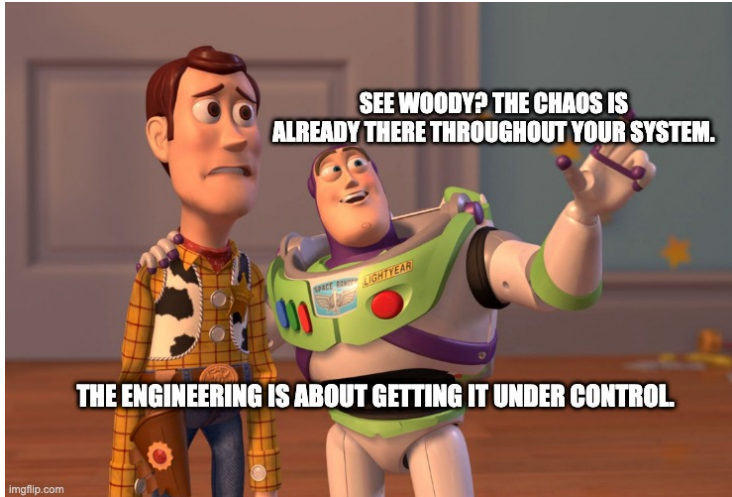


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Chaos is Everywhere!



What is a Dynamic System?

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Chaotic Attractors

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



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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- **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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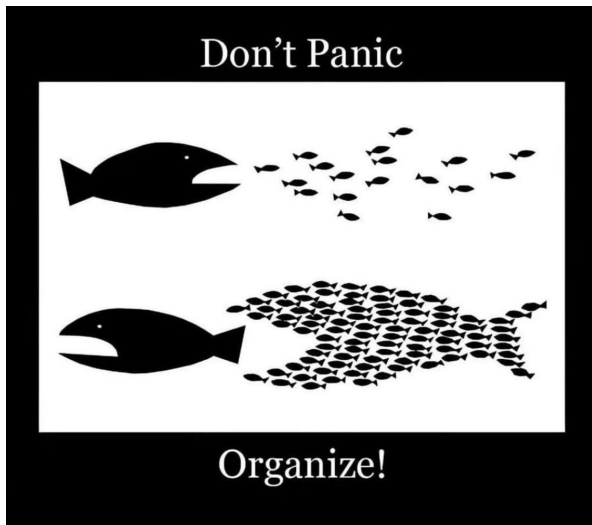


Emergent Behaviors

- **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.



School Fish Algorithm



School Fish Algorithm

- **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 based on the **social behavior** of **ants** and the use of **pheromones**. Watch [here](#).
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- Abstraction is the process of generalizing a specific system in order to apply it to other systems.



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

