# Systems Thinking

## Systems Analysis

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# Outline



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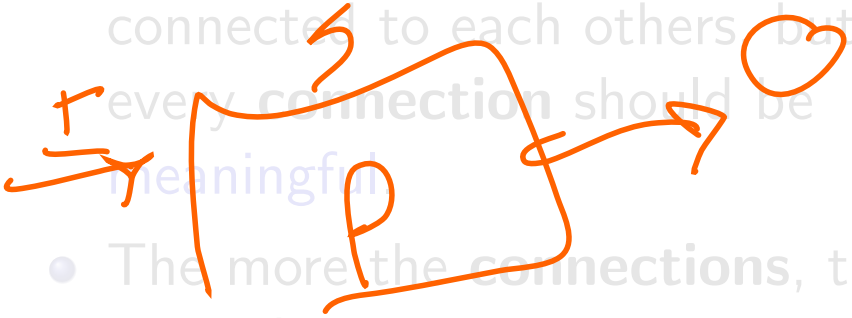
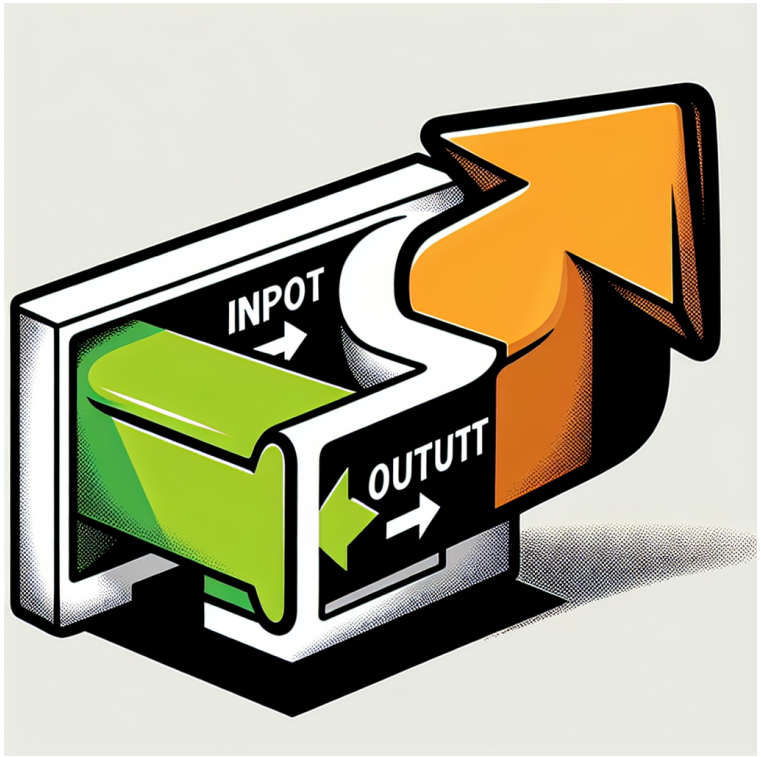
# Outline



# Introduction to Systems Thinking I

- A **system** is just a set of elements interconnected with a common purpose.
- Not all elements must be connected to each others, but every **connection** should be meaningful.
- The more the **connections**, the more the system complexity. Representation must be feasible.
- Each element must have **at least** one connection. Isolated elements makes no sense in a system.



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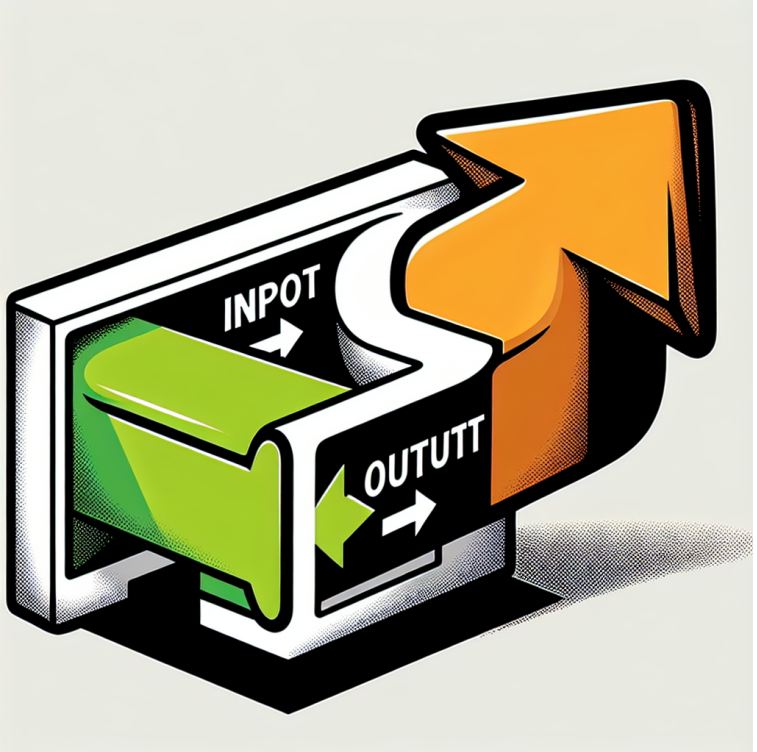


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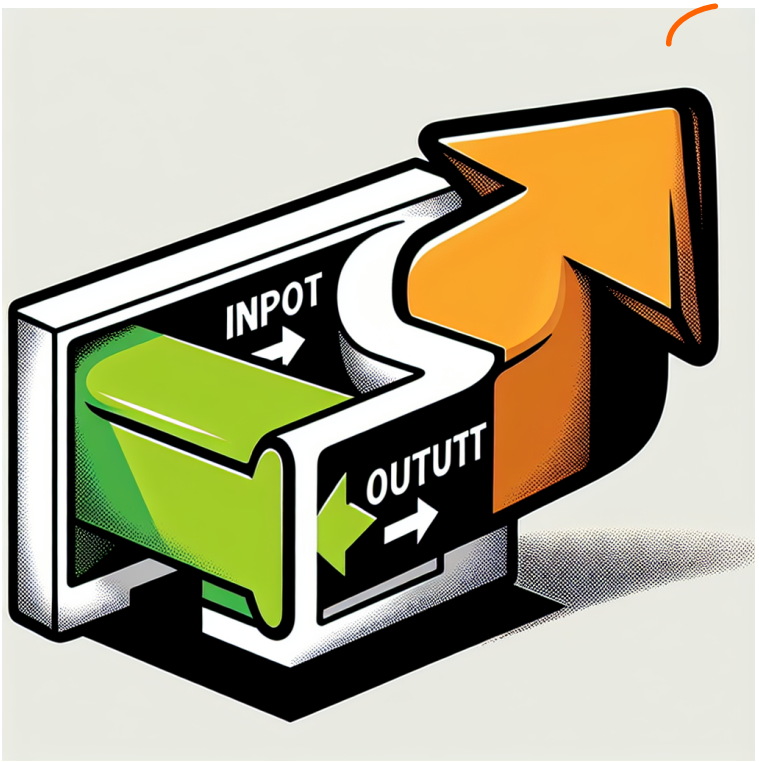


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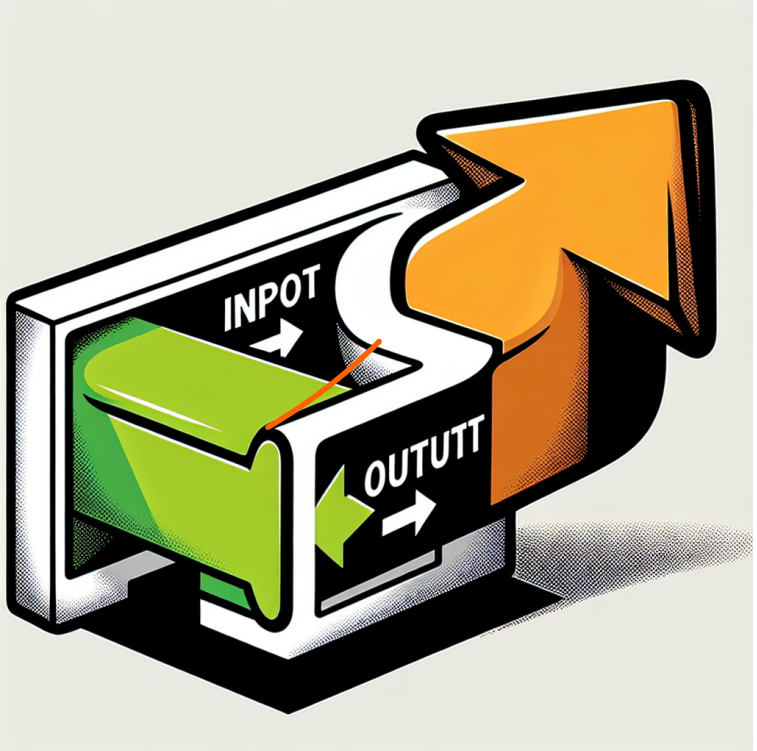


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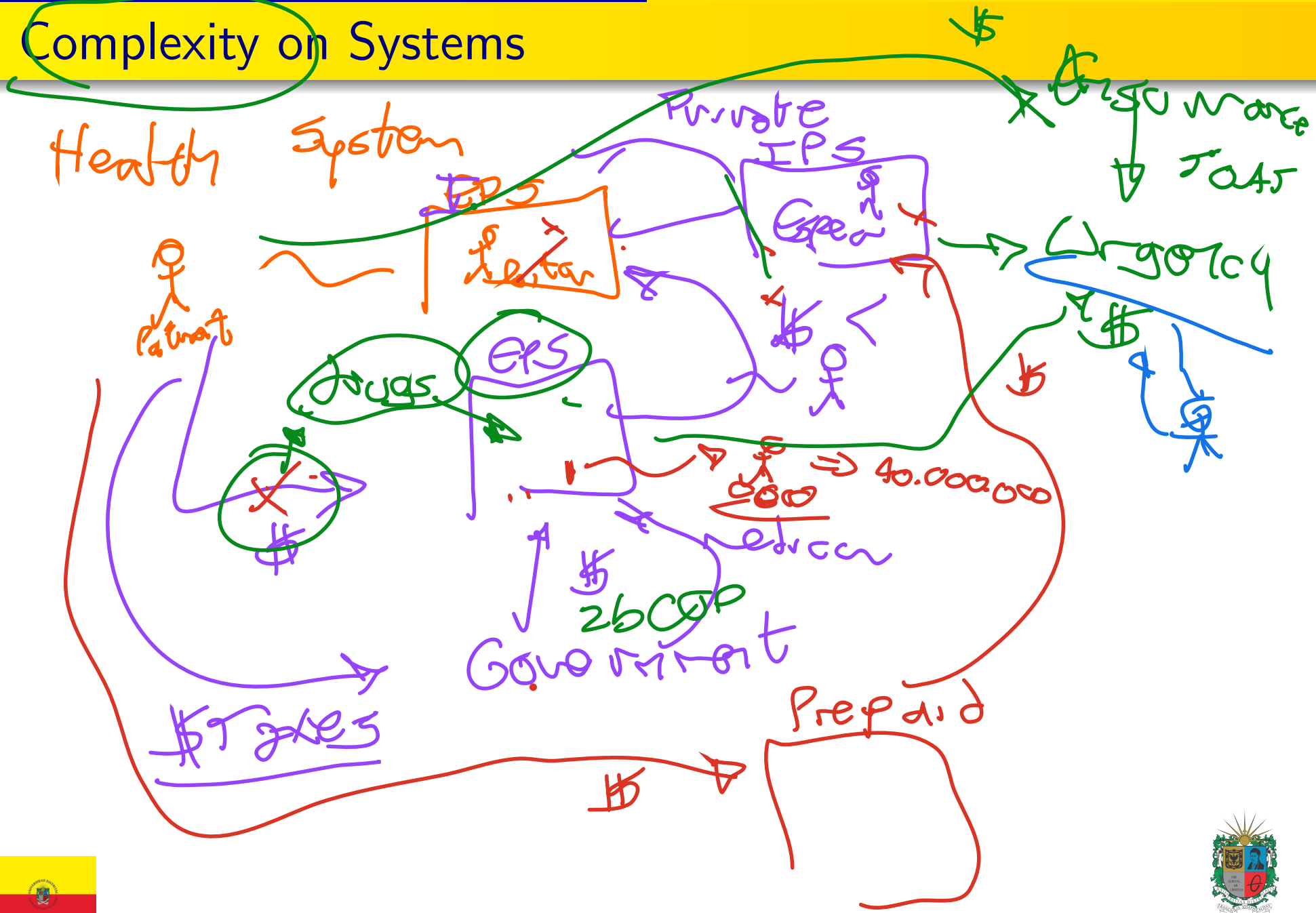
# Complexity on Systems



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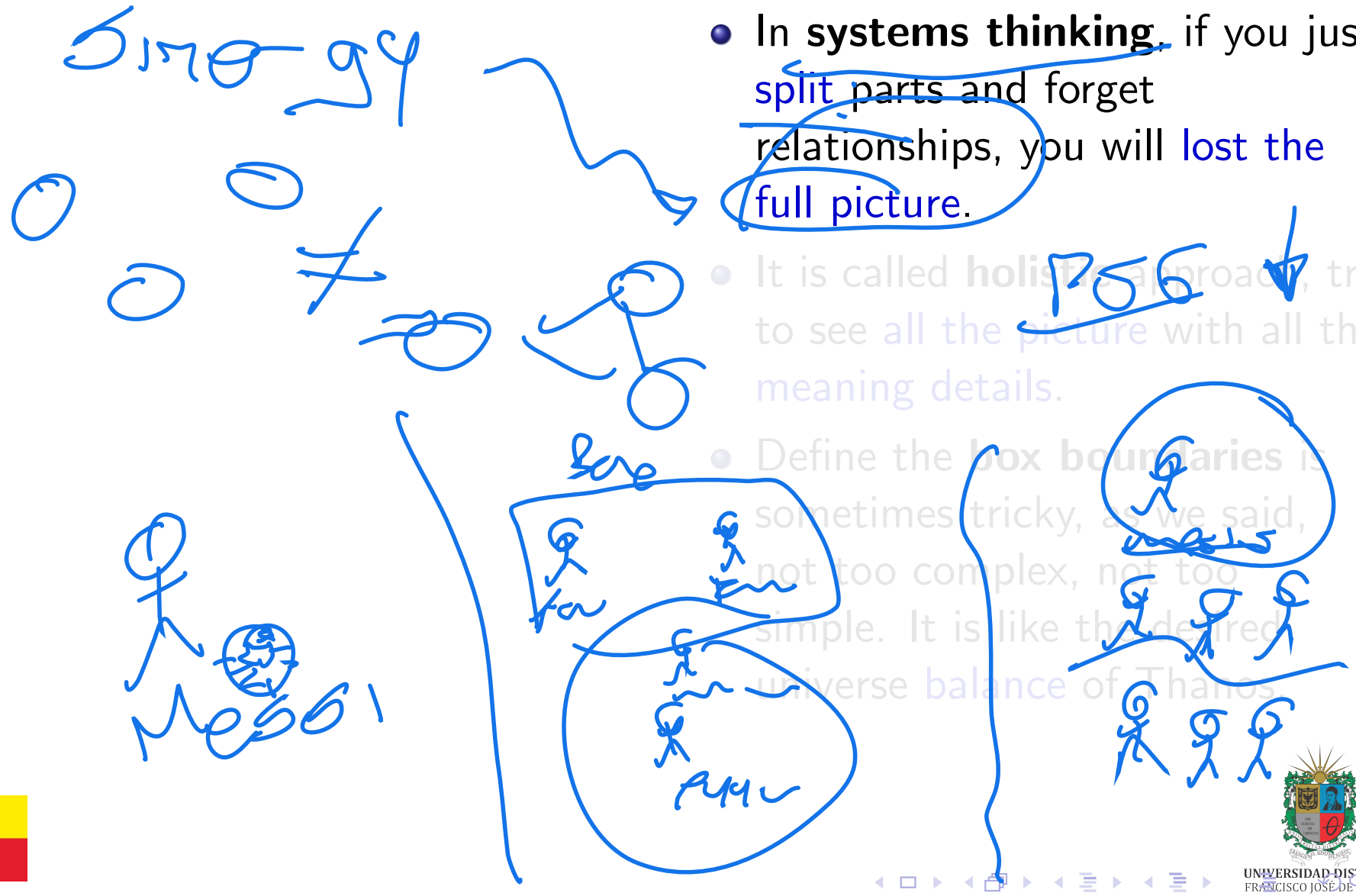

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- It is called **holistic** approach, try to see all the picture with all the meaning details.
- Define the **box boundaries** is sometimes tricky, as we said, not too complex, not too simple. It is like the desired universe balance of Thanos.

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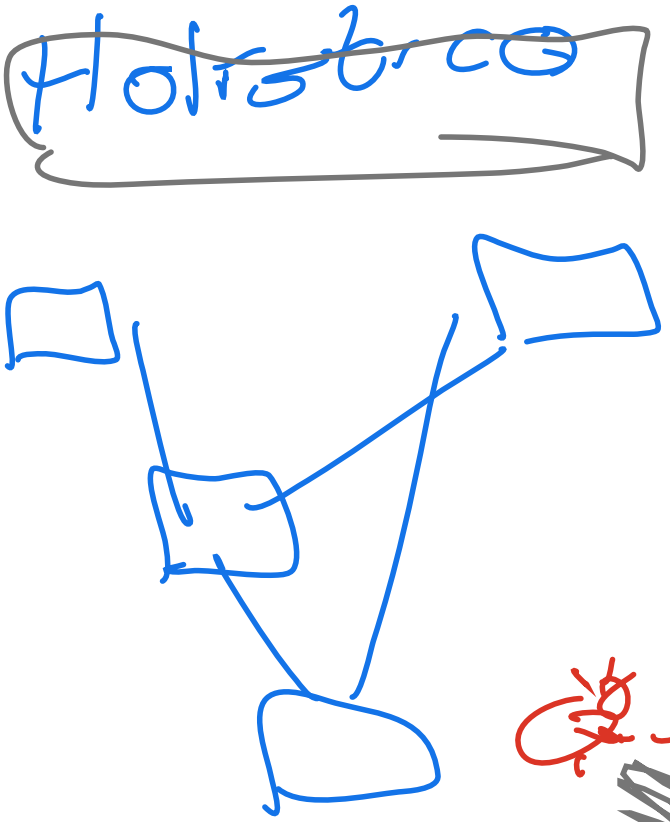


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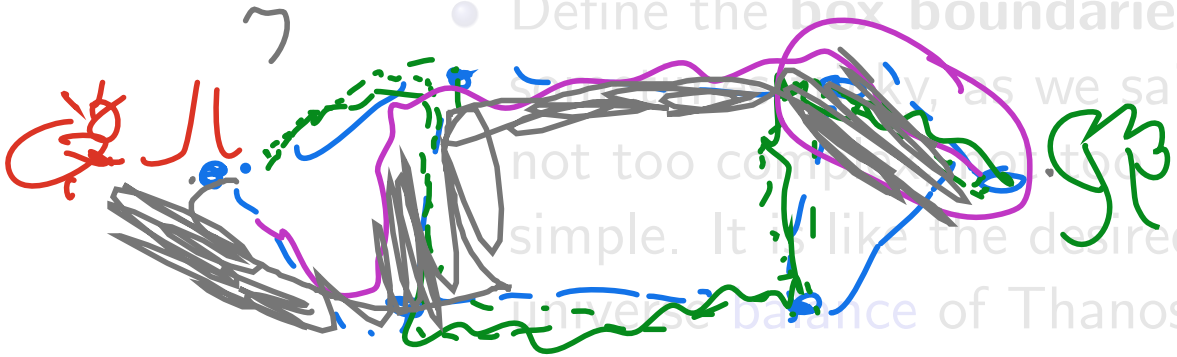

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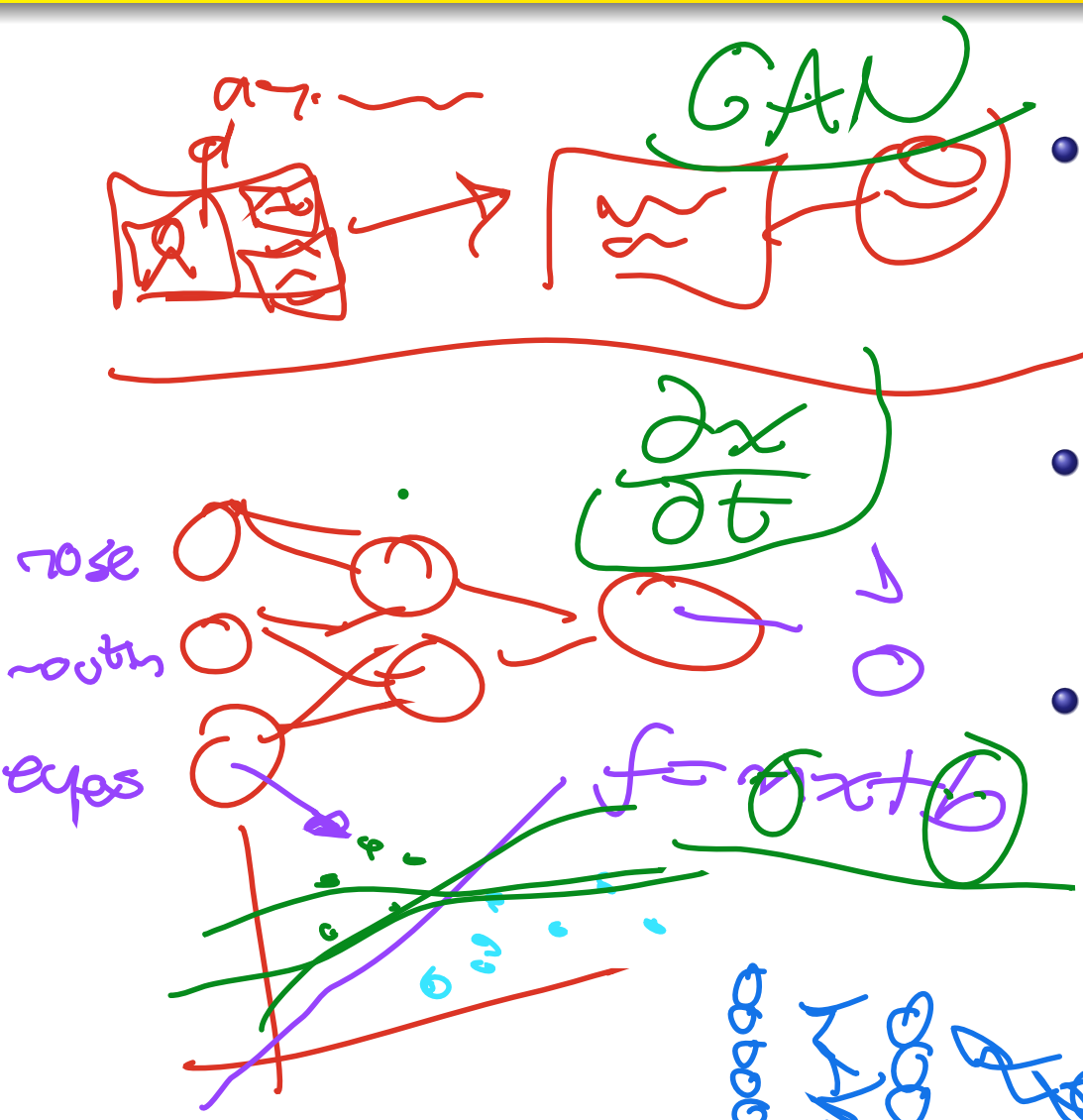

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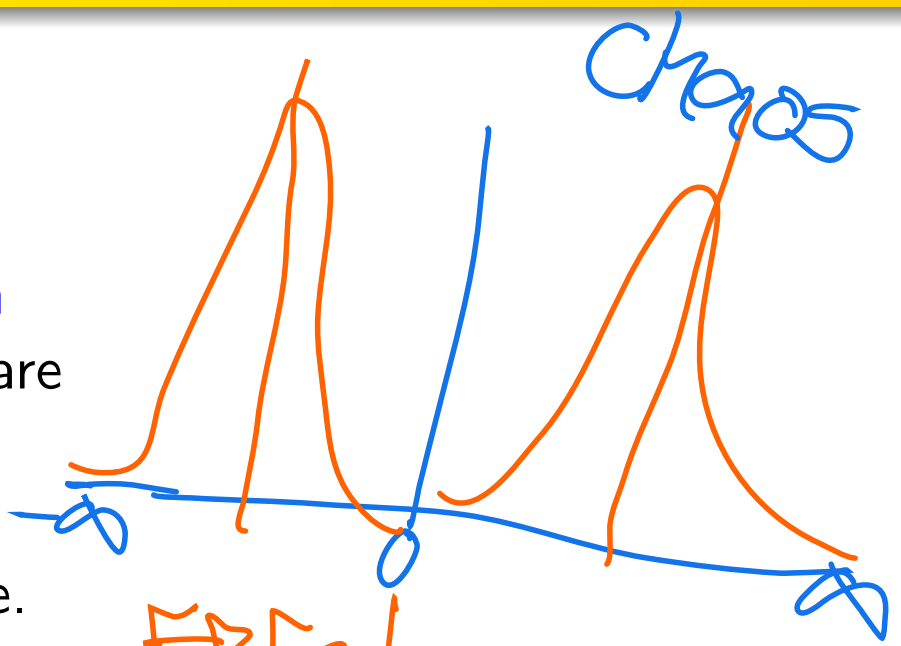
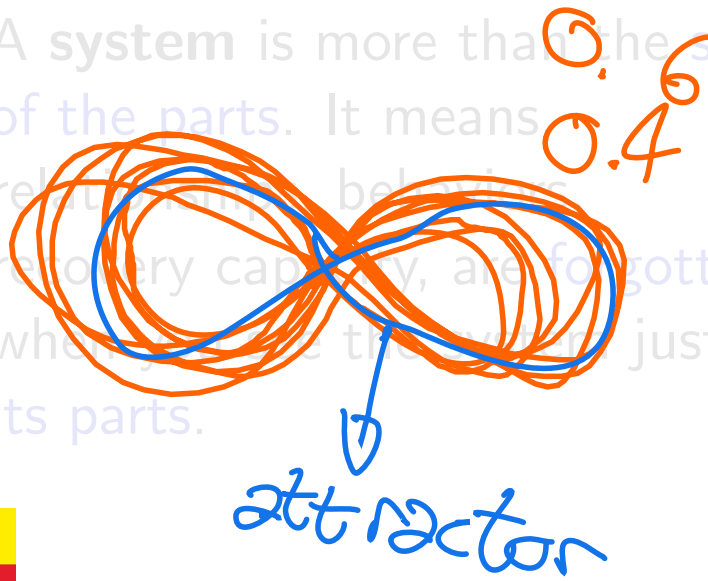
- Another important concept is the **homeostasis**, it means to put a system in an equilibrium state. That is hard, **systems** are both not in equilibrium and resilient to change. **Chaotic attractors** study is useful here.
- A **system** is more than the sum of the parts. It means relationships, behaviors, recovery capacity, are forgotten when we see the system just as its parts.




Fractales
Probabilistics
Randomness

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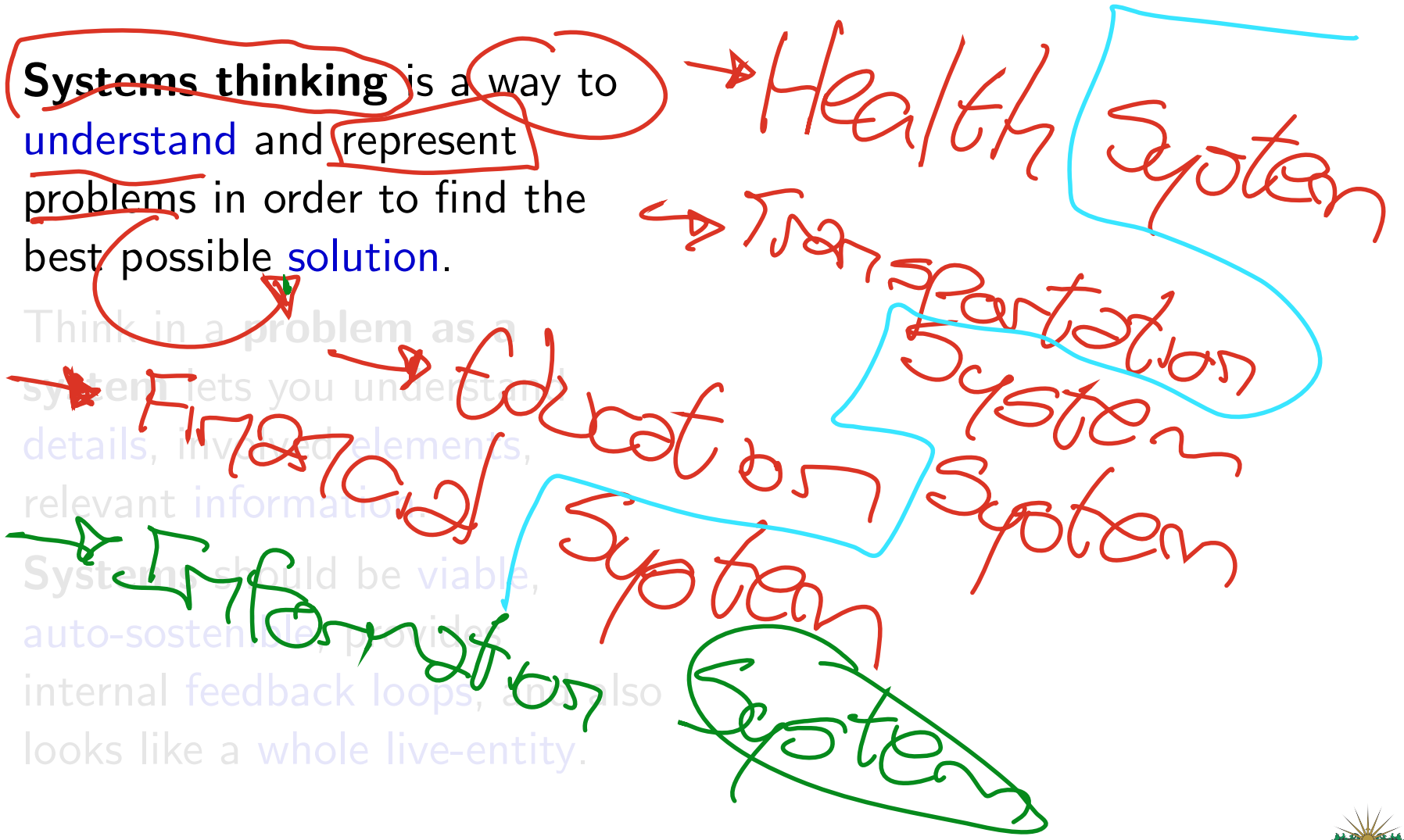
- **Systems thinking** is a way to understand and represent problems in order to find the best possible solution.
- Think in a **problem** as a **system** lets you understand details, involved elements, relevant information.
- **Systems** should be viable, auto-sostenible, provides internal feedback loops, and also looks like a whole live-entity.



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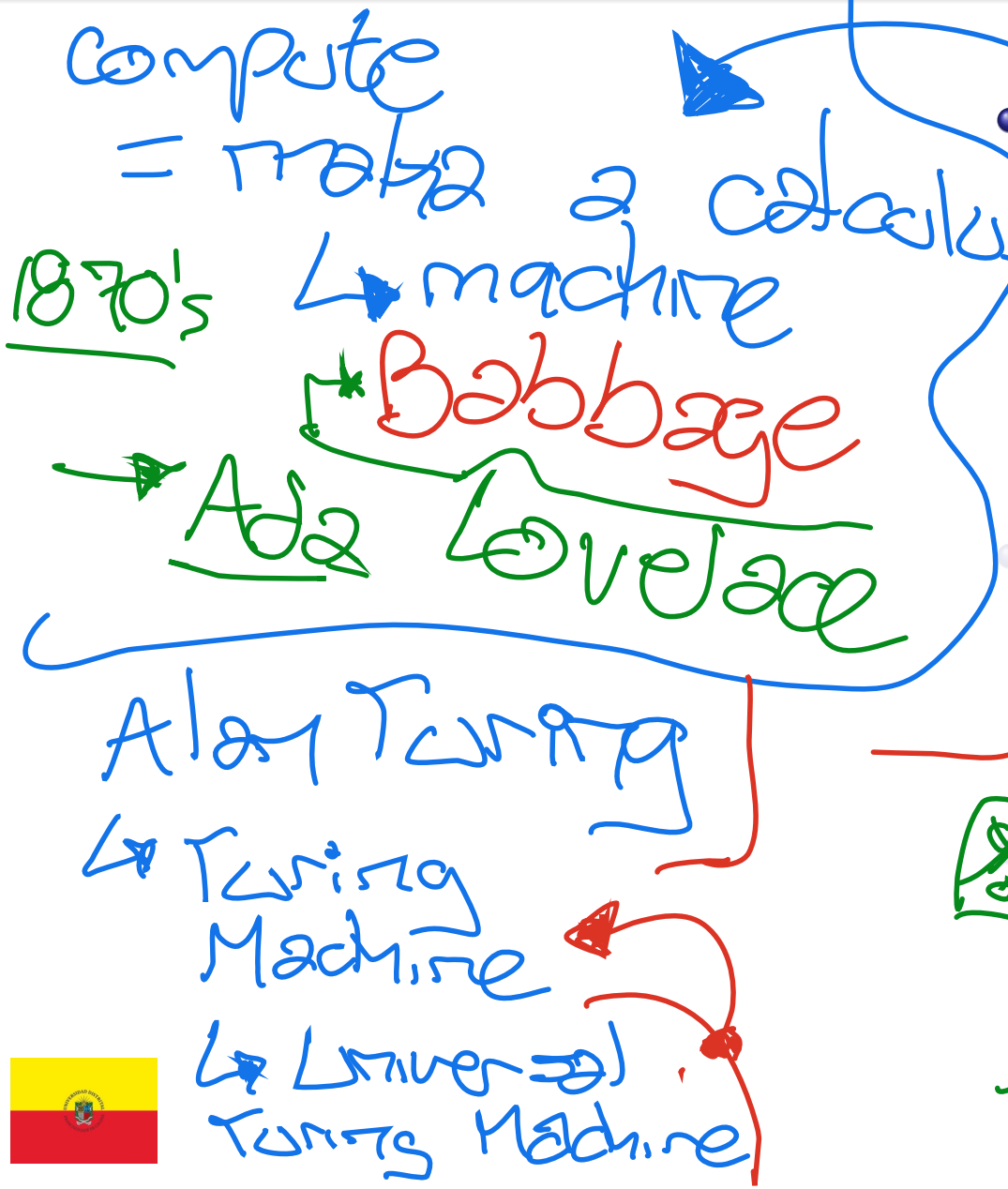


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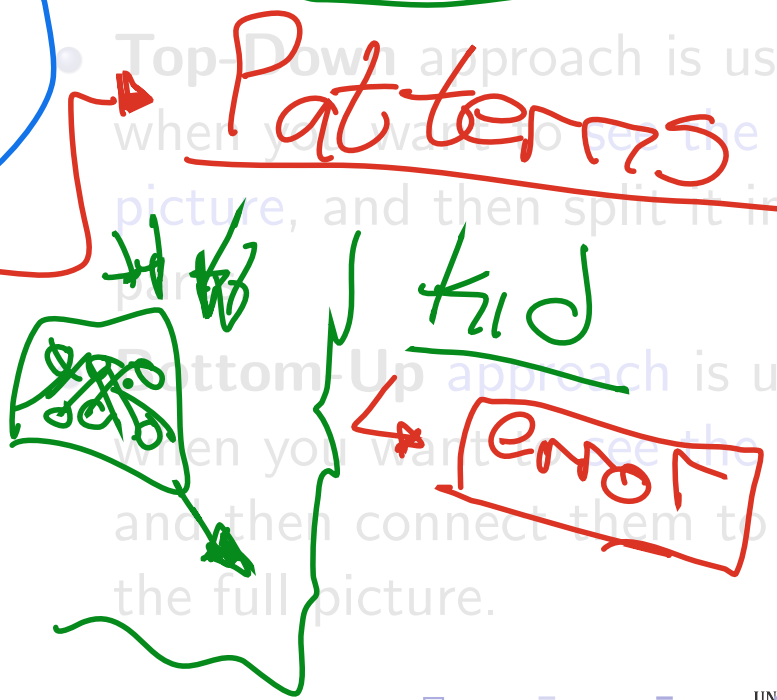


- **Top-Down** approach is useful when you want to see the full picture, and then split it into parts.
- **Bottom-Up** approach is useful when you want to see the parts and then connect them to get the full picture.

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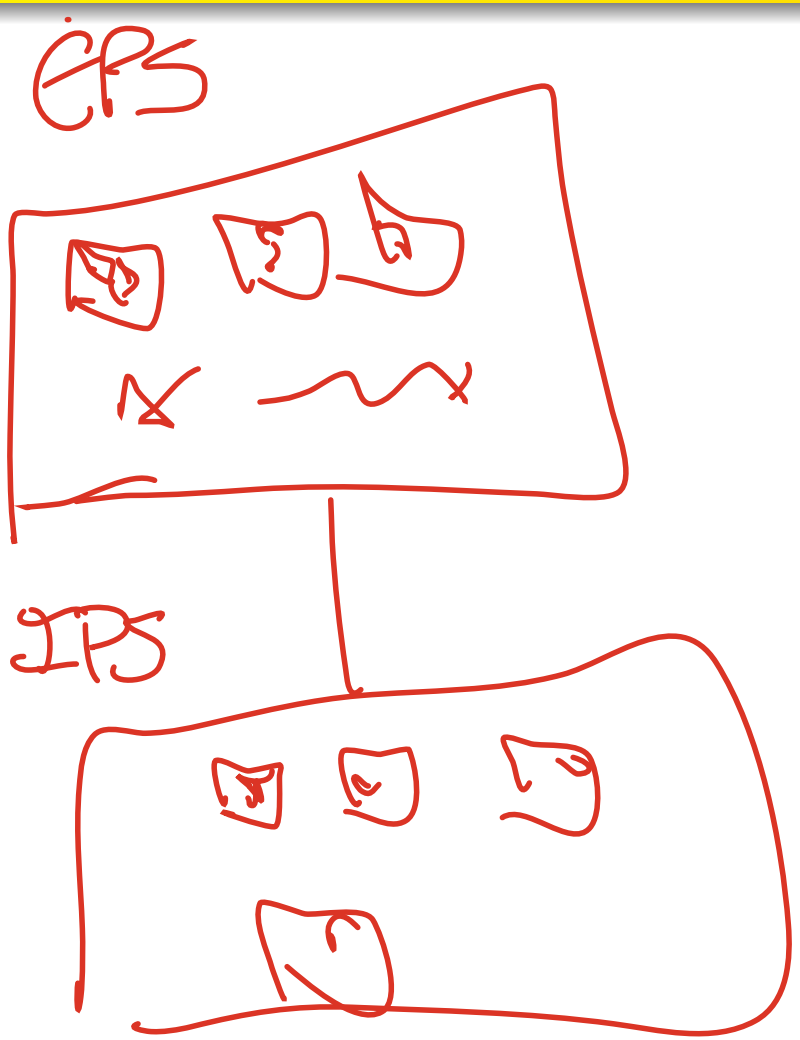


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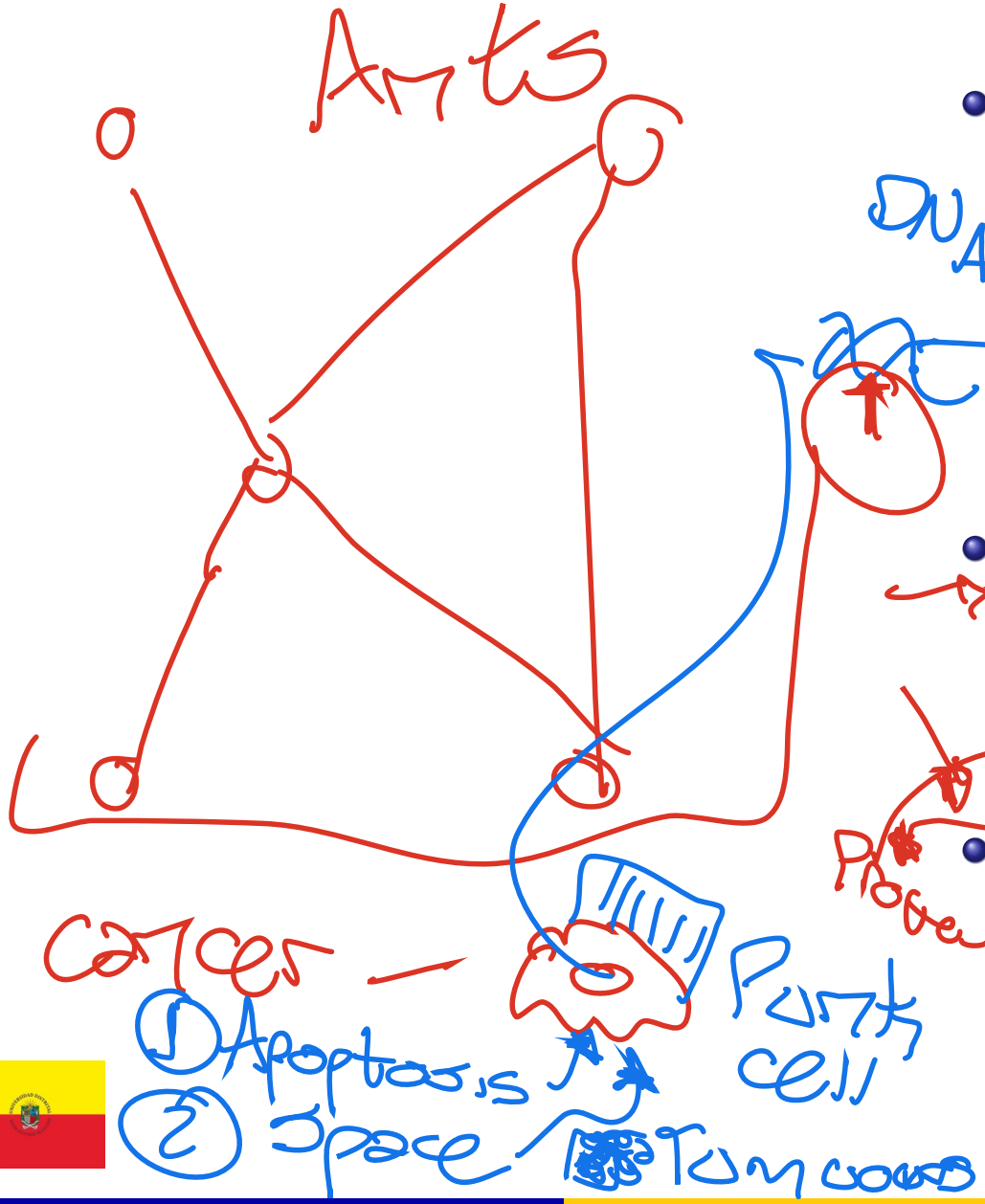

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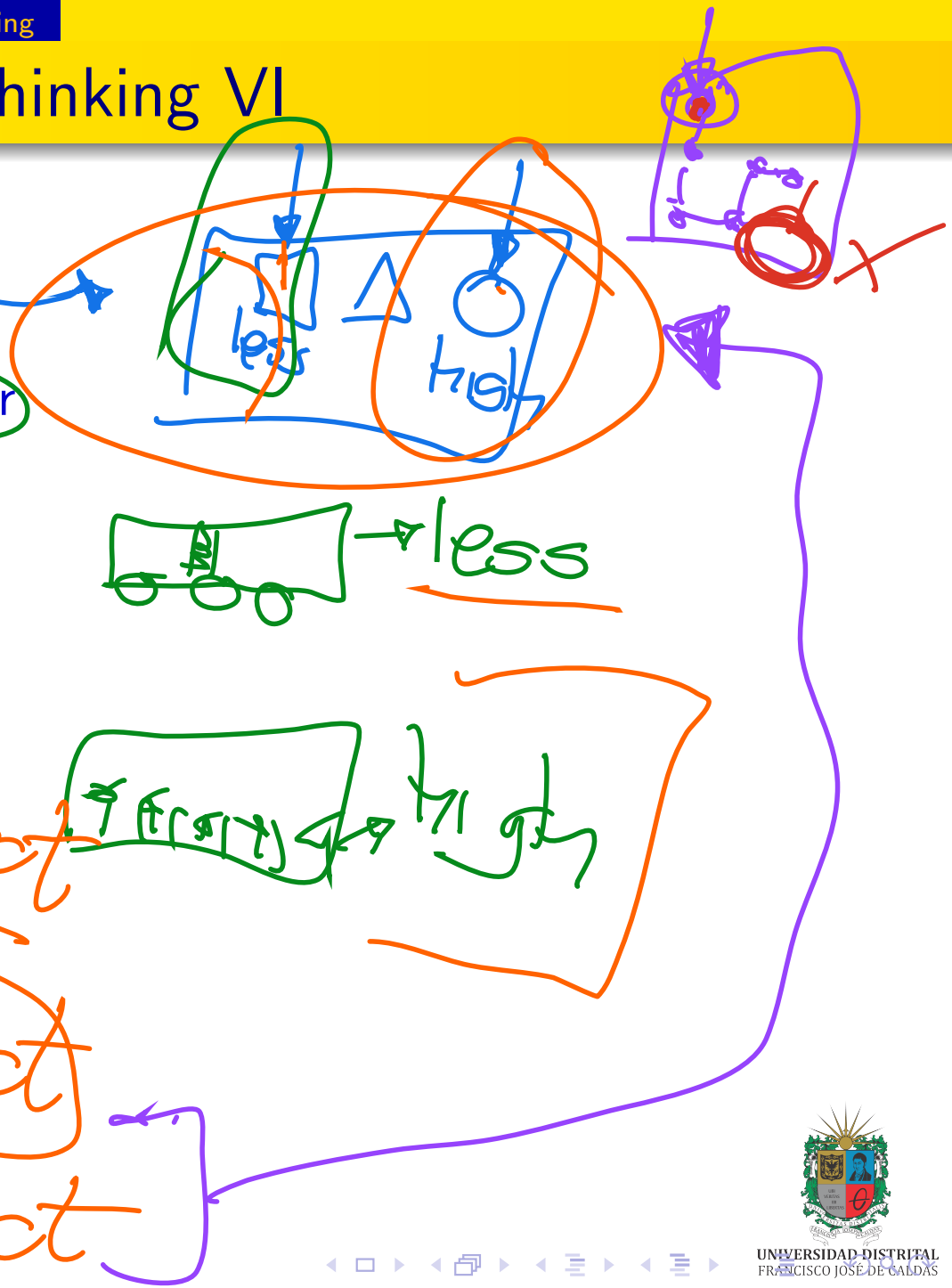
- It is important to understand the **sensitivity** of the problem, because it leads to make better decisions.
- The most simple system **definition** is: for some inputs, after apply them a designed process, you will get some outputs.
- In a **deterministic** world the same inputs get the same outputs. Real-life is not deterministic.



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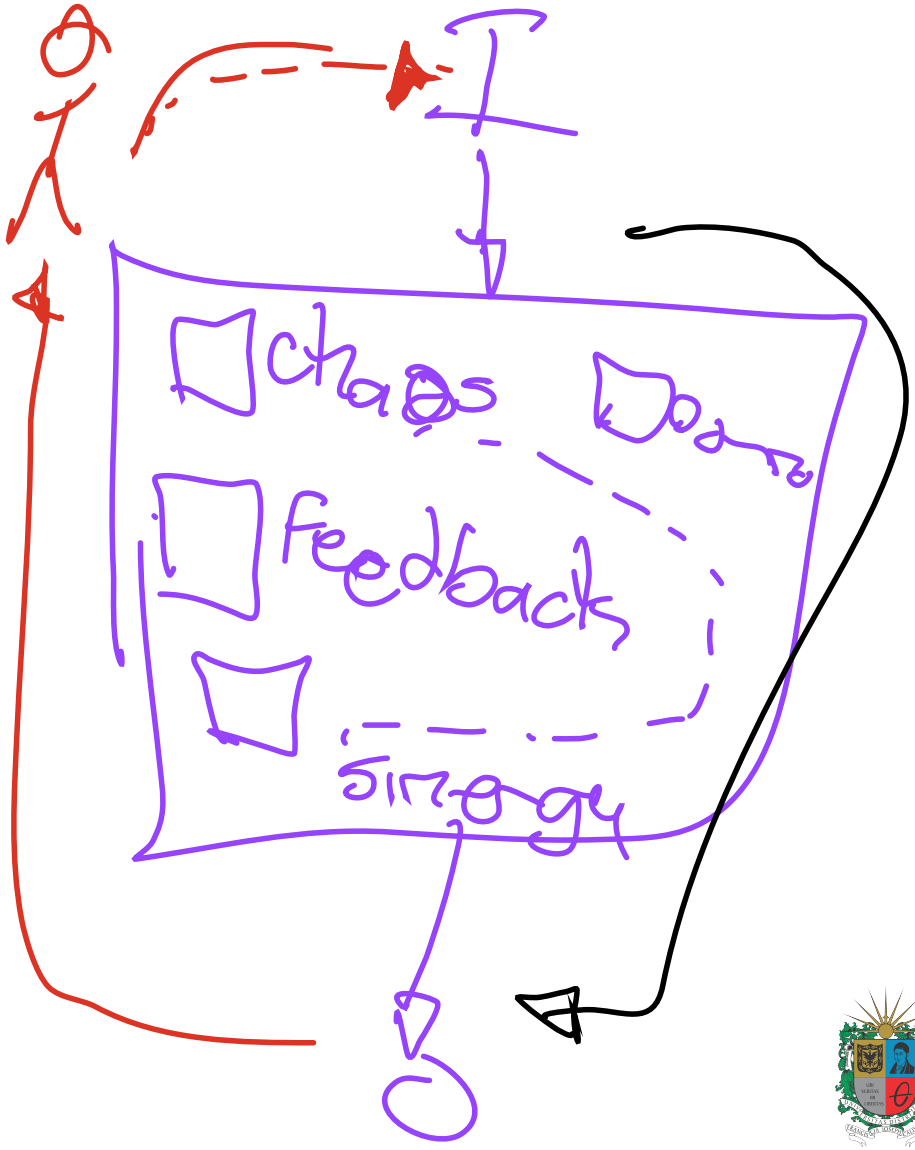

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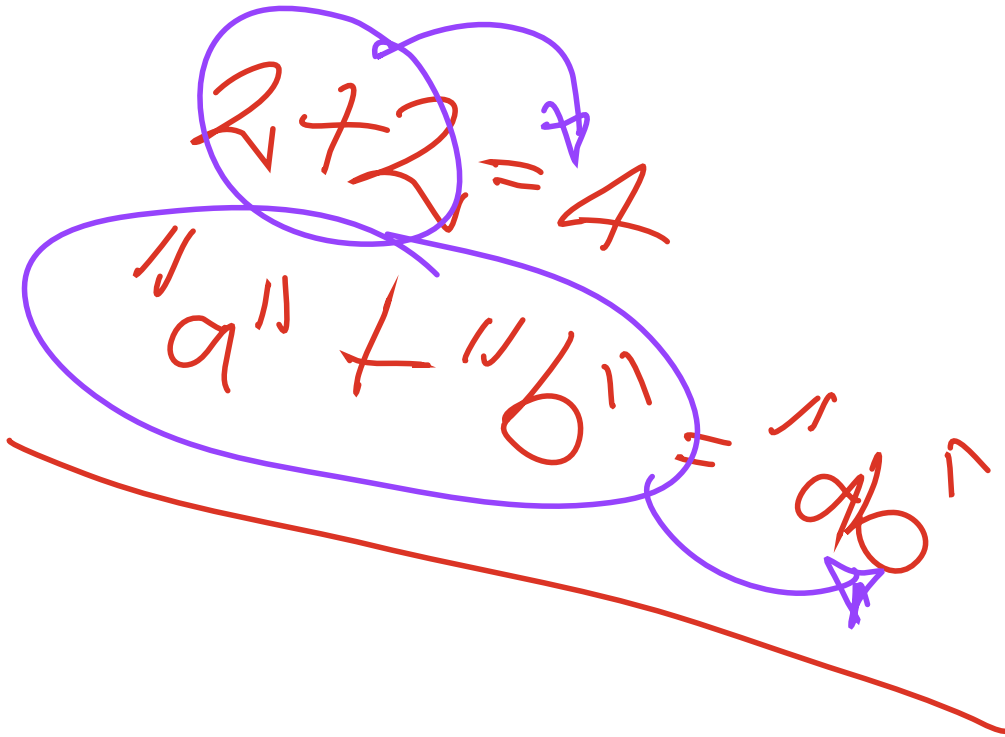

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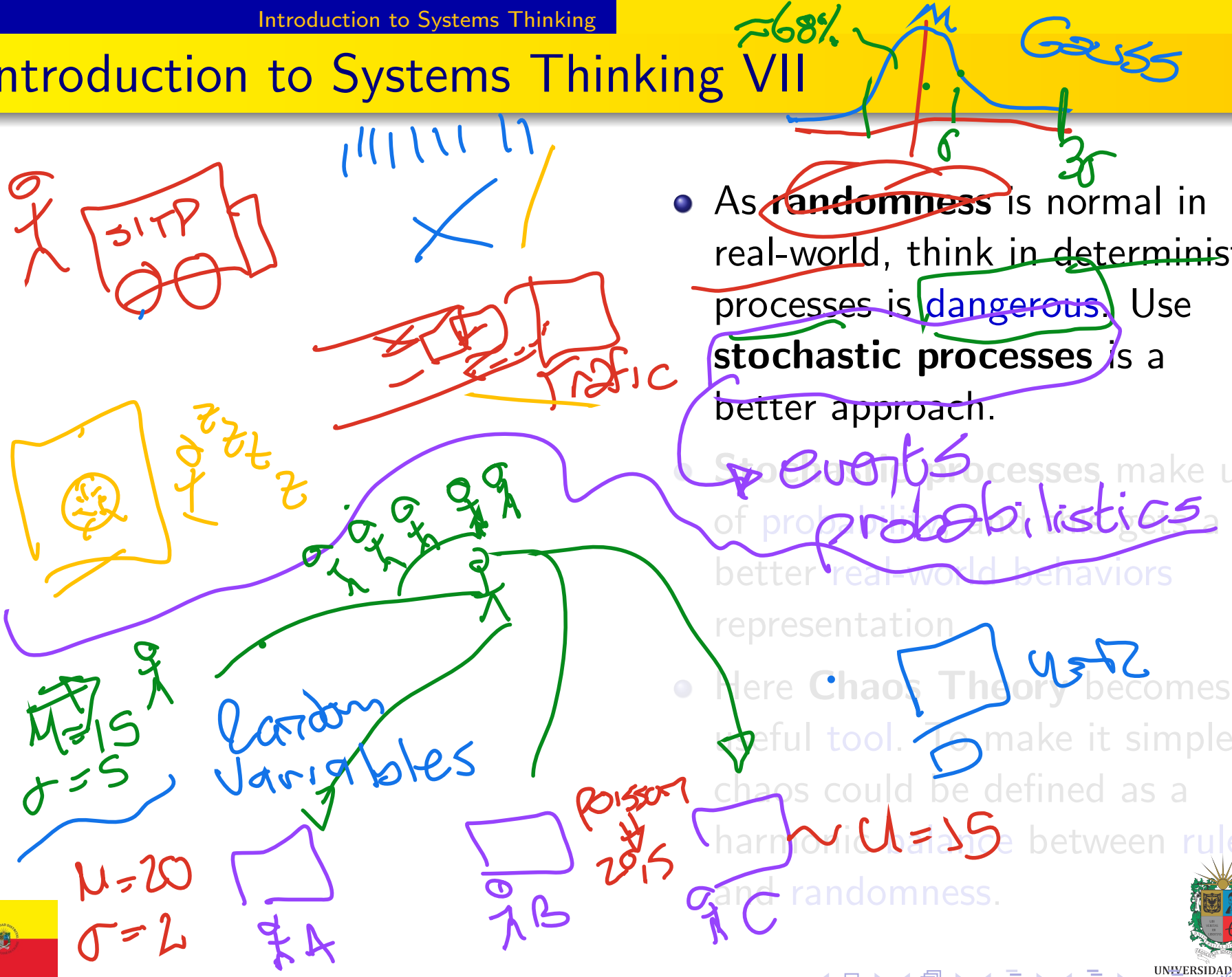


- As **randomness** is normal in real-world, think in deterministic processes is dangerous. Use **stochastic processes** is a better approach.
- **Stochastic processes** make use of probabilistic strategies for better real-world behaviors representation.
- Here **Chaos Theory** becomes a useful tool. To make it simple, chaos could be defined as a harmonic balance between rules and randomness.

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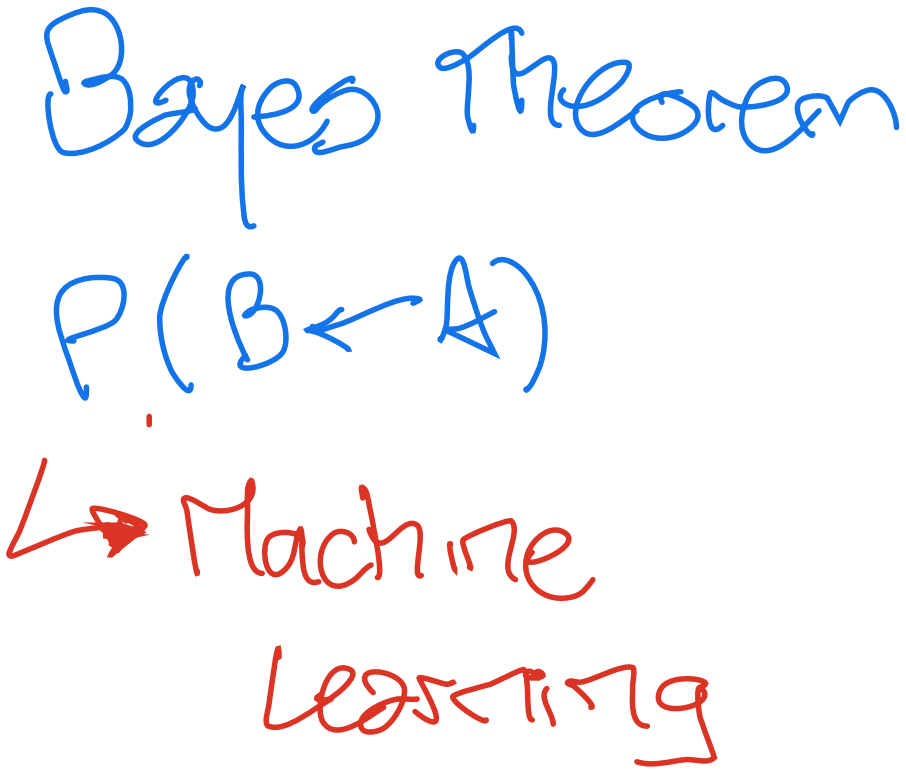


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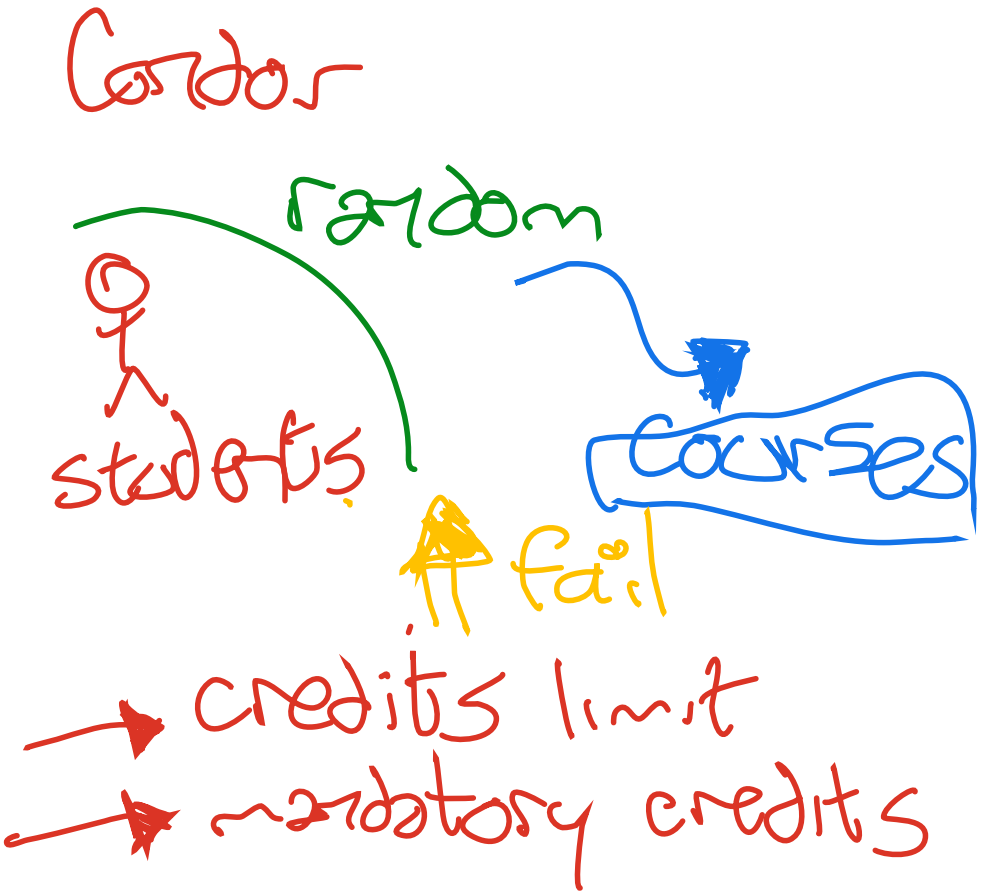


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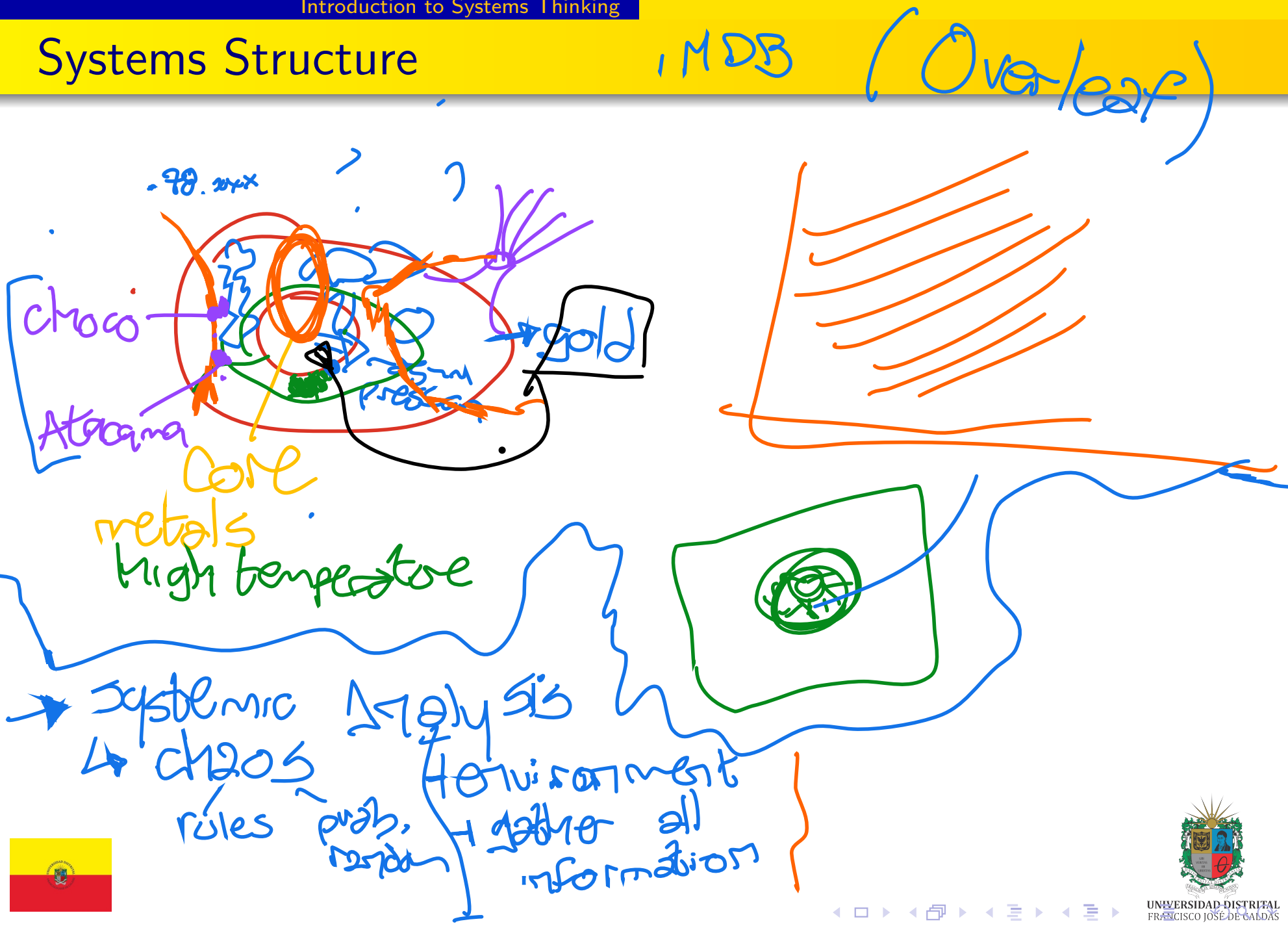
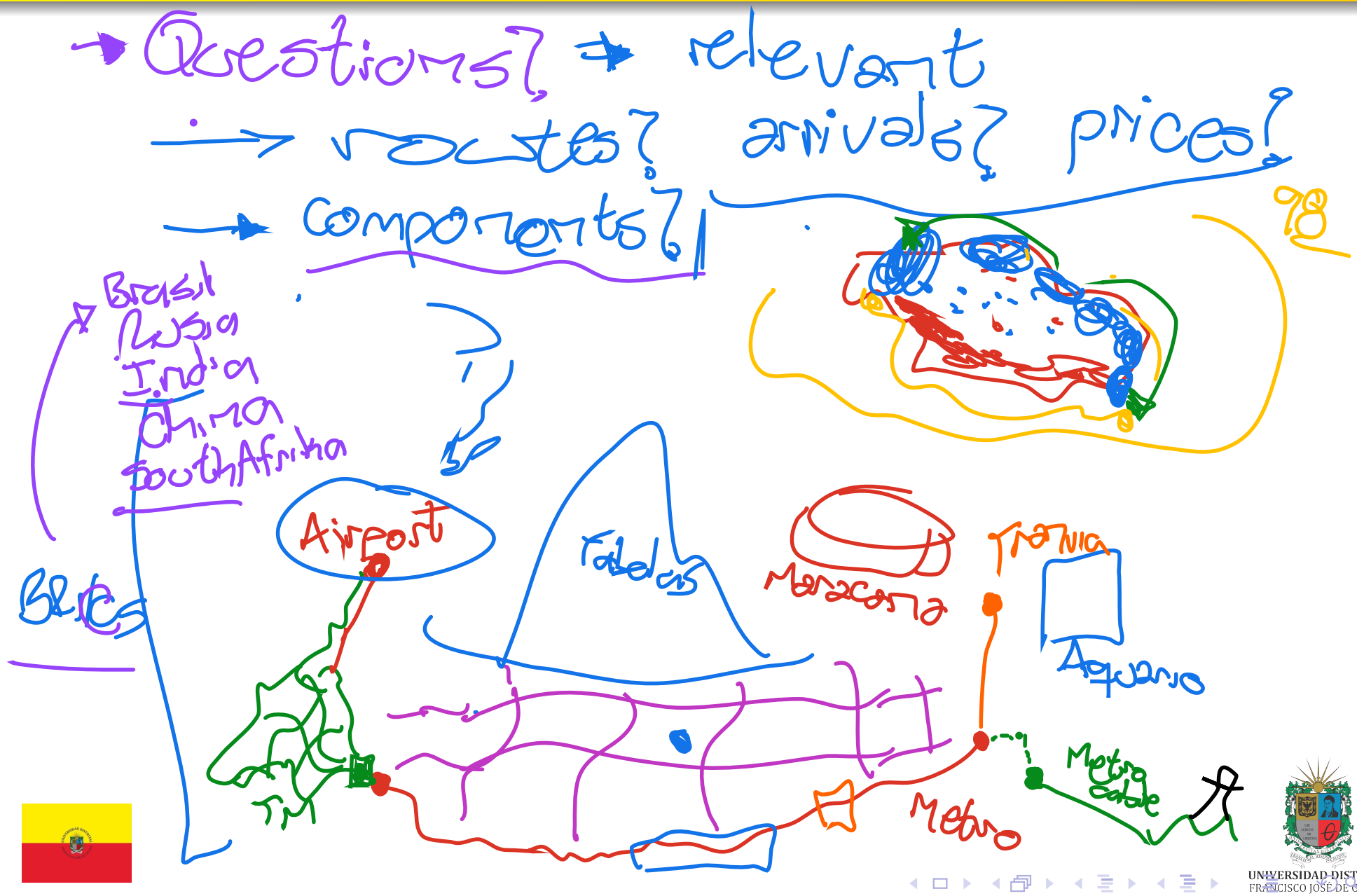
# Systems Structure



# Case of Study: Trasportation System



# Outline



# General Systems Theory I

- In **general systems theory** the idea is to see a problem since different autonomous study areas, it helps to create a better full-picture of a problem or situation.
- Systems are dynamical for that reason you need to define boundaries and constraints to control analysis. Also, some systems are highly susceptible to changes from the environment.

Figure: Prompt: Draw systems a different levels in the context astronomy.

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# General Systems Theory II


- A biologist call **Ludwig Von Bertallanfy** created the General Systems Theory around seventy years ago.
- His idea was to undertand and represents in a very simple way some **individuals** and **populations behaviors**, also the interactions or different elements in nature.

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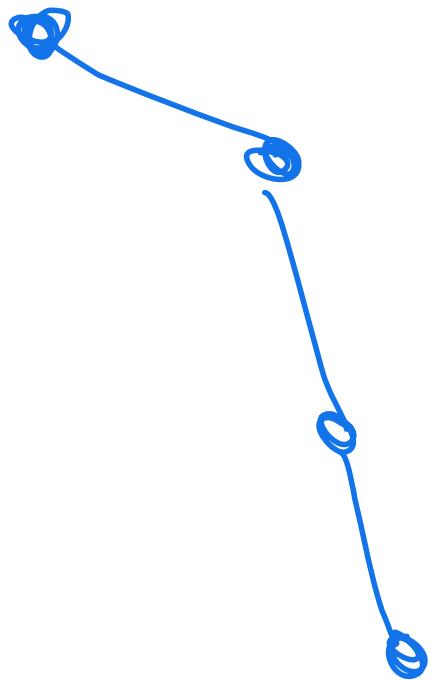
- He waited twenty years for mathematical and computational **concepts evolution**, and then he was capable to finish the book citing more applied concepts.



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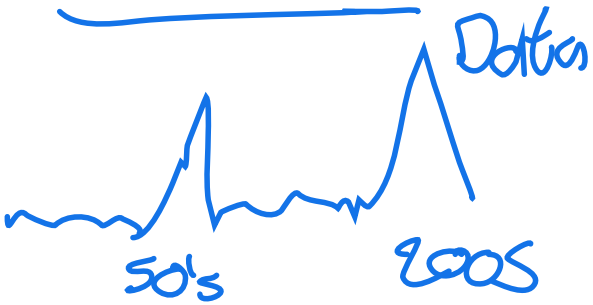

# General Systems Theory IV

- In nature, in real-world, **everything is a system**. However, more you go dive to understand the problem, more the complexity arises.
- In this point, **systems theory** is useful. Some **patterns** could be detected, some **details** could be discarded.

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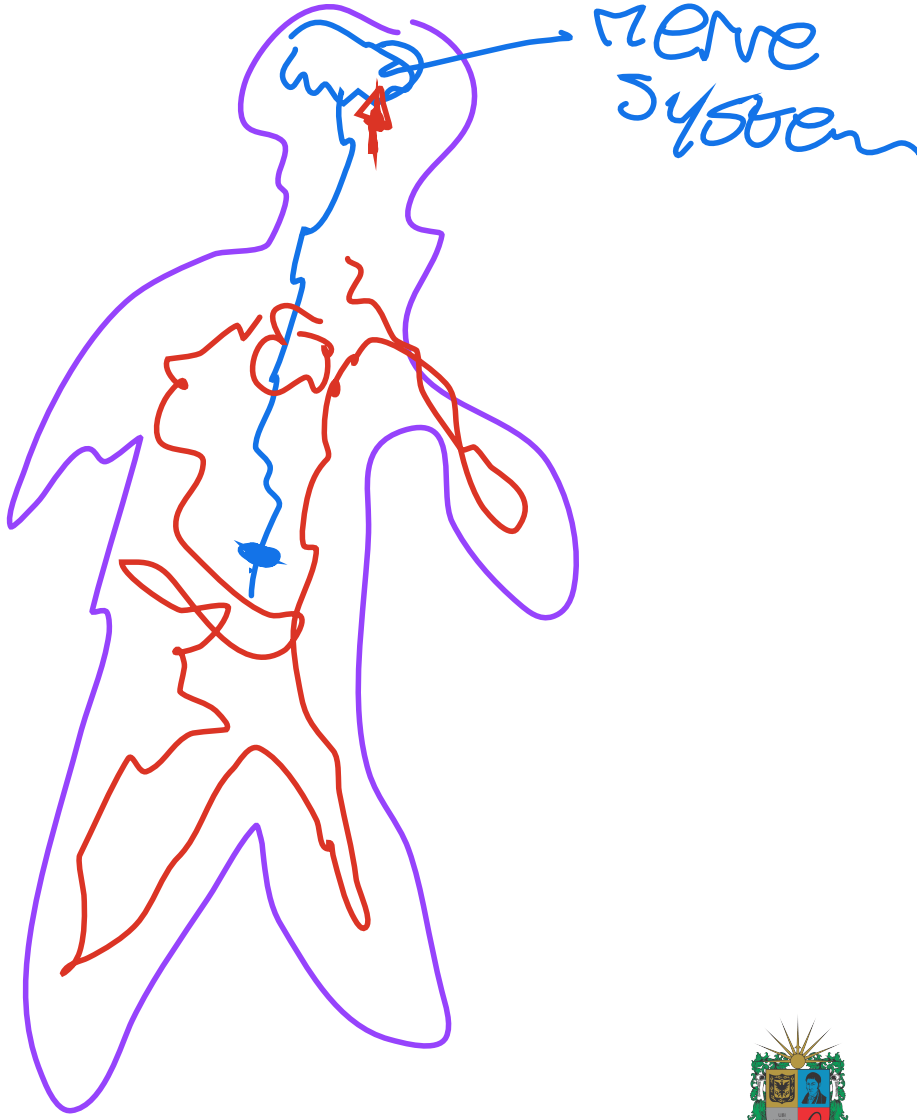
# General Systems Theory V

- **Systems hierarchies** are useful to split big problems into components, work on specific components, and then just connect as the context leads.
- A **system** could be represent by multiple internal systems. Big system is called **super system**, internal ones are called **subsystems**.



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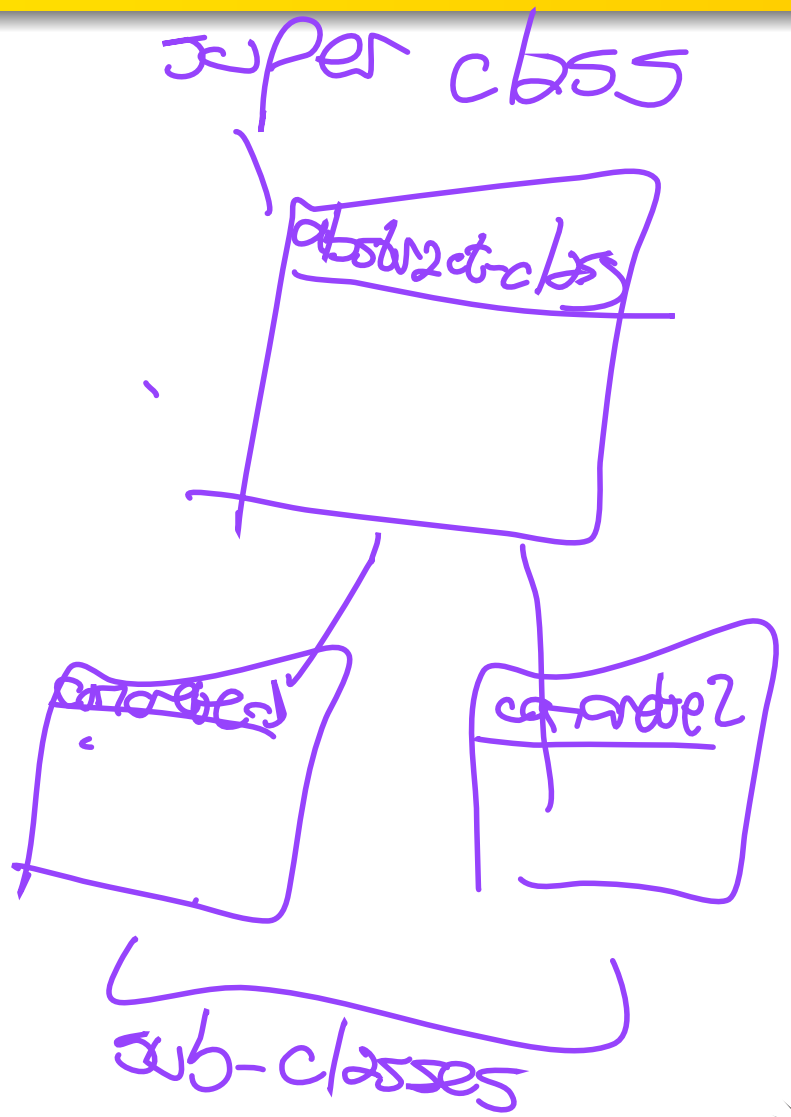


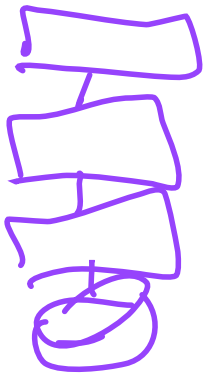

# General Systems Theory VI

- In nature ,you could think an ecosystem is a **super system** composed by different **subsystems**: water system, solar system, predator-victim , forest system,...
- The human body is a **system**, and inside there are many **subsystems**. Each **subsystem** it's basically connected to each other, and if one fails, it is like a domino effect.

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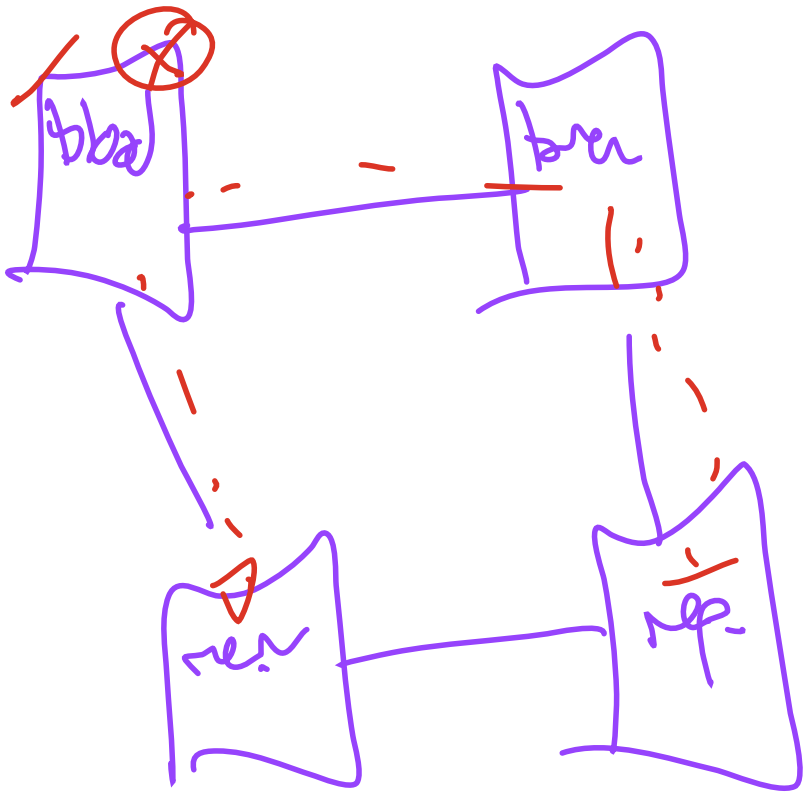

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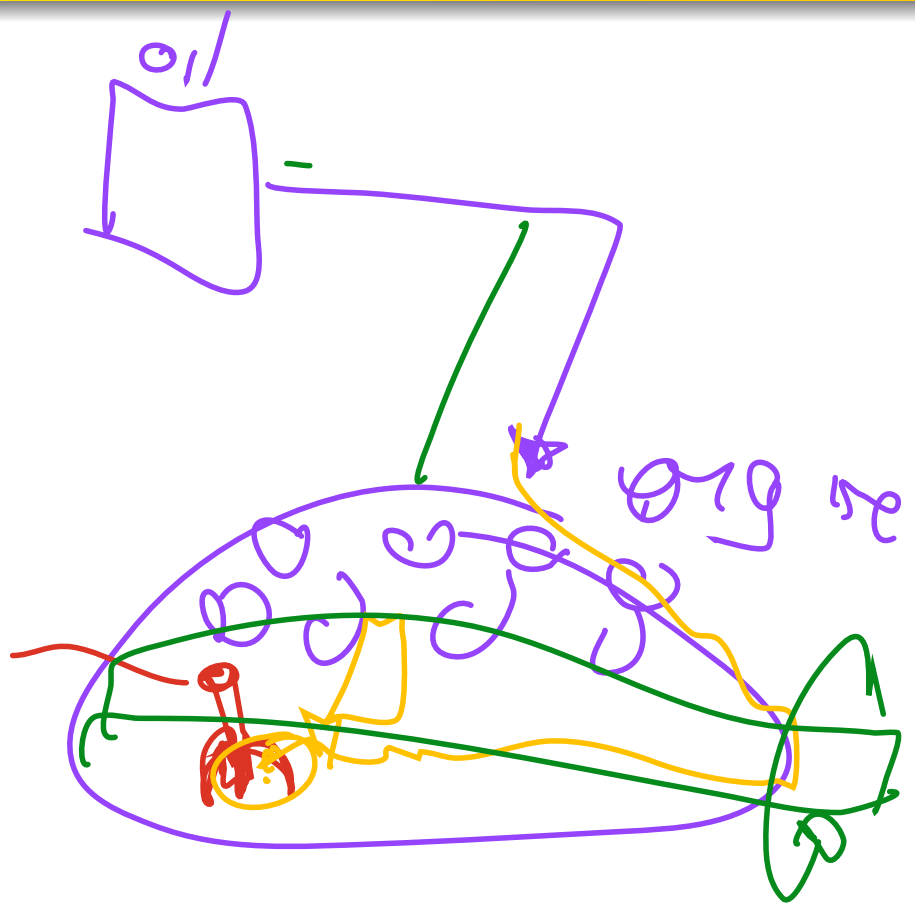
# General Systems Theory VII

- **Everything** in the real-world, in the universe, **is a system**. The hardest thing is to get the right representation.
- Remember **concepts** as: snowball effect, butterfly effect, domino effect, The message is the same, be careful with **details**, failures and changes, there is **not small impact**.



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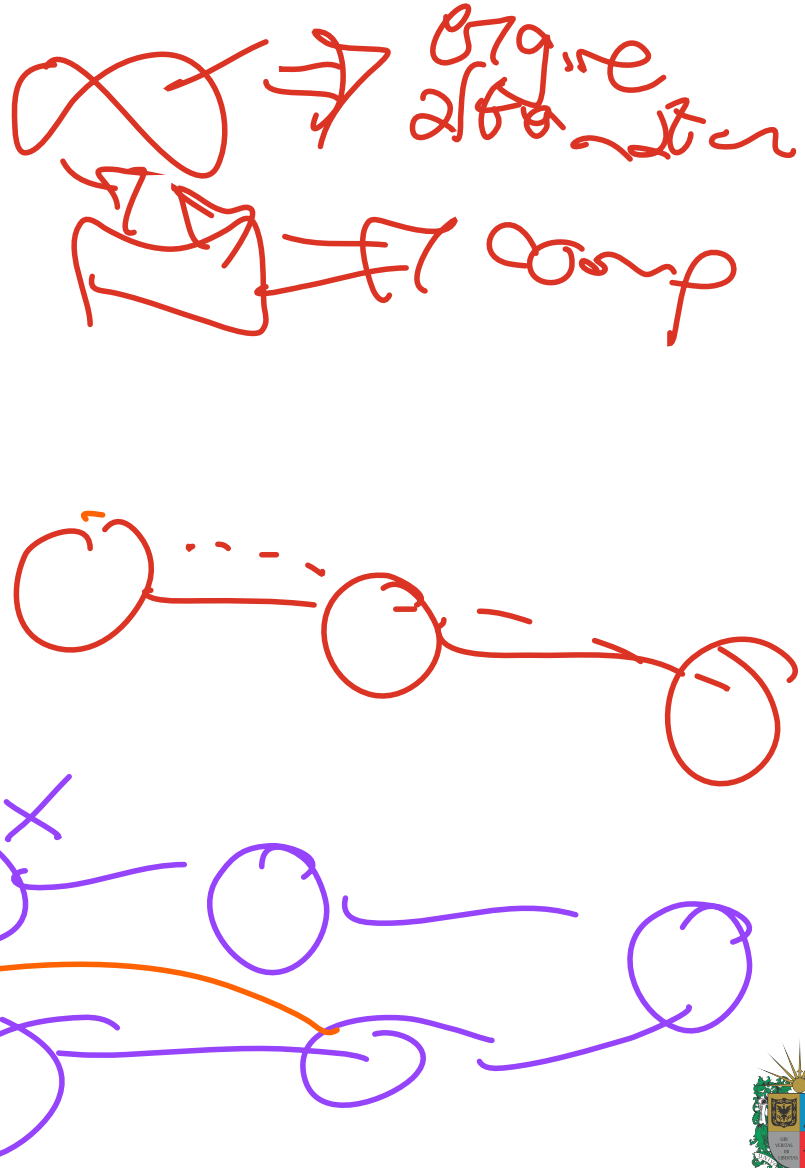


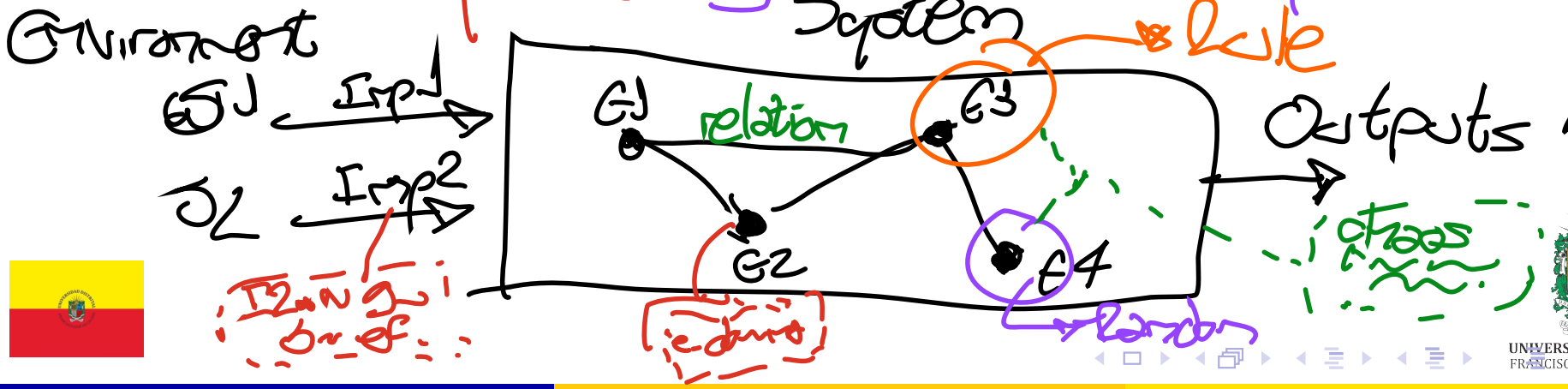
# Representation of a System

Draw.io

Lucid Chart

- Elements/Parts (not unique)
- relations ⇒ sinergy
  - emergent behavior
- purpose
- Context/Environment (chaos)
  - Inputs
  - Outputs

= Snowball Effect
= Domino Effect
= Butterfly Effect



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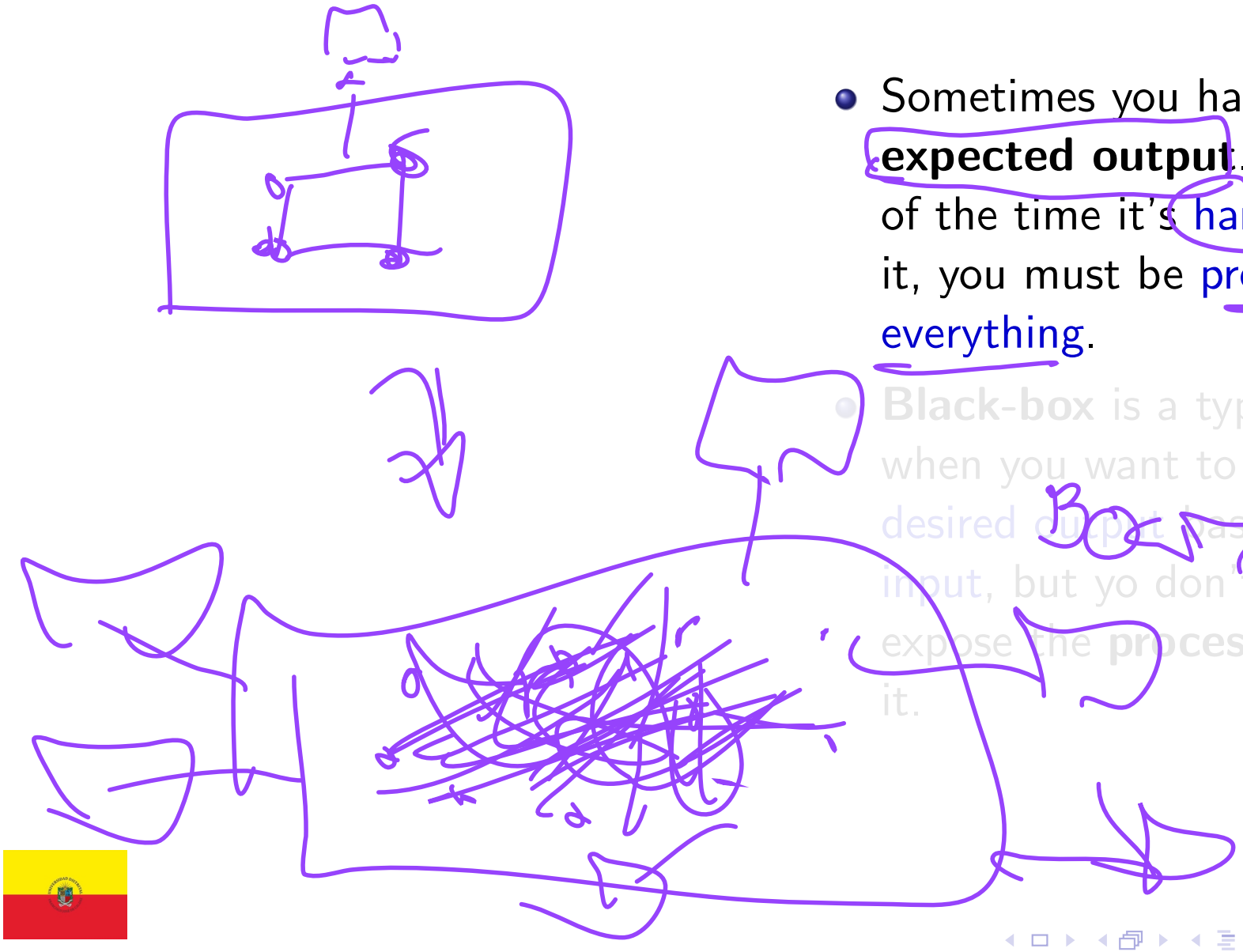
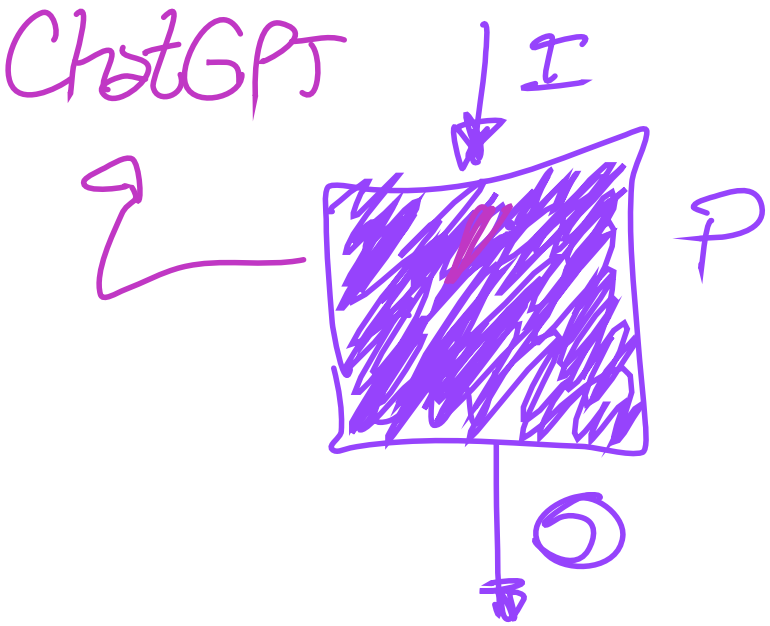



- Sometimes you have an **expected output**. Major part of the time it's hard to achieve it, you must be prepared for everything.
- **Black-box** is a type of model when you want to get the desired output based on specific input, but yo don't want to expose the **process** to achieve it.

# General Systems Theory VIII




- Sometimes you have an **expected output**. Major part of the time it's hard to achieve it, you must be prepared for everything.
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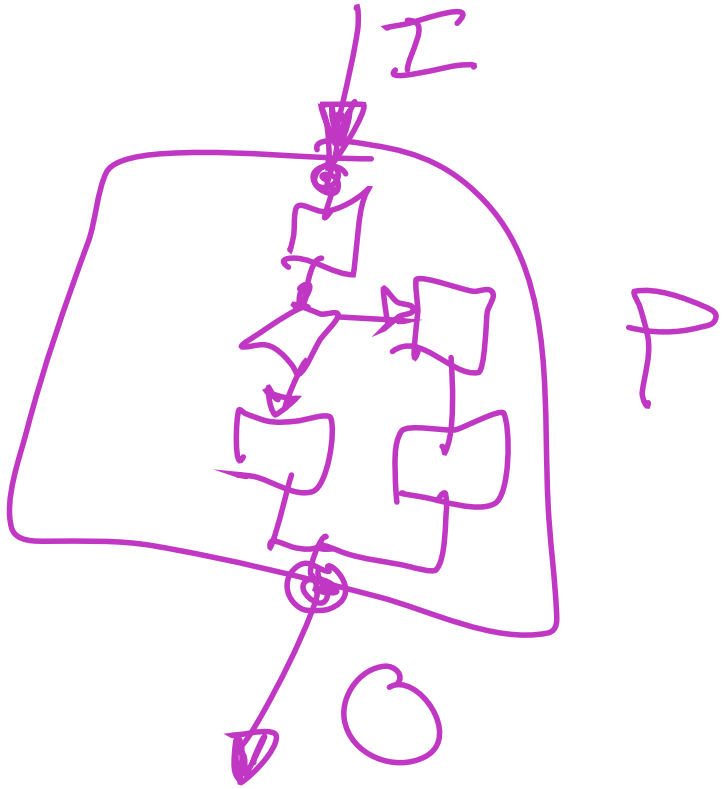
# General Systems Theory IX

- **White-box** are models where the processes are open to check, validate, follow step-by-step. It is useful when you want to understand how the **system works**.
- **Critical Systems Practice** is a methodology to deal with **Critical Systems Thinking** study field. CSP has 4 main stages: *Explore*, *Produce*, *Intervene*, and *Check* — $EPIC$.

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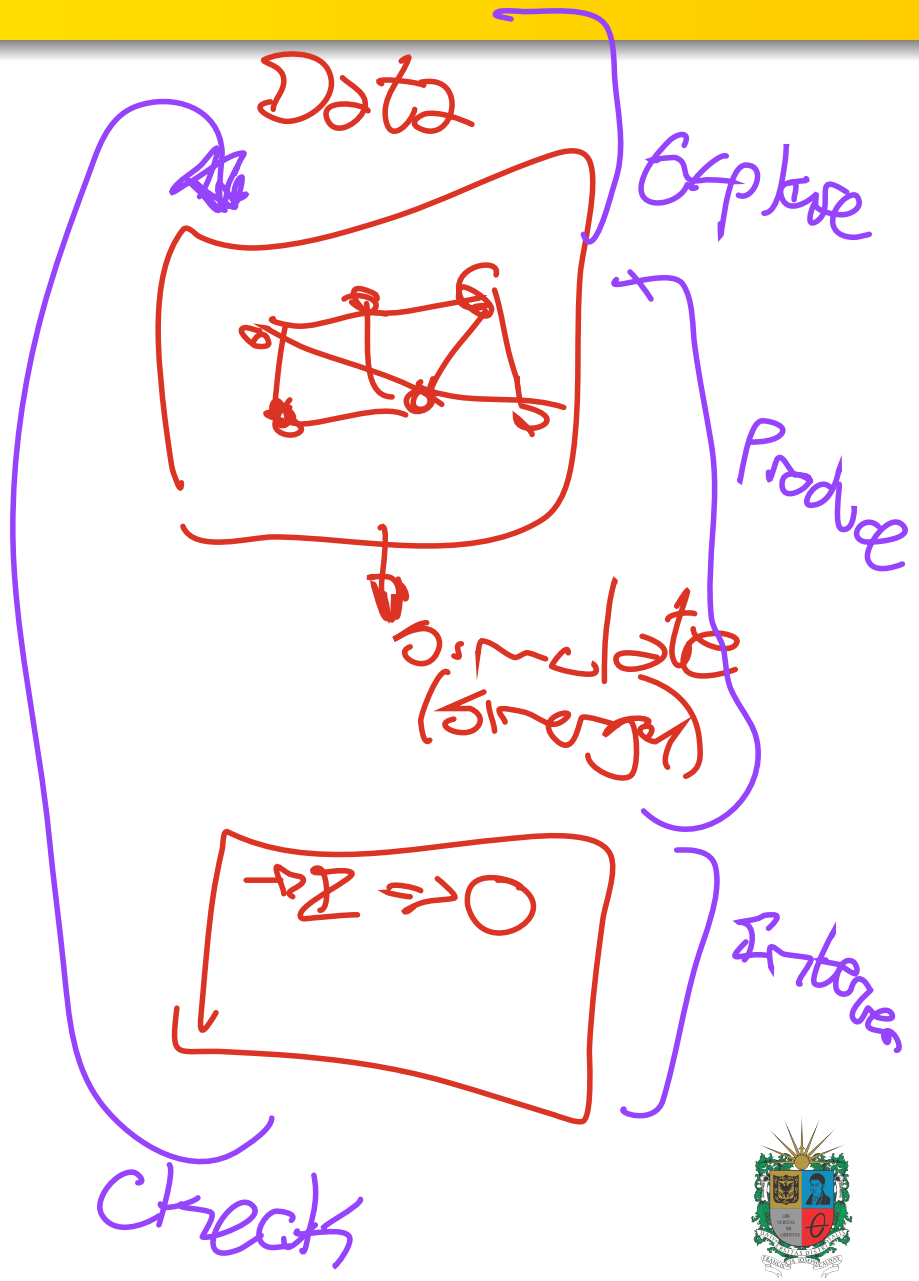
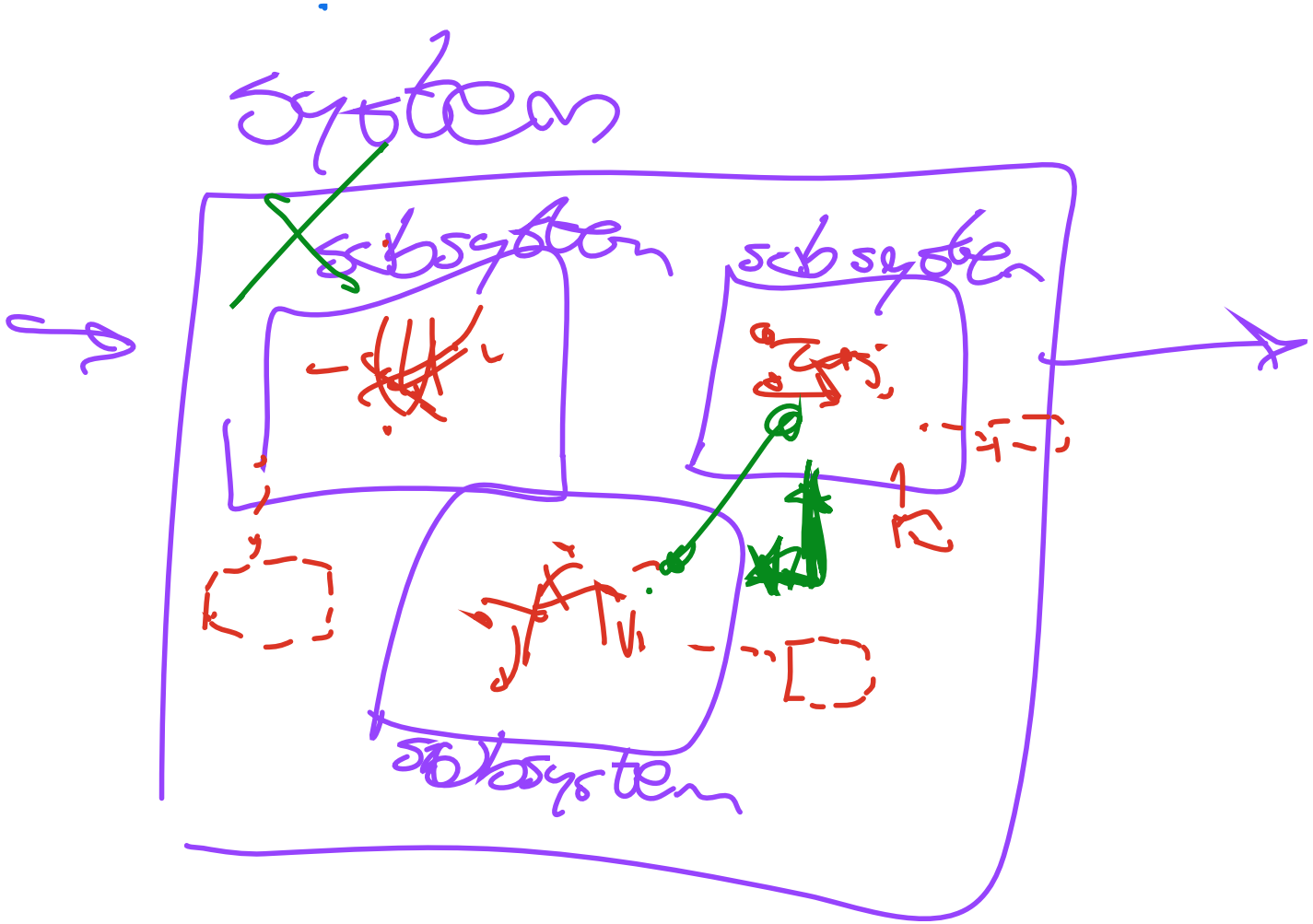


# Systems Structure



# Outline



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# Human Organizations I

- **Sinergy** is a simple but powerful concept: the aim of the parts is more than the parts itself.
- It means the **interactions** could boost the capabilities of the parts of the **system**. Also, it lets both understand **emergent behaviors** and define improvements in **systems**.
- One of the main concepts is the **theory of the computation**. Based on graphs, you could define a computational machine.

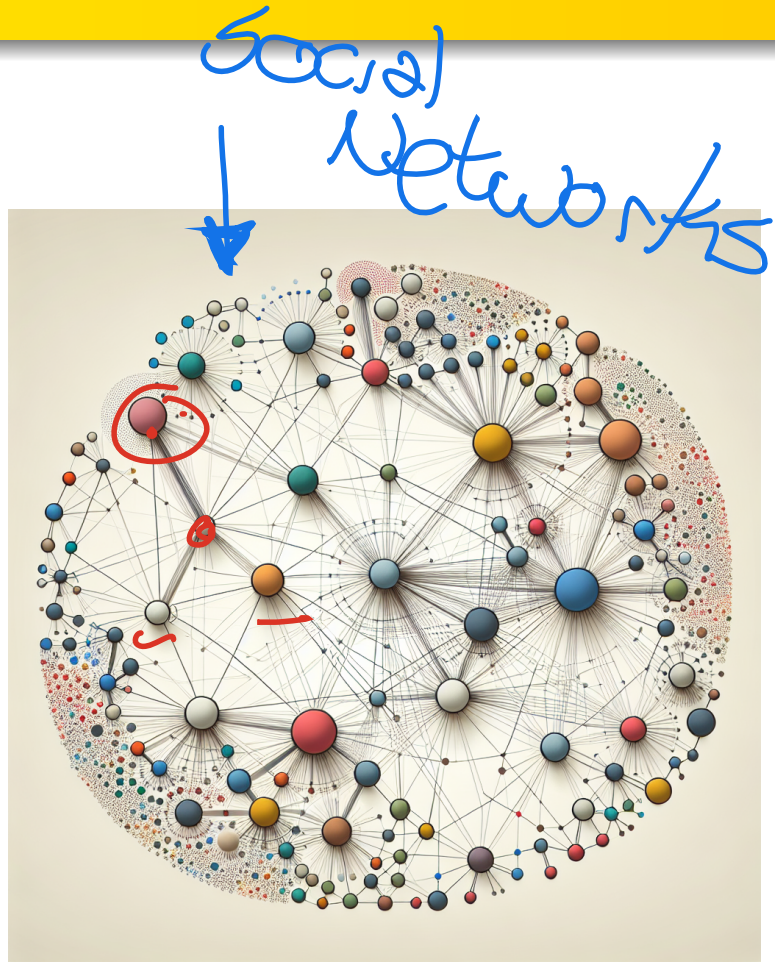


Figure: Prompt: Define a draw of clusters in social networks.

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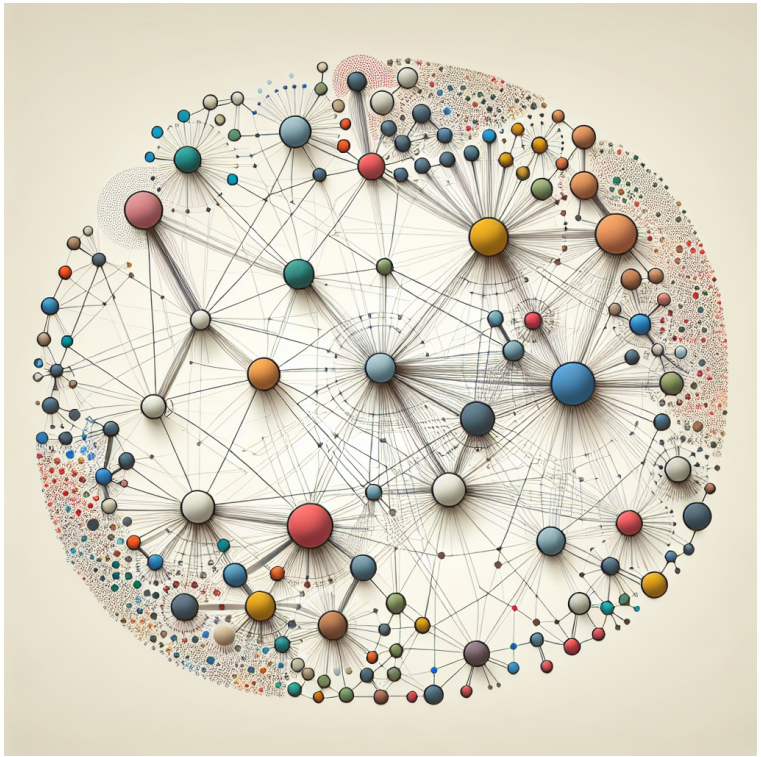

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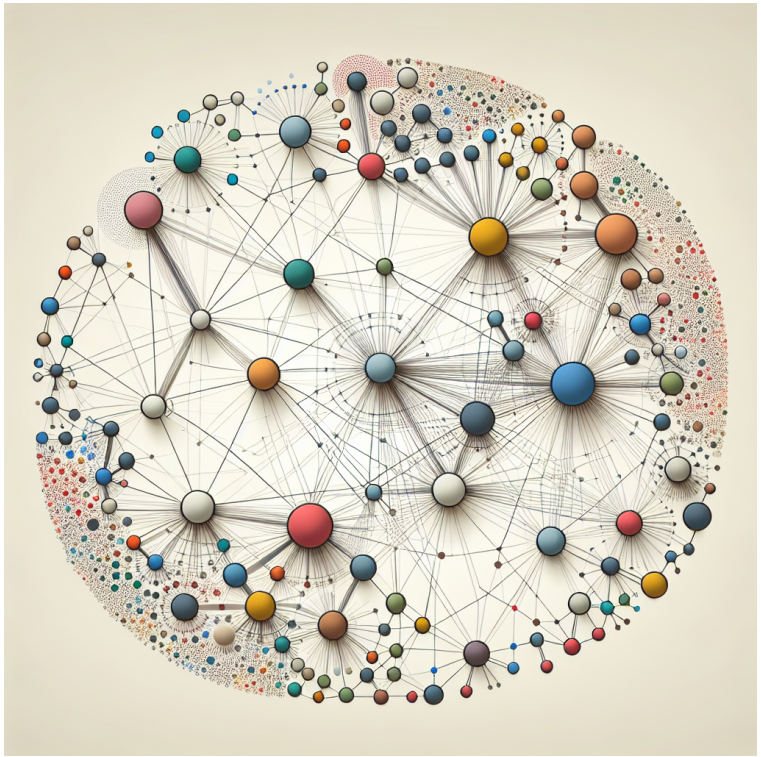

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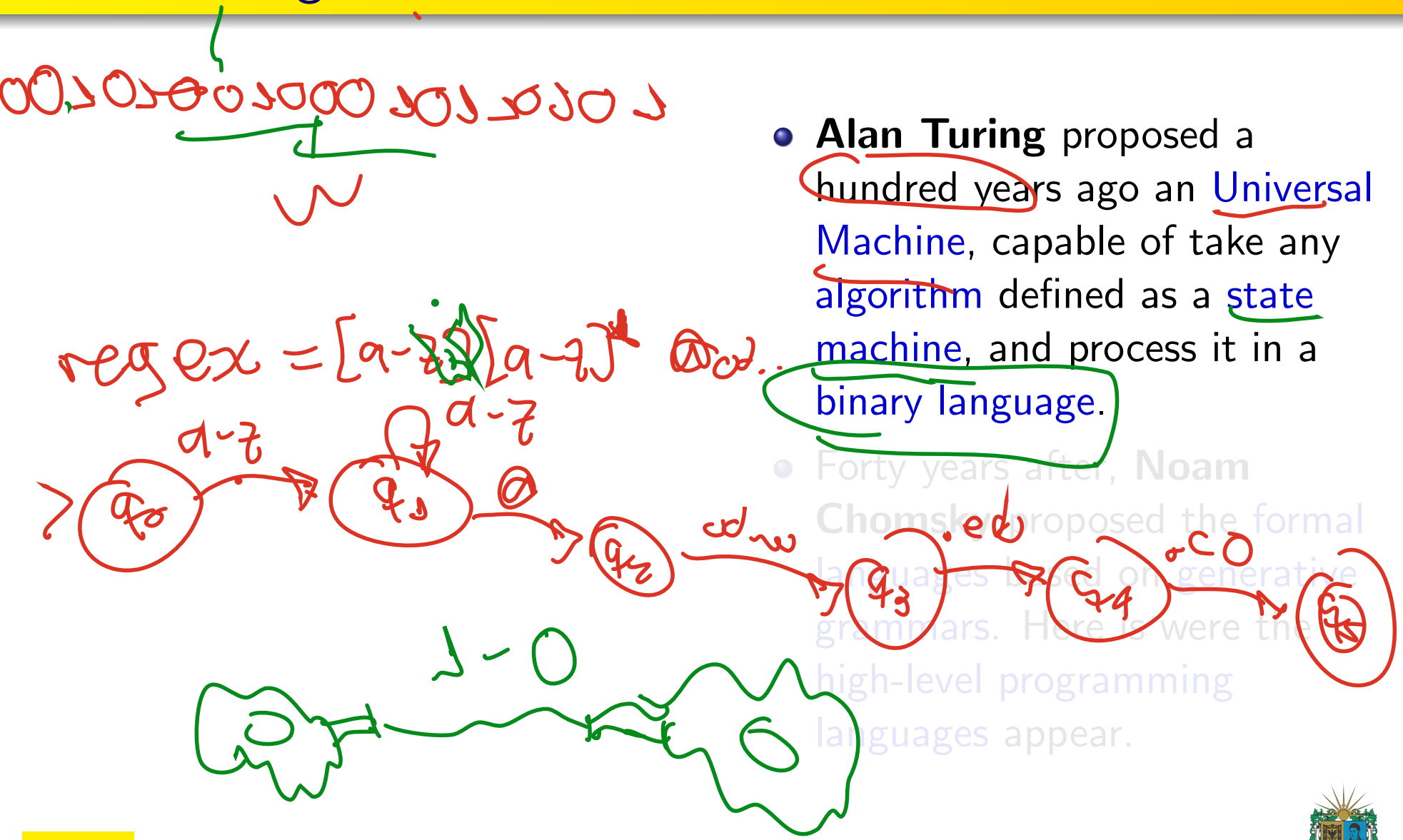
# Human Organizations II



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- Forty years after, **Noam Chomsky** proposed the formal languages based on generative grammars. Here is were the high-level programming languages appear.

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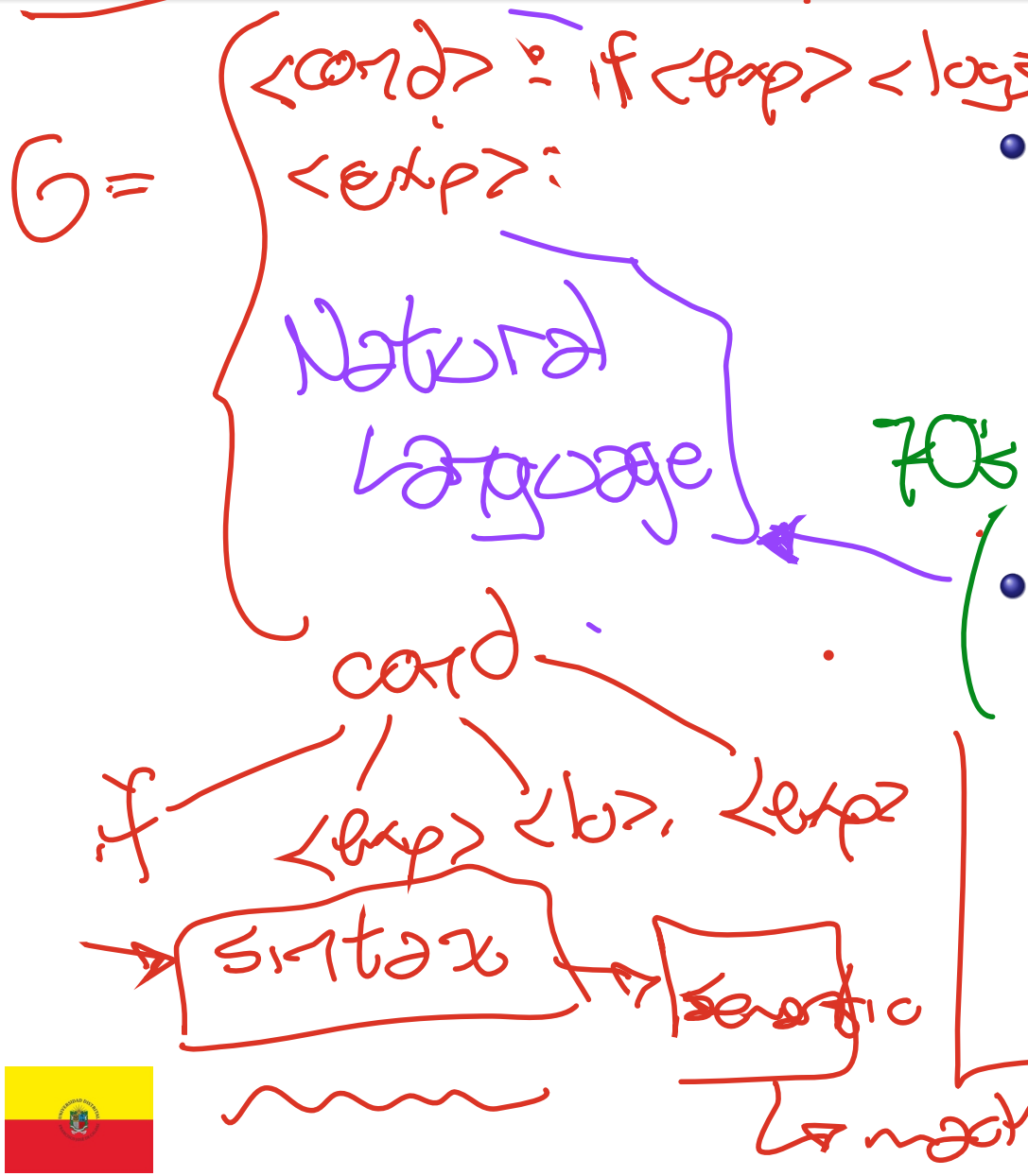

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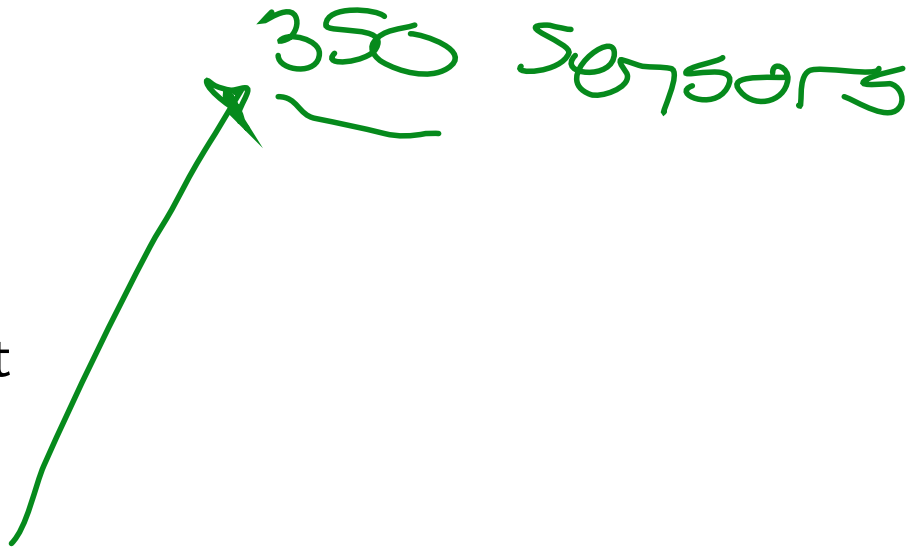
- **Programming Lenguajes** with more capabilities, easier comprehension had been created. Also, more people start to code into specific domain programming languages.
- **Andrej Kaparty**, hero in Tesla Company and now in OpenAI said: *nowadays, english is the more important programming languages*

# Human Organizations III

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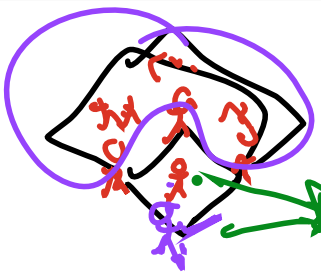
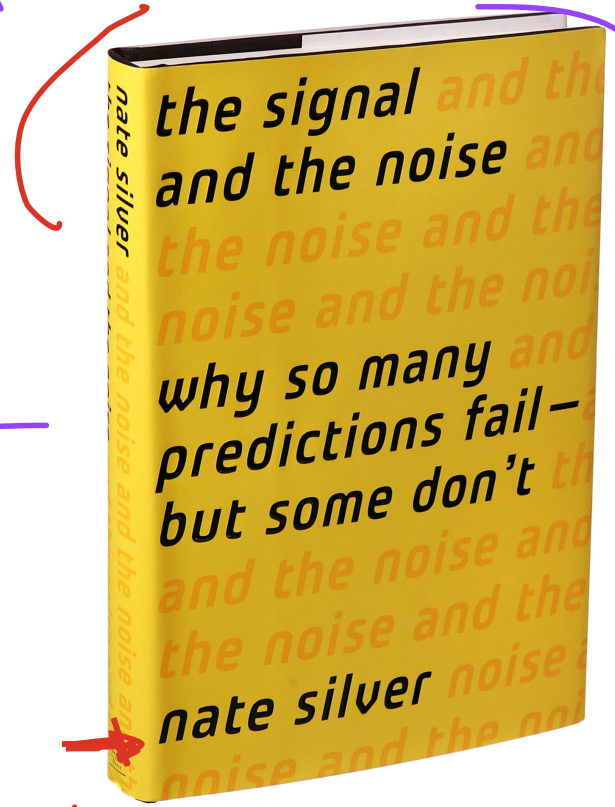
# Synergy: **Money Ball**



Mag Magazine
Sonny Bossa

Brad Pitt
John Hill




Statistics

Athletics Oakland

Data Science

# Outline



# Thanks!

# Questions?

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

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