

# SYSTEMS THINKING

## Systems Analysis

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# Outline

1 Introduction to Systems Thinking

2 General Systems Theory

3 Human Organizations



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# 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.

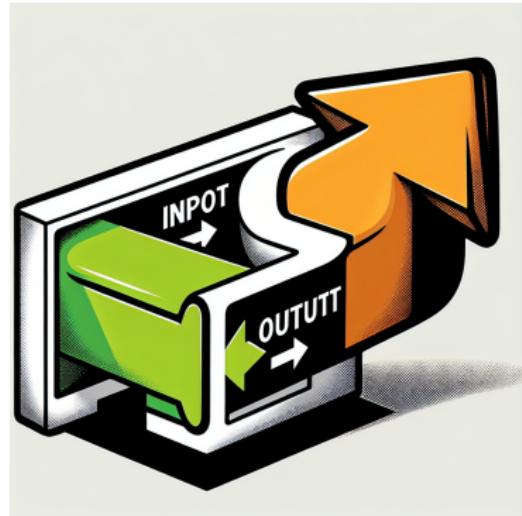


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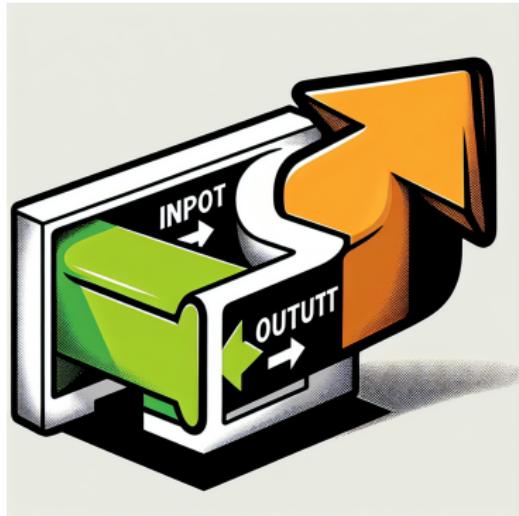


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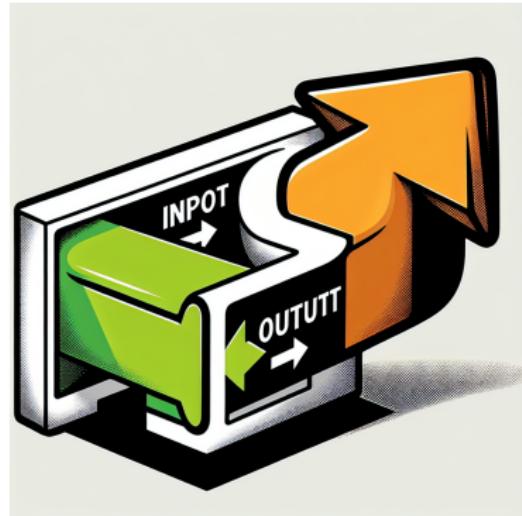


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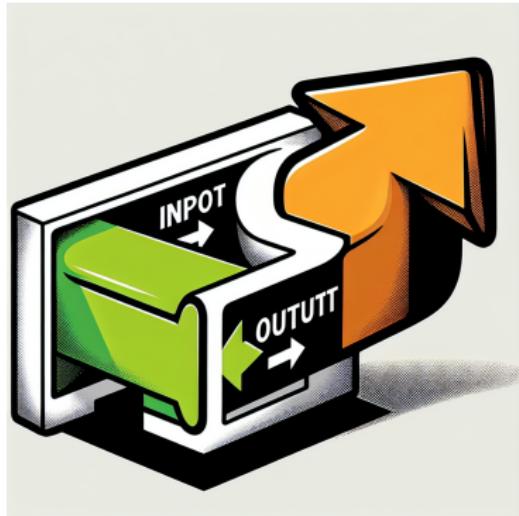


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# Complexity on Systems



# Introduction to Systems Thinking II

- In systems thinking, if you just split parts and forget relationships, you will lost the full picture.
- 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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# Introduction to Systems Thinking III

- Another important concept is the homeostasis, it means to put a system in an equilibrium state. That is hard, systems are 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 you see the system just as its parts.



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- Think in a problem as a system lets you understand details, involved elements, relevant information.



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- Systems could be viable, auto-sostenible, provide internal feedback loops, and also look like a whole live-entity.
- Computation helps to represent behaviors in a mathematical way. Also, it lets to find patterns, simplified process, even to find new information; an example of all this is the Artificial Intelligence.



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# Introduction to Systems Thinking VI

- 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. Major part of cases in life are not deterministic.



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- Stochastic processes make use of probability, and this gets a better real-world behaviors representation.
- Here Chaos Theory becomes a useful tool. To make it simple, chaos could be defines as a harmonic balance between rules and randomness.



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# Systems Structure



# Study Case: Transportation System



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# 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 adaptable to changes in the environment.



**Figure:** Prompt: Draw systems at different levels in the context of astronomy.



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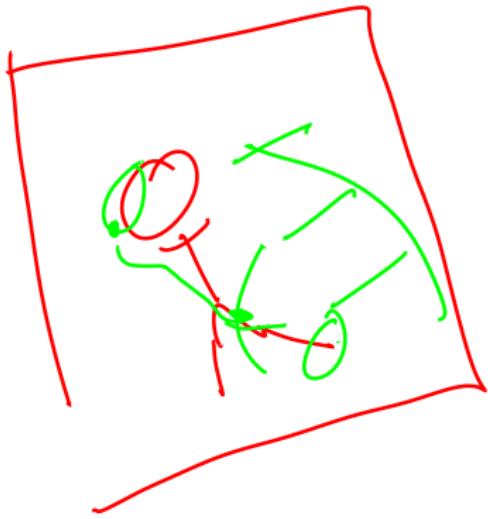
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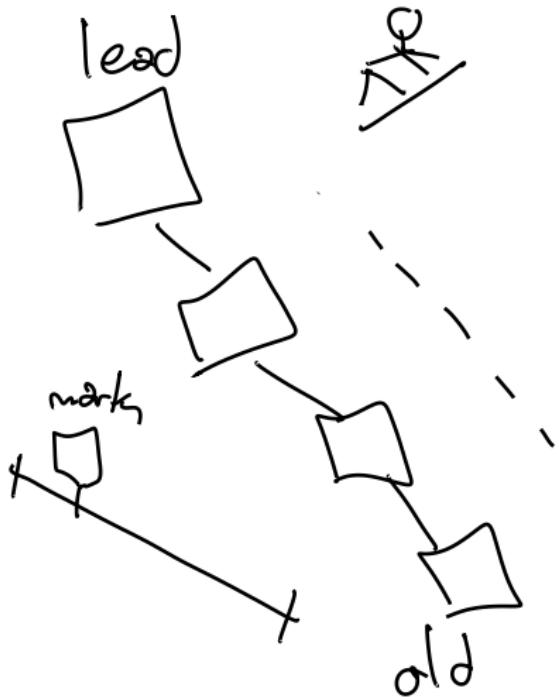
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- A biologist call Ludwig Von Bertallanfy created the General Systems Theory around seventy years ago.
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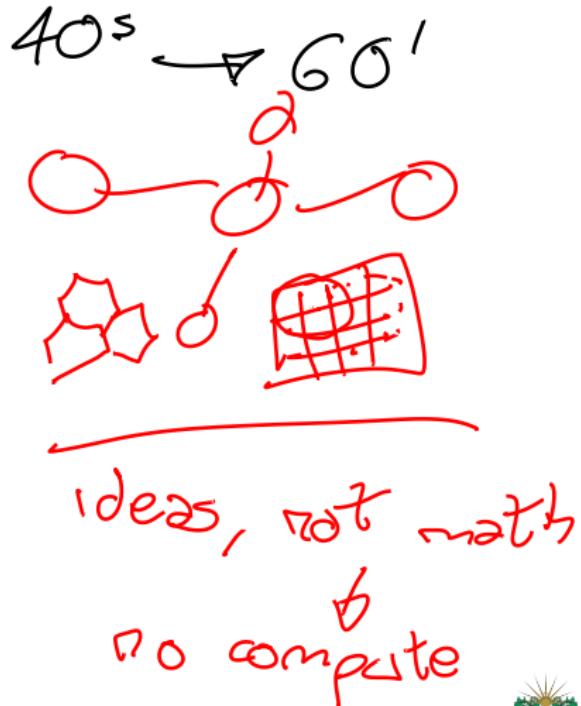


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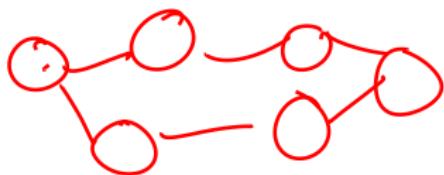
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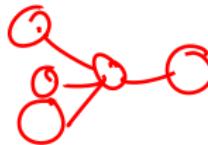
→ Networks



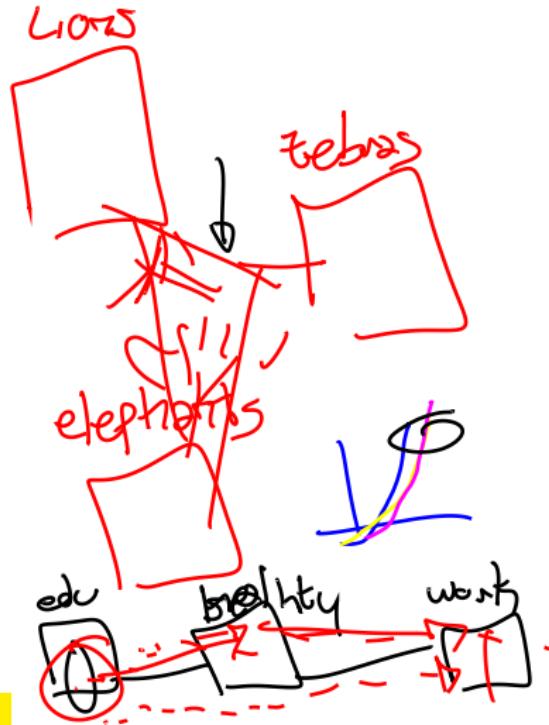
ANN - EC - Art  
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$$f(x) = x^2 + \text{const}$$



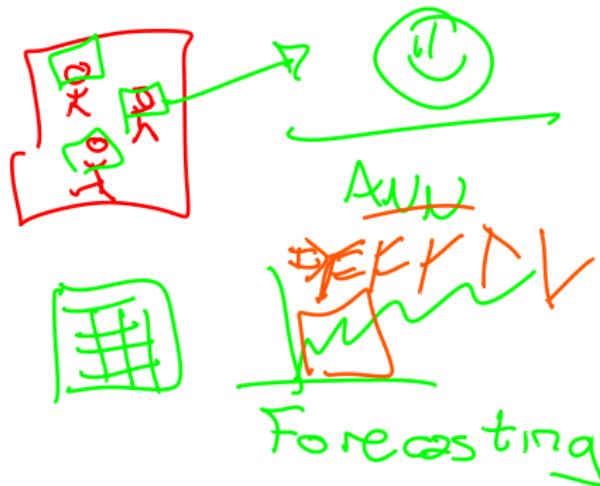
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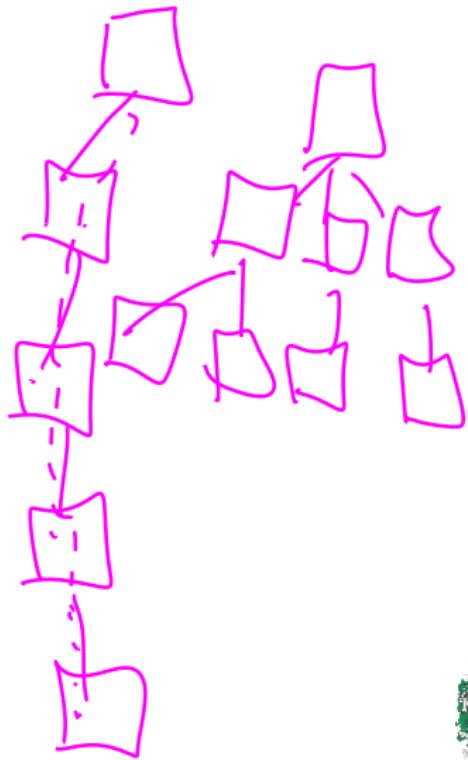


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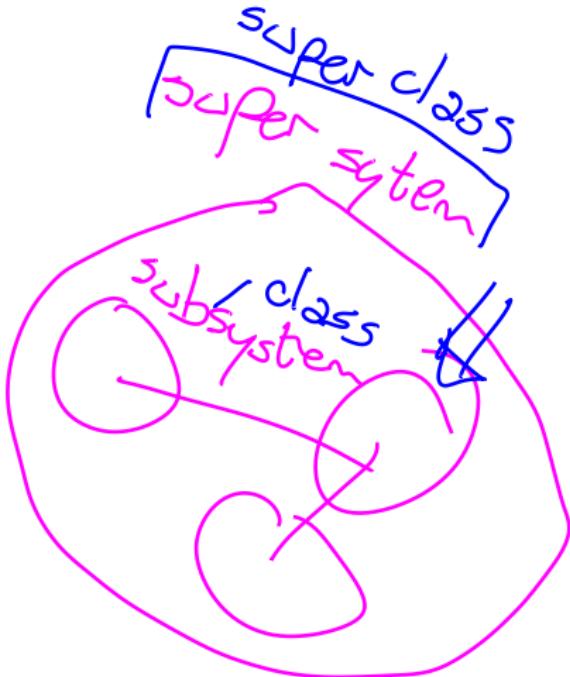
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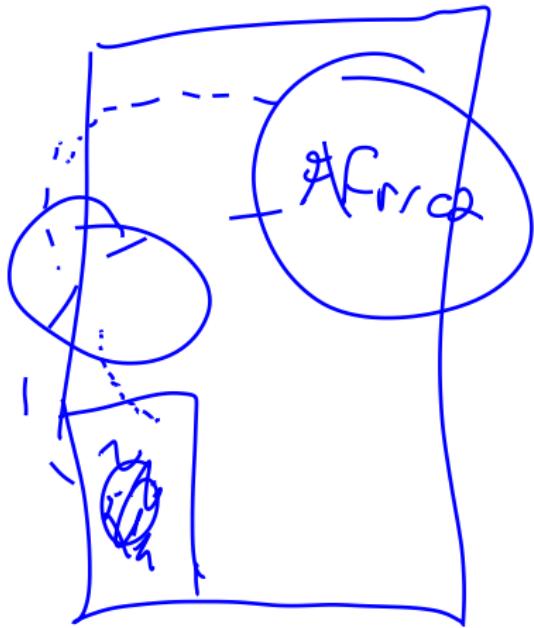


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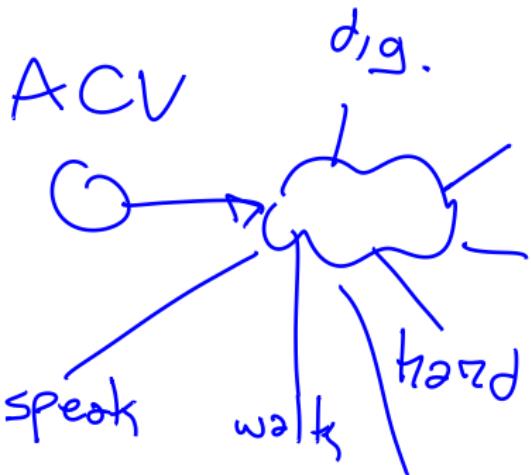
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- In nature you could think an ecosystem is a super system composed by different subsystems: water system, solar system, predator-victim system, forest system, ...
- The human body is a system, and inside the are a lot of systems. Every system is basically connected to each other, and if one fails, it is like a domino effect.



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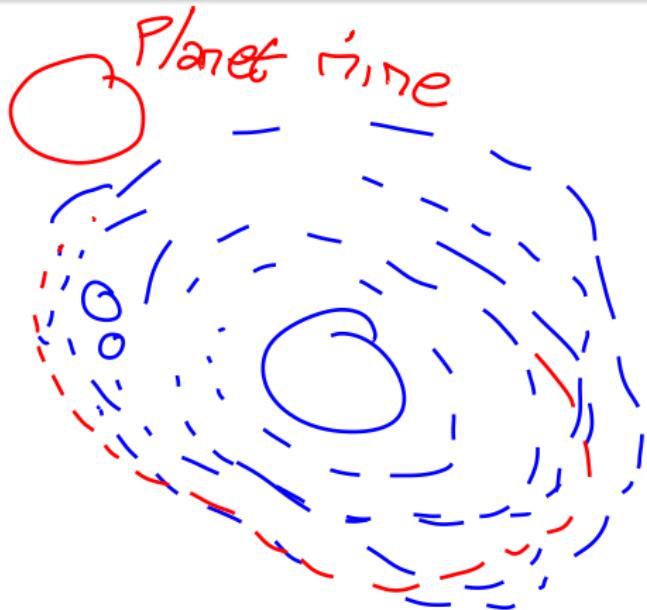


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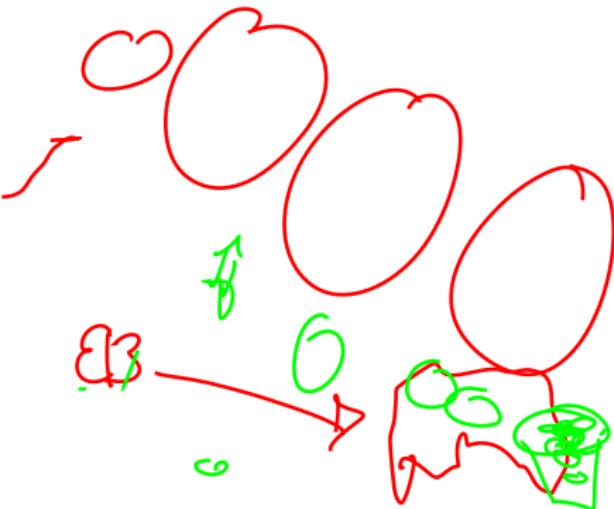
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- Everything in the real-world, in the universe, is a system. The hardest thing is to get the right representation.
- Remember concepts as:  
snowball effect, butterfly effect,  
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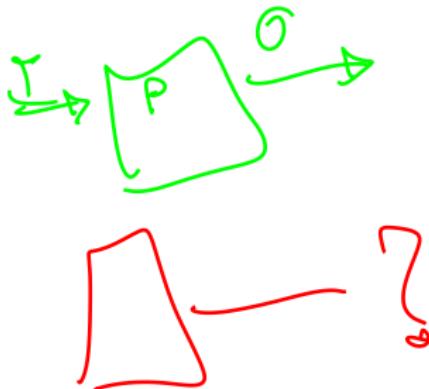


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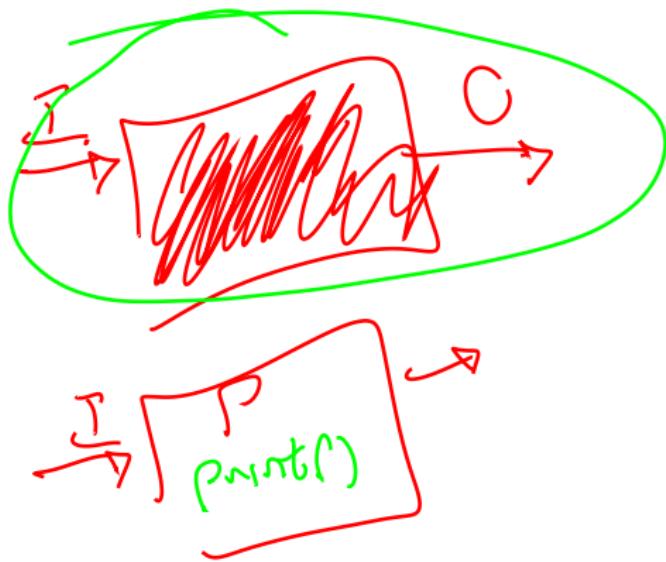
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- Sometimes you have an expected output. Major part of the time it is hard to get, be prepared for everything.
- Black-box is a type of model when you want to get the desired output based on specific input, but you don't want to expose the process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



# General Systems Theory VIII

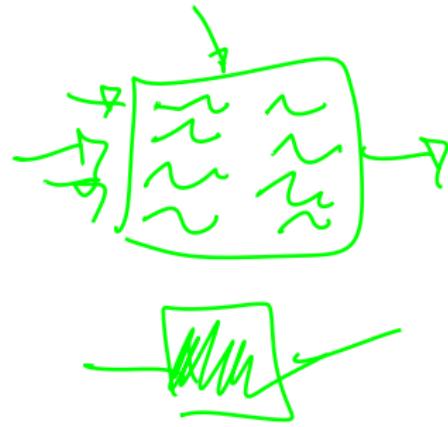


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- White-box are models where the processes are open to check, validate, follow step-by-step. It is useful when you want to understand how the system works.
- Critical Systems Practice is a methodology to deal with Critical Systems Thinking study field.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



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# Human Organizations I

The Signal  
and the Noise



- 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.

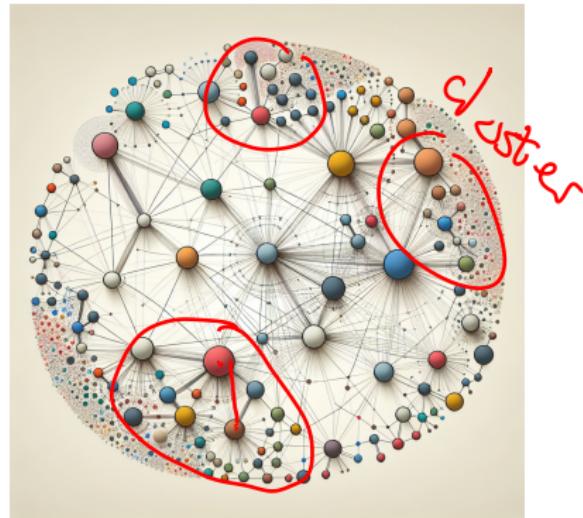
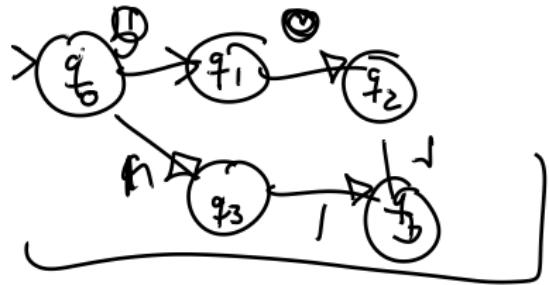


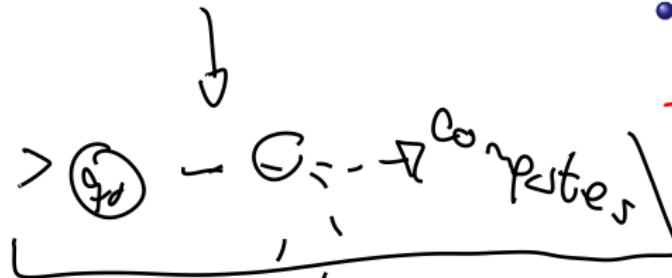
Figure: Prompt: Define a draw of clusters in social networks.



# Human Organizations II



00 10 - 01 -



verb  $\Rightarrow$  a, b, c  
sentence  $\Rightarrow$  - + noun + -

- Alan Turing proposed a hundred years ago a Universal Machine, capable of take any algorithm defined as a state machine, and process it in a binary language.
- Forty years after, Noam Chomsky proposed the formal languages based on generative grammars. Here is where the high level programming languages appear.



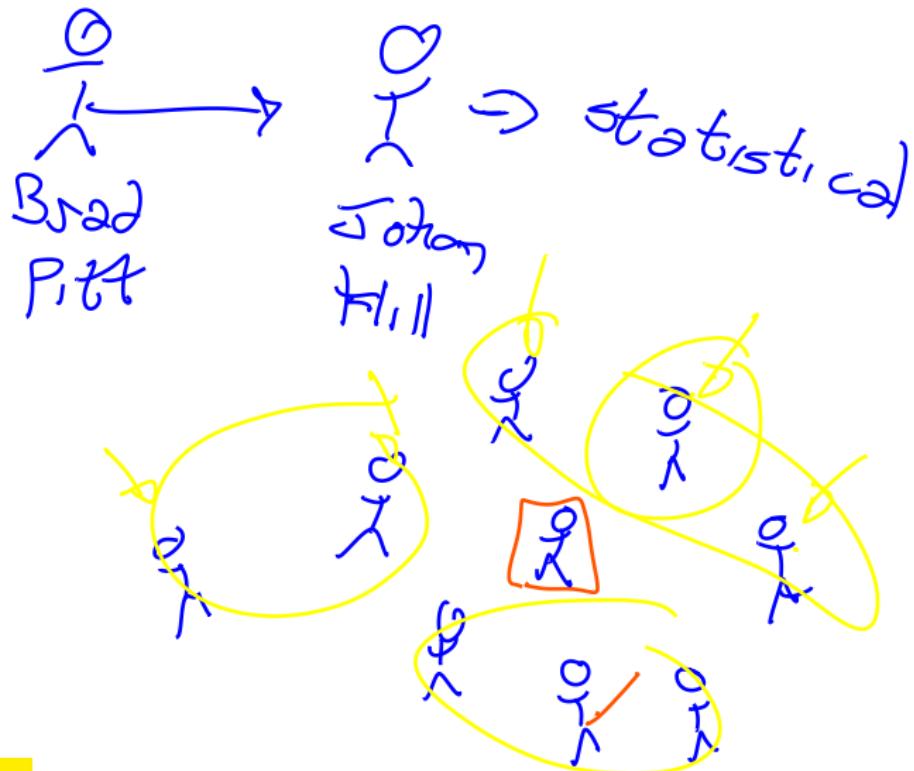
# Human Organizations III

- Lenguajes with more capabilities, easier comprehension had created.  
Also, more people start to code into specific domain programming languages.
- Andrej Kaparty, hero in tesla and now in open si said: nowadays, english is the more important programming language.

Economic  
Education  
Health  
Transport



# Synergy: Money Ball



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# Thanks!

# Questions?



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