

# SYSTEMS ENGINEERING

## Systems Analysis & Design

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School of Engineering  
Universidad Distrital Francisco José de Caldas

2025-III



# Outline

- 1 Basic Concepts
- 2 Human Activities •
- 3 Cibernetics and Technology
- 4 Teams-Based Structure as a System



# Outline

1 Basic Concepts

2 Human Activities

3 Cibernetics and Technology

4 Teams-Based Structure as a System



# What is Systems Engineering?

- **Systems Engineering** is a discipline that studies the design, implementation, and maintenance of complex systems.
- This discipline is based on interdisciplinary fields, such as control engineering, industrial engineering, software engineering, mechanical engineering, electrical engineering, organizational studies, project management, and others.
- Systems Engineering is a holistic approach to engineering that focuses on how to design and manage complex systems over their lifecycle.

.. draft



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- To's



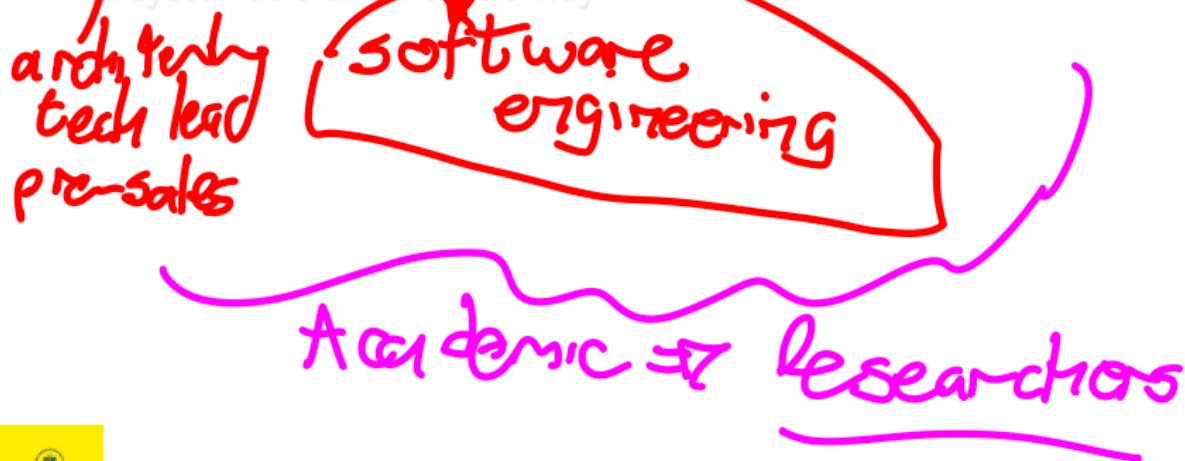
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# Systems Engineer as a Professional

- A **Systems Engineer** is a professional who is responsible for designing, implementing, and maintaining complex systems.
- A Systems Engineer must have a broad understanding of engineering, mathematics, science, and technology.
- A Systems Engineer must be able to analyze and solve problems in a systematic and logical way.



# Systems Engineer as a Professional

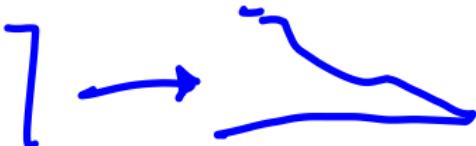
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electric  
systems

no applied

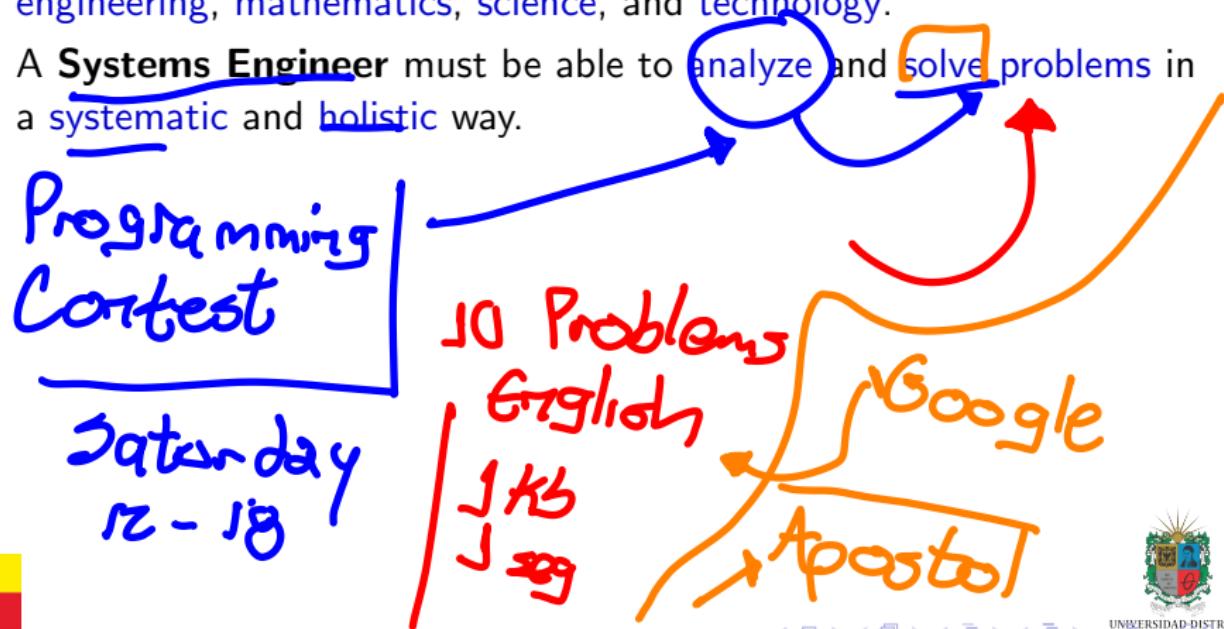
mechanic  
system

Patients  
Human &  
AI  
PM



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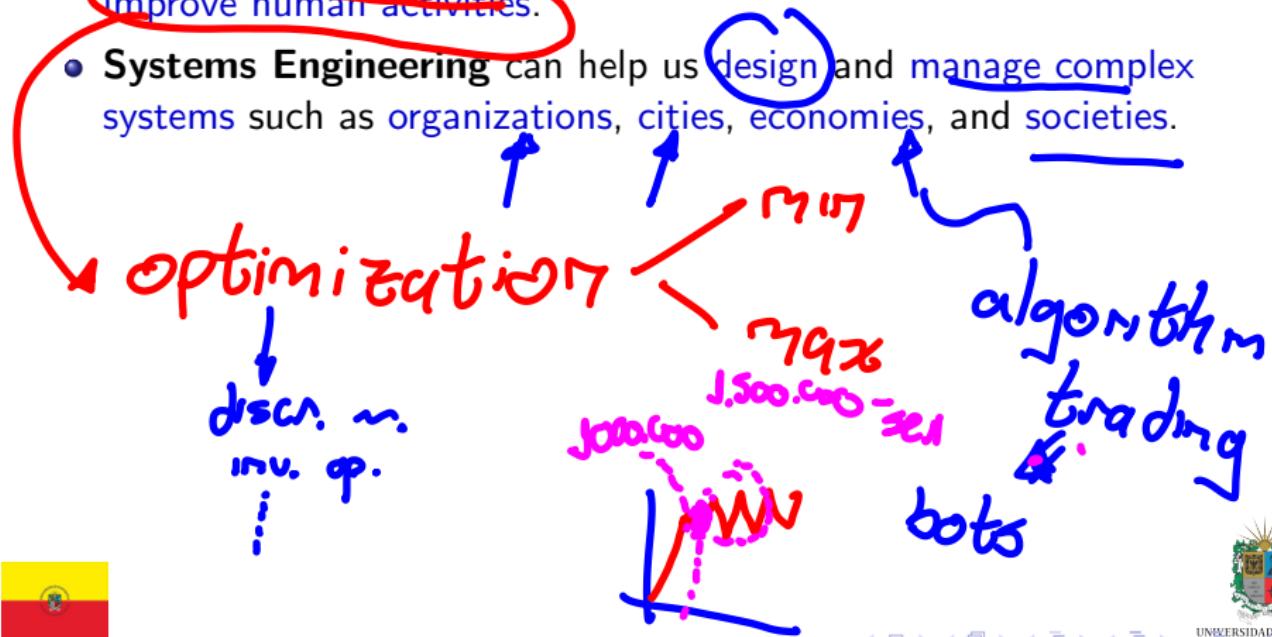
# Human Activities

- **Human activities** are **complex systems** that involve **multiple components, interactions, and feedback loops.**
- Systems Engineering can be applied to understand, analyze, and improve human activities.
- Systems Engineering can help us design and manage complex systems such as organizations, cities, economies, and societies.



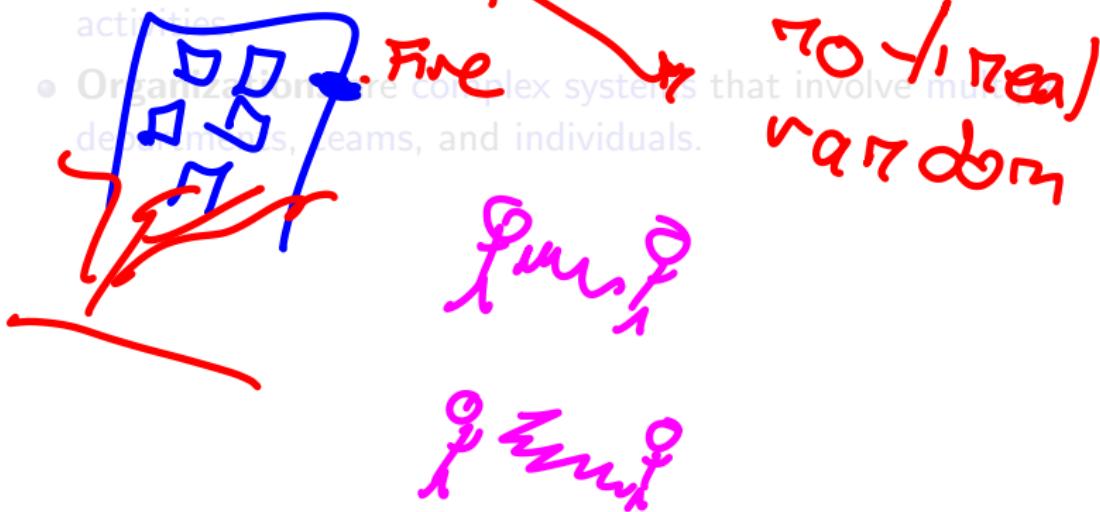
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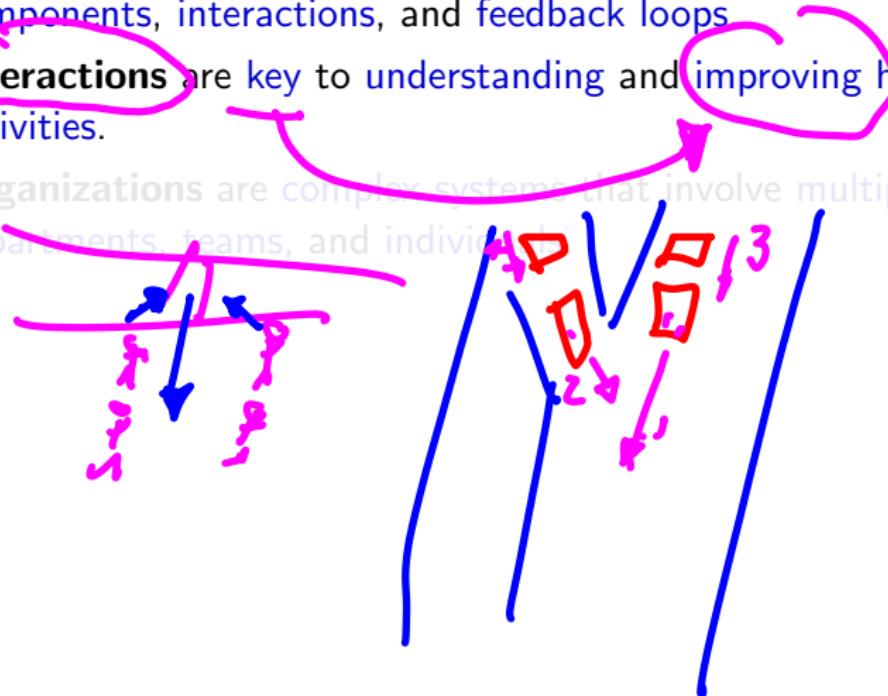
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- Interactions are the understanding and improving human activities.
- Organizations are complex systems that involve multiple departments, teams, and individuals.



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*Different points of view*      *different dynamics*      *not all days are the same*



# Organizations as Systems

- Organizations can be viewed as: a rational system, a natural system, or an open system.
- A rational system is a formal organization that is designed to achieve specific goals as a machine.
- A natural system is an informal organization that is emergent and adaptive based on human interactions.
- An open system is an organization that is interconnected with its environment and adapts to changes.



# Organizations as Systems

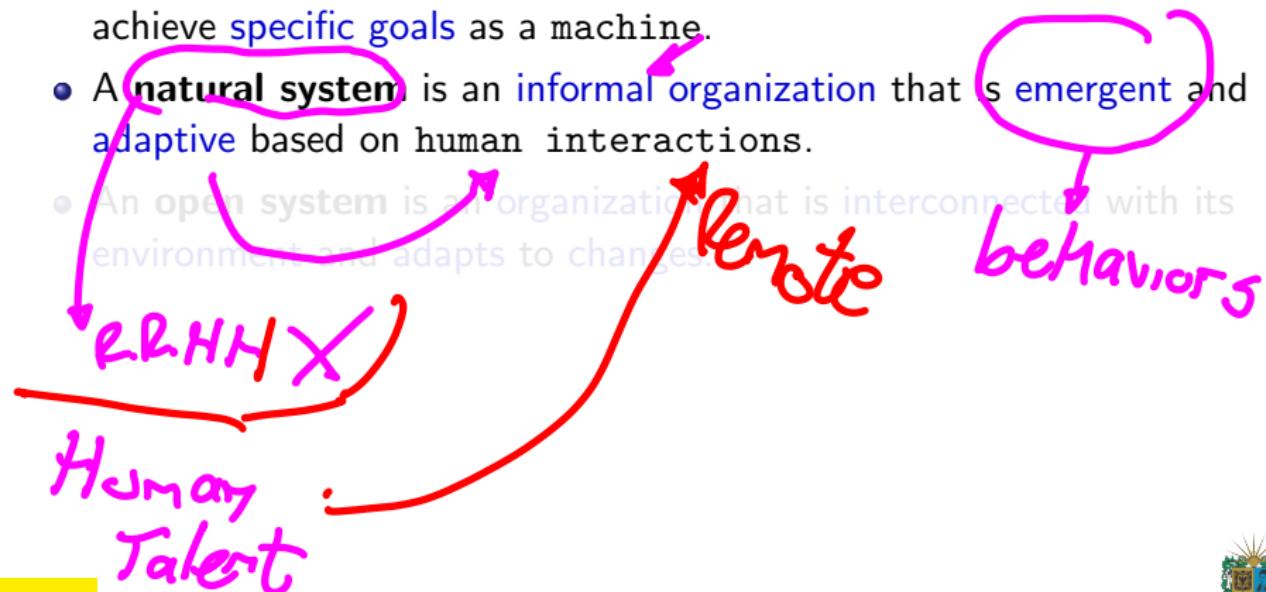
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MISIÓN  
VISIÓN  
GOALS



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clients  
suppliers  
competence  
& rivals



# Synergy

- **Synergy** is a simple but powerful concept: the whole is greater than the sum of its parts.
  - 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 computation. Based on graphs, you could define a computational model.
- 6-degree separation**

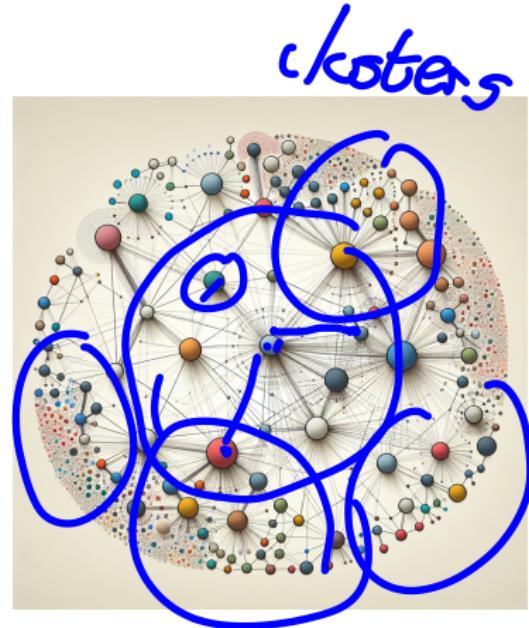
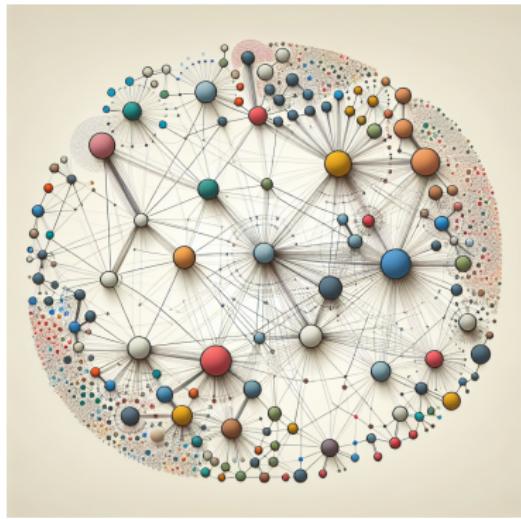


Figure: Prompt: Define a draw of clusters in social networks.

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  - One of the main concepts is the **theory of computation**. Based on graphs, you could define a computational machine.



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

# Algo Turino

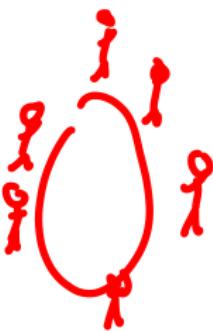


Synergy: Money Ball → Baseball

Manager



Brat Pitt



economist

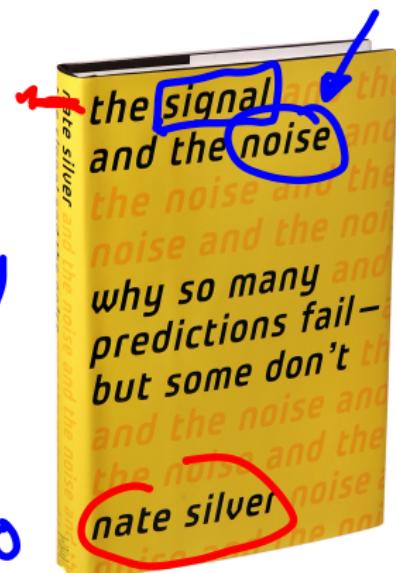
Market

Winton Hill

stats

22 win strike

\$100,000



# Talking with Machines!



**Algorithm**

↓  
DAG



finite state machine

is 10z

algo  
input



Parameter

Alonzo Church

Alan Turing

proposed a hundred years ago an **Universal Machine**, capable of take any algorithm defined as a **state machine**, and process it in a **binary language**. → **Digital**

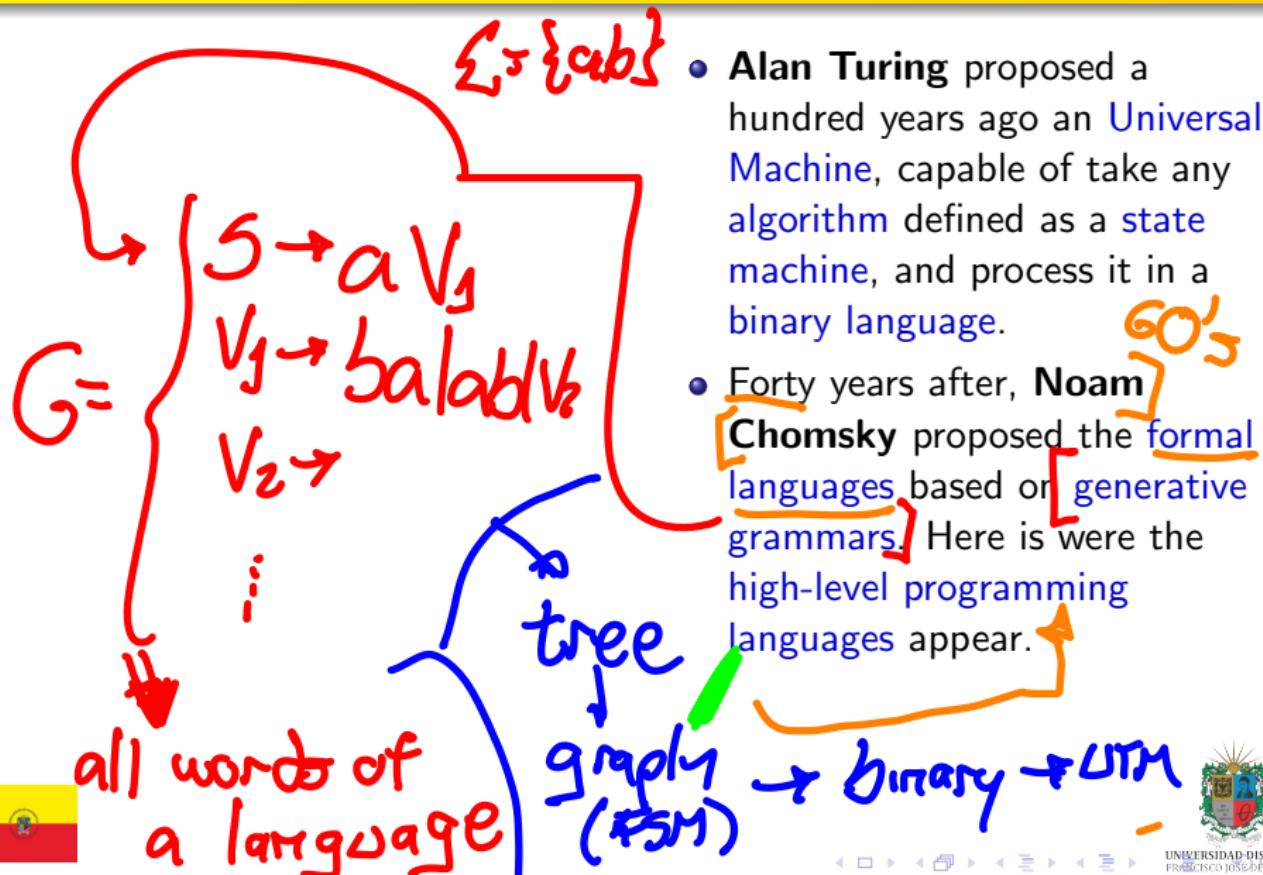
Forty years after, Noam Chomsky proposed the formal languages based on generative grammars. Here is where the high-level programming languages appear.



n.g.o.



# Talking with Machines!



# Programming Languages

- Programming Languages with more capabilities, easier comprehension had been created. Also, more people start to code into specific domain programming languages.

Demo time!

SQL

Andrej Karpathy, a leading figure at Tesla and now at OpenAI. Nowadays, English is the most important programming language.

Natural Language

Java: hungry? lunch: home;  
Python:

lunch if hungry else home

General-purpose

CD (Languages)

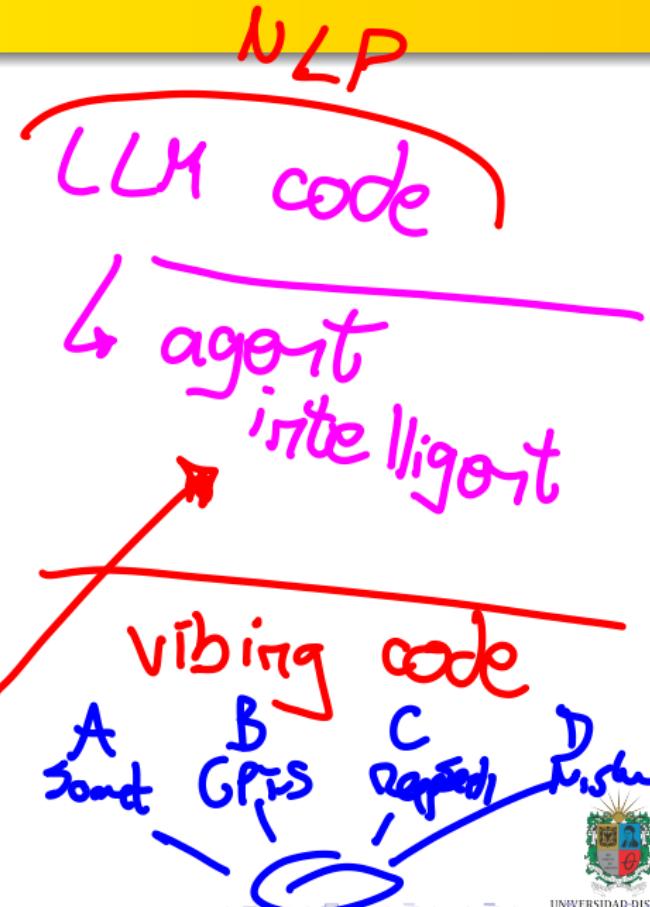


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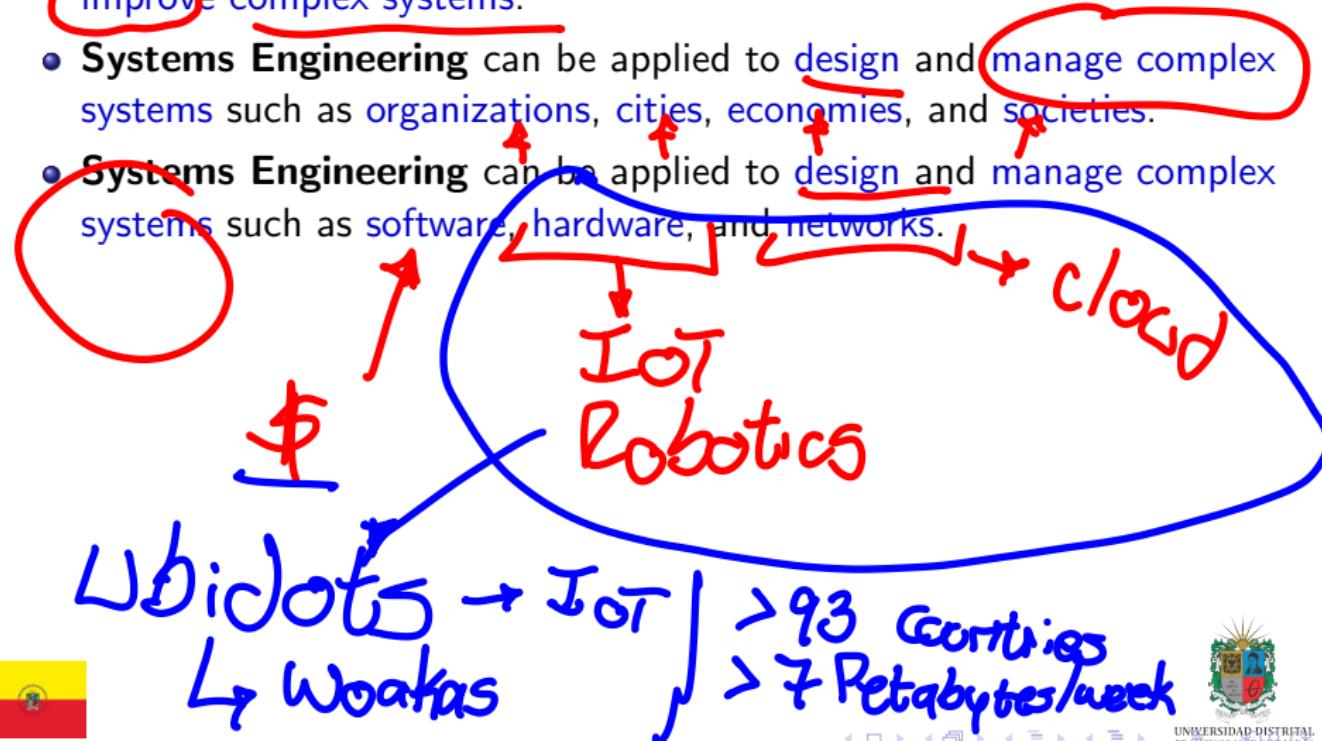
**Demo time!**

- Andrej Karpathy, a leading figure at Tesla and now at OpenAI, said: *Nowadays, English is the most important programming language.*



# Applications of Systems Engineering

- Systems Engineering can be applied to understand, analyze, and improve complex systems.
- Systems Engineering can be applied to design and manage complex systems such as organizations, cities, economies, and societies.
- Systems Engineering can be applied to design and manage complex systems such as software, hardware, and networks.



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# Cibernetics

~ 1948

- Cibernetics is the study of systems, control, and communication in animals, machines, and organizations.
- Cibernetics is a transdisciplinary field that involves engineering, mathematics, biology, psychology, and philosophy.
- Cibernetics is the foundation of systems engineering and information technology.

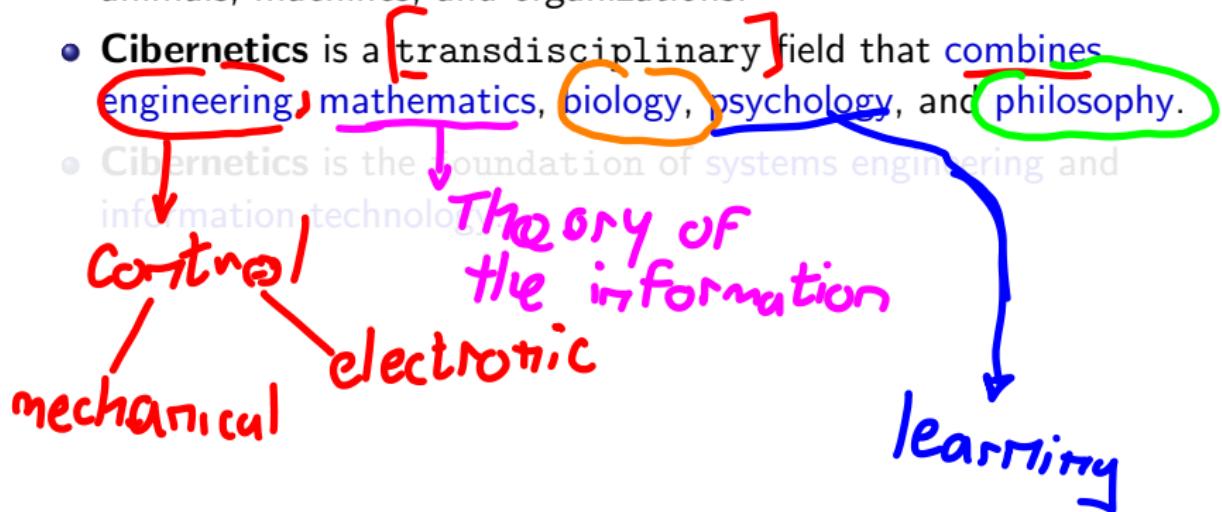
environment

auto-regulation



# Cibernetics

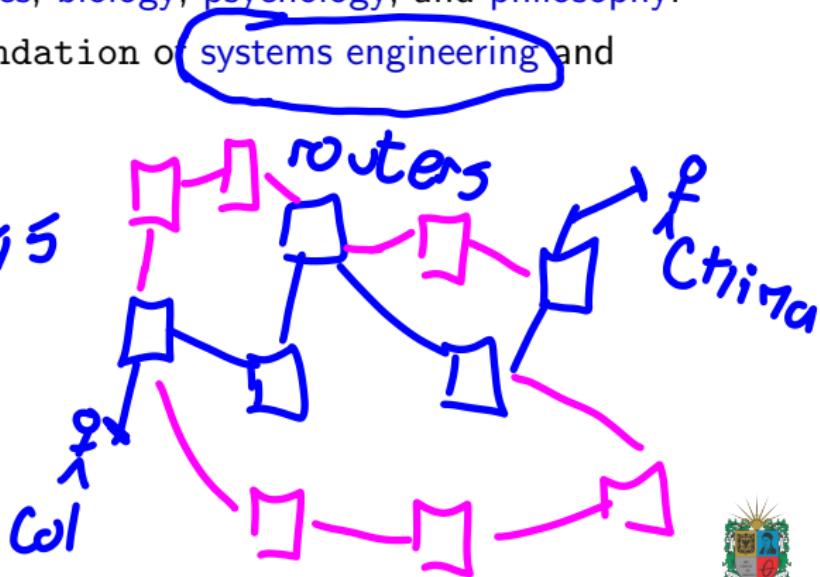
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# Cibernetics

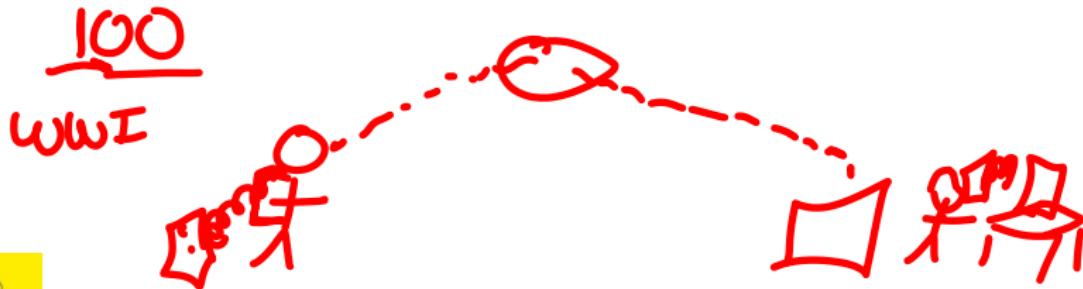
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networks



# Technology

- Technology is the *application* of scientific knowledge to solve problems and improve systems.
- Technology is the key to developing complex systems such as organizations, cities, economies, and societies.*
- Temporal ~2000-3000 years ago



# Technology

- **Technology** is the *application* of scientific knowledge to **solve problems** and **improve systems**.
- **Technology** is the **key** to **designing** and **managing complex systems** such as organizations, cities, economies, and societies.

Computers as tools

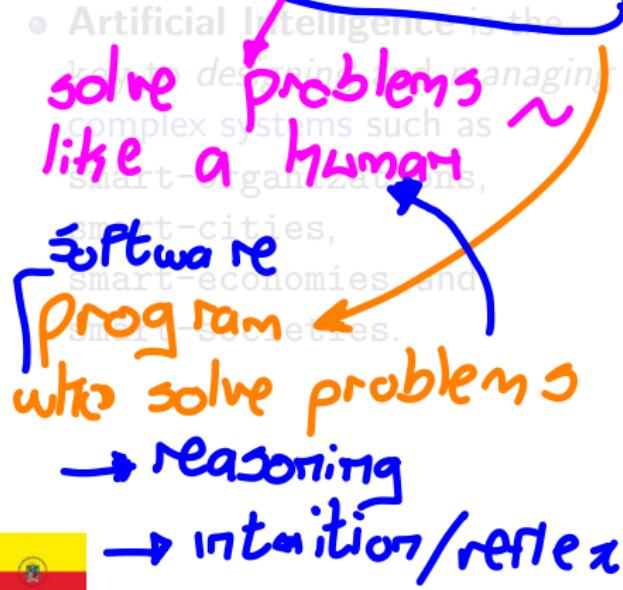
comp.  
science

math  
phys.  
bio.  
Chem.



# Technology: **AI**

- Artificial Intelligence is a field of computer science that studies how to design and implement intelligent agents.



maths

→ statistical  
probabilities

→ discrete

→ non-linear

biology

→ anatomy

→ eye-brain

psychology

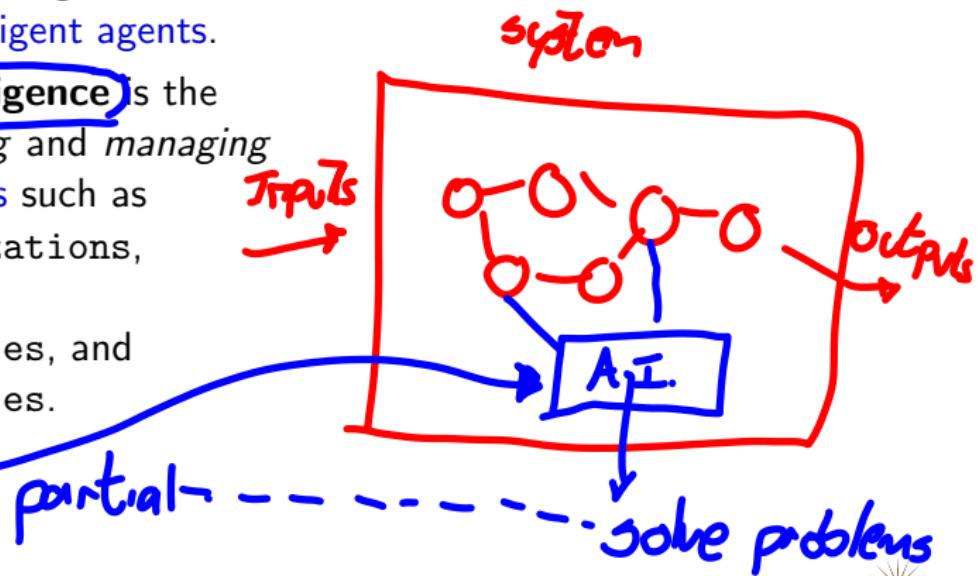
→ learning



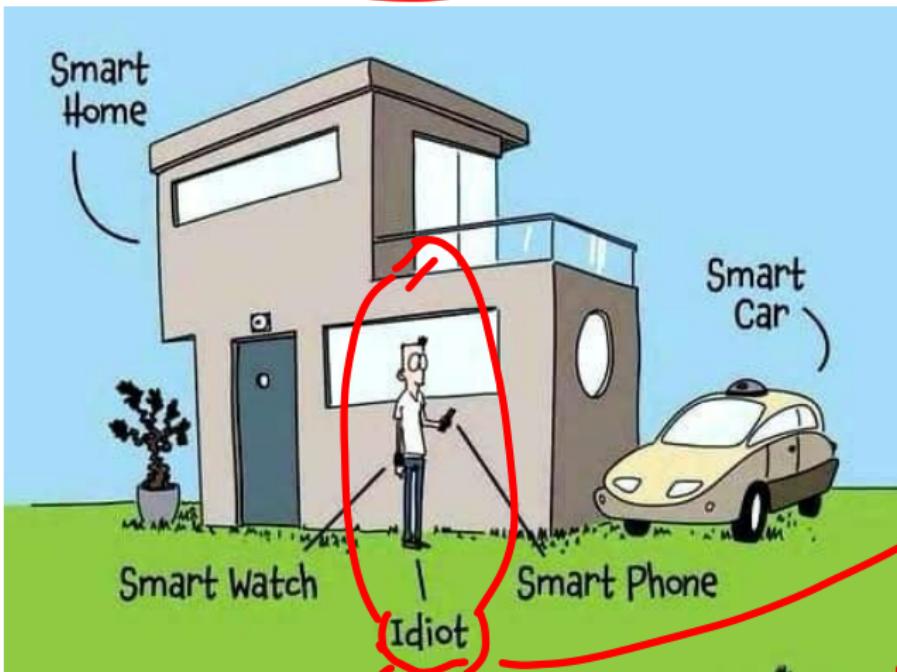
# Technology: AI

- Artificial Intelligence is a field of computer science that studies how to design and implement intelligent agents.

- Artificial Intelligence is the key to designing and managing complex systems such as smart-organizations, smart-cities, smart-economies, and smart-societies.



# Artificial Intelligence **not** as a System



Wall-e



# Cibernetics & Technology in Systems Context

- Cibernetics and technology are the foundation of systems engineering and information technology.
- Cibernetics and technology are the foundation of artificial intelligence and smart systems.

sciences  
control  
rage



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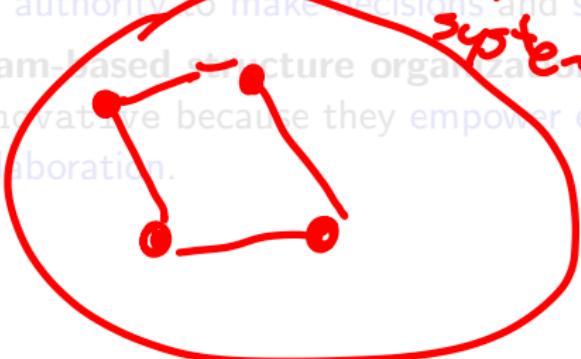


# Team-Based Structure Organizations

- Team-based structure organizations are a way to organize work and people in teams that are self-managed and cross-functional
  - Each team is responsible for a specific task or project and has the authority to make decisions and solve problems.
  - Team-based structure organizations are flexible, agile, and innovative because they empower employees and encourage collaboration.

*team as a system*

*team* → *agile*



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# Teams as a System

- **Teams** are a **system** where collaboration (**synergy**) and communication are **key** to **success**.
- Defining and **automating** the **processes** and **procedures** within the **team** is a **challenge** to **improve team performance**. **any Ops**
- **Teams** are like **pieces** in a **puzzle**, where each **piece** has a **specific role** and **responsibility**.

*daily*

*capabilities  
skills*



# Soft Skills

*1st step*

- **Soft skills** are personal attributes that enable someone to interact effectively and harmoniously with other people.
- Typical Soft Skills:
  - Communication skills (verbal and written).
  - Teamwork and collaboration.
  - Problem-solving and critical thinking.
  - Adaptability and flexibility.
  - Time management and organization.
  - Leadership and management.
  - Emotional intelligence.
  - Creativity and innovation.
  - Conflict resolution.
  - Networking and relationship building.
  - Customer service and client management.

*Programming  
Contest*

*Test of  
Wartegg*



# Computer Analyst

system

- Skills:

- Business process modeling and documentation.
- Data analysis and interpretation.
- Requirements gathering and management.
- Stakeholder management.

- Responsibilities:

- Analyzing business processes and identifying areas for improvement.
- Gathering and documenting business requirements.
- Collaborating with stakeholders to define project scope and objectives.
- Creating and maintaining project documentation, such as functional specifications and use cases.
- Facilitating communication between business users and technical teams.
- Participating in system testing and user acceptance testing.
- Providing support and training to end users.

statistical  
+  
descriptive



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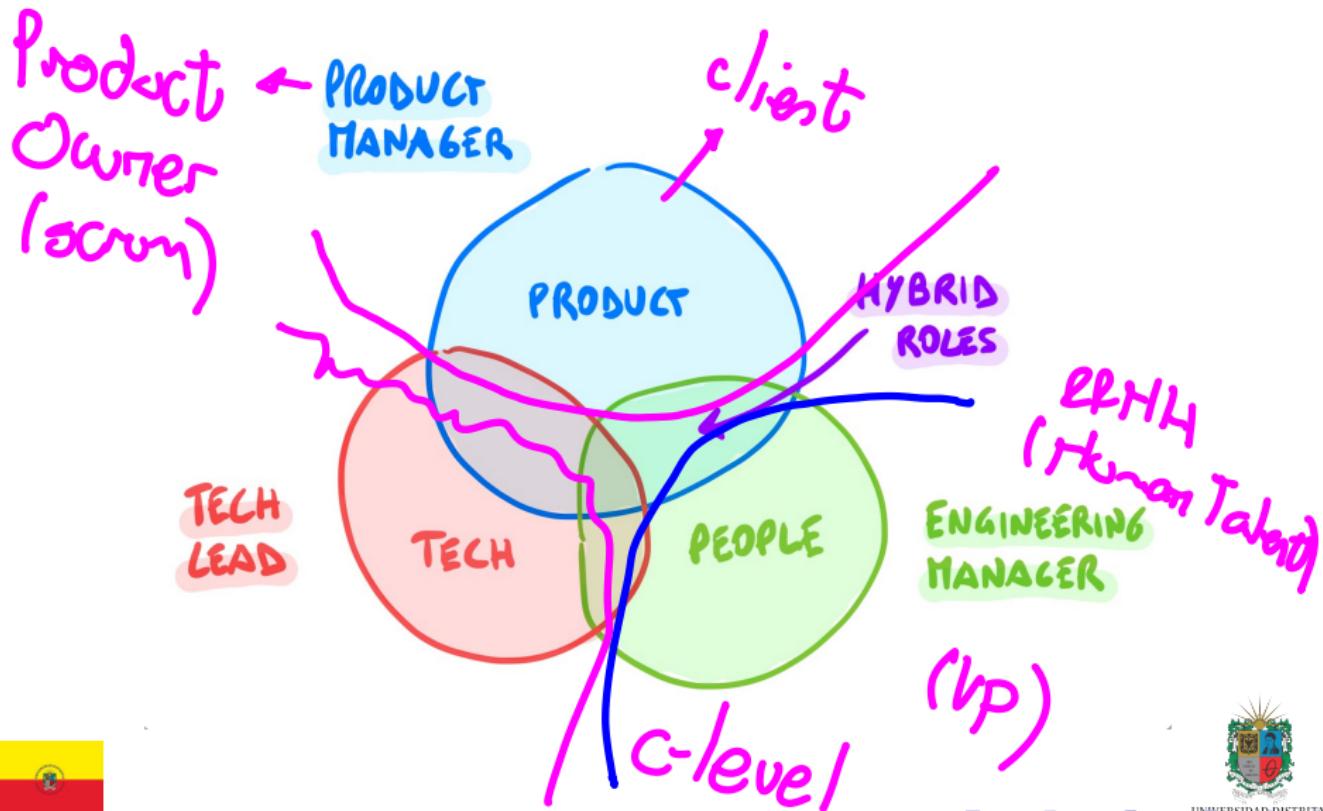
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startups



# Tech Company Typical Structure

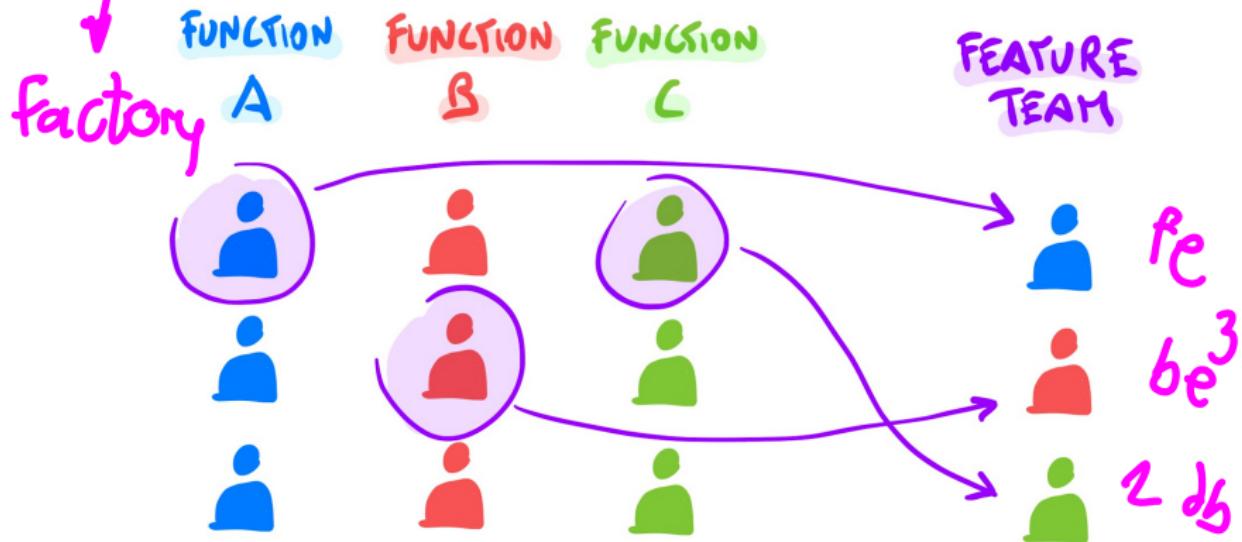


## Feature Teams

Feature Teams

Globant → pool → project

```
graph LR; Globant[Globant] --> Pool((pool)); Pool --> Project[project]
```



# What is to be a leader? I

- **Leading** a team is **not a role**. It is a **decision**, you could be a **leader** anytime and anywhere.
- Teamwork culture is pretty important. It creates habits, open communication, safety spaces for inclusion.
- Psychological safety is a key point to have an effective team. You could develop *technical skills*, but it is not enough.
- Hierarchy is very important. Anarchism tends to fail. Hierarchy exists by status and power.
- In a hierarchy experts **lead** to make better decisions. However, anyone must be careful to not leave people behind.

junior      senior  
                    lead



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- goals / results*
- (Jorn)*
- daily*



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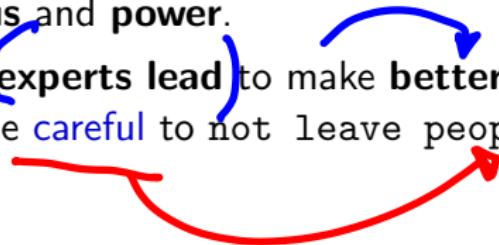
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# What is to be a leader? II

- With **crystal-clear communications** and clarity about **business goals** and achievements, people feel **more comfortable** pursuing the same goals as a **team**.  
*All-hands*
- A good leader should focus on outcomes rather than outputs. This helps bring **business value** rather than just complete tasks.
- Failure** is always an option. Learn how to **deal** with setbacks; do not punish — just fix and learn.
- Some believe you're born a leader, while others think that a leader can be developed over time. Either way, **context** and the desire for self-growth are vital.
- Making **ethical decisions** is key; it leads to taking the right and better actions.

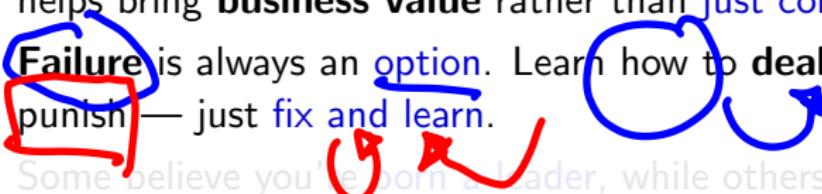


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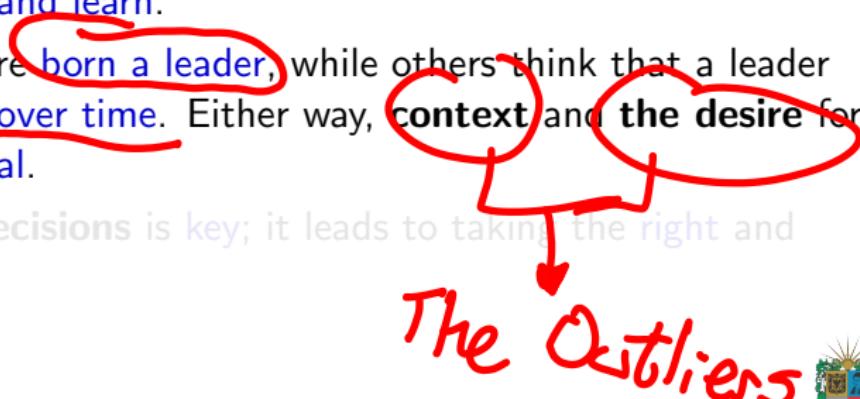
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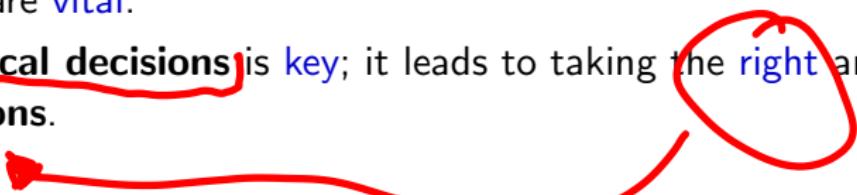
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# What is to be a leader? III

- It is important to maintain **psychological well-being**. You will be **stronger**, better able to **help** people, and have a better **perspective** on everything.
- A good leader builds trusting relationships and has the emotional intelligence to communicate effectively and understand others.
- To develop as a leader, follow the three C's: Curiosity, Courage, and Commitment.



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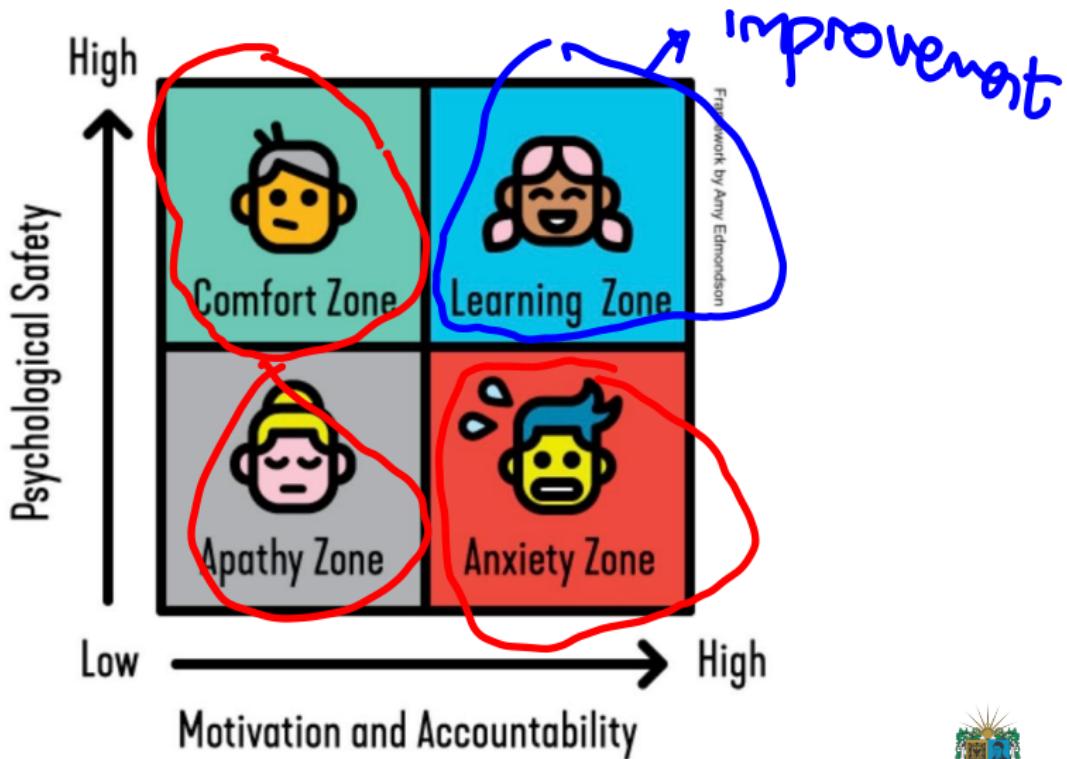


# What is to be a leader? III

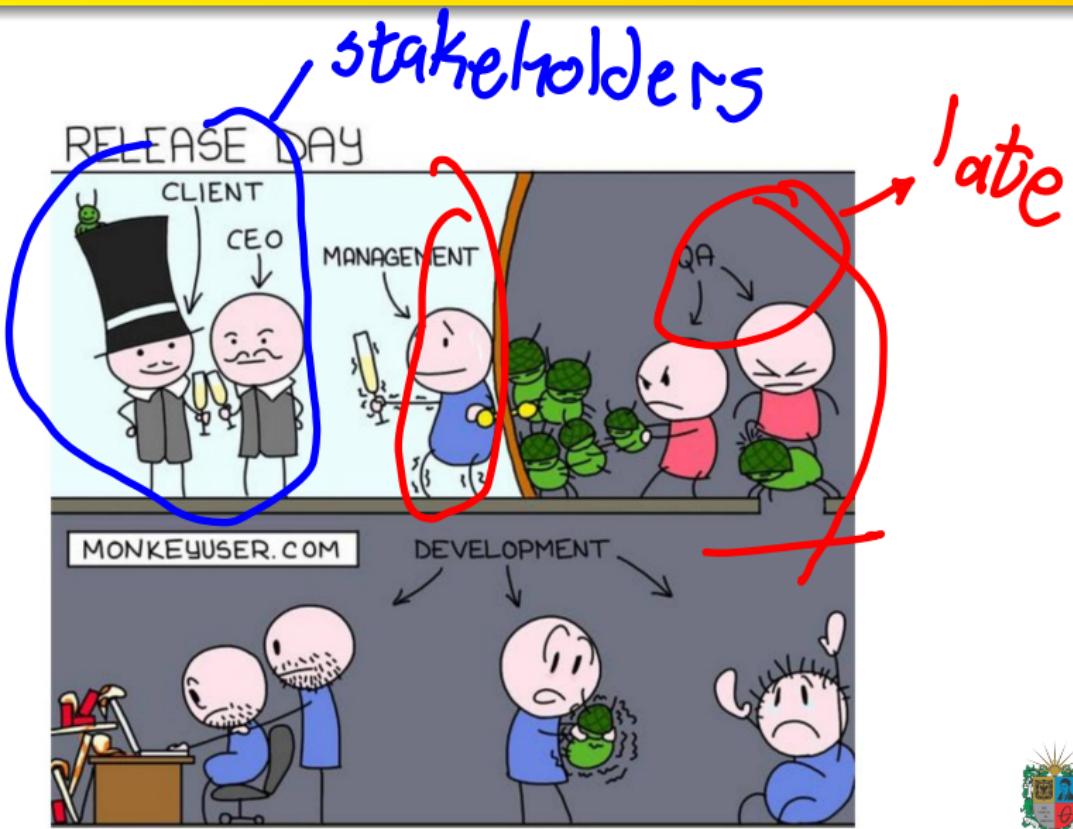
- It is important to maintain **psychological well-being**. You will be **stronger**, better able to **help** people, and have a better **perspective** on everything.
- A **good leader** builds **trusting relationships** and has the **emotional intelligence** to communicate effectively and understand others.
- To **develop as a leader**, follow the **three C's**: **Curiosity**, **Courage**, and **Commitment**.



# Working Zones



# Real World!



# Outline

- 1 Basic Concepts
- 2 Human Activities
- 3 Cibernetics and Technology
- 4 Teams-Based Structure as a System



# Thanks!

## Questions?



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

