

# SYSTEMS ENGINEERING

## Systems Analysis & Design

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2025-III



# Outline

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



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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 ~~CSRN~~, ~~Software~~, ~~Physical~~ 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.



# What is Systems Engineering?

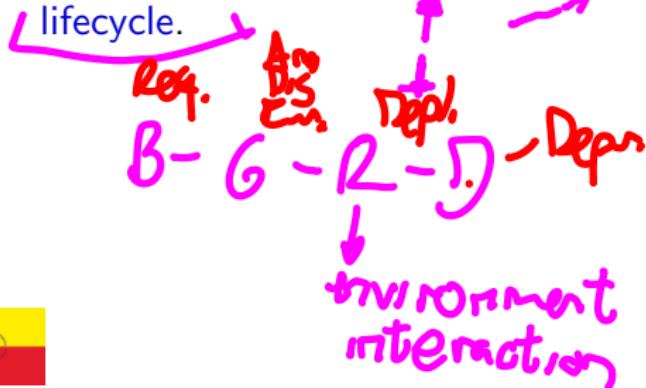
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80's



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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 is able to analyze and solve problems in a systematic and holistic way.

architect

software

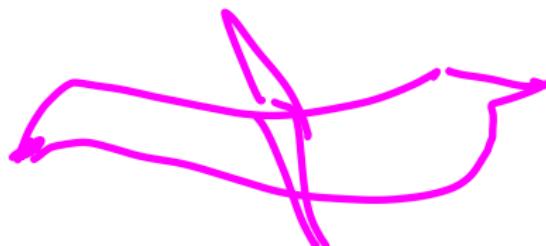
error-fix



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Humanos  
A.E.P. in

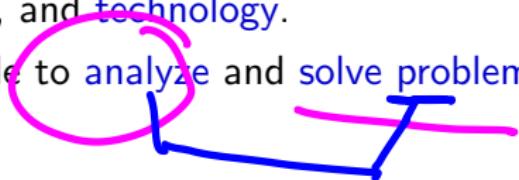


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Saturday  
12:00  
6  
10 problems  
english

Programming  
Contest

Google

A handwritten note on the left side of the slide. It includes the text "Saturday", "12:00", "6", "10 problems", and "english". To the right of this, there is a bracket grouping the text "Programming Contest" and "Google". An arrow points from the bracketed text towards the Google text.



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# Human Activities

random

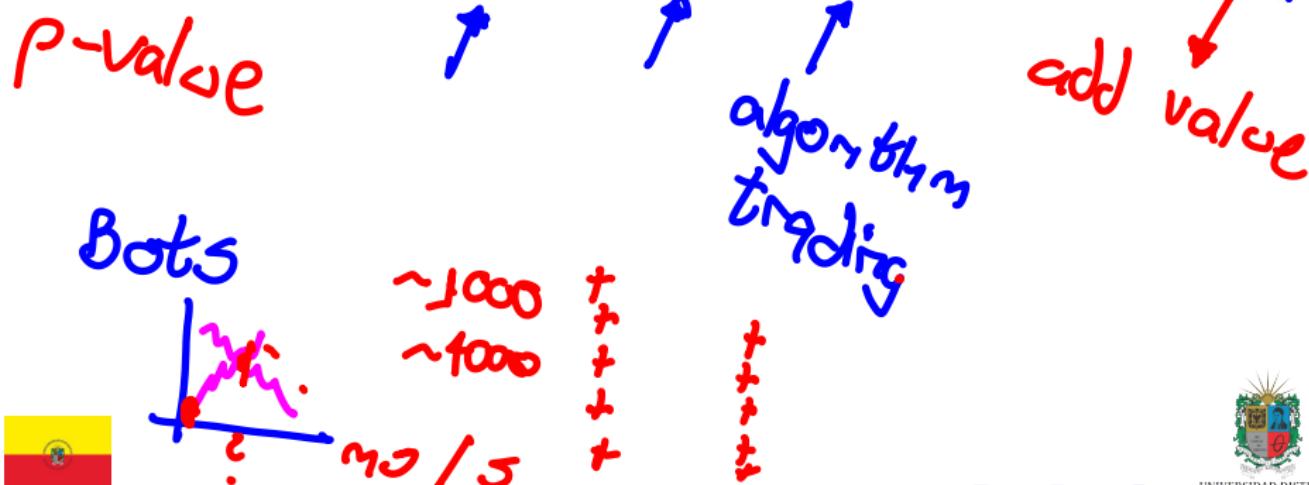
- Human activities are complex systems that involve multiple components, interactions, and feedback loops.
- Systems Engineering can be applied to understand, analyze, and improve human activities.
- Systems Engineering can help us design and manage complex systems such as organizations, cities, economies,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

variability



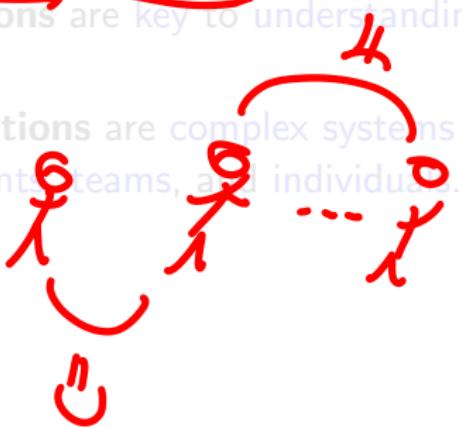
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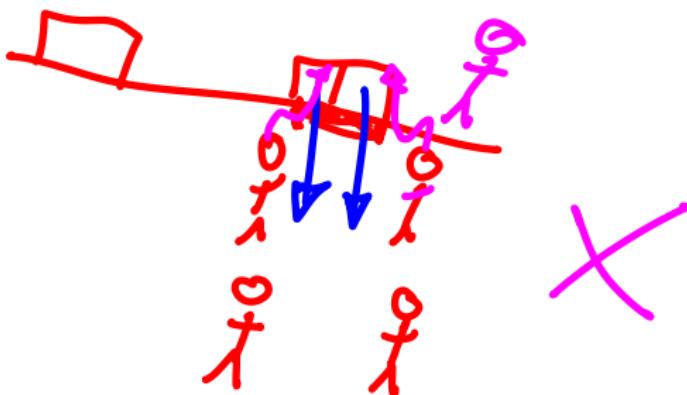
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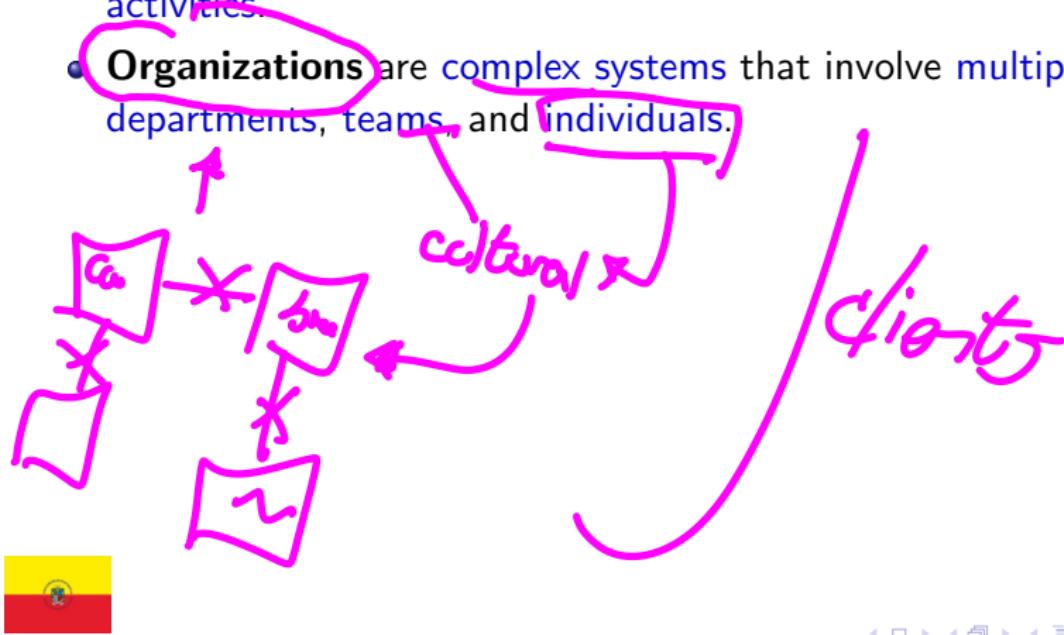
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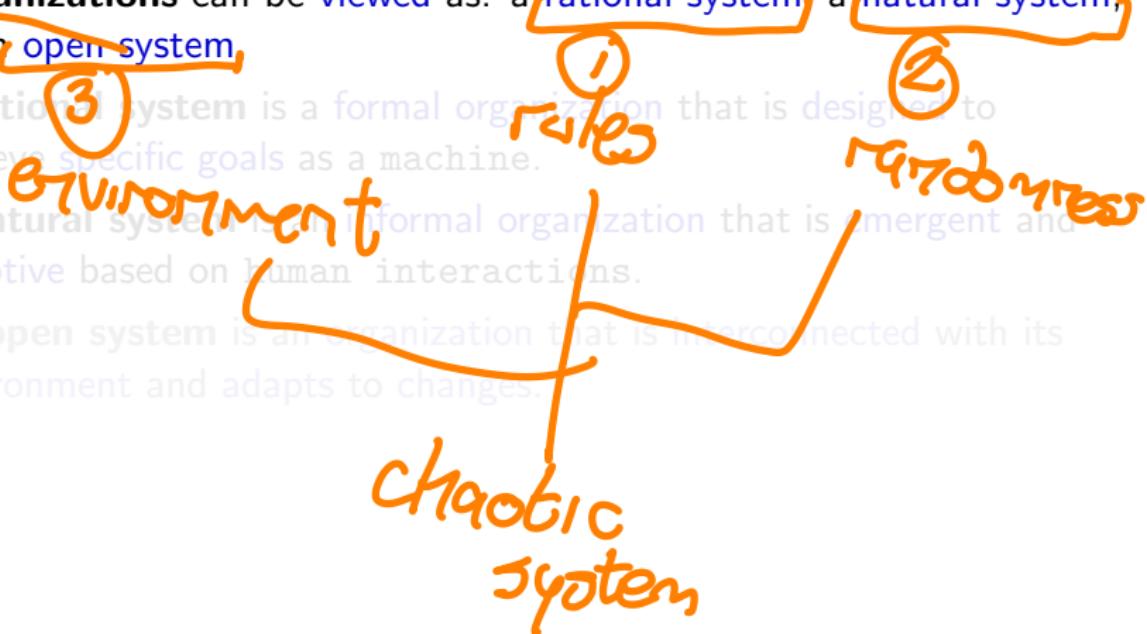
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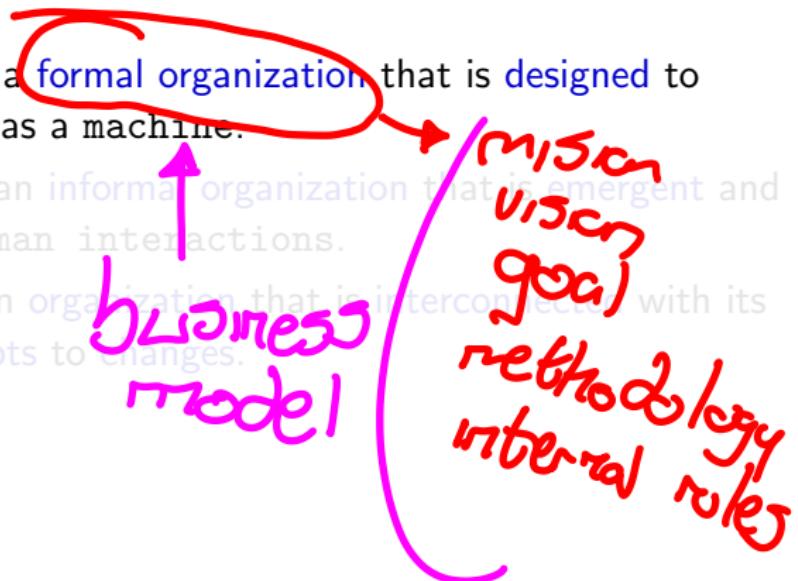
# Organizations as Systems

- 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.



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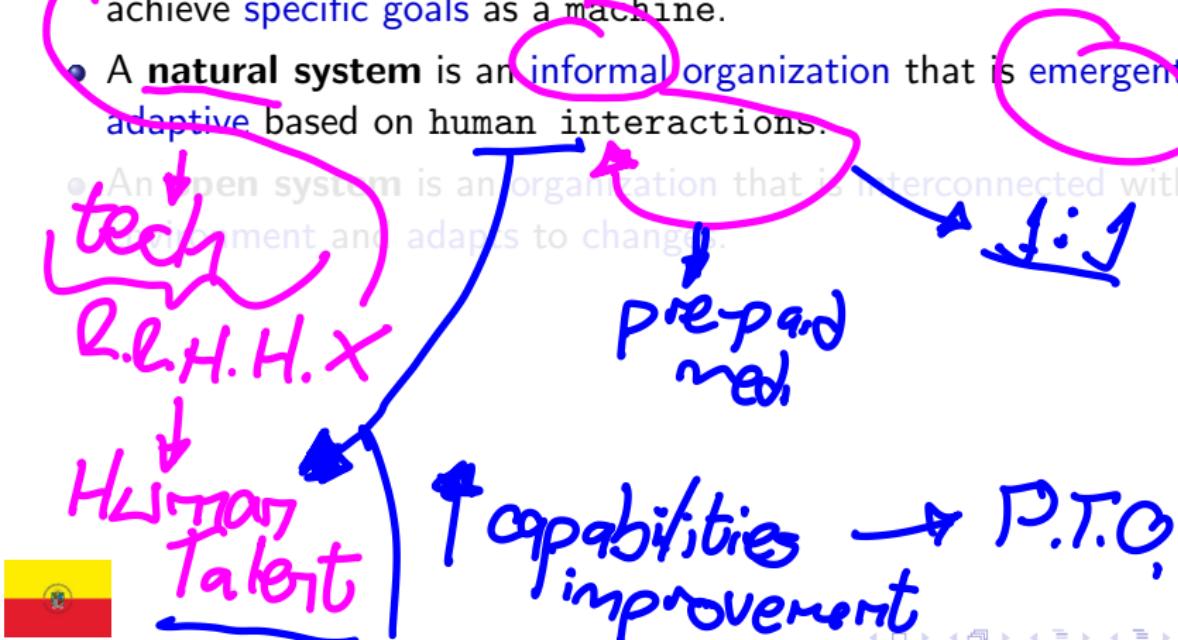
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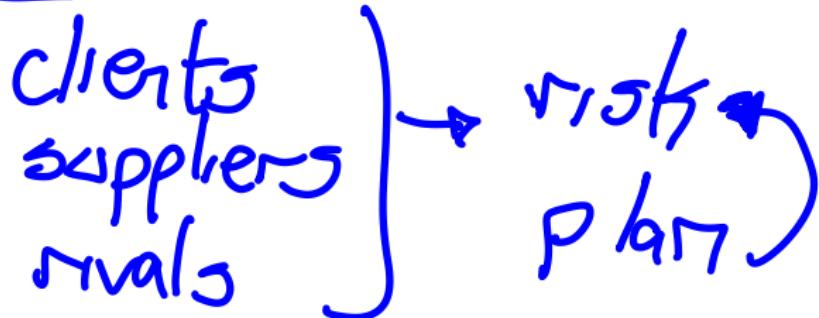
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Synergy

→ remote

• **Synergy** is a simple but powerful concept: the whole is greater than the sum of its parts.

team football

- 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.

time → simulation

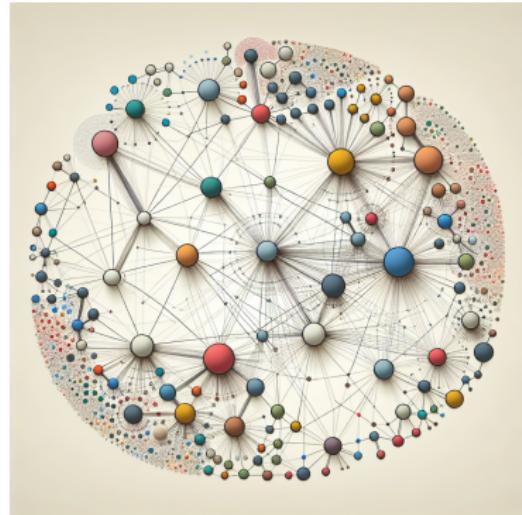


Figure: Prompt: Define a draw of clusters in social networks.



# Synergy

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- 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 machine.

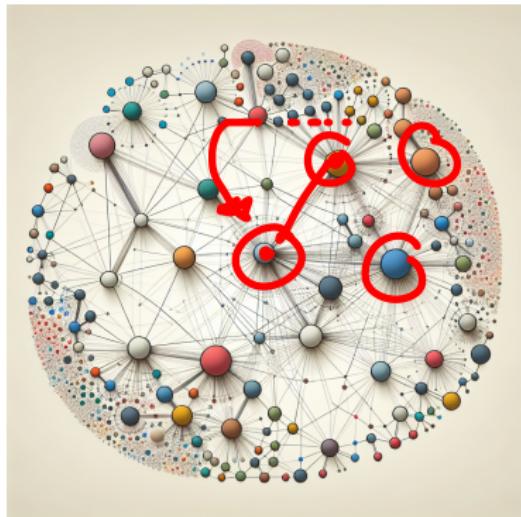
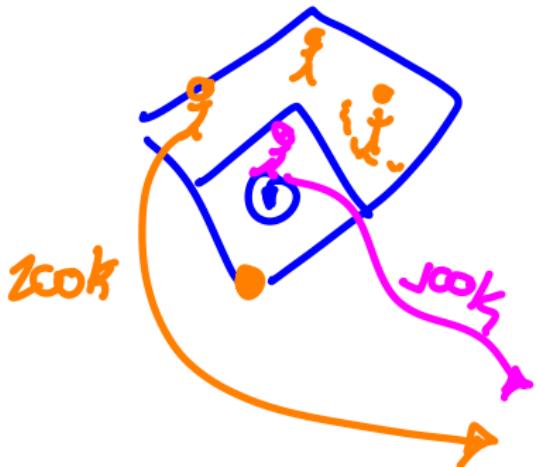


Figure: Prompt: Define a draw of clusters in social networks.

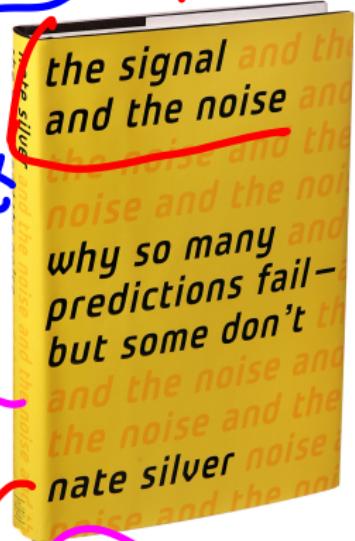


Synergy: Money Ball

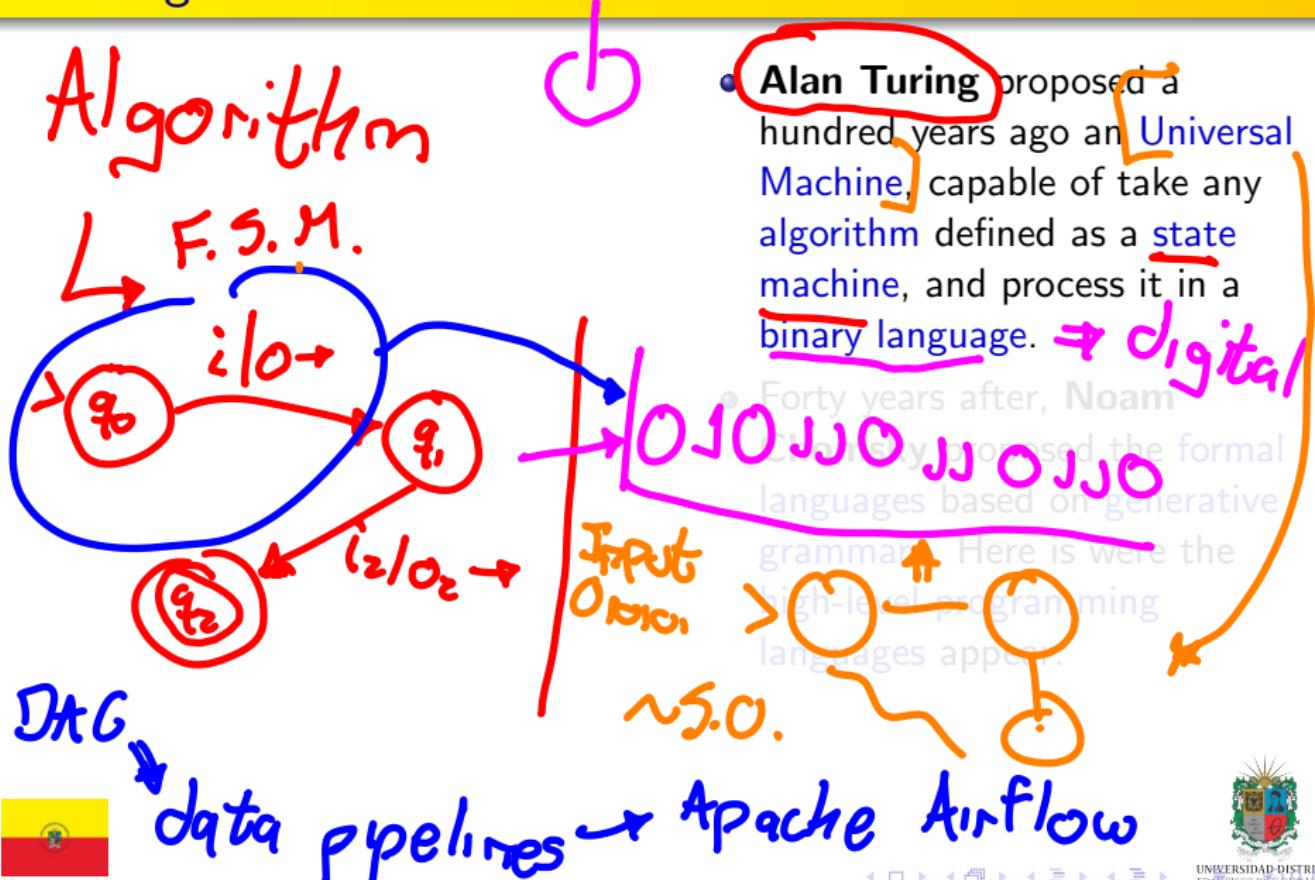
→ Brad Pitt / Jonah Hill  
Manager The Athletics



25-22



# Talking with Machines!



# Talking with Machines!

$$\Sigma = \{a, b, c\}$$

$$G = \left\{ \begin{array}{l} S \rightarrow aV_1 \\ V_1 \rightarrow bclV_2 \end{array} \right.$$



JVM

tree  
binary

CPL

- 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.

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

60's



# Programming Languages

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

Natural Language

Java: hungry? break class;  
Python:

break if hungry else class

Demo time!

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

- **JQL**  
- **Terraform (IAC)**



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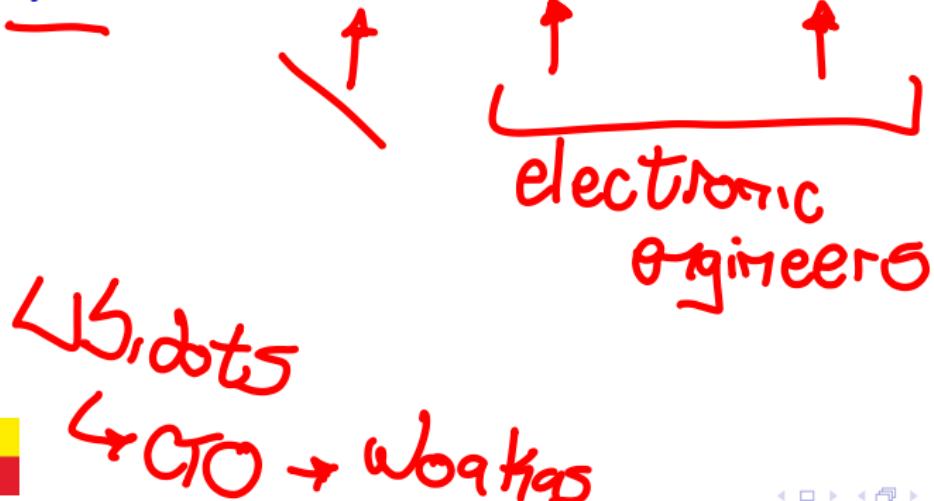
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# Applications of Systems Engineering

- **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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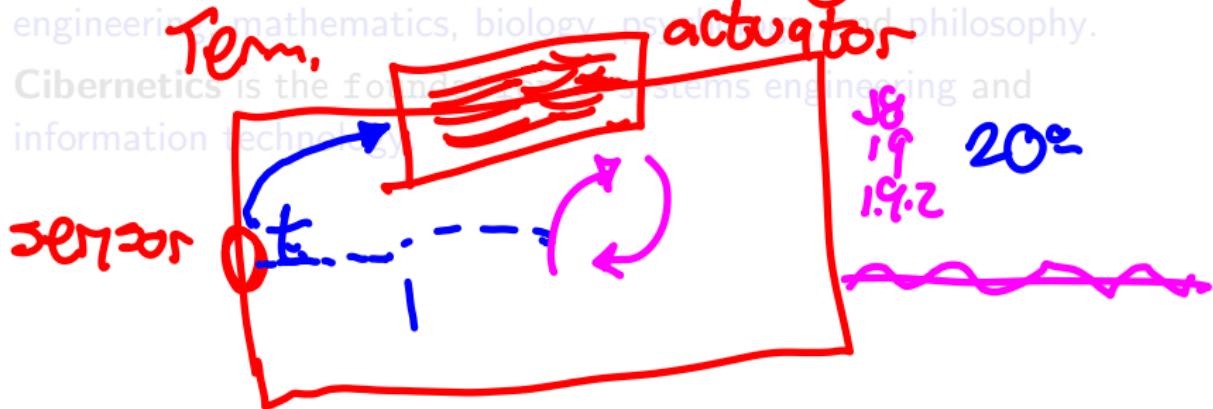


# Cibernetics

- Cibernetics is the study of systems, control, and communication in animals, machines, and organizations.

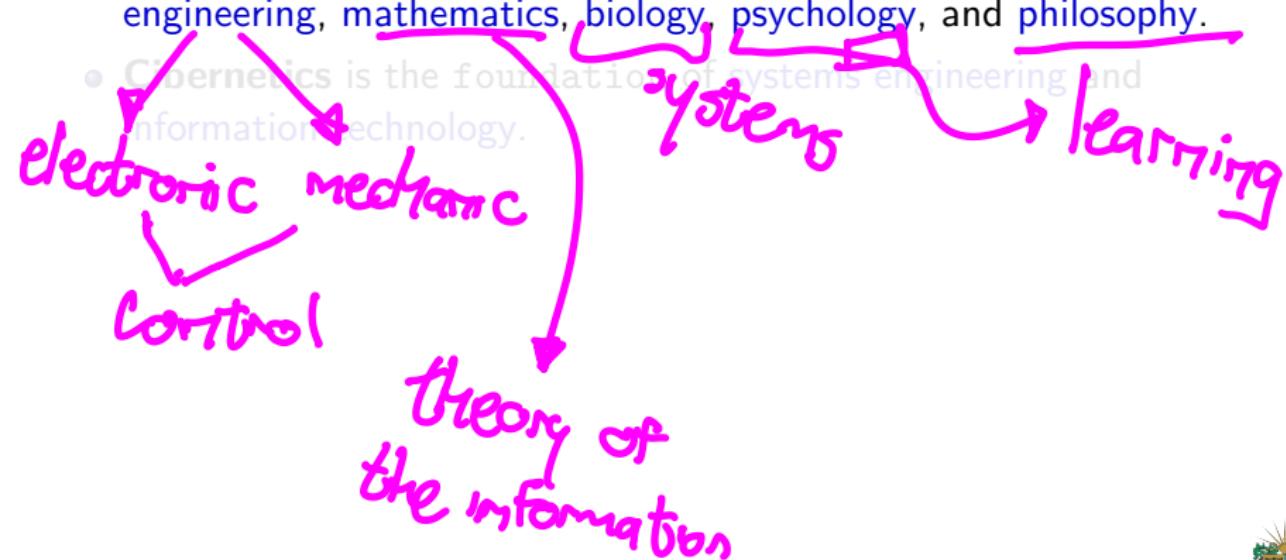
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- Cibernetics is the foundation of systems engineering and information technology.



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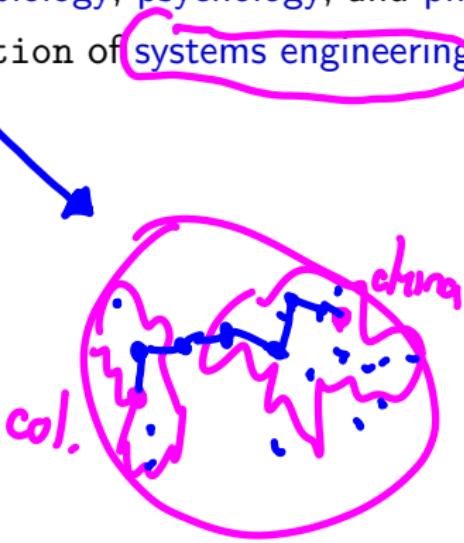
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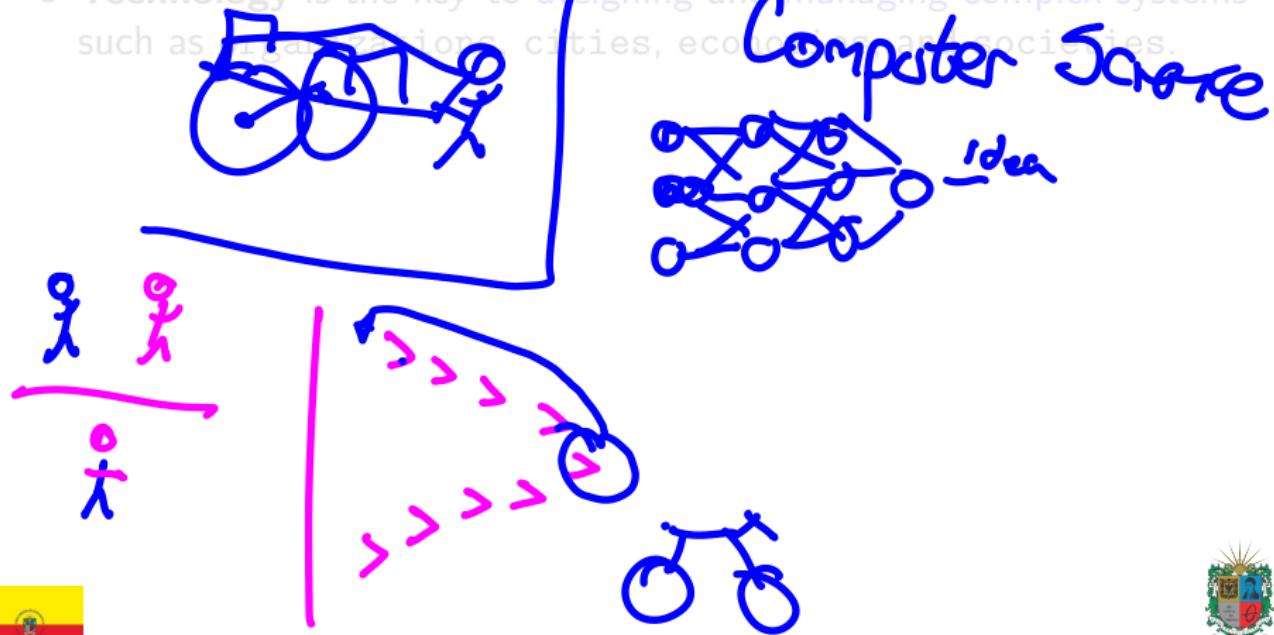
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networks



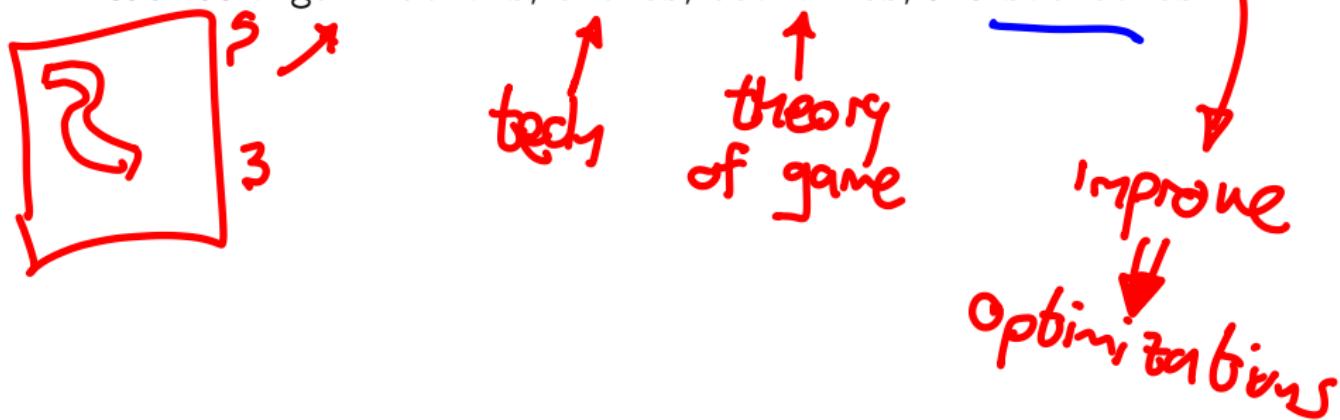
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## Technology

AI

1954

- 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.

A.I.M.A.

solve problems  
like a human



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~  
2016

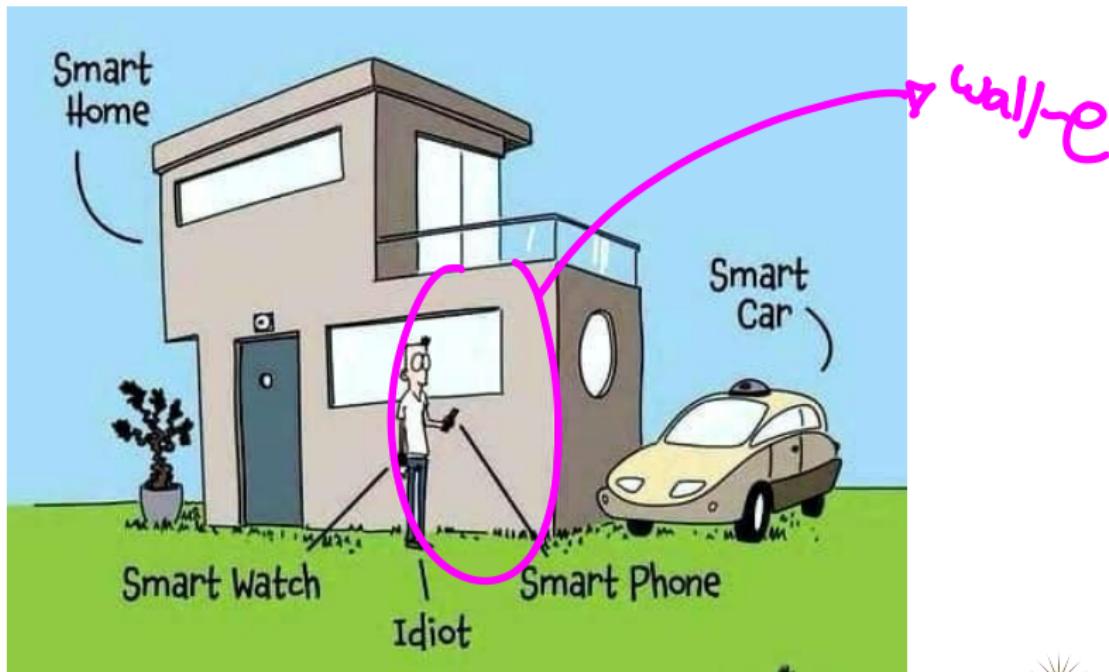
patterns  
recognition

information  
process  
speed

Chatbots → Khan Academy  
historical figures

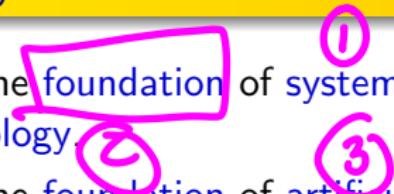


# Artificial Intelligence **not** as a System

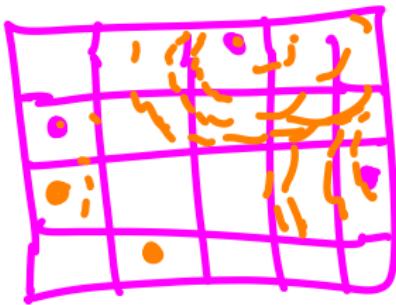


# Cibernetics & Technology in Systems Context

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



Sample



# Outline

## 1 Counting Sort → repeat

- 1 Basic Concepts

1 2 1 2 3 2 1 3 1 2 1 3 5 7

- 2 Human Activities

1 1 1 1 1 2 2 2 2 3 3 3 5 7

- 3 Cibernetics and Technology

$\overline{\overline{1}}$   $\overline{\overline{2}}$   $\overline{\overline{3}}$

0 1 2 3 4 5 6 7

- 4 Teams-Based Structure as a System



# 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.
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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**.
- **Teams** are like **pieces** in a **puzzle**, where each **piece** has a **specific role** and **responsibility**.



# Soft Skills

- **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.



# Computer Analyst

- **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.



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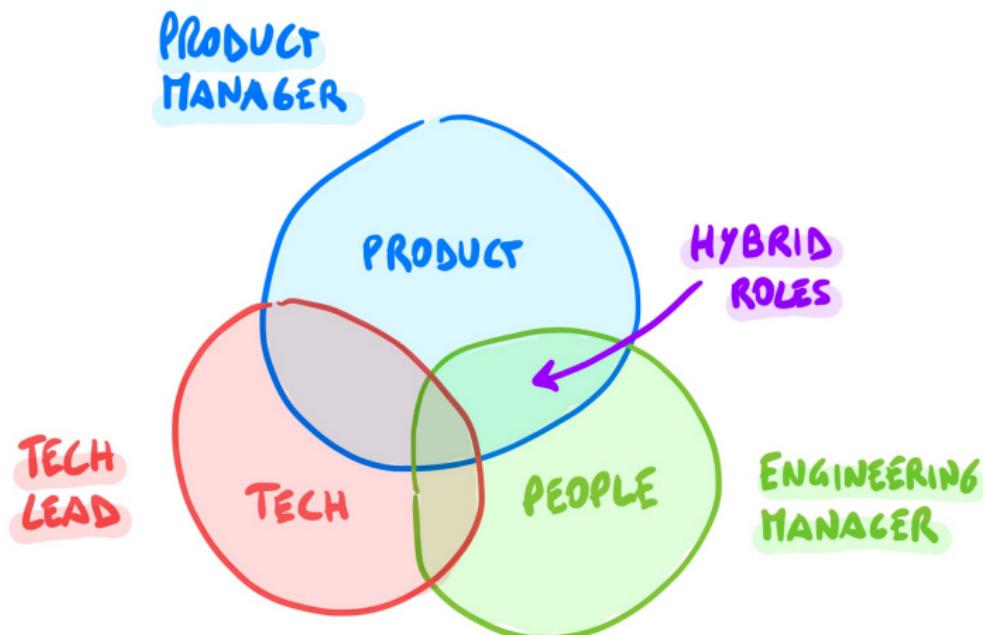
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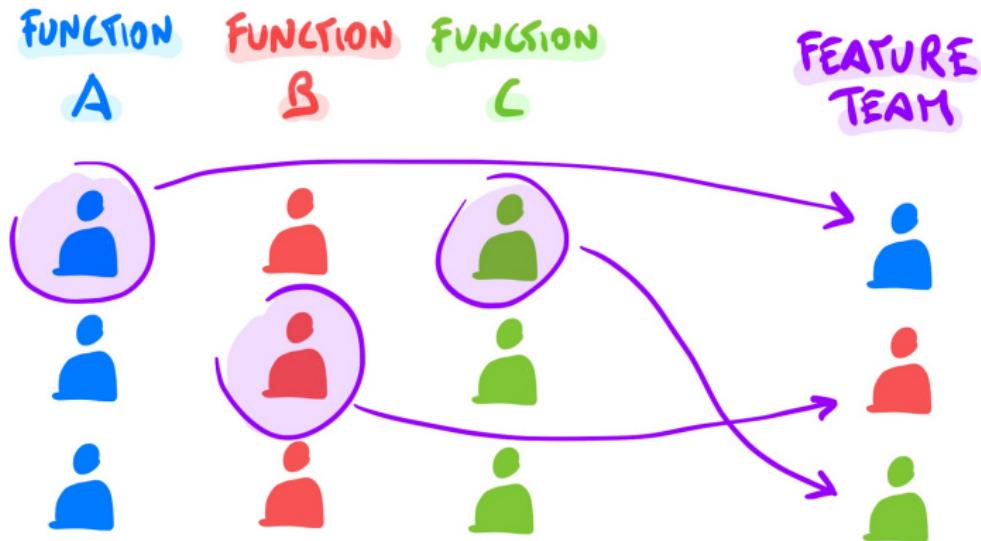
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# Tech Company Typical Structure



# Feature Teams



# 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.



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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**.
- 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.
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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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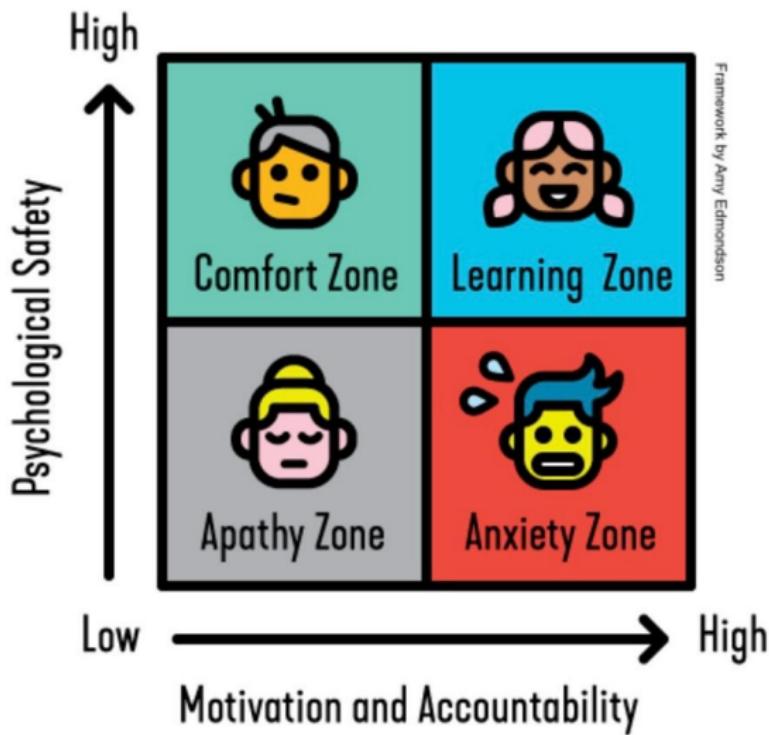


# What is to be a leader? III

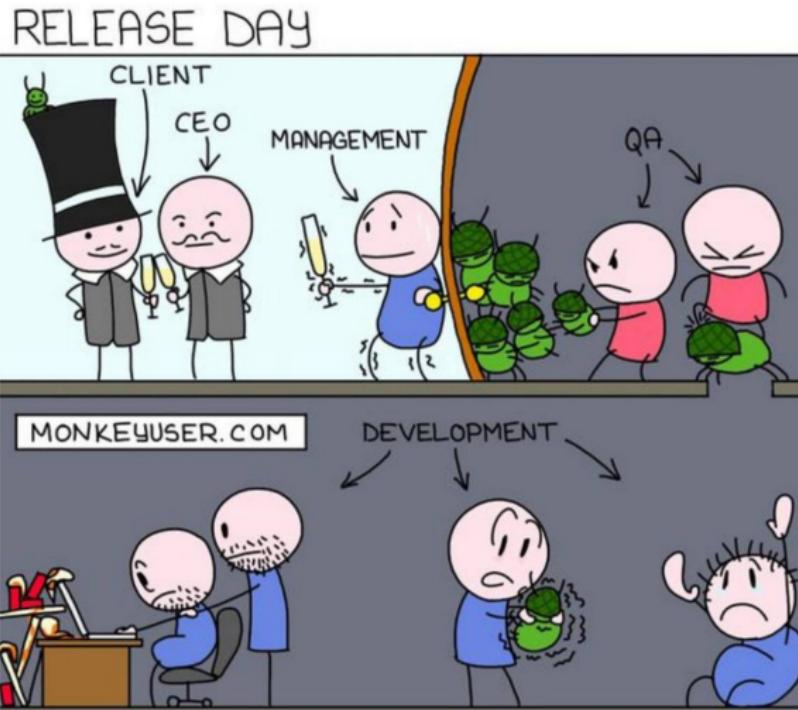
- It is important to maintain **psychological well-being**. You will be **stronger**, better able to **help** people, and have a better **perspective** on everything.
- A **good leader** builds **trusting relationships** and has the **emotional intelligence** to communicate effectively and understand 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>

