

SYSTEMS ENGINEERING

Systems Analysis & Design

Author: Eng. Carlos Andrés Sierra, M.Sc.
cavirguezs@udistrital.edu.co

Full-time Adjunct Professor
Computer Engineering Program
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



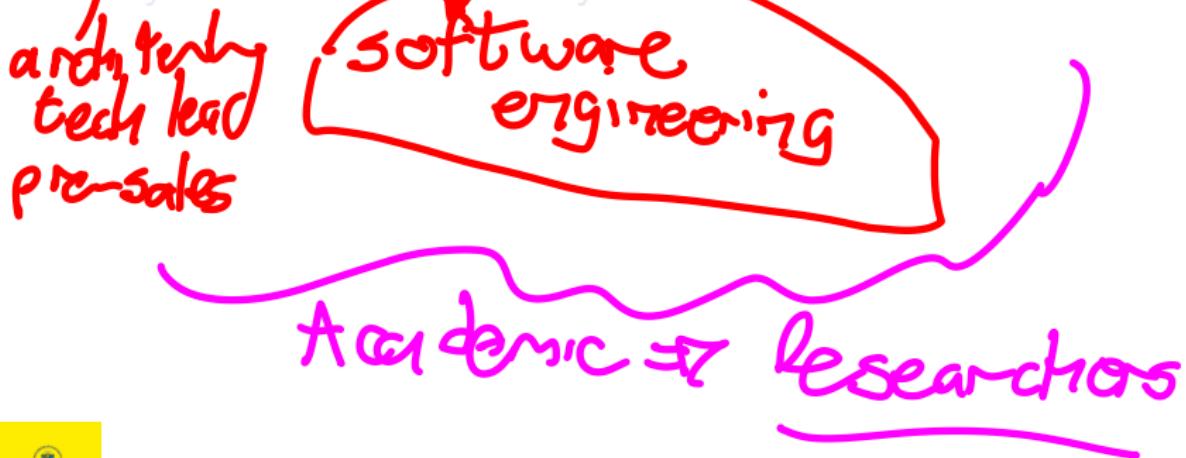
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Systems Engineer as a Professional

- 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

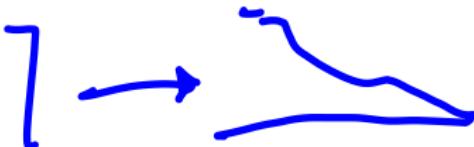
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electric
systems

no applied

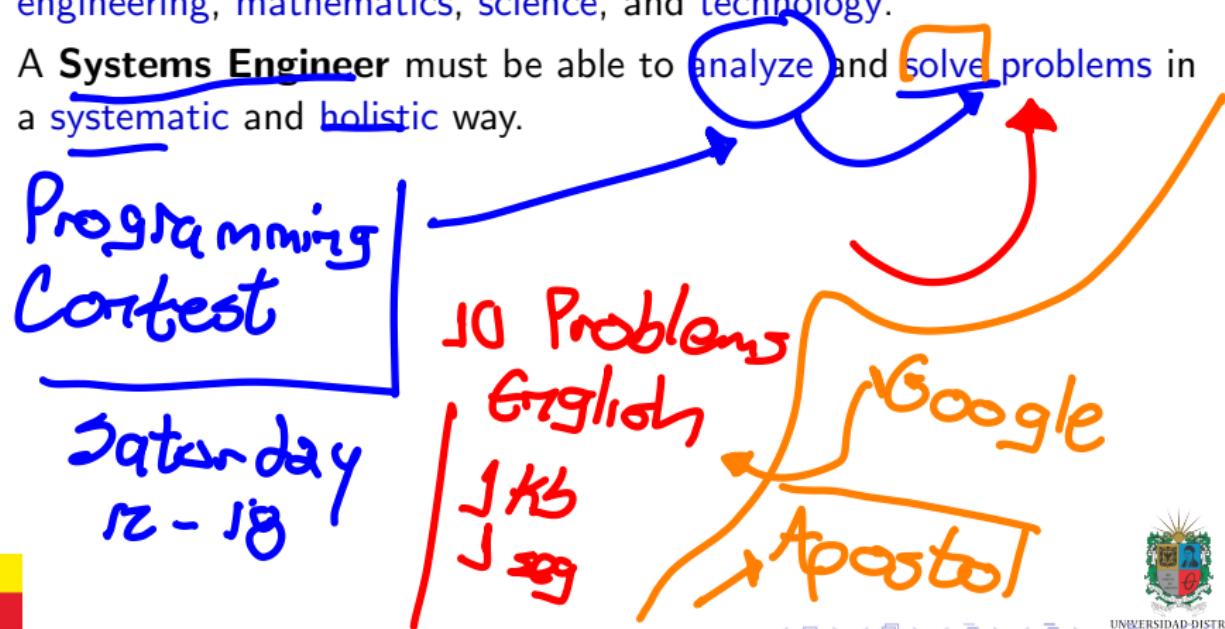
mechanic
system

Patients
Human AI
P.M



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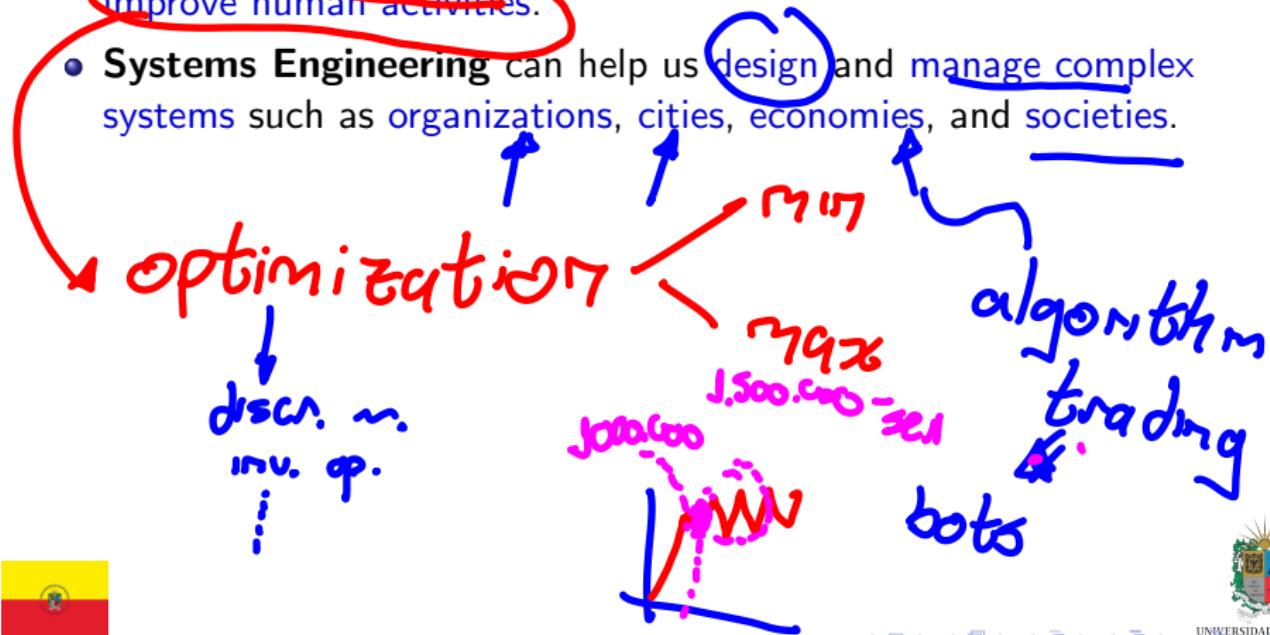
Human Activities

- **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.



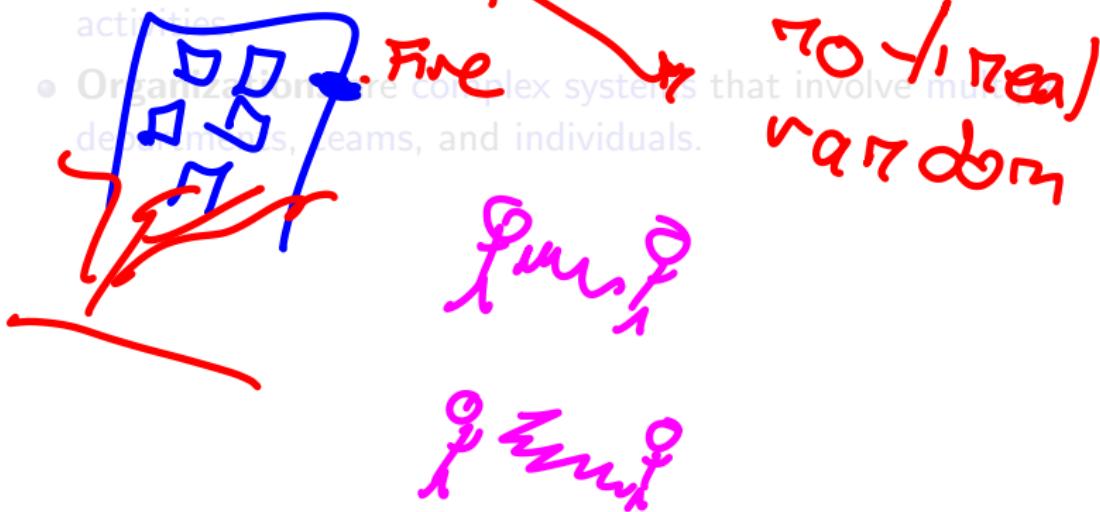
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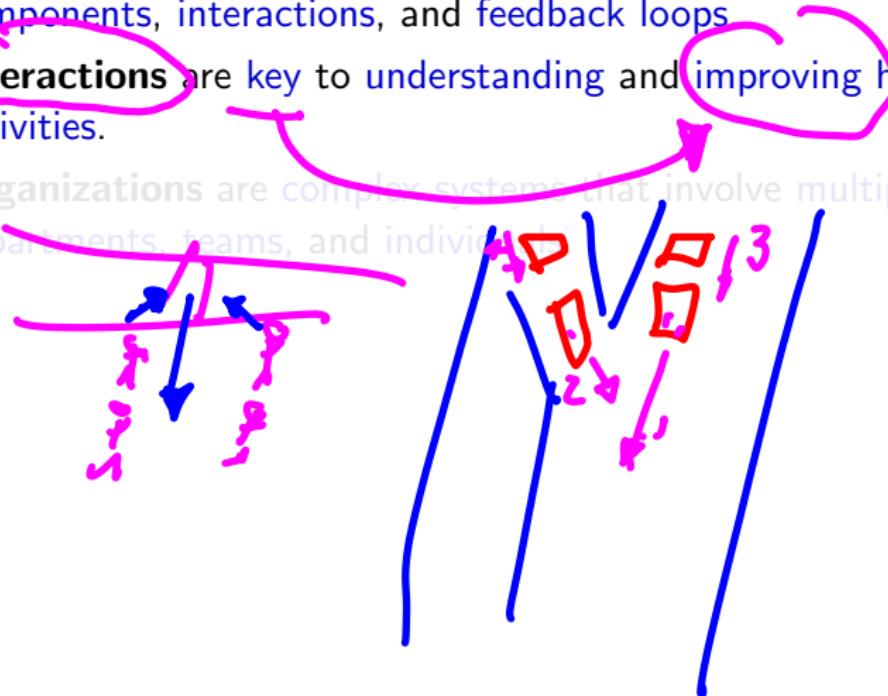
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- Interactions are the understanding and improving human activities.
- Organizations are complex systems that involve multiple departments, teams, and individuals.



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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.



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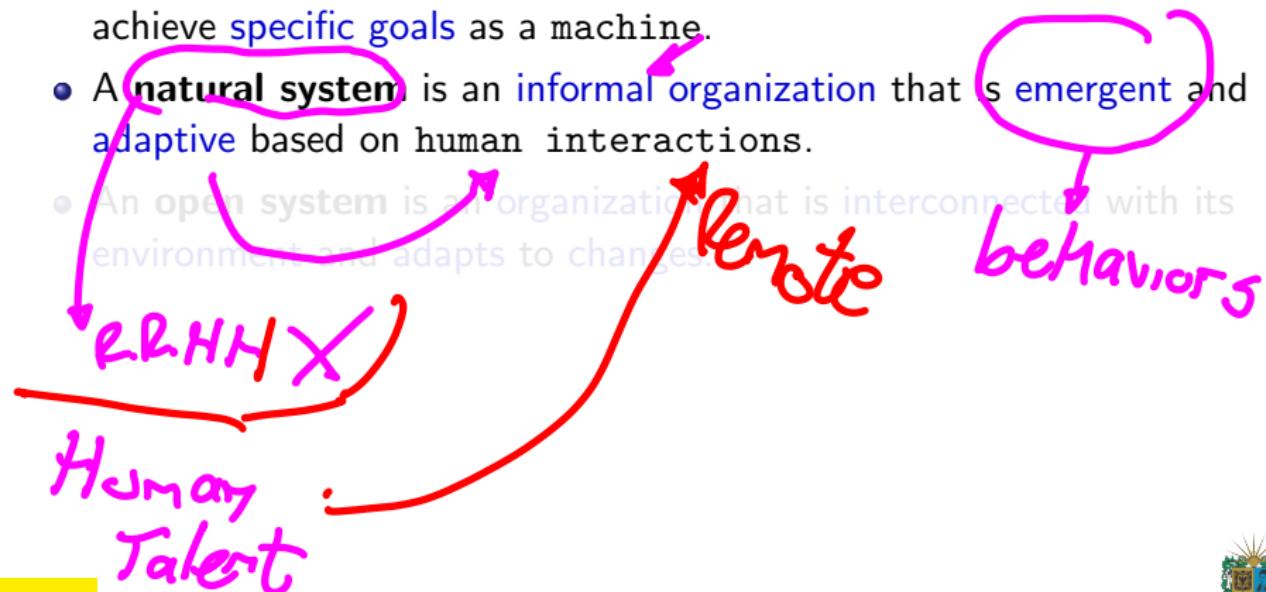
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MISIÓN
VISIÓN
GOALS



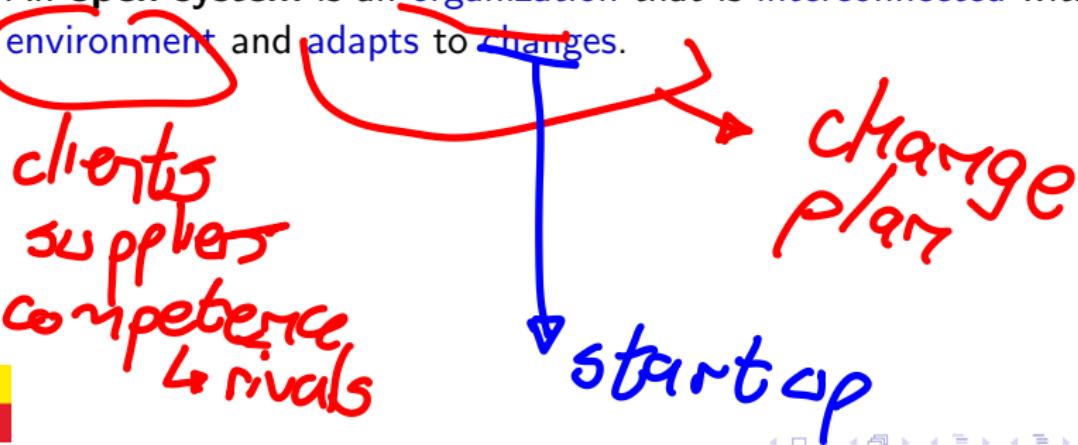
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Synergy

- **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**

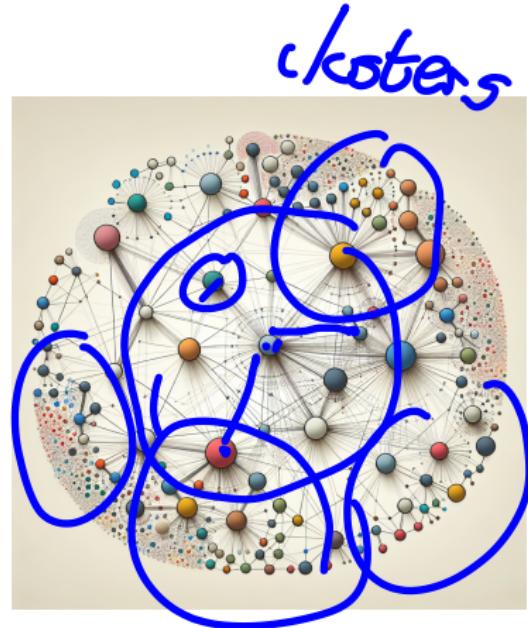


Figure: Prompt: Define a draw of clusters in social networks.

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

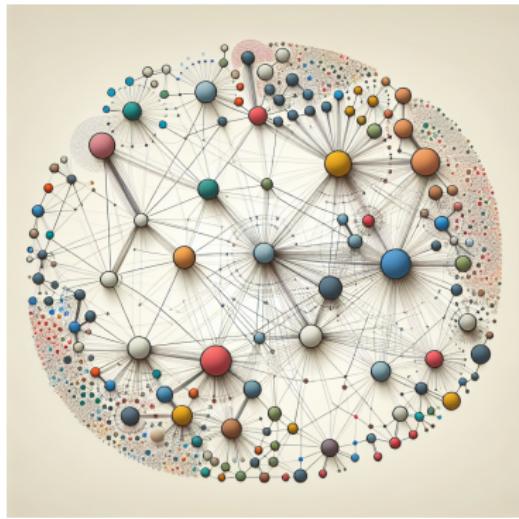


Figure: Prompt: Define a draw of clusters in social networks.

Alan Turing

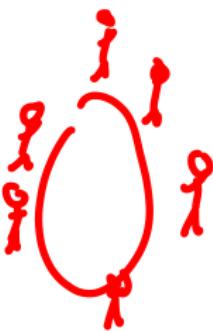


Synergy: Money Ball → Baseball

Manager



Brat Pitt



economist

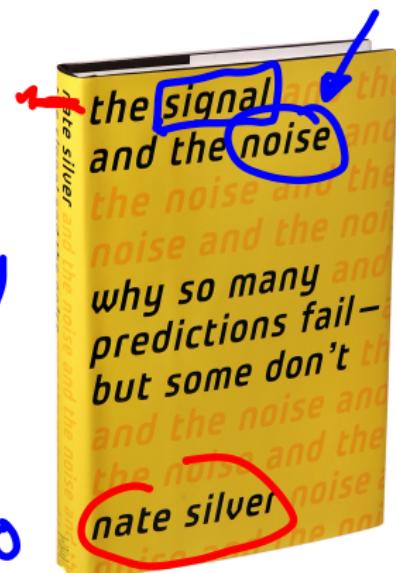
Market

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**

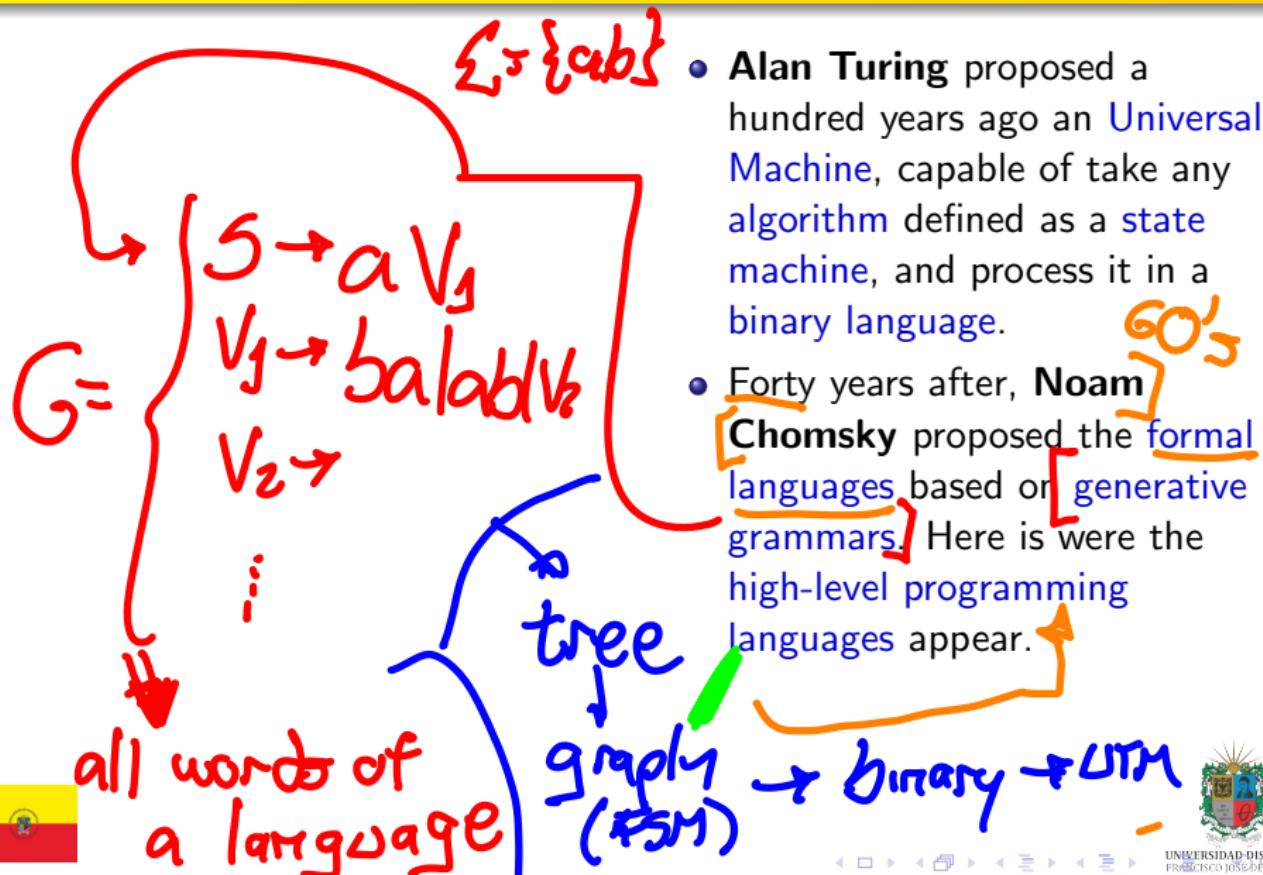
Forty years after, Noam Chomsky proposed the formal languages based on generative grammars. Here is where the high-level programming languages appear.



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)

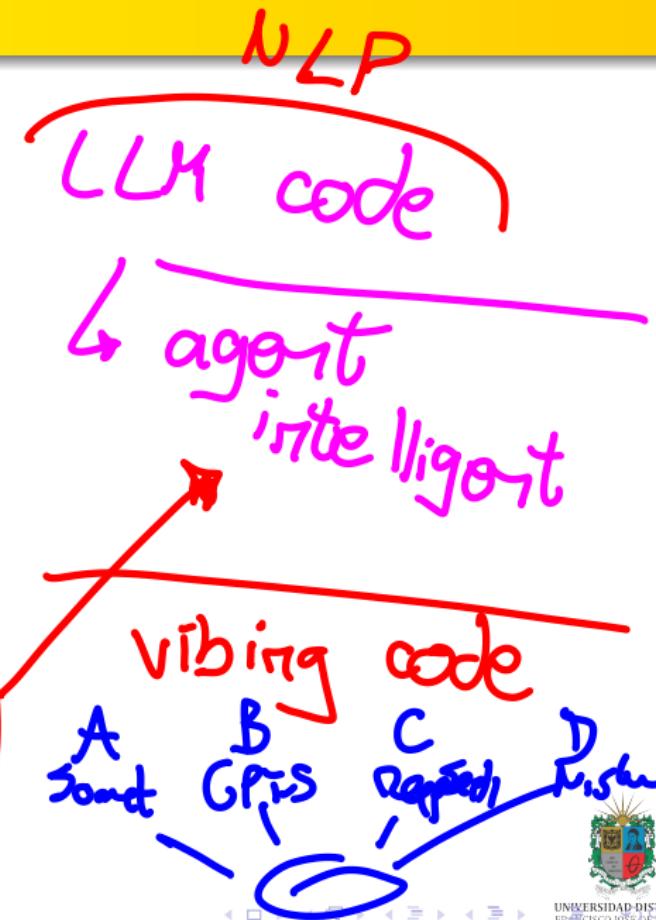


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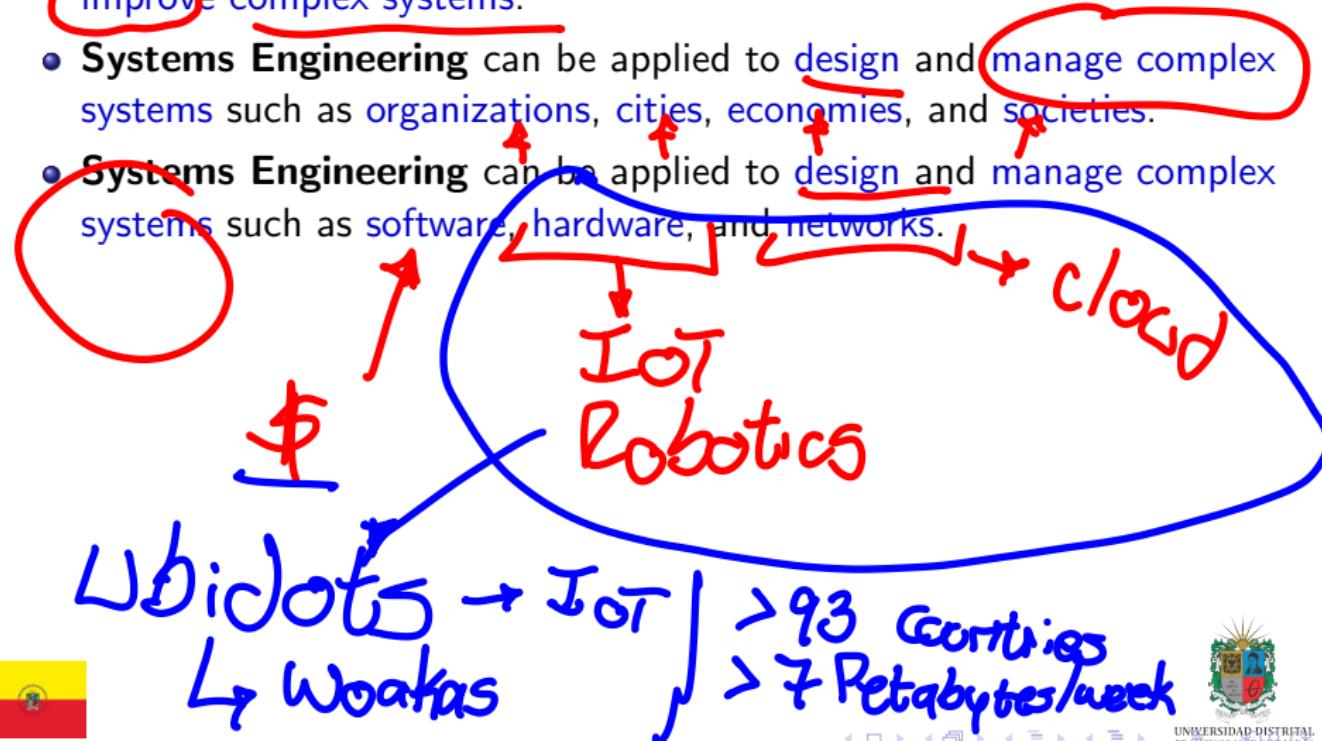
Demo time!

- 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.

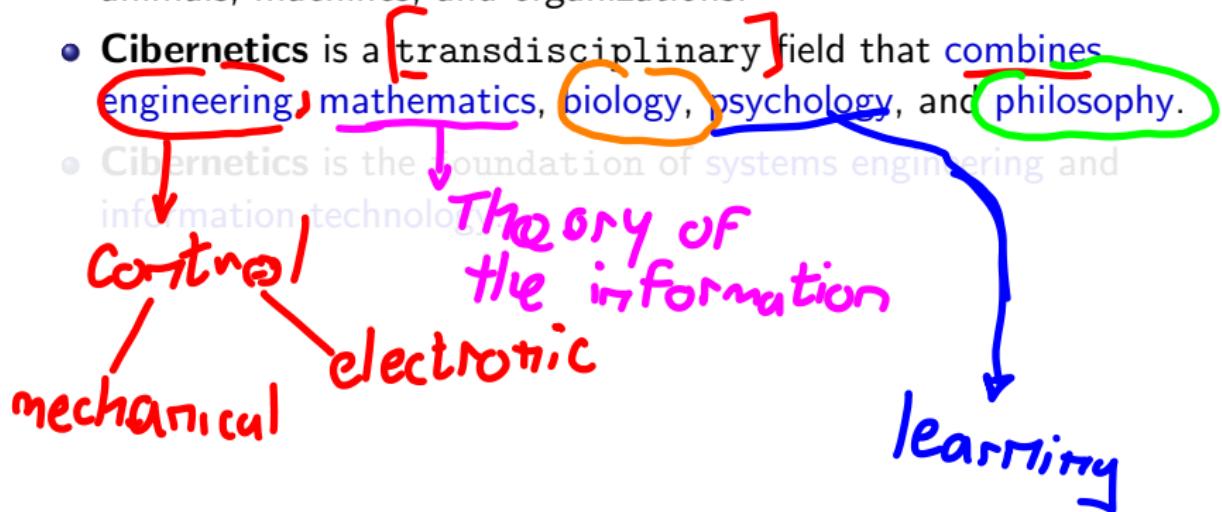
environment

auto-regulation



Cibernetics

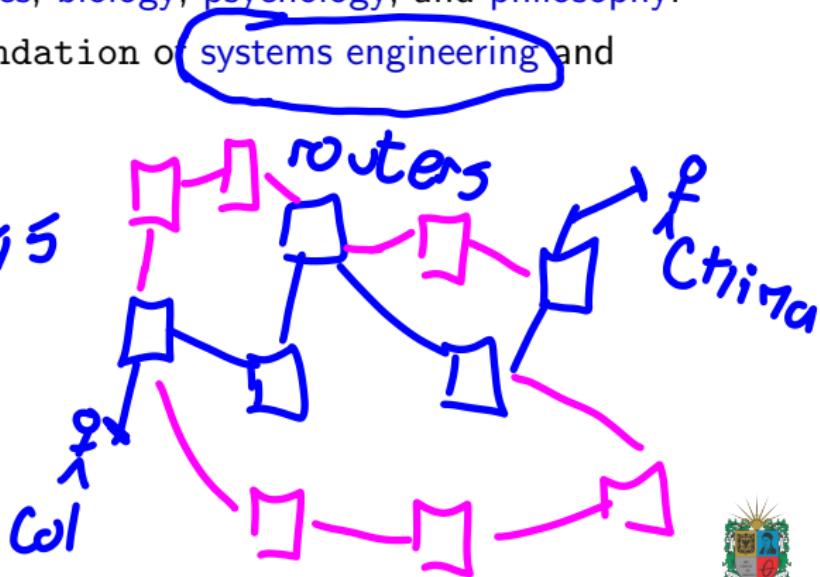
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networks



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.



100
WWI



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

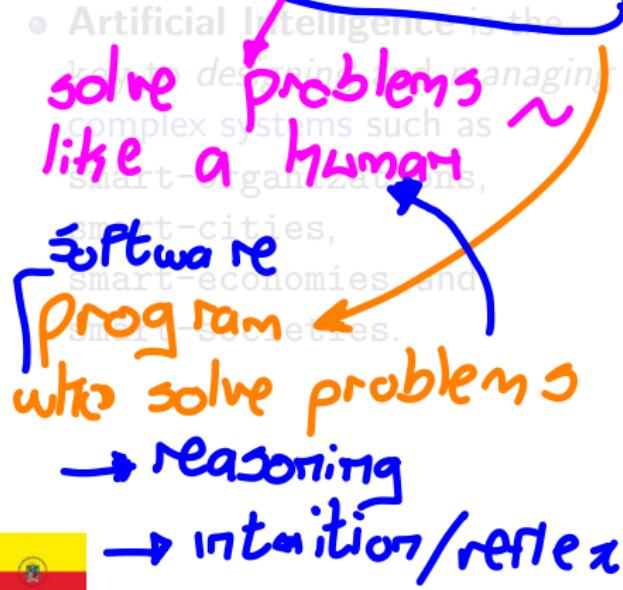
comp.
science

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

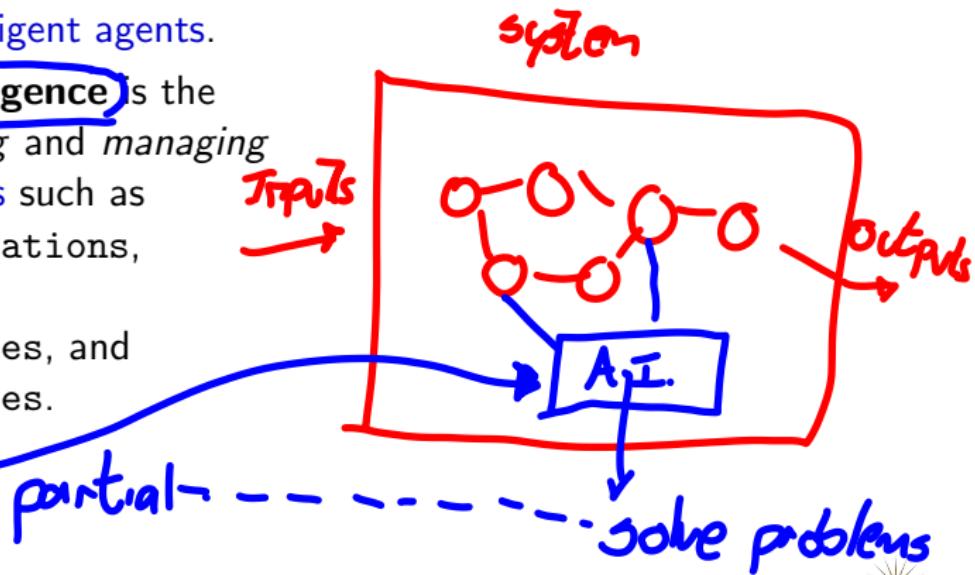
→ learning



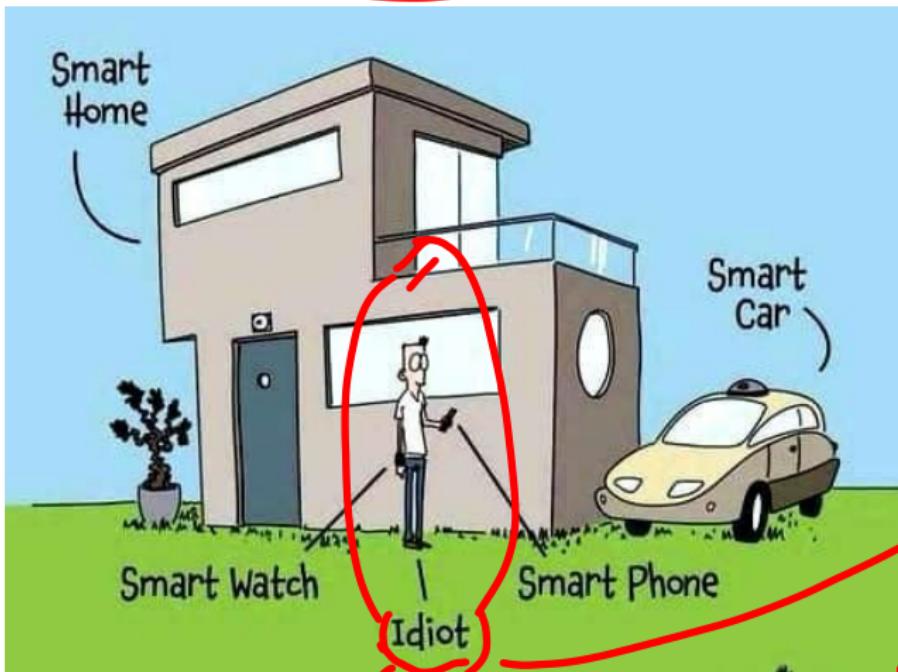
Technology: AI

- **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



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.



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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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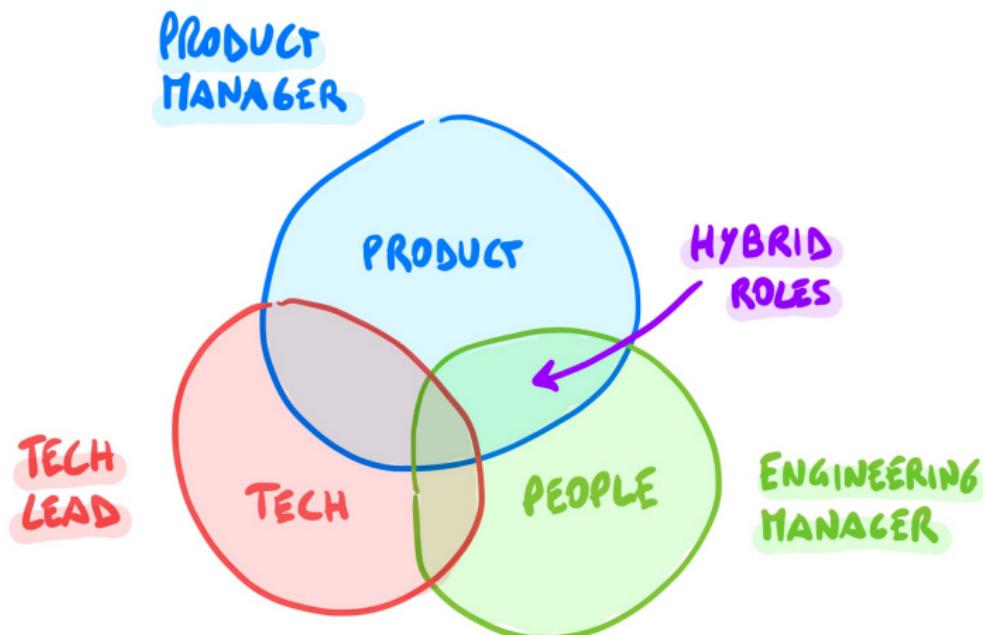
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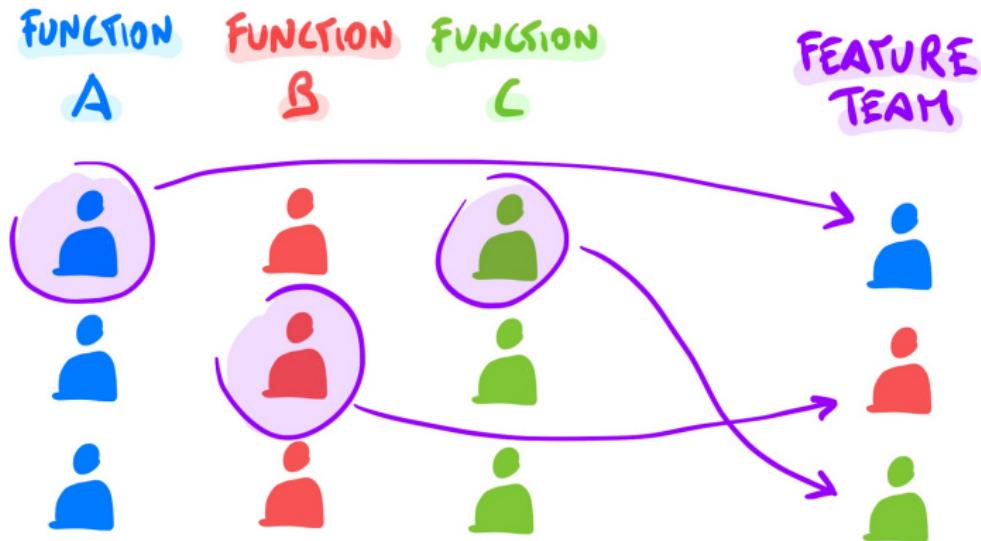
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Tech Company Typical Structure



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.
- Making **ethical decisions** is key; it leads to taking the right and better actions.



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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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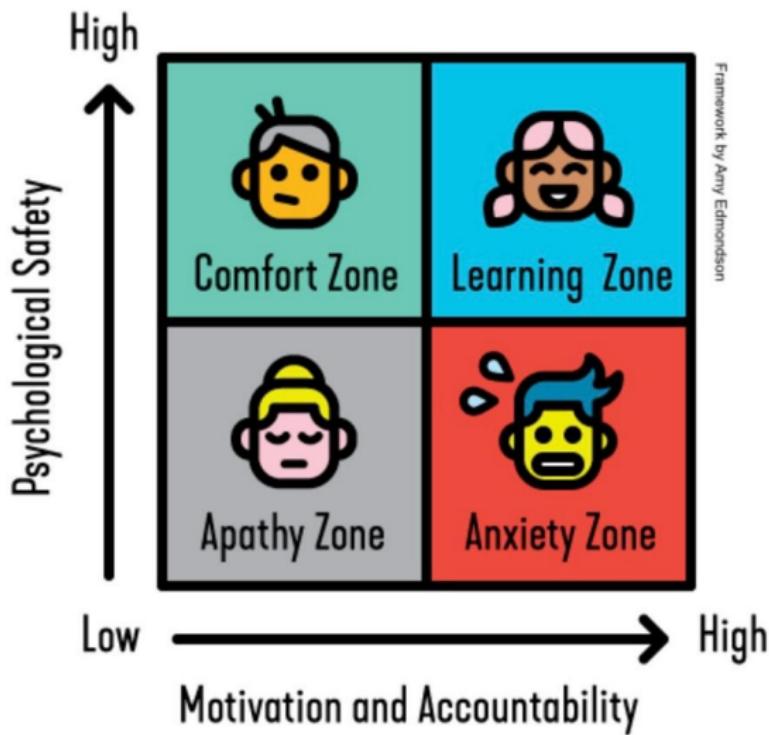


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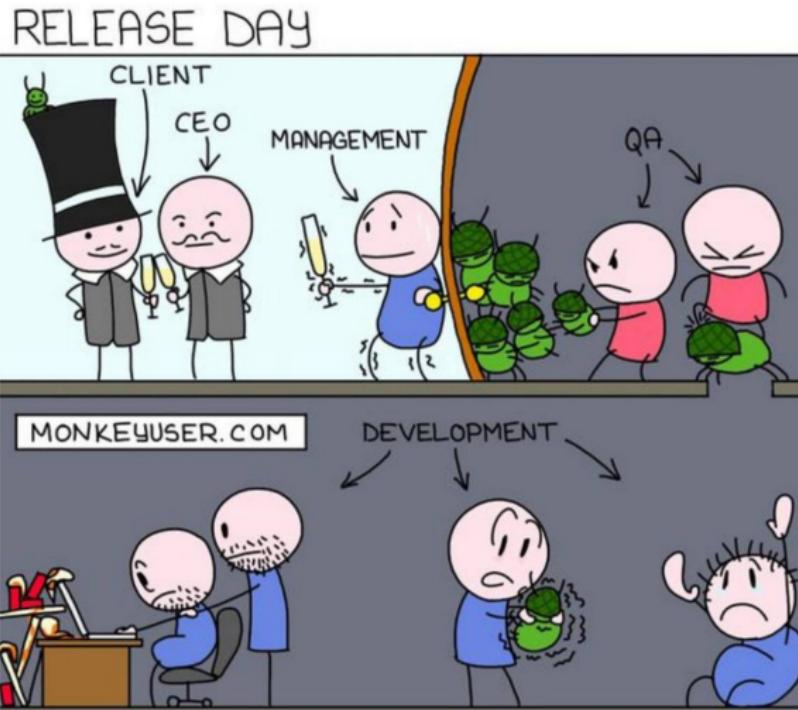
Working Zones



Framework by Amy Edmondson



Real World!



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Thanks!

Questions?



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

