

INTRODUCTION TO SYSTEMS SCIENCES

Systems Sciences Foundations

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

Lecturer
Computer Engineering
School of Engineering
Universidad Distrital Francisco José de Caldas

2025-I



Outline

1 Definitions

2 The History

3 Artificial Intelligence

4 Cybernetics

5 Application Fields



Outline

1 Definitions

2 The History

3 Artificial Intelligence

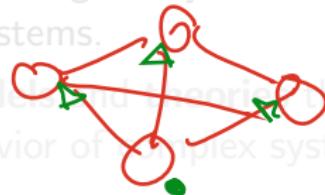
4 Cybernetics

5 Application Fields

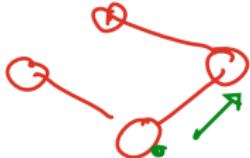


Systems Sciences

- Systems Sciences is an interdisciplinary field that studies the nature of **complex systems** in nature, society, and science.
 - Systems Sciences uses a holistic approach to study the interactions and interdependencies between the parts of a system.
 - Systems Sciences is used to study a wide range of systems, including biological, social, and technological systems.
 - Systems Sciences is used to develop models and theories that can be used to understand and predict the behavior of complex systems.
- * Interactions*
- * Flows*



Traffic



Systems Sciences

- Systems Sciences is an interdisciplinary field that studies the nature of **complex systems** in nature, society, and science.
- Systems Sciences uses a **holistic approach** to study the **interactions** and **interdependencies** between the parts of a system.
- Systems Sciences is used to study a wide range of systems, including biological, social, and technological systems.
- Systems Sciences is used to develop models and theories that can be used to understand and predict the behavior of complex systems.

holistic
→ *synergy*
↓
interdependencies
→ *emergent*



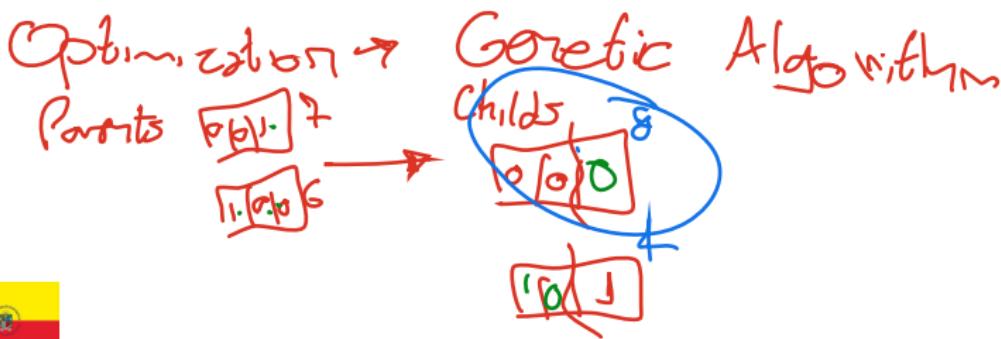
Systems Sciences

- Systems Sciences is an interdisciplinary field that studies the nature of **complex systems** in nature, society, and science.
- Systems Sciences uses a **holistic** approach to study the **interactions** and **interdependencies** between the parts of a system.
- Systems Sciences is used to study a wide range of systems, including **biological**, **social**, and **technological** systems.
- Systems Sciences is used to develop **models** and **theories** that can be used to understand and predict the behavior of complex systems.



Systems Sciences

- Systems Sciences is an interdisciplinary field that studies the nature of **complex systems** in nature, society, and science.
- Systems Sciences uses a **holistic** approach to study the **interactions** and **interdependencies** between the parts of a system.
- Systems Sciences is used to study a wide range of systems, including **biological**, **social**, and **technological** systems.
- **Systems Sciences** is used to develop **models** and **theories** that can be used to understand and predict the behavior of complex systems.



Systems Thinking

- Systems Thinking is a way of thinking that focuses on the interrelationships between the parts of a system.
- Systems Thinking is based on the idea that the **whole** is greater than the sum of its parts.
- Systems Thinking is used to study the interactions and interdependencies between the parts of a system.
- Systems Thinking is used to develop models and theories that can be used to understand and predict the behavior of complex systems.



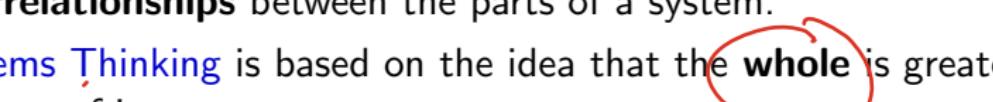
Systems Thinking

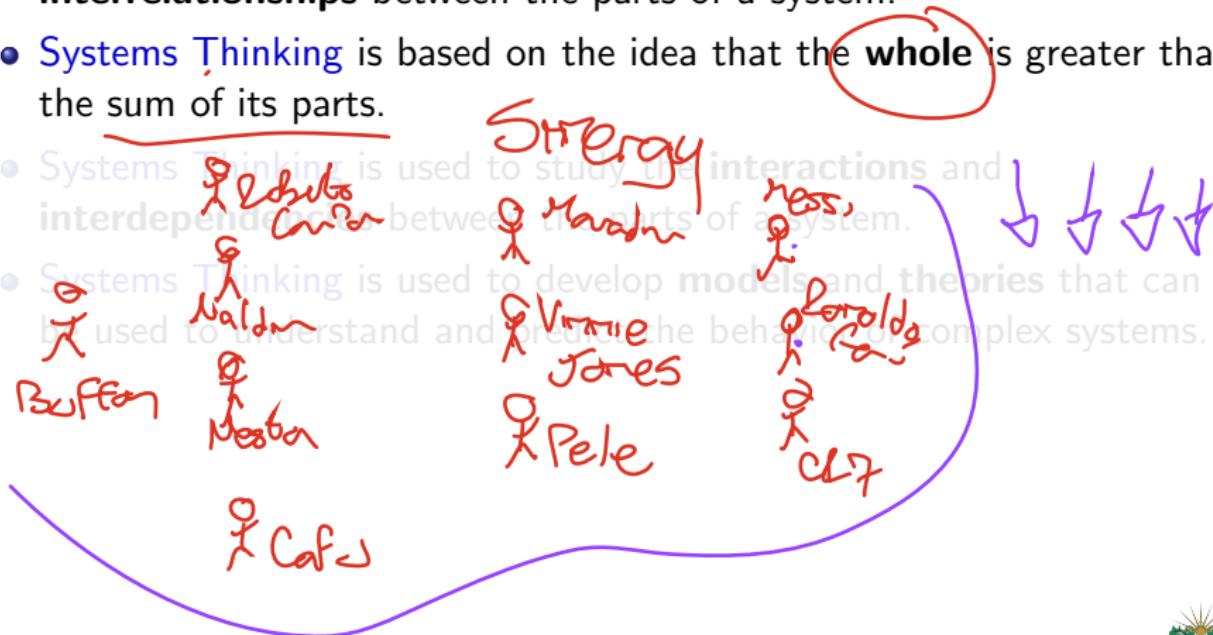
- Systems Thinking is a way of thinking that focuses on the interrelationships between the parts of a system.
 - Systems Thinking is based on the idea that the **whole** is greater than the sum of its parts.
 - Systems Thinking is used to study the interactions and interdependence between the parts of a system.
 - Systems Thinking is used to develop models and theories that can be used to understand and predict the behavior of complex systems.

Strategy
Globally
Local
Context

Marshall
ness,
in.

Vonne
oroldo
g





Systems Thinking

- Systems Thinking is a way of thinking that focuses on the **interrelationships** between the parts of a system.
 - Systems Thinking is based on the idea that the **whole** is greater than the sum of its parts.
 - Systems Thinking is used to study the **interactions** and **interdependencies** between the parts of a system.
 - Systems Thinking is used to develop **models** and **theories** that can help us understand and predict the behavior of complex systems.

Dr. House



Systems Thinking

- Systems Thinking is a way of thinking that focuses on the **interrelationships** between the parts of a system.
- Systems Thinking is based on the idea that the **whole** is greater than the sum of its parts.
- Systems Thinking is used to study the **interactions** and **interdependencies** between the parts of a system.
- Systems Thinking is used to develop **models** and **theories** that can be used to understand and predict the behavior of complex systems.

Systems
Thinking → Systems
Sciences



Systems Engineering

- Systems Engineering is an interdisciplinary field that focuses on the design and management of complex systems.
- Systems Engineering is used in a wide range of fields, including biology, engineering, and management.

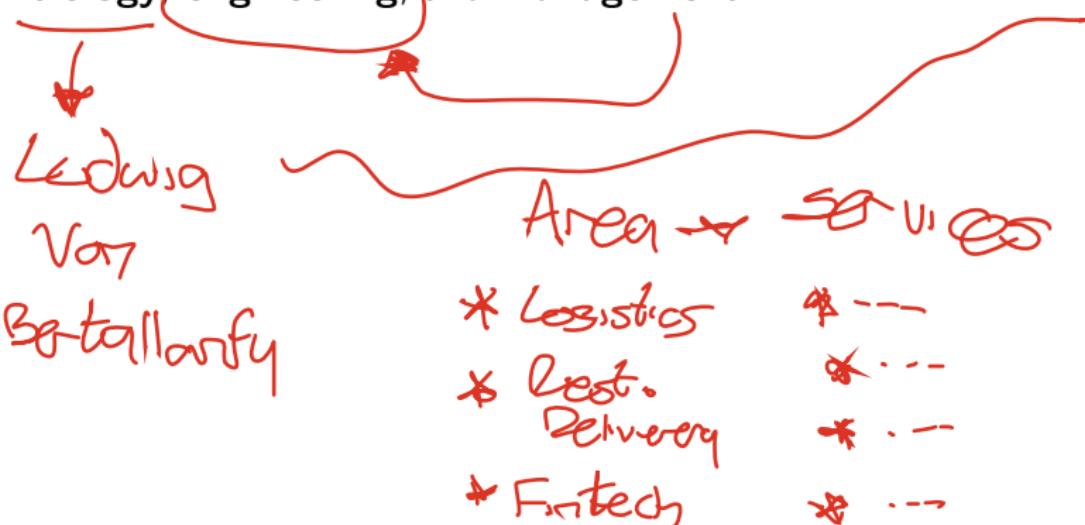
10 careers

resources
information
changes



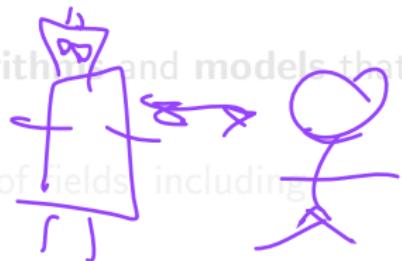
Systems Engineering

- Systems Engineering is an interdisciplinary field that focuses on the design and management of complex systems.
- Systems Engineering is used in a wide range of fields, including **biology**, **engineering**, and **management**.



Artificial Intelligence

- Artificial Intelligence (AI) is a branch of computer science that focuses on the development of intelligent machines.
- Artificial Intelligence is based on the idea that machines can be taught to think like humans.
- Artificial Intelligence is used to develop algorithms and models that can be used to solve complex problems.
- Artificial Intelligence is used in a wide range of fields, including robotics, healthcare, and finance.
- Artificial Intelligence is used to develop intelligent systems that can perform tasks that require human-like intelligence.



Artificial Intelligence

- Artificial Intelligence (AI) is a branch of computer science that focuses on the development of **intelligent machines**.
- Artificial Intelligence is based on the idea that machines can be **taught** to think and act like humans.
- Artificial Intelligence is used to develop **algorithms** and **models** that can be used to solve complex problems.
- Artificial Intelligence is used in a wide range of fields, including **robotics**, **healthcare**, and **finance**.
- Artificial Intelligence is used to develop **intelligent systems** that can perform tasks that require human-like intelligence.



Artificial Intelligence

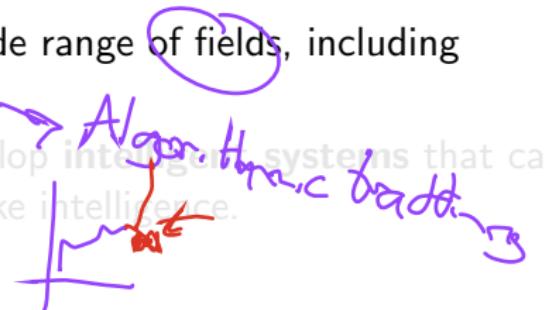
- Artificial Intelligence (AI) is a branch of computer science that focuses on the development of **intelligent machines**.
- Artificial Intelligence is based on the idea that machines can be **taught** to think and act like humans.
- Artificial Intelligence is used to develop **algorithms** and **models** that can be used to solve **complex problems**.
- Artificial Intelligence is used in a wide range of fields, including **robotics**, **healthcare**, and **finance**.
- Artificial Intelligence is used to develop **intelligent systems** that can perform tasks that require human-like intelligence.



Artificial Intelligence

- Artificial Intelligence (AI) is a branch of computer science that focuses on the development of **intelligent machines**.
- Artificial Intelligence is based on the idea that machines can be **taught** to think and act like humans.
- Artificial Intelligence is used to develop **algorithms** and **models** that can be used to solve complex problems.
- Artificial Intelligence is used in a wide range of fields, including **robotics**, **healthcare**, and **finance**.
- Artificial Intelligence is used to develop intelligent systems that can perform tasks that require human-like intelligence.

Computer vs.
Organistic
machines



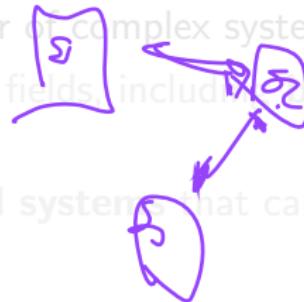
Artificial Intelligence

- Artificial Intelligence (AI) is a branch of computer science that focuses on the development of **intelligent machines**.
- Artificial Intelligence is based on the idea that machines can be **taught** to think and act like humans.
- Artificial Intelligence is used to develop **algorithms** and **models** that can be used to solve complex problems.
- Artificial Intelligence is used in a wide range of fields, including **robotics**, **healthcare**, and **finance**.
- Artificial Intelligence is used to develop **intelligent systems** that can perform tasks that require human-like intelligence.



Cybernetics

- Cybernetics is an interdisciplinary field that studies the **control** and **communication** in living organisms and machines.
- Cybernetics is based on the idea that systems can be controlled and regulated using feedback mechanisms.
- Cybernetics is used to develop **models** and **theories** that can be used to understand and predict the behavior of complex systems.
- Cybernetics is used in a wide range of fields including **biology**, **engineering**, and **management**.
- Cybernetics is used to develop **control systems** that can regulate the behavior of complex systems.



Cybernetics

- Cybernetics is an interdisciplinary field that studies the **control** and **communication** in living organisms and machines.
- Cybernetics is based on the idea that systems can be **controlled** and **regulated** using feedback mechanisms.
- Cybernetics is used to develop models and theories that can be used to understand and predict the behavior of complex systems.
- Cybernetics is used in a wide range of fields, including **biology**, **engineering**, and **management**.
- Cybernetics is used to develop control systems that can regulate the behavior of complex systems.



Cybernetics

- Cybernetics is an interdisciplinary field that studies the **control** and **communication** in living organisms and machines.
- Cybernetics is based on the idea that systems can be **controlled** and **regulated** using feedback mechanisms.
- Cybernetics is used to develop **models** and **theories** that can be used to understand and predict the behavior of complex systems.
- Cybernetics is used in a wide range of fields, including biology, engineering, and management.
- Cybernetics is used to develop **control systems** that can regulate the behavior of complex systems.



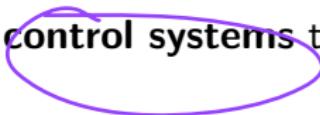
Cybernetics

- Cybernetics is an interdisciplinary field that studies the **control** and **communication** in living organisms and machines.
- Cybernetics is based on the idea that systems can be **controlled** and **regulated** using feedback mechanisms.
- Cybernetics is used to develop **models** and **theories** that can be used to understand and predict the behavior of complex systems.
- Cybernetics is used in a wide range of fields, including **biology**, **engineering**, and **management**.
- Cybernetics is used to develop **control systems** that can regulate the behavior of complex systems.

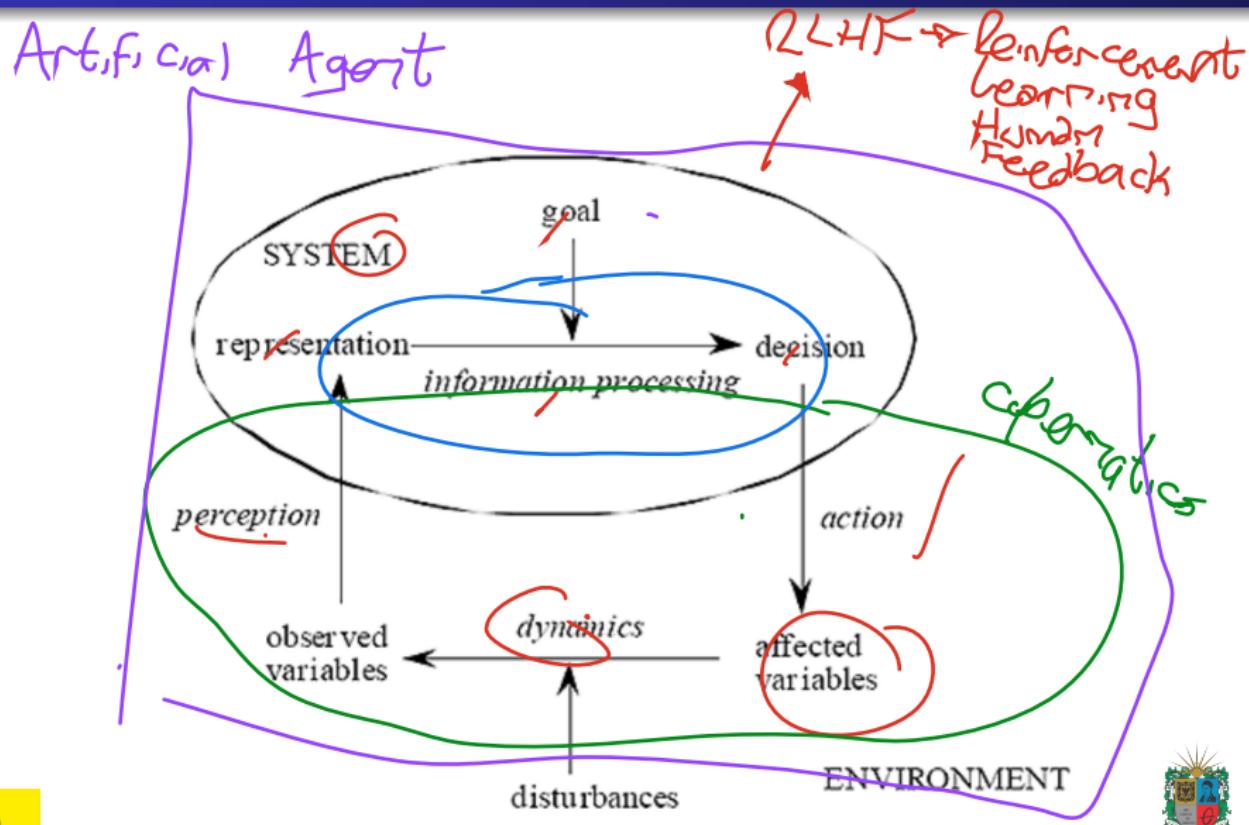


Cybernetics

- Cybernetics is an interdisciplinary field that studies the **control** and **communication** in living organisms and machines.
- Cybernetics is based on the idea that systems can be **controlled** and **regulated** using feedback mechanisms.
- Cybernetics is used to develop **models** and **theories** that can be used to understand and predict the behavior of complex systems.
- Cybernetics is used in a wide range of fields, including **biology**, **engineering**, and **management**.
- Cybernetics is used to develop **control systems** that can regulate the behavior of complex systems.



Typical Cybernetics System



Robotics

- **Robotics** is a branch of engineering that focuses on the design and construction of **robots**.
- Robotics is used in a wide range of fields, including **manufacturing**, **healthcare**, and **entertainment**.
- Robotics is related to **artificial intelligence** and **cybernetics** because it involves the development of intelligent systems that can perform tasks that require human-like intelligence.
-



Robotics

- **Robotics** is a branch of engineering that focuses on the design and construction of **robots**.
- **Robotics** is used in a wide range of fields, including **manufacturing**, **healthcare**, and **entertainment**.
- **Robotics** is related to **artificial intelligence** and **cybernetics** because it involves the development of intelligent systems that can perform tasks that require human-like intelligence.



Robotics

- **Robotics** is a branch of engineering that focuses on the design and construction of **robots**.
- **Robotics** is used in a wide range of fields, including **manufacturing**, **healthcare**, and **entertainment**.
- **Robotics** is related to **artificial intelligence** and **cybernetics** because it involves the development of **intelligent systems** that can perform tasks that require **human-like intelligence**.



Outline

1 Definitions

2 The History

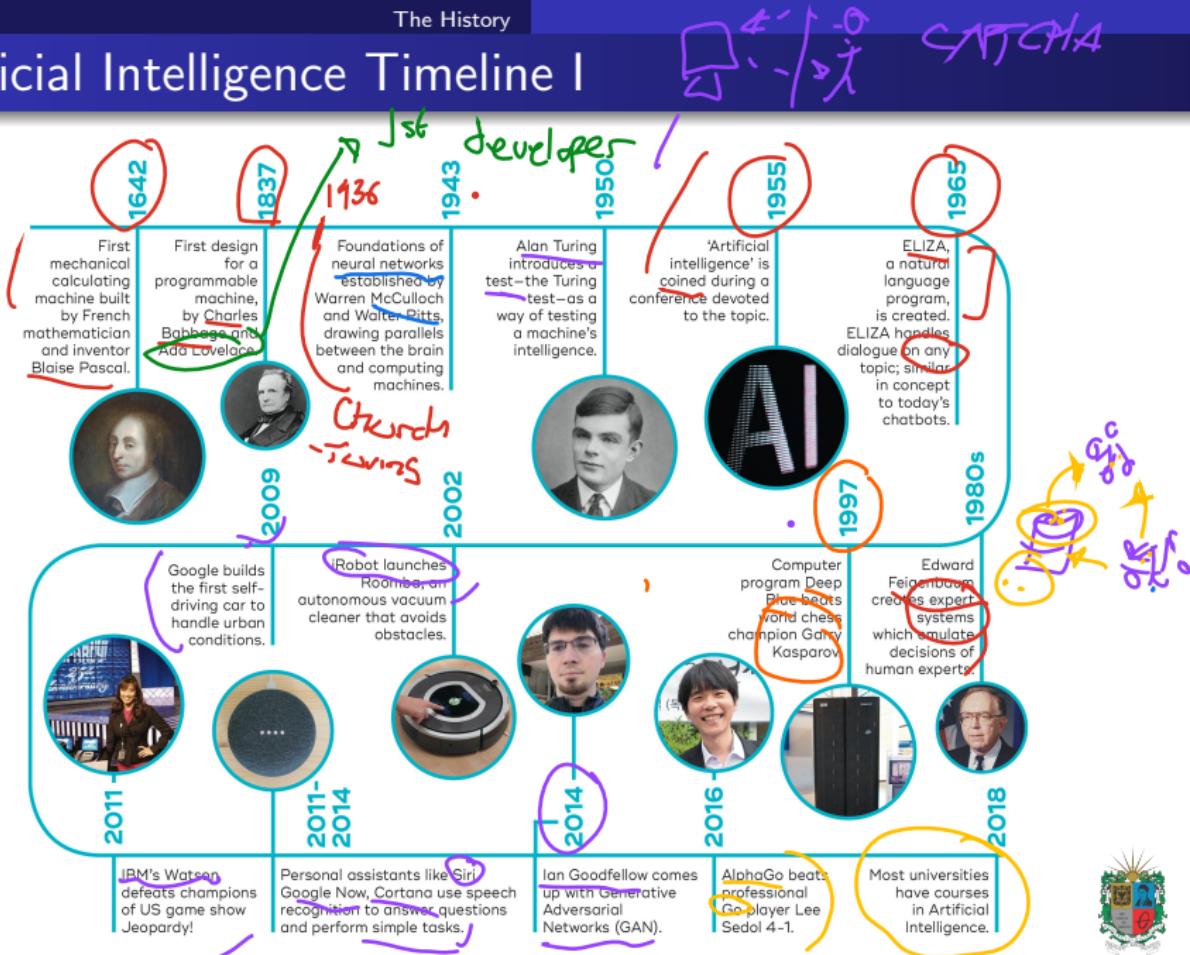
3 Artificial Intelligence

4 Cybernetics

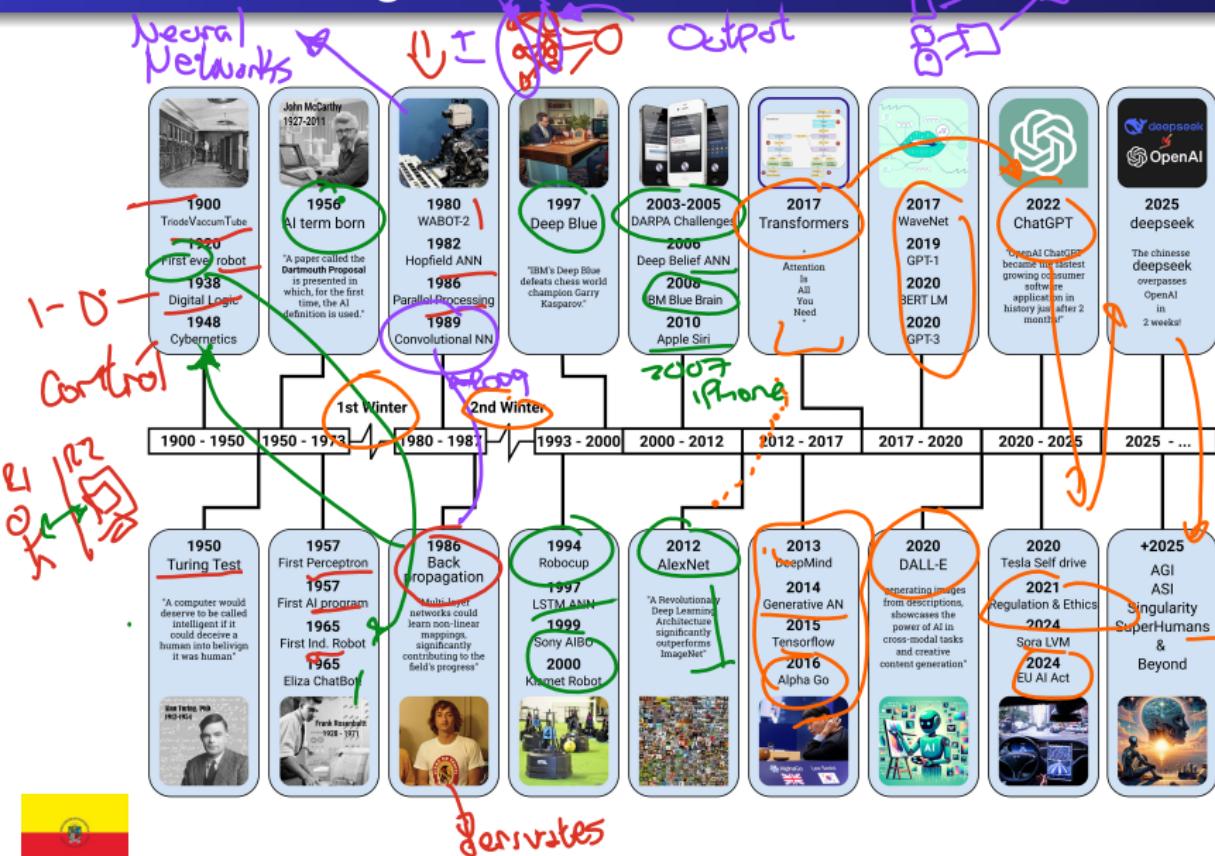
5 Application Fields



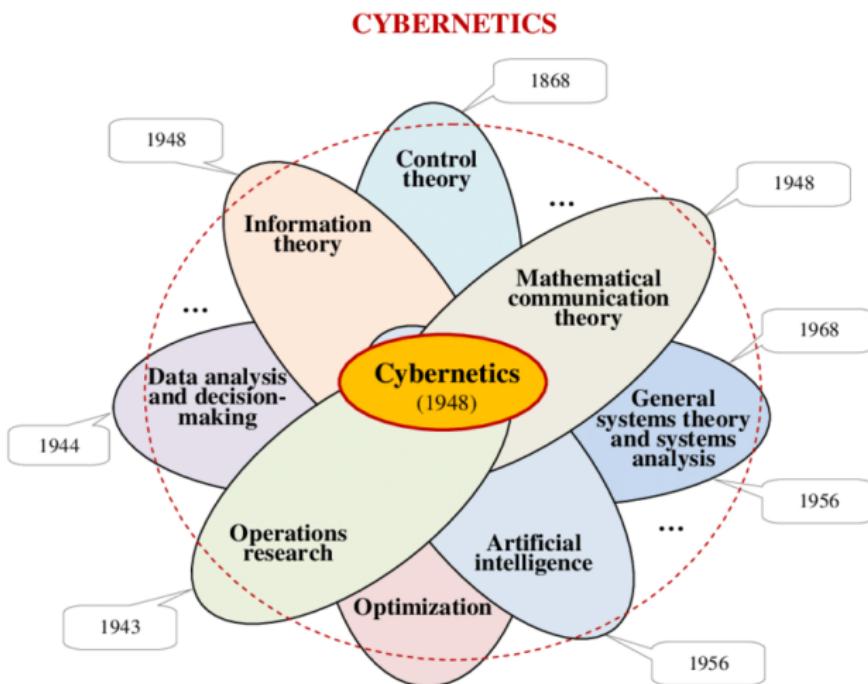
Artificial Intelligence Timeline I



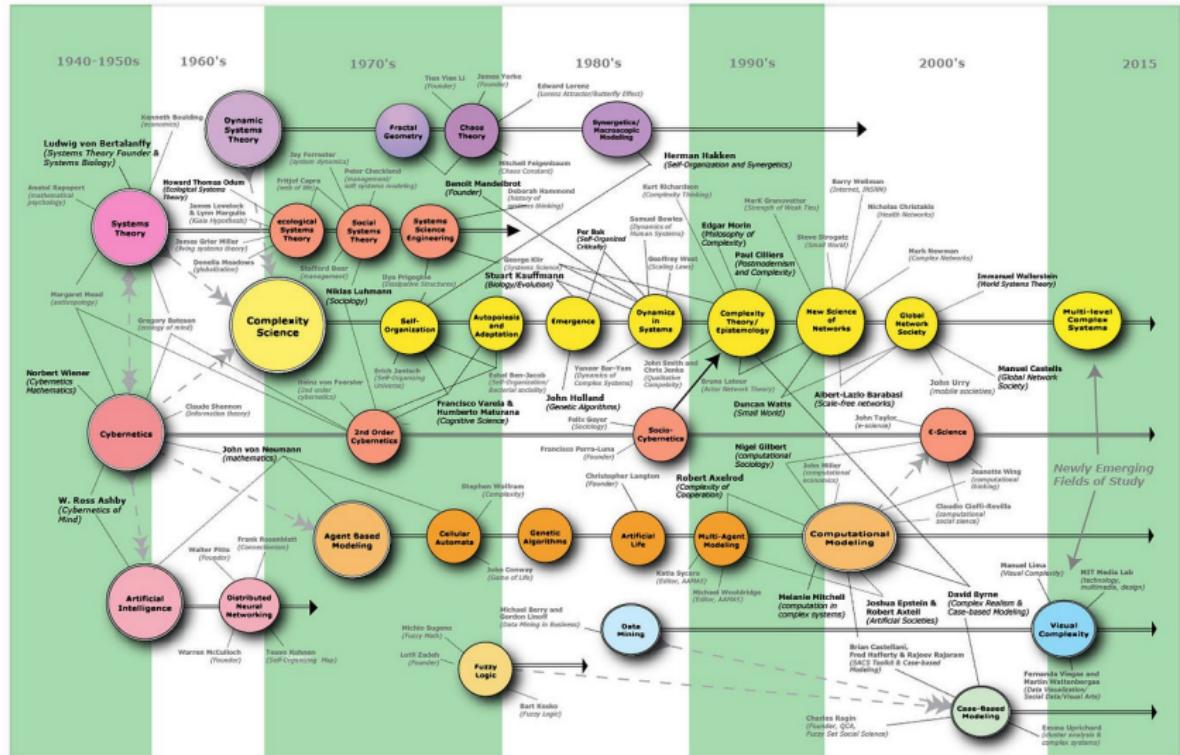
Artificial Intelligence Timeline II



Cybernetics Timeline



Systems Sciences Timeline



Outline

1 Definitions

2 The History

3 Artificial Intelligence

4 Cybernetics

5 Application Fields



Main Brances of AI

36

Main branches of AI



AI Types

- **Artificial Intelligence** can be divided into **two main types**:
 - **Narrow AI**: Also known as **Weak AI**, this type of AI is designed to perform a specific task, such as playing chess or driving a car.
 - **General AI**: Also known as **Strong AI**, this type of AI is designed to perform any intellectual task that a human can do.
- Also, there is a **third type of AI**:
 - **Superintelligent AI**: This type of AI is designed to perform intellectual tasks that are beyond human capabilities.



AI Types

- **Artificial Intelligence** can be divided into **two main types**:
 - **Narrow AI**: Also known as **Weak AI**, this type of AI is designed to perform a specific task, such as playing chess or driving a car.
 - **General AI**: Also known as **Strong AI**, this type of AI is designed to perform any intellectual task that a human can do.
- Also, there is a **third type of AI**:
 - Superintelligent AI: This type of AI is designed to perform intellectual tasks that are beyond human capabilities



AI Types

- **Artificial Intelligence** can be divided into **two main types**:
 - **Narrow AI**: Also known as **Weak AI**, this type of AI is designed to perform a specific task, such as playing chess or driving a car.
 - **General AI**: Also known as **Strong AI**, this type of AI is designed to perform any intellectual task that a human can do.
- Also, there is a **third type of AI**:
 - **Superintelligent AI**: This type of AI is designed to perform intellectual tasks that are beyond human capabilities.



Weak AI vs Strong AI

Criteria	Weak AI (Narrow AI)	Strong AI (General AI)
Definition	Designed to perform a specific task.	Designed to perform any intellectual task that a human can do.
Examples	Chatbots, self-driving cars, and recommendation systems.	Human-like robots and superintelligent AI.

Table: Comparison between Weak AI and Strong AI



Outline

1 Definitions

2 The History

3 Artificial Intelligence

4 Cybernetics

5 Application Fields



Types of Cybernetics

- Cybernetics can be divided into two main types:
 - First-order Cybernetics: This type of cybernetics focuses on the **control** and **communication** in living organisms and machines.
 - Second-order Cybernetics: This type of cybernetics focuses on the **observer** and the **observed** in living organisms and machines.



Types of Cybernetics

- Cybernetics can be divided into two main types:
 - First-order Cybernetics: This type of cybernetics focuses on the **control** and **communication** in living organisms and machines.
 - Second-order Cybernetics: This type of cybernetics focuses on the **observer** and the **observed** in living organisms and machines.



Sub-areas of Cybernetics

- Cybernetics can be divided into several sub-areas:
 - Biological Cybernetics: This sub-area focuses on the **control** and **communication** in living organisms.
 - Engineering Cybernetics: This sub-area focuses on the **control** and **communication** in machines and systems.
 - Social Cybernetics: This sub-area focuses on the **control** and **communication** in social systems.
 - Management Cybernetics: This sub-area focuses on the **control** and **communication** in organizations and businesses.
 - Educational Cybernetics: This sub-area focuses on the **control** and **communication** in educational systems.



Sub-areas of Cybernetics

- Cybernetics can be divided into several sub-areas:
 - Biological Cybernetics: This sub-area focuses on the **control** and **communication** in living organisms.
 - Engineering Cybernetics: This sub-area focuses on the **control** and **communication** in machines and systems.
 - Social Cybernetics: This sub-area focuses on the **control** and **communication** in social systems.
 - Management Cybernetics: This sub-area focuses on the **control** and **communication** in organizations and businesses.
 - Educational Cybernetics: This sub-area focuses on the **control** and **communication** in educational systems.



Sub-areas of Cybernetics

- Cybernetics can be divided into several sub-areas:
 - Biological Cybernetics: This sub-area focuses on the **control** and **communication** in living organisms.
 - Engineering Cybernetics: This sub-area focuses on the **control** and **communication** in machines and systems.
 - Social Cybernetics: This sub-area focuses on the **control** and **communication** in social systems.
 - Management Cybernetics: This sub-area focuses on the **control** and **communication** in organizations and businesses.
 - Educational Cybernetics: This sub-area focuses on the **control** and **communication** in educational systems.



Sub-areas of Cybernetics

- Cybernetics can be divided into several sub-areas:
 - Biological Cybernetics: This sub-area focuses on the **control** and **communication** in living organisms.
 - Engineering Cybernetics: This sub-area focuses on the **control** and **communication** in machines and systems.
 - Social Cybernetics: This sub-area focuses on the **control** and **communication** in social systems.
 - Management Cybernetics: This sub-area focuses on the **control** and **communication** in organizations and businesses.
 - Educational Cybernetics: This sub-area focuses on the **control** and **communication** in educational systems.



Sub-areas of Cybernetics

- Cybernetics can be divided into several sub-areas:
 - Biological Cybernetics: This sub-area focuses on the **control** and **communication** in living organisms.
 - Engineering Cybernetics: This sub-area focuses on the **control** and **communication** in machines and systems.
 - Social Cybernetics: This sub-area focuses on the **control** and **communication** in social systems.
 - Management Cybernetics: This sub-area focuses on the **control** and **communication** in organizations and businesses.
 - Educational Cybernetics: This sub-area focuses on the **control** and **communication** in educational systems.



Outline

1 Definitions

2 The History

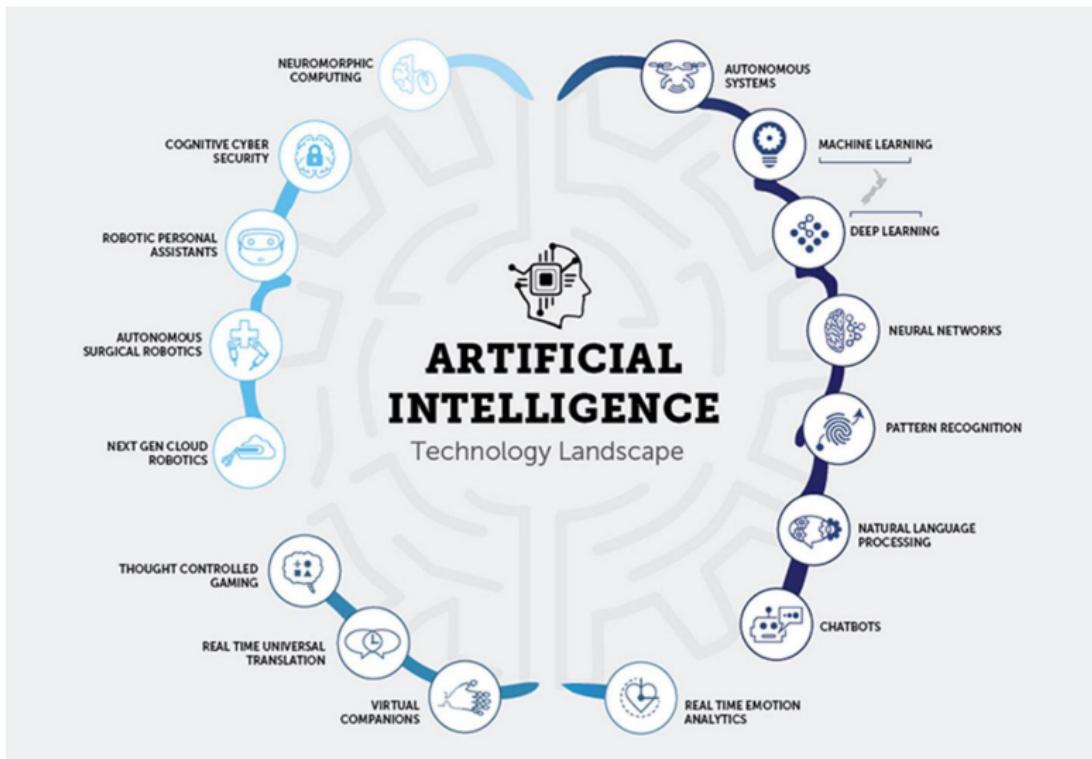
3 Artificial Intelligence

4 Cybernetics

5 Application Fields

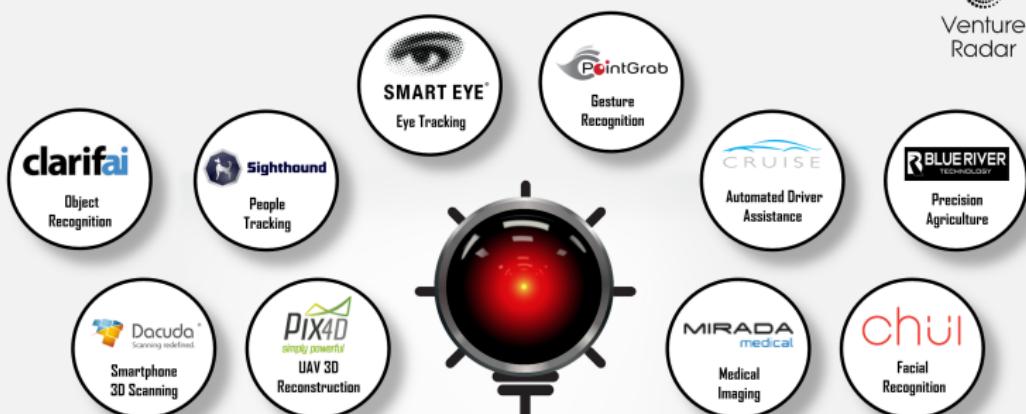


AI Landscape



Computer Vision Startups — 2015

Leading Computer Vision Innovators

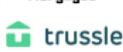


More: <https://www.ventureradar.com/>



UK Fintech Startups — 2015

Top 25 Emerging UK Fintech Startups

Compliance 	Smart Retail Bank 	Insurance 	Bond Marketplace 	Mobile Payments 	Student Finances 	Smart Retail Bank 
Credit Scoring 	Big Data Privacy 	Top 25 Emerging UK Fintech Startups				Fraud Detection 
Invoice Trading 	Mortgages 	Nanopayments 	Mobile Security 	Shared Expenses 	Payroll for the Unbanked 	Personal Finance 
Personal Finance 	Financial Planning 	Credit Scoring 	Smart Retail Bank 	Blockchain Cross-chains 	Biometric Security 	Emerging Markets Crowdfunding 



VentureRadar

More: <https://www.ventureradar.com/>



Artificial Intelligence Startups — 2017



Artificial Intelligence Startups

Augmenting knowledge work using AI



25% of all job-based tasks will be automated by 2019
- Forrester Research

Many experts believe that by 2050 machines will have reached human level intelligence

Hundreds of startups are already using AI to augment knowledge work



Law & Contracts	Customer Service	Sales	Personal Assistants
ROSS Okira Kelson LEGAL ROBOT	FinGenius DigitalGenius CAPITO SYSTEMS COGNICOR Wise.io	AVISO CONVERSICA re:infer Investing	x.ai VANARE WEALTHARC INOVANCE
Humans focus more on creativity, social intelligence, manual dexterity, and... Business Intelligence, Journalism, Research			
Audit & Compliance	Medical & Other Image Analysis		Other Medical
AppZen	MetaMind	clarifai enlitic Tractable	Wired Informatics

More: <https://www.ventureradar.com/>



Outline

1 Definitions

2 The History

3 Artificial Intelligence

4 Cybernetics

5 Application Fields



Thanks!

Questions?



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

