IntroductionTo AI

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History Of AI

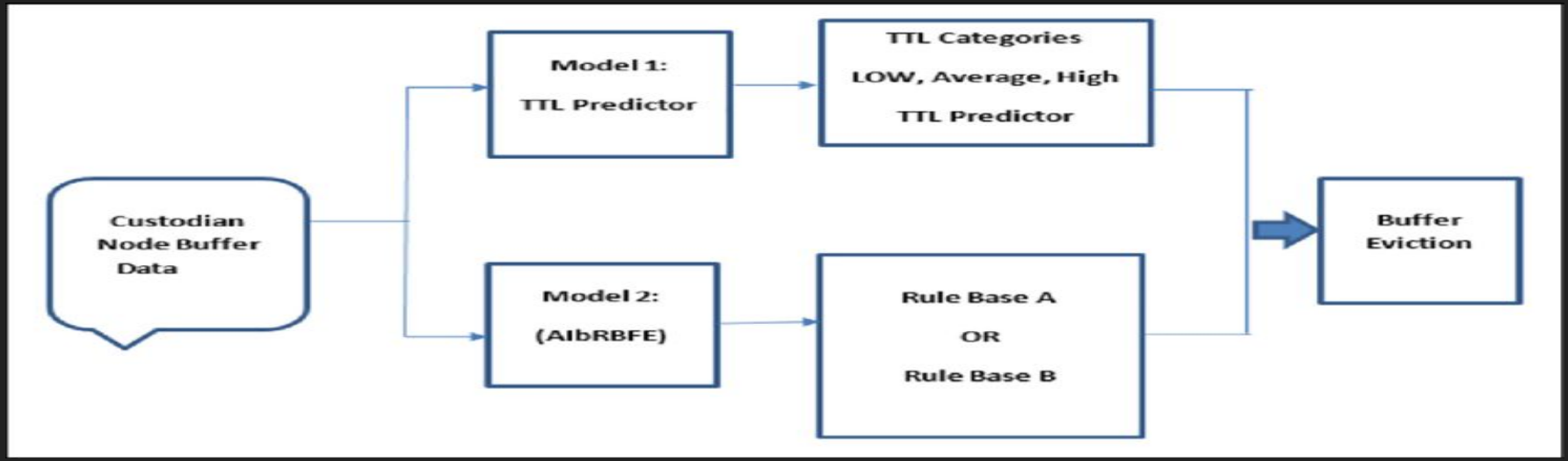
A Brief Overview

The birth of the field

- Dartmouth Conference (1950s)
- Objective: Create a machine that can "think" like a human

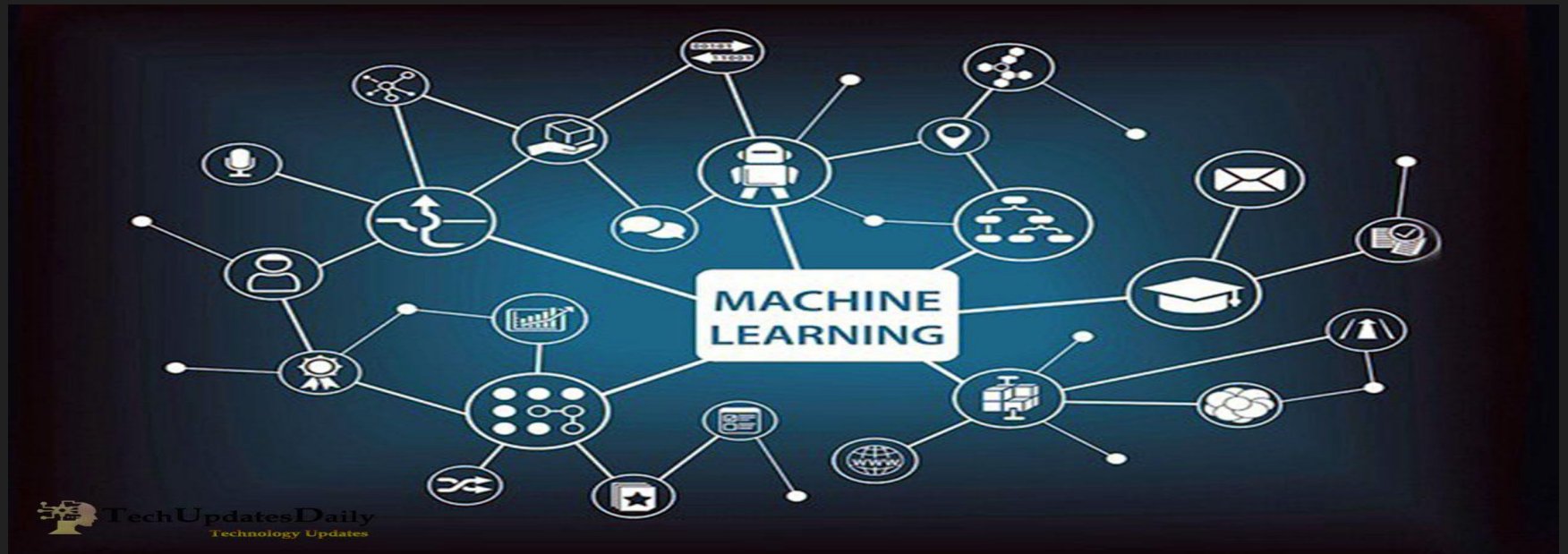
Early days of AI research

- Expert systems (rule-based systems)
- Mimic decision-making of human experts in specific domains



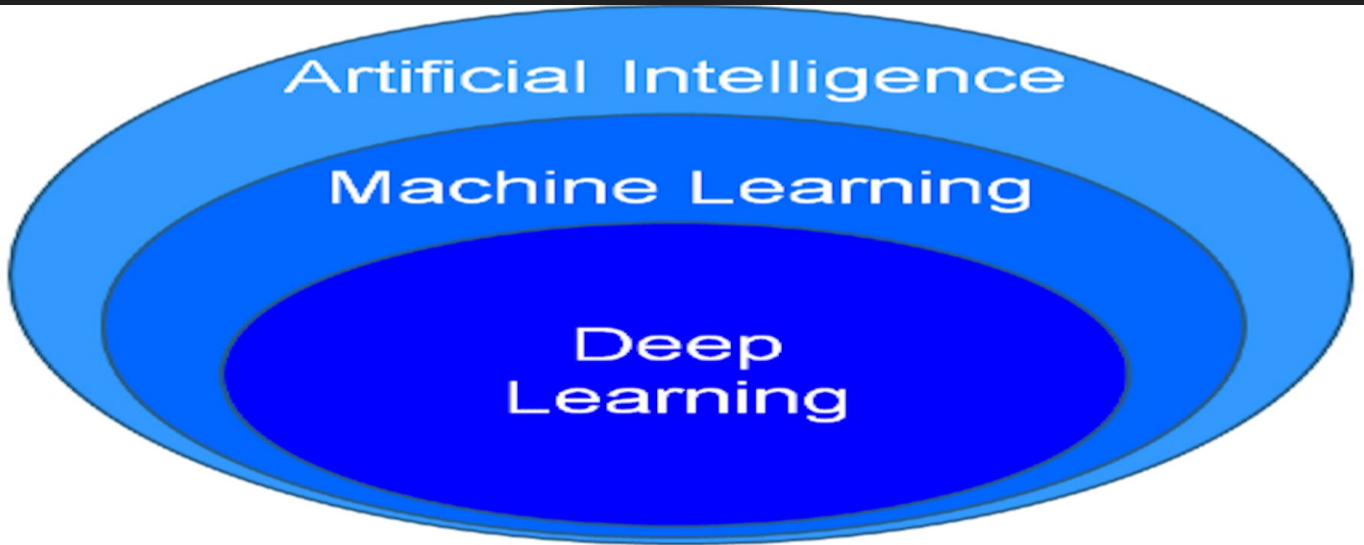
Shift Towards Machine Learning(1980 and 1990s)

- Development of new AI techniques: decision trees, neural networks, genetic algorithms



21st century

- Advancements in natural language processing, computer vision, robotics, and self-driving cars
- Growing interest in deep learning

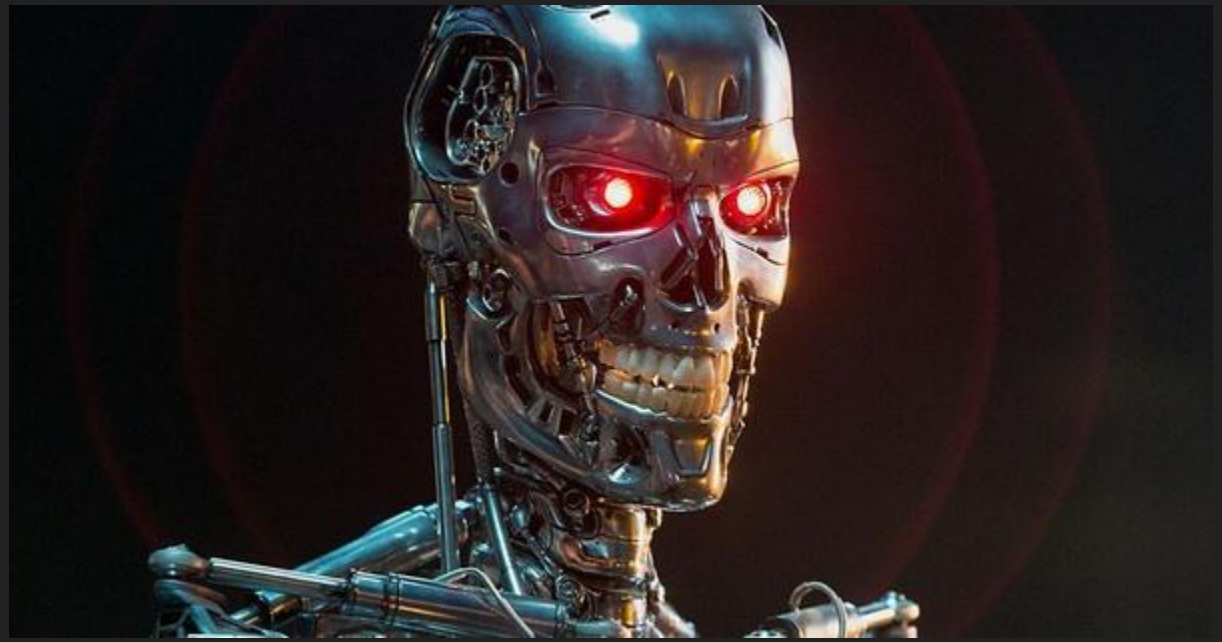


Today

- AI in everyday life: Healthcare, finance, transportation, and more
- Expectations for continued growth in importance

Controversies

Fear of AI becoming more intelligent than humans, ethical concerns

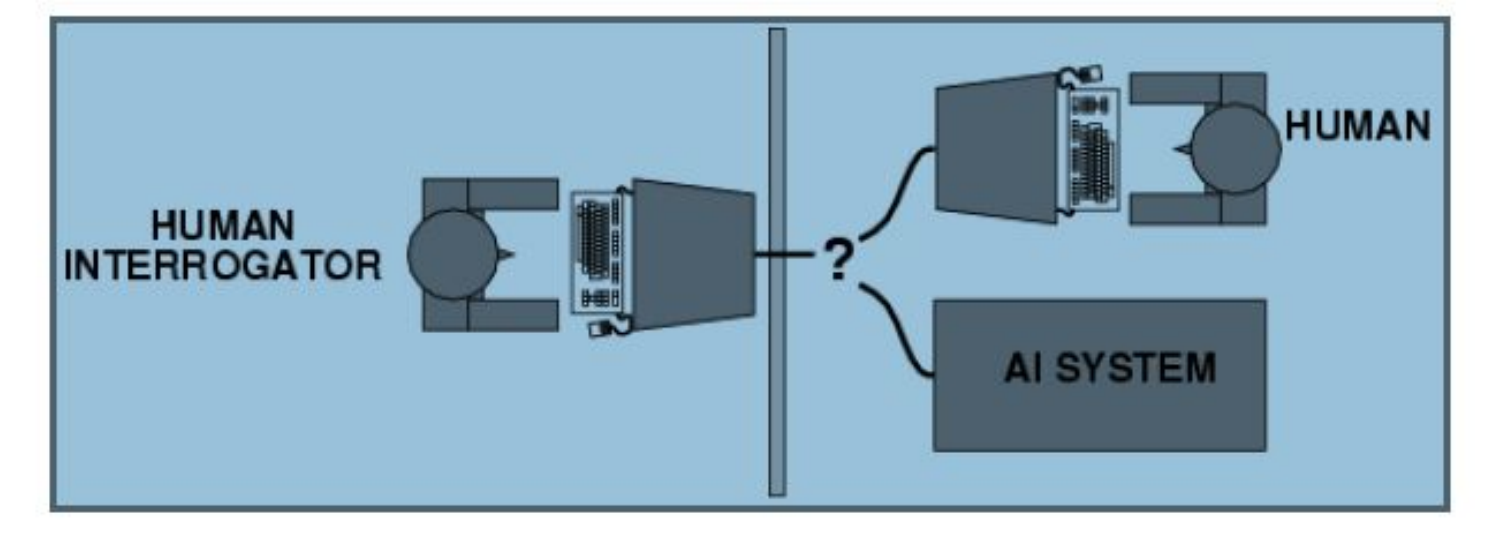


What is AI?

Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998) "AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Figure 1.1 Some definitions of artificial intelligence, organized into four categories.

Acting humanly: The Turing Test approach

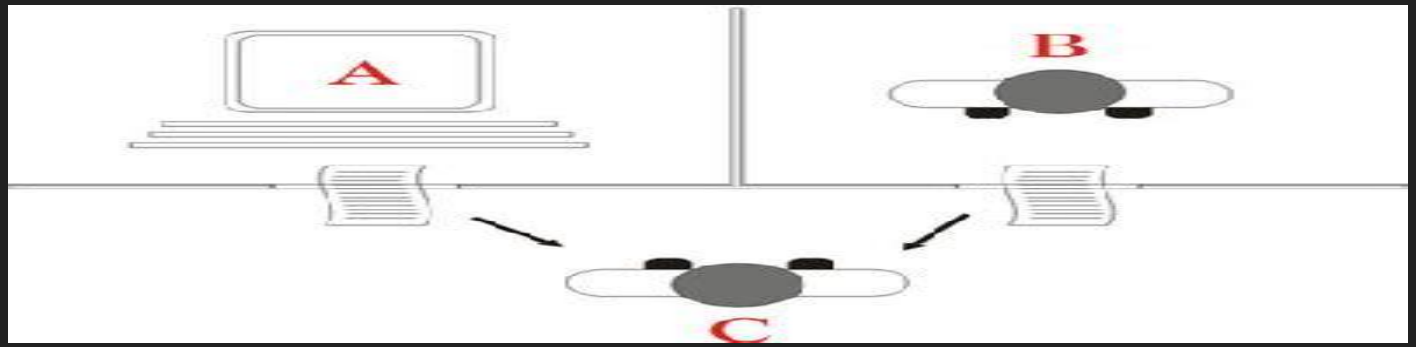


The Turing Test

- A test for determining if a machine can "think" like a human
- Developed by Alan Turing in 1950
- Test involves a human judge engaging in natural language conversations with another human and a machine, and determining which of the two they are communicating with

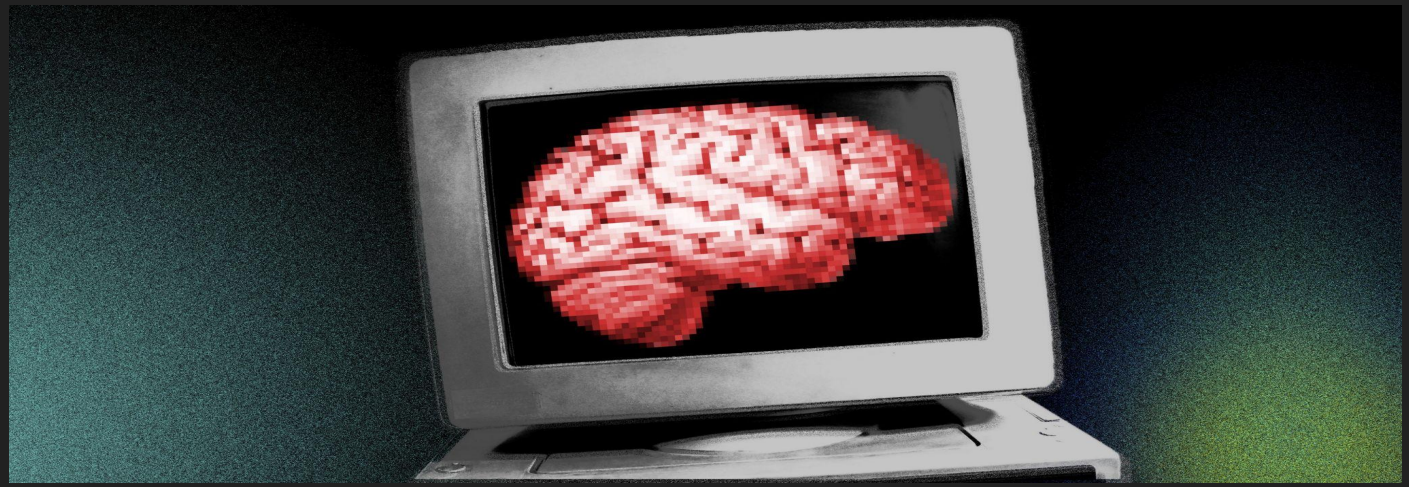
Key features of the Turing Test

- Natural Language Processing: ability to understand and generate human language
- Knowledge Representation: ability to store and retrieve information
- Reasoning: ability to draw logical conclusions from information
- Machine Learning: ability to improve performance through experience



Criticisms of the Turing Test

- Lack of consideration of other forms of intelligence
- Difficulty in defining human intelligence
- Potential for deception



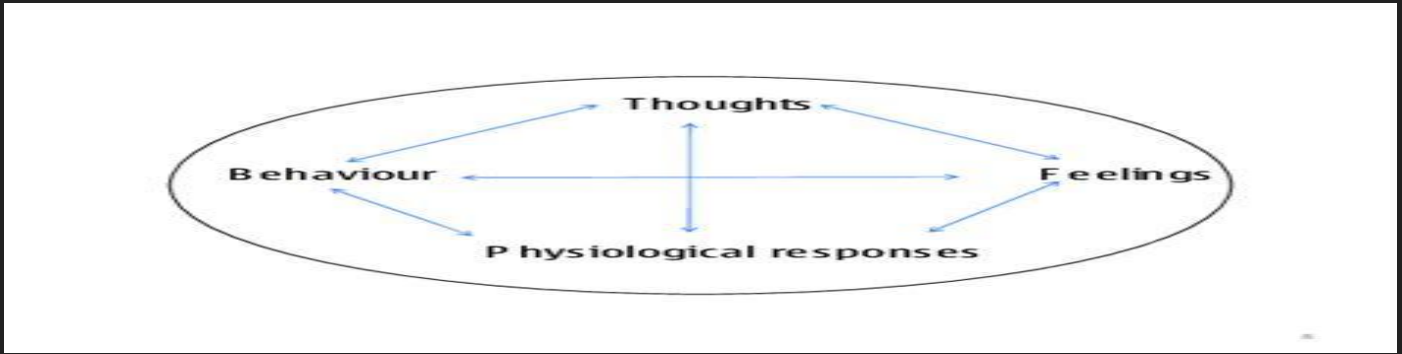
Conclusion

The Turing Test is an important benchmark for AI research, but it is not the only measure of intelligence, and other approaches should be considered as well.

Thinking humanly: The cognitive modeling approach

Cognitive Modeling

- A method for understanding and simulating human thought processes
- Based on the study of cognitive psychology and neuroscience
- Goal is to create computational models of human cognition that mimic the way humans process information



Key features of Cognitive Modeling

- Knowledge Representation: ability to store and retrieve information in a way that mirrors human memory
- Attention and Perception: ability to focus on relevant information and process it efficiently
- Reasoning and Problem-solving: ability to draw logical conclusions and solve problems in a way that mirrors human thought processes
- Learning: ability to improve performance through experience in a way that mirrors human learning

Applications of Cognitive Modeling

- Cognitive Psychology: understanding human cognition
- Artificial Intelligence: creating intelligent agents that mimic human thought processes
- Human-computer interaction: designing more natural and intuitive interfaces
- Robotics: creating robots that can navigate and interact with their environment in a way that mimics human behavior

Conclusion

The Cognitive Modeling approach is an important method for understanding and simulating human thought processes, and has many potential applications in AI, cognitive psychology, and other fields.

Thinking Rationally: The 'Laws of Thought' Approach

The "laws of thought" approach

- a method for designing intelligent systems based on logical reasoning and formal logic
- Developed by philosophers and mathematicians such as Aristotle, Leibniz and Boole
- Goal is to create systems that can make rational decisions based on logical reasoning
- Example: “Socrates is a man; all men are mortal; therefore, Socrates is mortal.”

Key features of the "laws of thought" approach

- Formal Logic: the use of mathematical symbols and logical rules to represent and manipulate knowledge
- Reasoning: the ability to make inferences and draw logical conclusions from knowledge
- Planning: the ability to plan and make decisions based on logical reasoning
- Automated reasoning: the ability to reason automatically using mathematical algorithms

Applications of the "laws of thought" approach

- Expert systems: the use of formal logic to represent and manipulate knowledge in specific domains
- Automated theorem proving: automated reasoning in mathematics and logic
- Planning and decision-making: the use of logical reasoning to plan and make decisions
- Knowledge representation: the use of formal logic to represent knowledge
- MYCIN, XCON, and DENDRAL for expert systems, Otter, and Prover9 for automated theorem proving systems.

Conclusion

The "laws of thought" approach is an important method for creating intelligent systems based on logical reasoning and formal logic, and has many potential applications in AI, expert systems, and other fields.

Acting Rationally: The Rational Agent Approach

The rational agent

- Approach: a method for designing intelligent systems based on the principles of rationality and decision theory
- Developed by computer scientists, economists, and mathematicians
- Goal is to create systems that can make rational decisions based on a set of goals and constraints

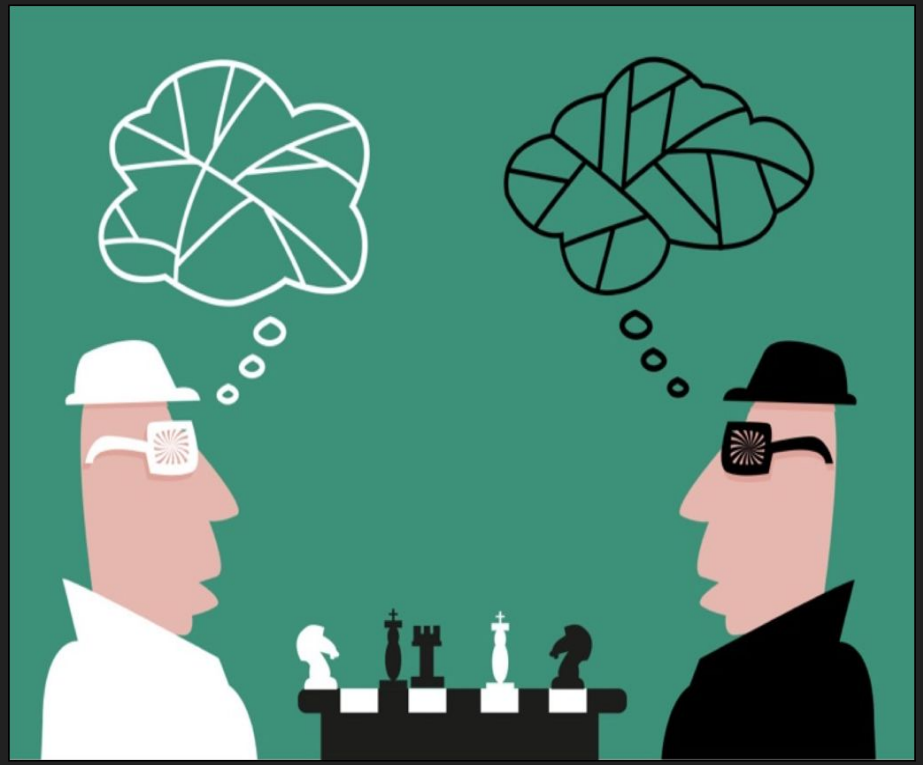
Key features of the rational agent approach

- Decision theory: the use of mathematical models to analyze decision-making under uncertainty
- Utility theory: the use of mathematical models to represent an agent's preferences and goals
- Planning: the ability to plan and make decisions based on decision theory and utility theory
- Learning: the ability to improve performance through experience and feedback

Applications of the rational agent approach

- Robotics: the use of rational agents to control autonomous robots
- Artificial Intelligence: the use of rational agents to design intelligent agents and multi-agent systems
- Game theory: the use of rational agents to model and analyze strategic decision-making
- Economics: the use of rational agents to model and analyze decision-making in markets

Examples

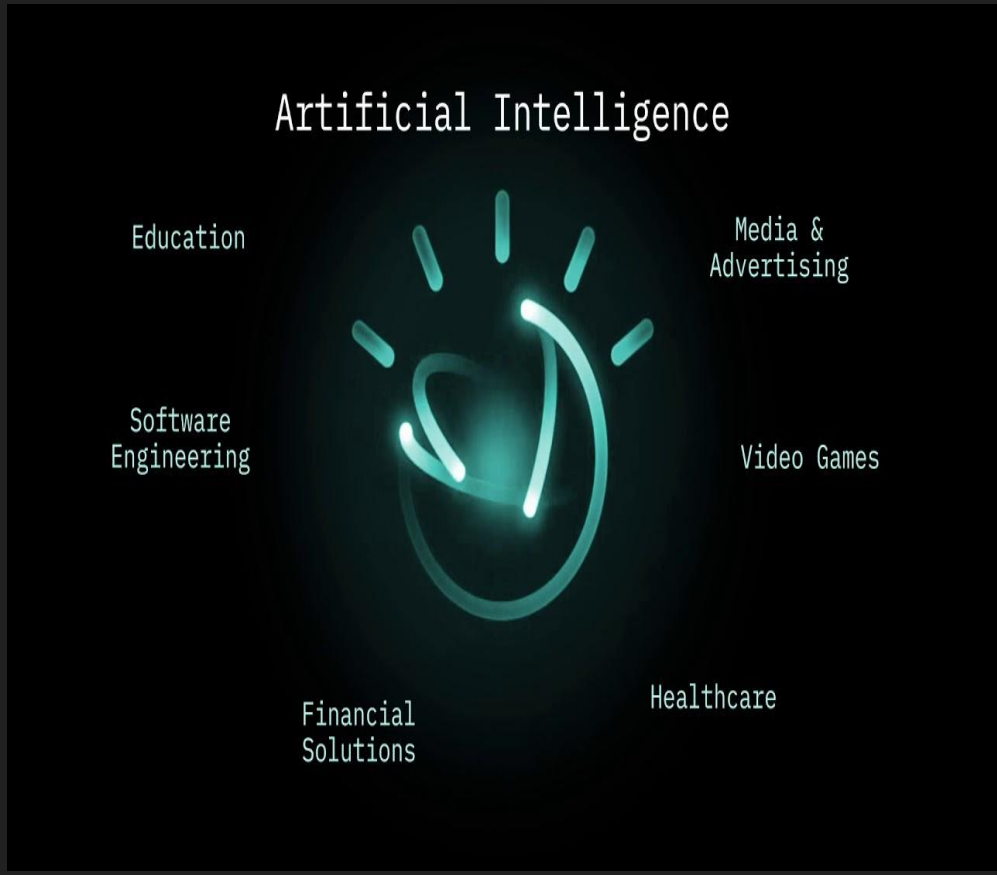


Conclusion

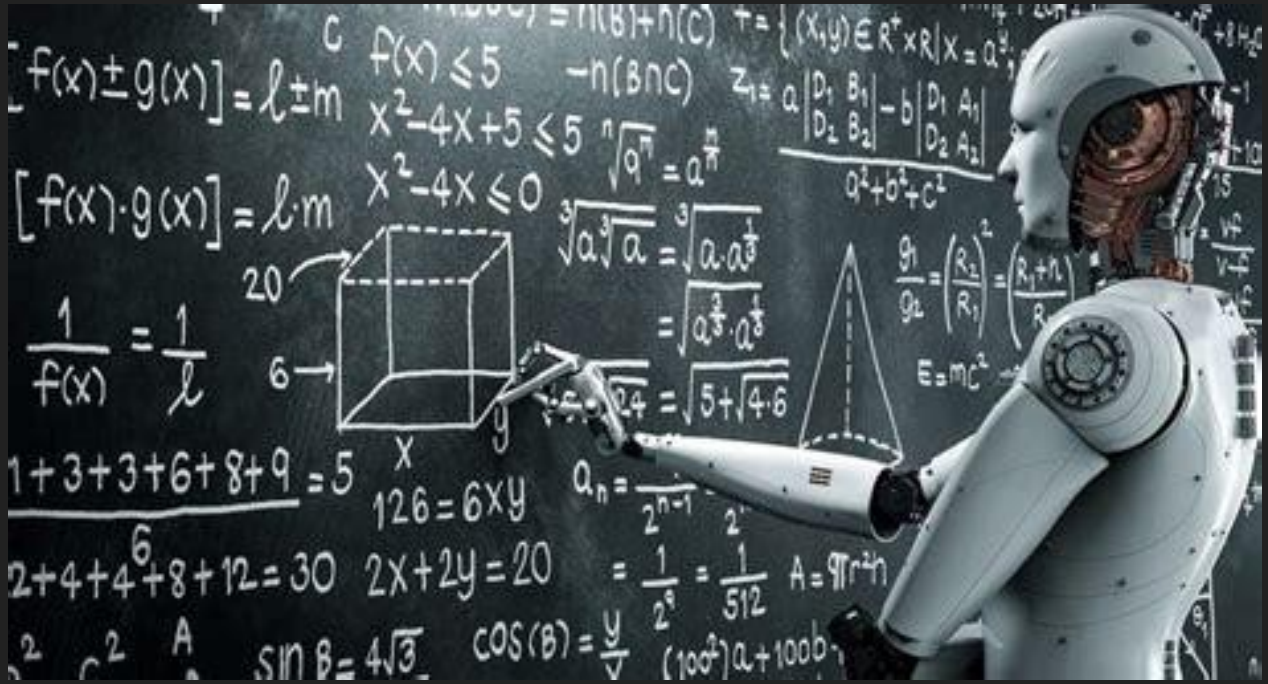
The rational agent approach is an important method for creating intelligent systems based on rationality and decision theory, and has many potential applications in AI, robotics, game theory, and other fields.

Applications of AI

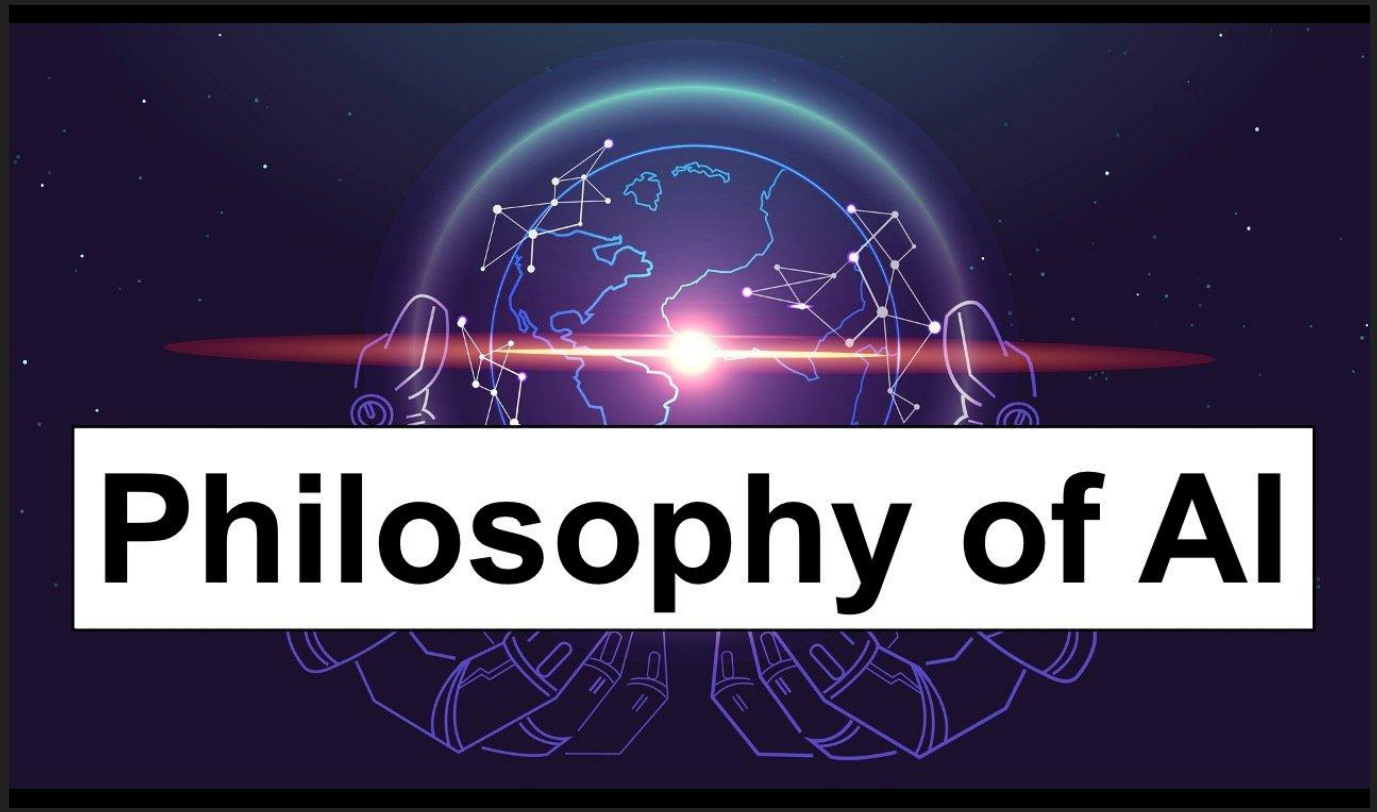
- Natural Language Processing
- Computer Vision
- Robotics
- Self-driving cars
- Game playing
- Expert systems



The Foundation Of AI



The Philosophy of Artificial Intelligence



The Philosophy of AI

- A branch of philosophy that deals with the nature of artificial intelligence and its relationship to the human mind and society.
- It is an interdisciplinary field that draws on philosophy, computer science, psychology, and other disciplines.
- Can formal rules be used to draw valid conclusions? •
- How does the mind arise from a physical brain?
- Where does knowledge come from?
- How does knowledge lead to action?

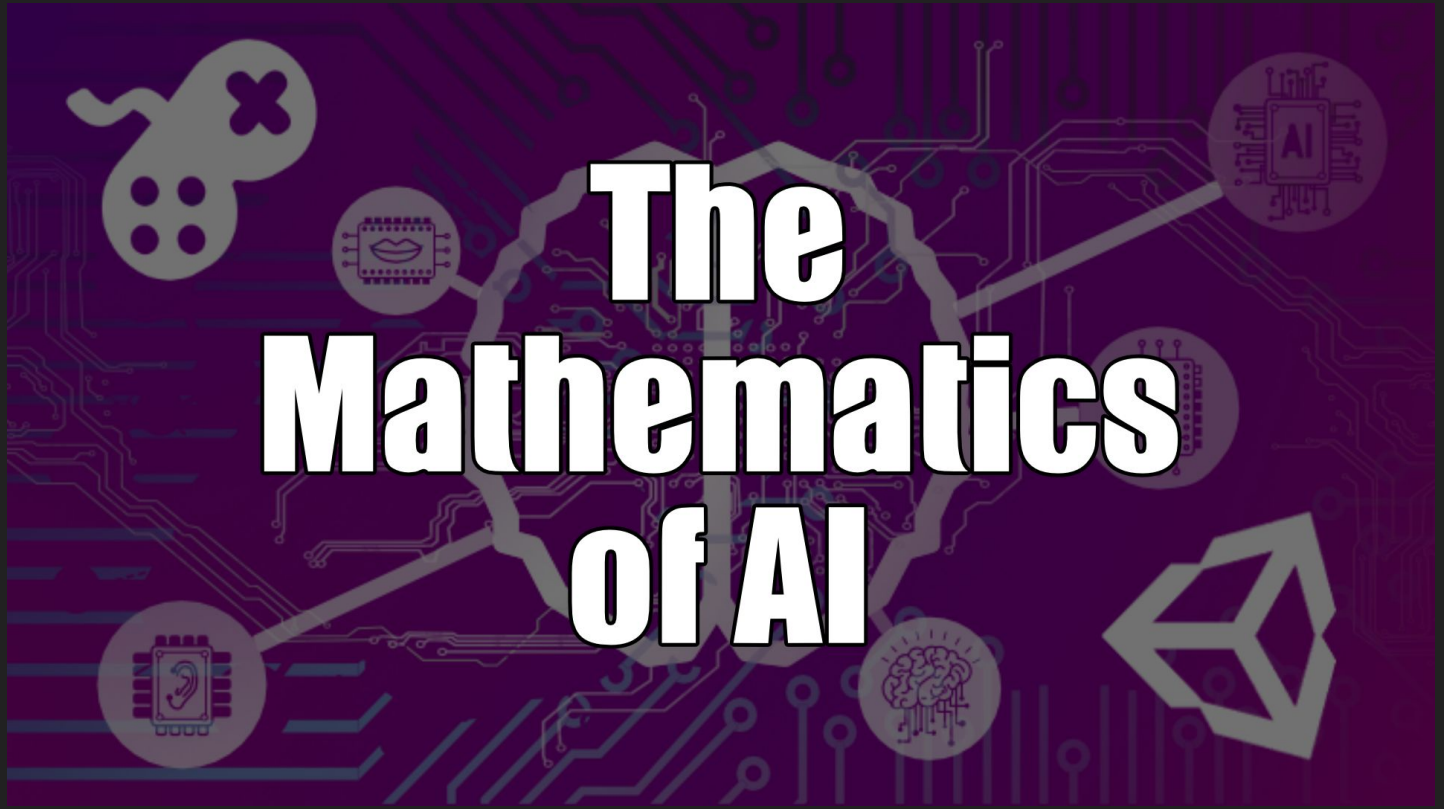
Key areas of inquiry in the philosophy of AI

- The nature of intelligence
- Mind-body problem
- The Turing test
- The Chinese room argument
- The ethics of AI
- The impact of AI on society

Conclusion

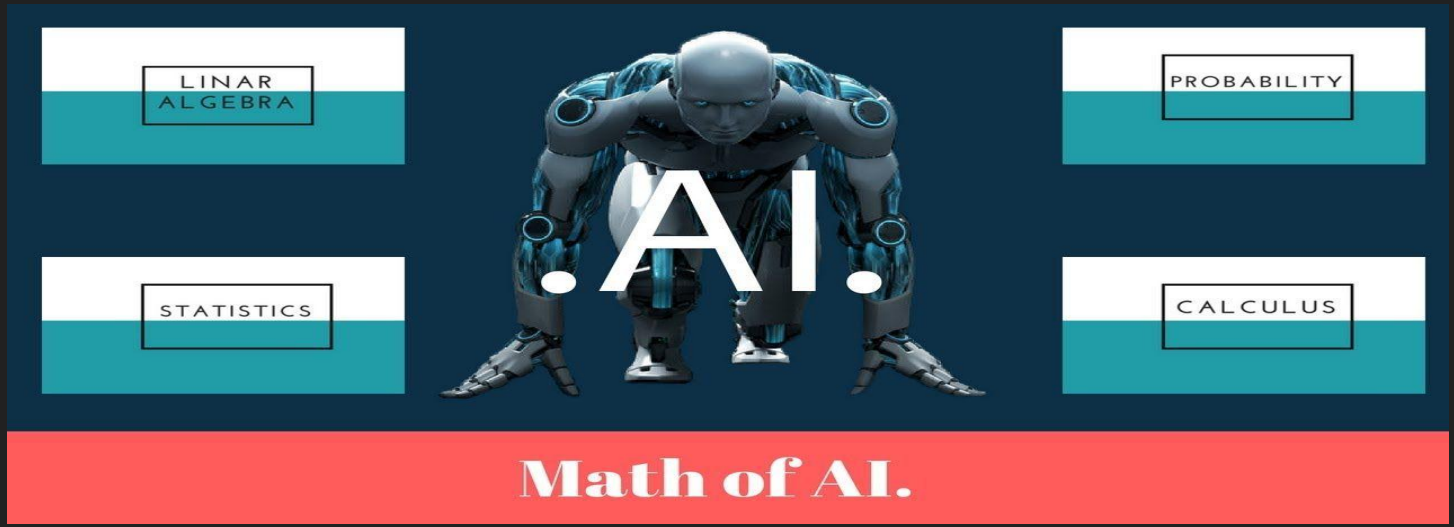
The philosophy of AI is an important field of study as it helps us to understand the nature of intelligence and the implications of creating machines that can perform tasks that would normally require human intelligence, and also helps us to identify ethical considerations, and to anticipate and address the societal impact of AI.

AI and Mathematics



AI and Mathematics

- The use of mathematical methods and formal reasoning to solve problems in AI.
- AI relies heavily on mathematical methods to reason, learn, and make decisions



Formal rules to draw valid conclusions

- Formal logic: the use of mathematical symbols and logical rules to represent and manipulate knowledge
- Proofs and theorem: the use of mathematical reasoning to prove the correctness of algorithms and decision-making
- Optimization techniques: the use of mathematical methods to find optimal solutions to problems

What can be computed?

- Complexity theory: the study of the resources (such as time and space) required to solve problems
- Decidability: the study of whether problems can be solved in a finite amount of time
- Algorithm design: the study of how to design efficient algorithms to solve problems

How do we reason with uncertain information?

- Probability theory: the study of how to reason with uncertain information
- Bayesian inference: the use of probability theory to update beliefs in light of new evidence
- Decision theory: the study of how to make decisions under uncertainty

Conclusion

AI relies heavily on mathematical methods, including formal logic, proof, optimization, complexity theory, decidability, algorithm design, probability theory, bayesian inference, and decision theory to reason, learn, and make decisions

Economics and AI

How should we make decisions so as to maximize payoff?

- Game theory: the study of decision-making in strategic situations
- Mechanism design: the study of how to design institutions, such as markets and contracts, to achieve desired outcomes
- Principal-agent theory: the study of how to align the incentives of different actors to achieve a common goal

How should we do this when others may not go along?

- Cooperative game theory: the study of decision-making in situations where actors can form coalitions
- Social choice theory: the study of how to aggregate the preferences of different actors
- Fairness, accountability, and transparency: the study of how to ensure that AI systems are fair, accountable, and transparent

How should we do this when the payoff may be far in the future?

- Discounted utility: the study of how to value future payoffs
- Dynamic decision making: the study of how to make decisions when the state of the world changes over time
- Long-term economic impact of AI: the study of how AI will affect the economy in the long-term.
- Examples: Trading bots, stock market prediction and analysis

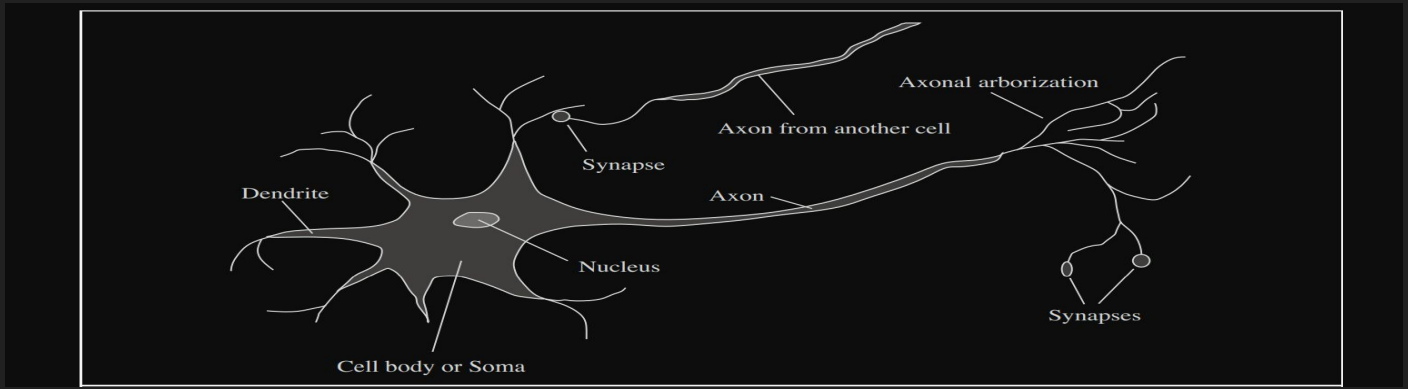
Conclusion

Economics and AI is an interdisciplinary field that uses economic principles and models to study the design, use, and impact of AI systems. It covers a wide range of topics, from decision-making, mechanism design, incentive alignment, to fair, accountable and transparent AI.

Neuroscience and AI

Neuroscience and AI

- The study of how the brain processes information and how this knowledge can be used to improve AI systems.(synapses, neurons, axioms etc..)
- AI has the potential to help us understand the brain better, and neuroscience can help to improve AI.



How do brains process information?

- Neural networks: the study of how networks of neurons in the brain process information
- Neural coding: the study of how the brain represents and processes information
- Learning and memory: the study of how the brain learns and remembers information

Applications of neuroscience in AI

- Neural networks: AI models that are inspired by the structure and function of the brain
- Brain-computer interfaces: technology that allows the brain to communicate directly with computers
- Cognitive architectures: AI models that aim to replicate the cognitive processes of the brain

Example Of Neurscience and AI

- Neural networks: AI models that are inspired by the structure and function of the brain, such as deep learning networks, which are modeled after the hierarchical structure of the neocortex and have been shown to be effective in tasks such as image and speech recognition.
- Brain-computer interfaces: technology that allows the brain to communicate directly with computers, such as systems that use electroencephalography (EEG) to record brain activity and translate it into commands for a computer, or systems that use functional magnetic resonance imaging (fMRI) to read brain activity and control a robotic arm.

Human Brain Vs Computer

	Supercomputer	Personal Computer	Human Brain
Computational units	10^4 CPUs, 10^{12} transistors	4 CPUs, 10^9 transistors	10^{11} neurons
Storage units	10^{14} bits RAM	10^{11} bits RAM	10^{11} neurons
	10^{15} bits disk	10^{13} bits disk	10^{14} synapses
Cycle time	10^{-9} sec	10^{-9} sec	10^{-3} sec
Operations/sec	10^{15}	10^{10}	10^{17}
Memory updates/sec	10^{14}	10^{10}	10^{14}

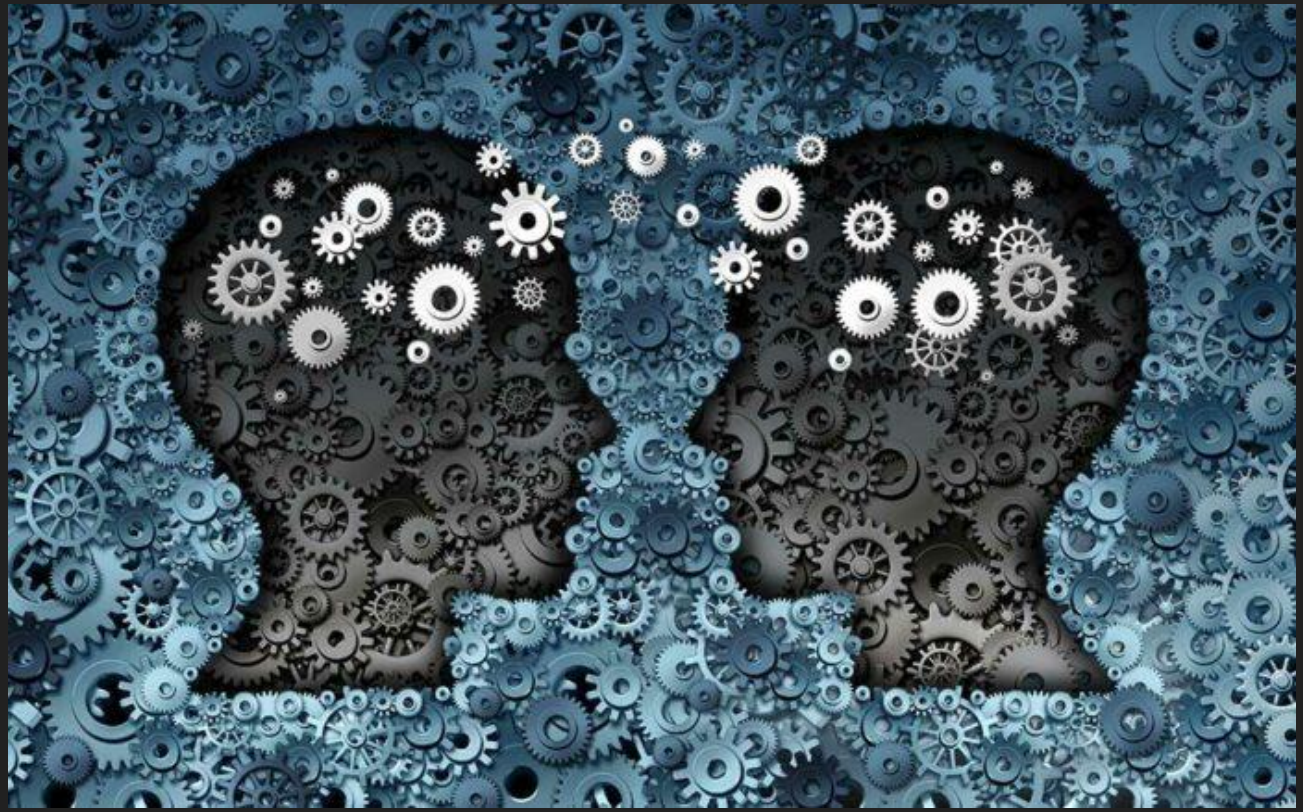
Figure 1.3 A crude comparison of the raw computational resources available to the IBM BLUE GENE supercomputer, a typical personal computer of 2008, and the human brain. The brain's numbers are essentially fixed, whereas the supercomputer's numbers have been increasing by a factor of 10 every 5 years or so, allowing it to achieve rough parity with the brain. The personal computer lags behind on all metrics except cycle time.

In Your Opinion Which is more efficient?

Conclusion

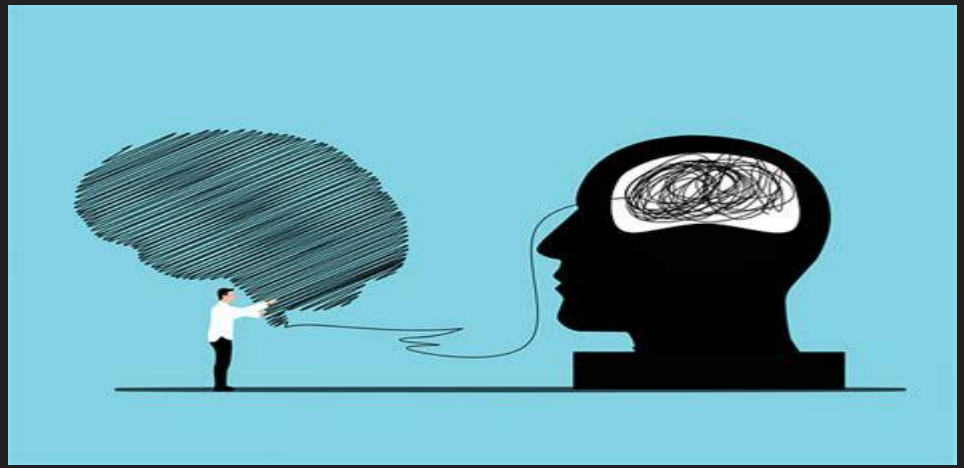
Neuroscience and AI is an interdisciplinary field that uses knowledge of the brain to improve AI systems, and AI can also help us to understand the brain better. By studying how the brain processes information, we can develop more efficient and intelligent AI systems.

Psychology and AI



Psychology and AI

- The study of how humans and animals think and act, and how this knowledge can be used to improve AI systems.
- AI has the potential to help us understand human and animal cognition better, and psychology can help to improve AI.



How do humans and animals think and act?

- Perception: the study of how we process and interpret sensory information
- Attention: the study of how we selectively focus on certain information
- Memory: the study of how we encode, store and retrieve information
- Decision making: the study of how we make choices based on the information available
- Social cognition: the study of how we understand and interact with other people

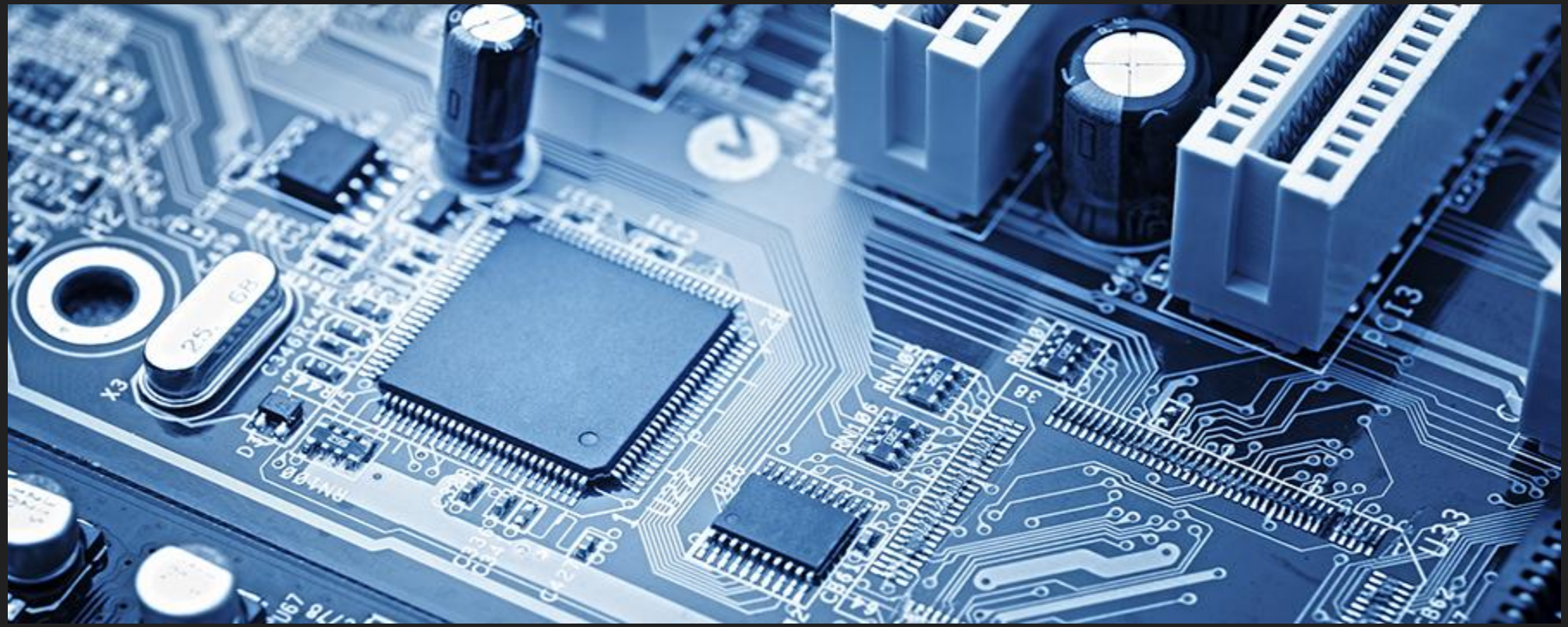
Applications of psychology in AI

- Human-computer interaction: the study of how people interact with technology and how to make technology more user-friendly
- Computational cognitive modeling: the use of computational models to simulate and explain human cognition
- Artificial general intelligence: the study of how to build AI systems that can perform tasks that typically require human intelligence.

Conclusion

Psychology and AI is an interdisciplinary field that uses knowledge of human and animal cognition to improve AI systems. By studying how humans and animals think and act, we can develop more human-like and effective AI systems.

Computer engineering And AI



The Birth Of THe Computer

- The first operational computer was the electromechanical Heath Robinson, built in 1940 by Alan Turing’s team for a single purpose: deciphering German messages.
- In 1943, the same group developed the Colossus, a powerful general-purpose machine based on vacuum tubes.
- The first operational programmable computer was the Z-3, the invention of Konrad Zuse in Germany in 1941.
- Zuse also invented floating-point numbers and the first high-level programming language, Plankalkul.
- The first electronic computer, the ABC, was assembled by John Atanasoff and his student Clifford Berry between 1940 and 1942 at Iowa State University.

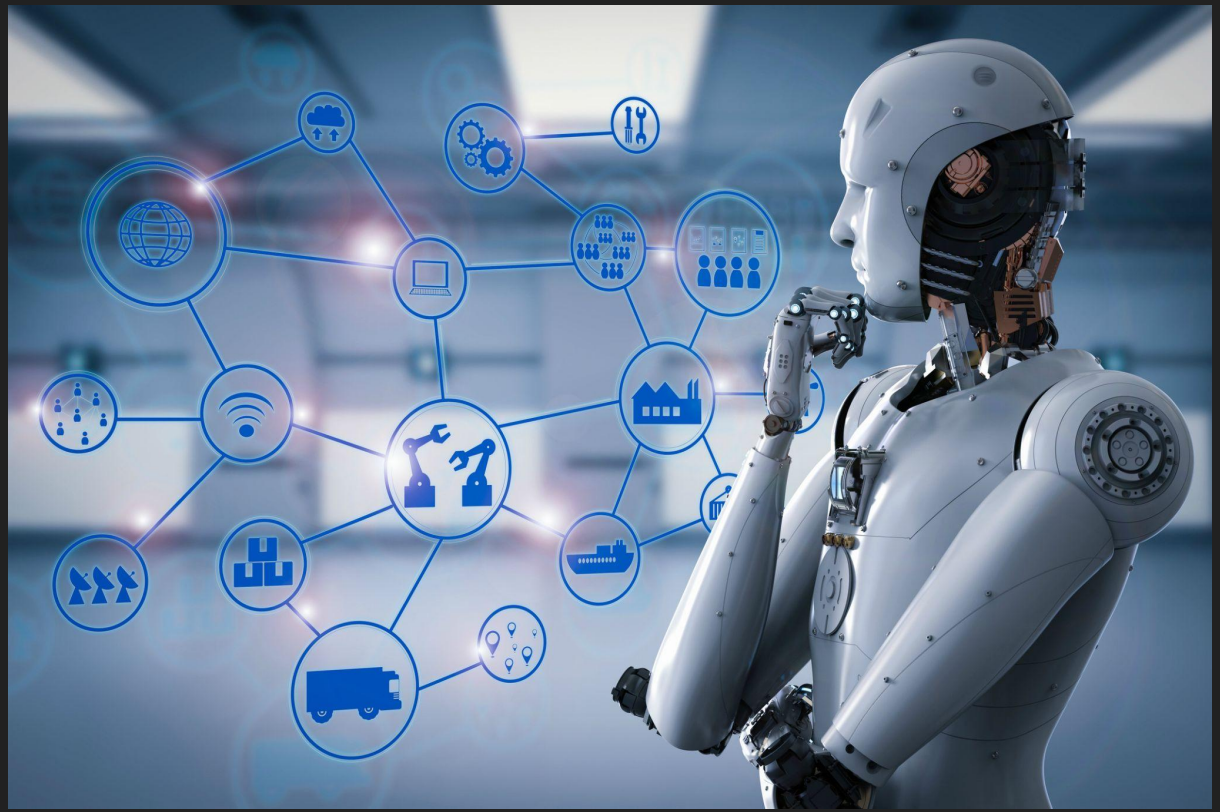
Revolution Of Computers

- The ENIAC, developed as part of a secret military project at the University of Pennsylvania by a team including John Mauchly and John Eckert, proved to be the most influential forerunner of modern computers.
- The performance of the computer doubled every 18 months or so until around 2005, when power dissipation problems led manufacturers to start multiplying the number of CPU cores rather than the clock speed.
- Current expectations are that future increases in power will come from massive parallelism—a curious convergence with the properties of the brain

How can we build an efficient computer?

- To build efficient computers for AI, we need to focus on maximizing performance and capacity.
- This can be achieved by:
  - Using powerful processors and graphics processing units (GPUs) that are specifically designed for AI workloads.
  - Increasing the amount of memory and storage, to allow the AI system to process large amounts of data.
  - Optimizing the software and algorithms used, to ensure that the system is running efficiently and effectively.
  - Parallel computing and distributed systems, to take advantage of the massive parallelism of the hardware

Control theory and cybernetics in AI



Control theory and cybernetics

- The study of how systems operate and how they can be controlled.
- It is used to design and analyze systems that can operate under their own control.
- It is based on mathematical models and algorithms that can be applied to a wide range of systems, including mechanical, electrical, and biological systems.

Applications of control theory and cybernetics in AI

- Autonomous systems: Control theory and cybernetics are used to design AI systems that can operate autonomously, without human intervention.
- Robotics: Control theory and cybernetics are used to design robots that can move, sense, and interact with the environment.
- Self-driving cars: Control theory and cybernetics are used to design vehicles that can drive themselves, without human intervention.

Key concepts in control theory and cybernetics

- Feedback control: The use of feedback from the system to control its behavior.
- Stability: The ability of a system to maintain a desired behavior over time.
- Adaptive control: The ability of a system to adjust its behavior based on changes in the environment.
- Examples: personalized ads, netflix recommendation system etc..

Examples

- Autonomous drones: Drones that can fly and navigate without human intervention,
- Smart home systems: Home automation systems that can control lights, temperature, and other devices using feedback from sensors to adjust the environment based on user preferences or changes in the environment.
- Industrial robots: Robots that can work in manufacturing and assembly lines, using control algorithms to perform repetitive tasks with high precision and speed.
- Autonomous vehicles: Cars, trucks, and other vehicles that can drive themselves, using control algorithms to sense and respond to the environment, make decisions, and navigate to a destination.

Conclusion

Control theory and cybernetics are an important field in AI, they are used to design AI systems that can operate autonomously, without human intervention, by providing mathematical models and algorithms that can be applied to a wide range of systems. Key concepts of control theory and cybernetics include feedback control, stability, and adaptive control which are essential for the AI system to operate under its own control.

Linguistics and AI

Linguistics

- The study of language and its structure, meaning, and use.
- It aims to understand how language relates to thought and how it can be used to convey meaning.
- It encompasses a wide range of fields, including phonetics, phonology, morphology, syntax, semantics, and pragmatics.

Applications of linguistics in AI

- Natural Language Processing (NLP): Linguistics is used to design AI systems that can understand and generate human language, such as machine translation, text-to-speech, and speech-to-text.
- Language understanding: Linguistics is used to design AI systems that can understand the meaning of text, speech, and other forms of language, such as question answering and sentiment analysis.
- Language generation: Linguistics is used to design AI systems that can generate human-like text, speech, and other forms of language, such as chatbots and virtual assistants.

Key concepts in linguistics

- Syntax: The study of the rules that govern the structure of sentences in a language.
- Semantics: The study of the meaning of words and sentences in a language.
- Pragmatics: The study of how language is used in context and how it conveys meaning.

Conclusion

Linguistics plays a crucial role in AI, particularly in the field of natural language processing. It helps to connect language and thought by providing a way to understand and model the structure, meaning, and use of human language. Key concepts in linguistics such as Syntax, semantics, and pragmatics are essential to the design of AI systems that can understand and generate human language.

The State Of The Art

- Deep Learning
- Reinforcement Learning
- Generative Models
- Supervised Learning
- Unsupervised Learning
- etc...

End Of Lecture!!