

Artificial Intelligence

2025



- Introduction to AI
- Problem solving and agents
- Uninformed search
- Informed search
- Local search
- Constraint satisfaction problems
- Adversarial search, Minmax and Alpha beta pruning



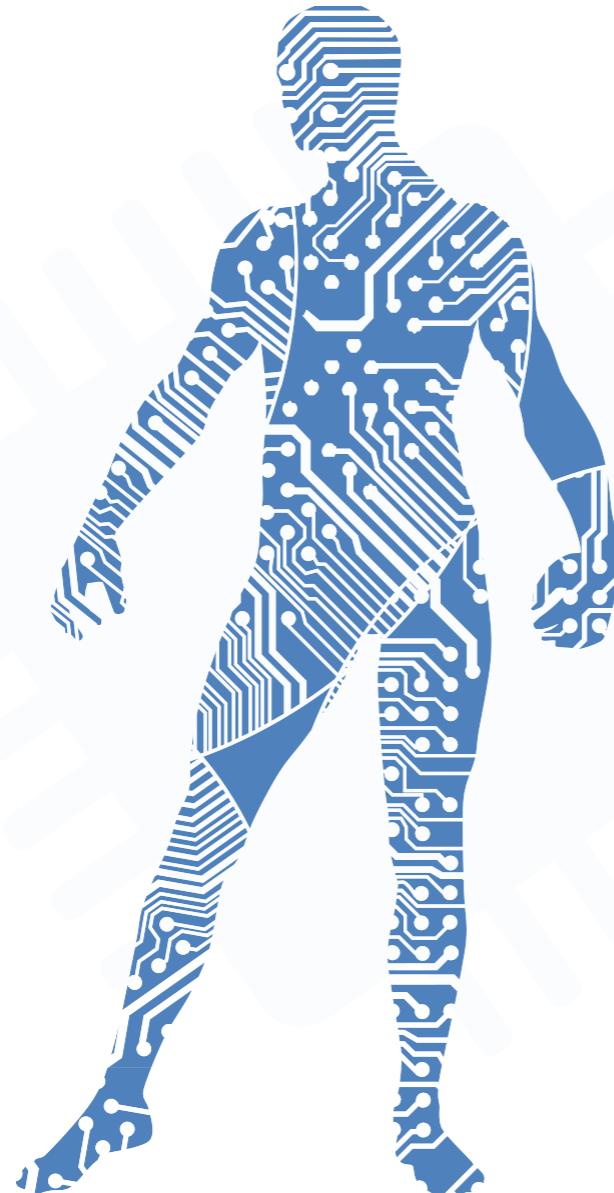
- Machine learning
- Natural language Processing
- Neural Network
- Generative AI
- Evolutionary Computing
- Agentic AI



- **Artificial Intelligence: A Modern Approach, 3rd edition by S. Russell and P. Norvig, Prentice Hall, 2010.**
- Artificial Intelligence: Structures and Strategies for Complex Problem Solving, 6th ed. G. Luger, Addison Wesley, 2009
- AI Algorithms, Data Structures, and Idioms in Prolog, Lisp and Java, G. Luger and W. Stubblefield, Addison Wesley, 2009
- Artificial Intelligence: A Systems Approach. M. Tim Jones, Infinity Science Press, 2008

Today's Agenda

- 1. What is AI ?**
 - 2. A brief history**
-
- 03 Applications of AI**
-
-
- 04 The state of the art**





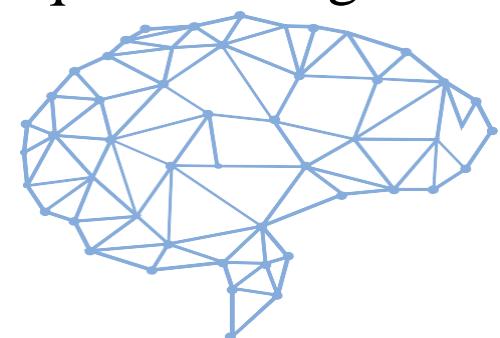
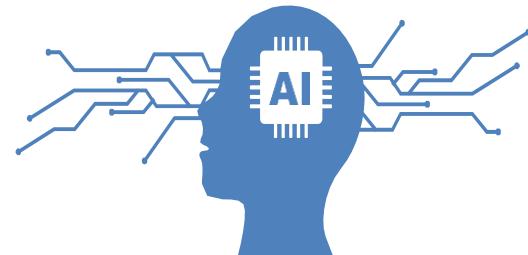
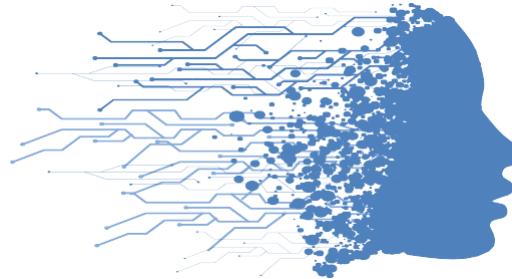
What is  ?



What is Artificial Intelligence ?

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- Making computers that think ?
- The automation of activities we associate with human thinking, like decision making, learning ... ?
- The art of creating machines that perform functions that require intelligence when performed by people ?





What is Artificial Intelligence ?

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- Artificial
 - Produced by human art or effort, rather than originating naturally.
- Intelligence
 - "is the ability to acquire knowledge and use it" [Pigford and Baur]
- **So, AI is defined as:**
 - **AI** is the study of ideas that enable computers to be intelligent.
 - **AI** is the part of computer science concerned with design of computer systems that exhibit human intelligence(From the Concise Oxford Dictionary)



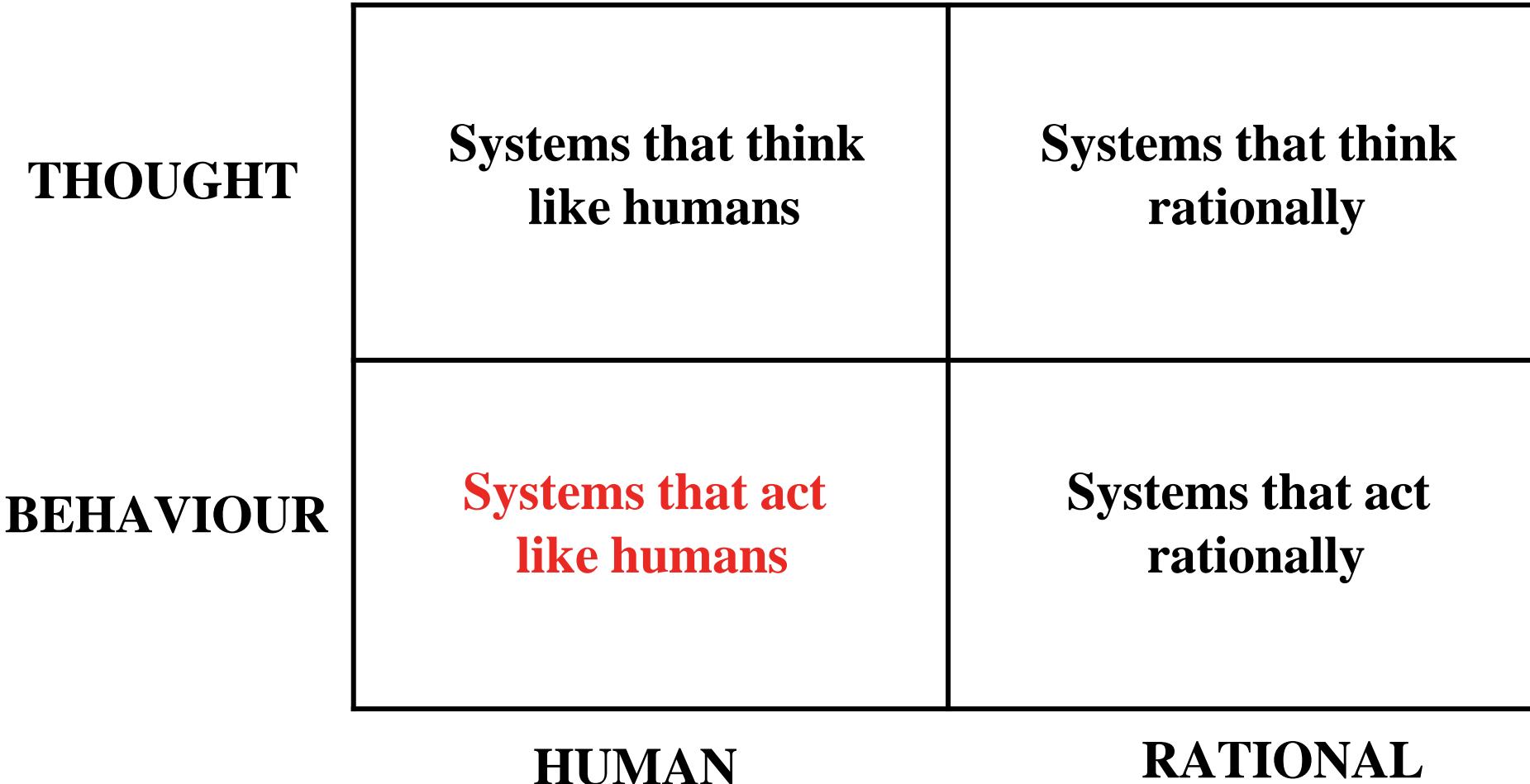
What is Artificial Intelligence ?

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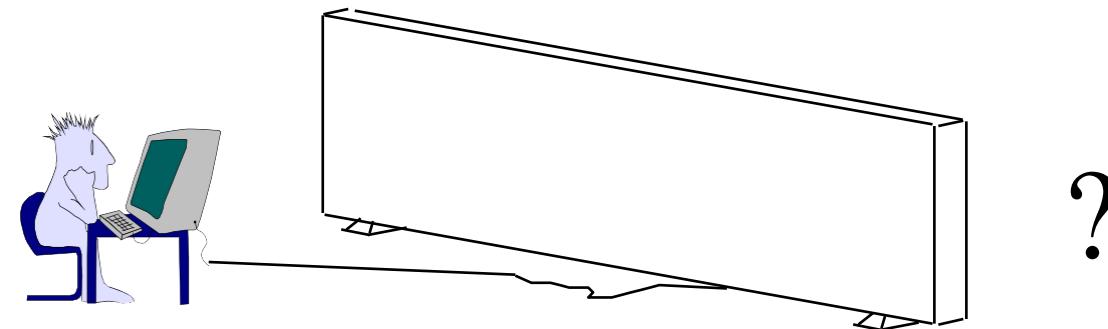
- From the above two definitions, we can see that AI has two major roles:
 - Study the intelligent part concerned with humans.
 - Represent those actions using computers.



What is Artificial Intelligence ?



- You enter a room which has a computer terminal. You have a fixed period of time to type what you want into the terminal and study the replies. At the other end of the line is either a human being or a computer system.



- If it is a computer system, and at the end of the period you cannot reliably determine whether it is a system or a human, then the system is deemed to be intelligent.

- The Turing Test approach
 - a human questioner cannot tell if there is a computer or a human answering his question, via teletype (remote communication)
 - The computer must behave intelligently
- Intelligent behavior
 - to achieve human-level performance in all cognitive tasks

TURING TEST EXTRA CREDIT:
CONVINCE THE EXAMINER
THAT HE'S A COMPUTER.

YOU KNOW, YOU MAKE
SOME REALLY GOOD POINTS.

I'M ... NOT EVEN SURE
WHO I AM ANYMORE.





Acting humanly

- Proposed by Alan Turing (1950)
- Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes
- Anticipated all major arguments against AI in following 50 years

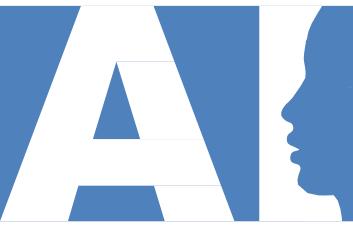


Systems that Act like Humans

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Suggested major components of AI:

- *Natural language processing*
 - for communication with human
- *Knowledge representation*
 - to store information effectively & efficiently
- *Automated reasoning*
 - to retrieve & answer questions using the stored information
- *Machine learning*
 - to adapt to new circumstances



What is Artificial Intelligence ?

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THOUGHT

BEHAVIOUR

Systems that think
like humans

Systems that think
rationally

Systems that act
like humans

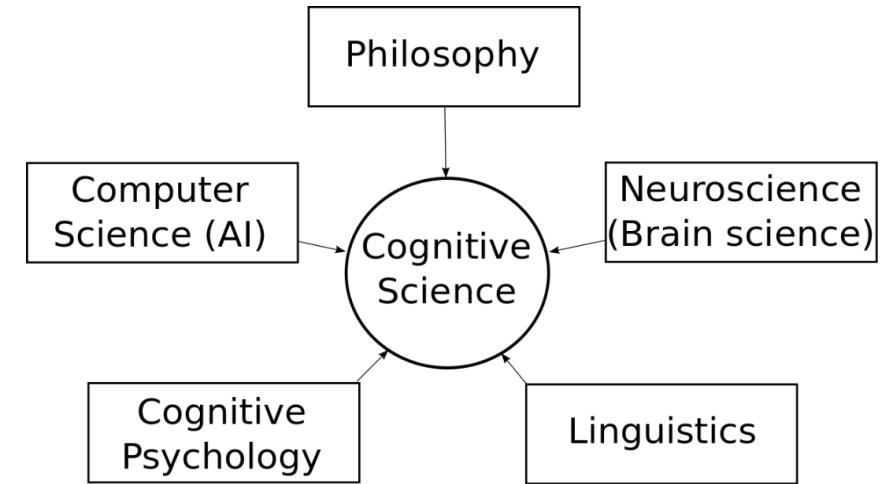
Systems that act
rationally

HUMAN

RATIONAL

Cognitive Science

- Humans as observed from ‘inside’
- How do we know how humans think?
 - Introspection vs. psychological experiments
- “[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning …” (Bellman)





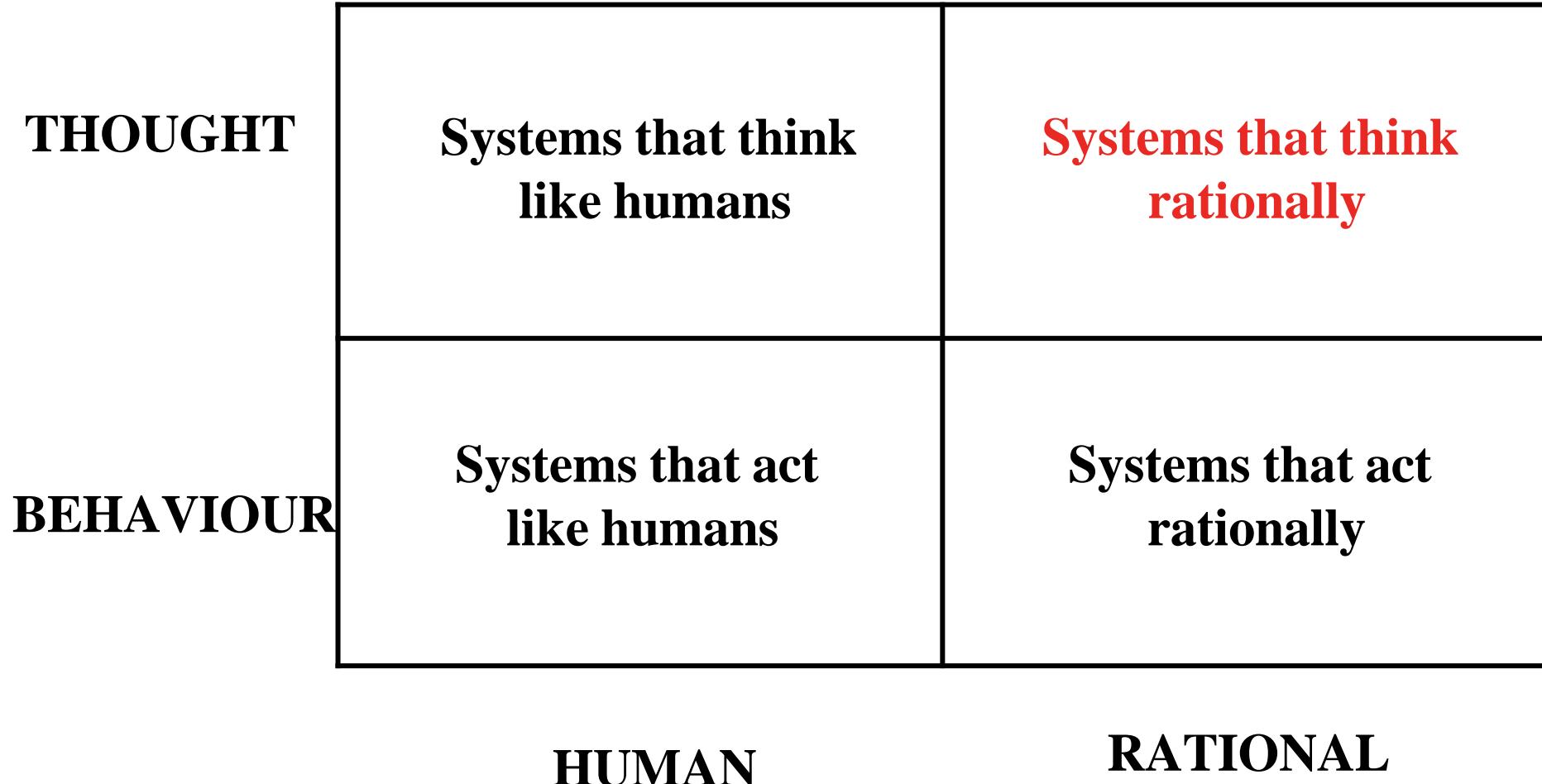
Thinking humanly: Cognitive Science

- 1960s --cognitive revolution: information-processing psychology replaced prevailing orthodoxy of behaviorism
- Requires scientific theories of internal activities of the brain
- How to validate? Requires
- Predicting and testing behavior of human subjects (topdown)
 - or
- Direct identification from neurological data (bottom-up)



What is Artificial Intelligence ?

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Systems that think ‘rationally’

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"laws of thought"

- Humans are not always ‘rational’
- Rational - defined in terms of logic?
- Logic can’t express everything (e.g. uncertainty)
- Logical approach is often not feasible in terms of computation time (needs ‘guidance’)
- “The study of the computations that make it possible to perceive, reason, and act” (Winston)



Thinking rationally: Laws of Thought

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- Normative (or prescriptive) rather than descriptive
- Aristotle: what are correct arguments/thought processes?
- Several Greek schools developed various forms of logic:
- Notation and rules of derivation for thoughts
- Direct line through mathematics and philosophy to modern AI



What is Artificial Intelligence ?

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| | | |
|-------------------------|---|--------------------------------------|
| | <p>THOUGHT</p> <p>Systems that think like humans</p> | <p>Systems that think rationally</p> |
| <p>BEHAVIOUR</p> | <p>Systems that act like humans</p> | <p>Systems that act rationally</p> |

HUMAN **RATIONAL**

AI Systems that act ‘rationally’

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- Rational behavior: doing the right thing
- The right thing: that which is expected to maximize goal achievement, given the available information
- Giving answers to questions is ‘acting’.
- I don't care whether a system:
 - Replicates human thought processes
 - Makes the same decisions as humans
 - Uses purely logical reasoning



Systems that act ‘rationally’

- Logic
 - Sometimes logic cannot reason a correct conclusion
 - At that time, some specific (in domain) human knowledge or information is used
- Thus, it covers more generally different situations of problems
 - Compensate the incorrectly reasoned conclusion



AI prehistory

- Philosophy
 - logic, methods of reasoning
 - mind as physical system
 - foundations of learning, language, rationality
- Mathematics
- formal representation and proof
- algorithms, computation, (un)decidability, (in)tractability
- probability
- Psychology
 - adaptation
 - phenomena of perception and motor control
 - experimental techniques (psychophysics, etc.)



- Economics
 - formal theory of rational decisions
- Linguistics
 - knowledge representation
 - grammar
- Neuroscience
 - physical substrate for mental activity
- Control theory
 - homeostatic systems, stability
 - simple optimal agent designs



History of AI

- 1943 McCulloch & Pitts: Boolean circuit model of brain
- 1950 Turing's Computing Machinery and Intelligence"
- 1950s Early AI programs, including Samuel's checkers program,
- Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
- 1956 Dartmouth meeting: "Artificial Intelligence" adopted
- 1965 Robinson's complete algorithm for logical reasoning
- 1966--74 AI discovers computational complexity
- Neural network research almost disappears
- 1969--79 Early development of knowledge-based systems
- 1980--88 Expert systems industry booms
- 1988--93 Expert systems industry fall: "AI Winter"
- 1985--95 Neural networks return to popularity
- 1988--- Resurgence of probability; Nouvelle AI: A Life, GAs, soft computing
- 1995--Agents, agents, everywhere :: :
- 2003-- Human-level AI back on the agenda.....

AI Applications

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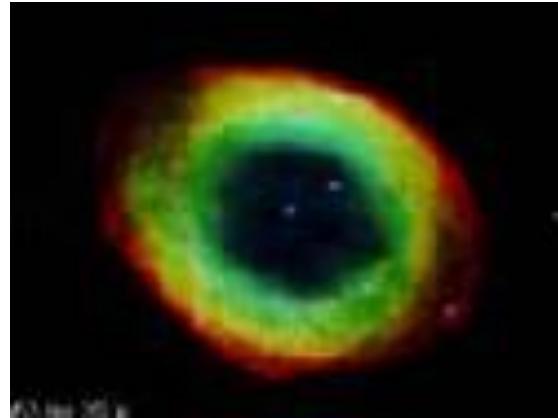
- Autonomous Planning & Scheduling:
 - Autonomous rovers.



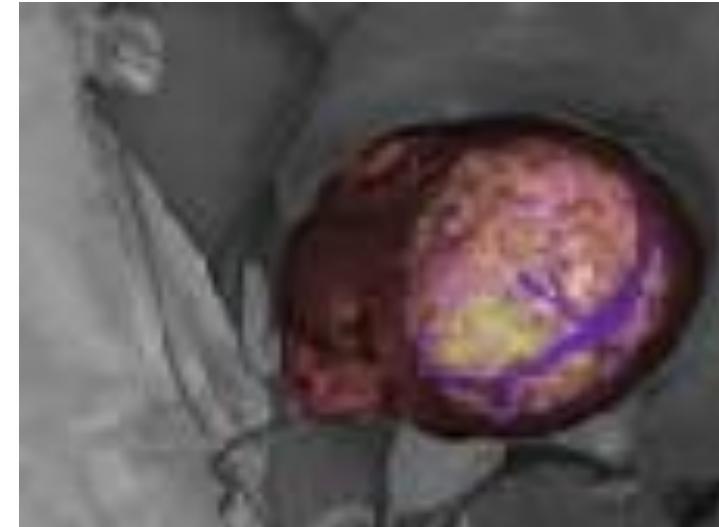
- Autonomous Planning & Scheduling:
 - Telescope scheduling



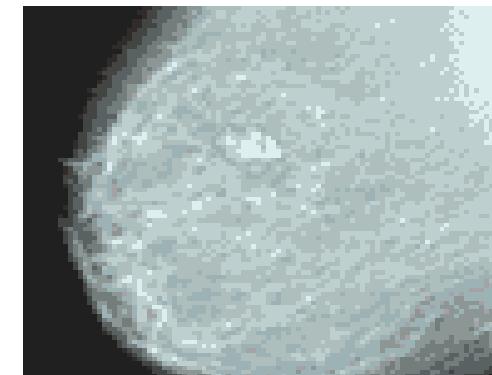
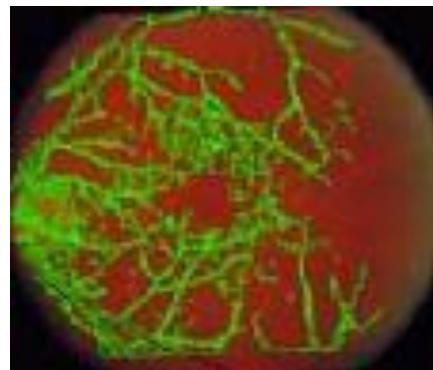
- Autonomous Planning & Scheduling:
 - Analysis of data



- **Medicine:**
 - Image guided surgery
 - Disease Prediction



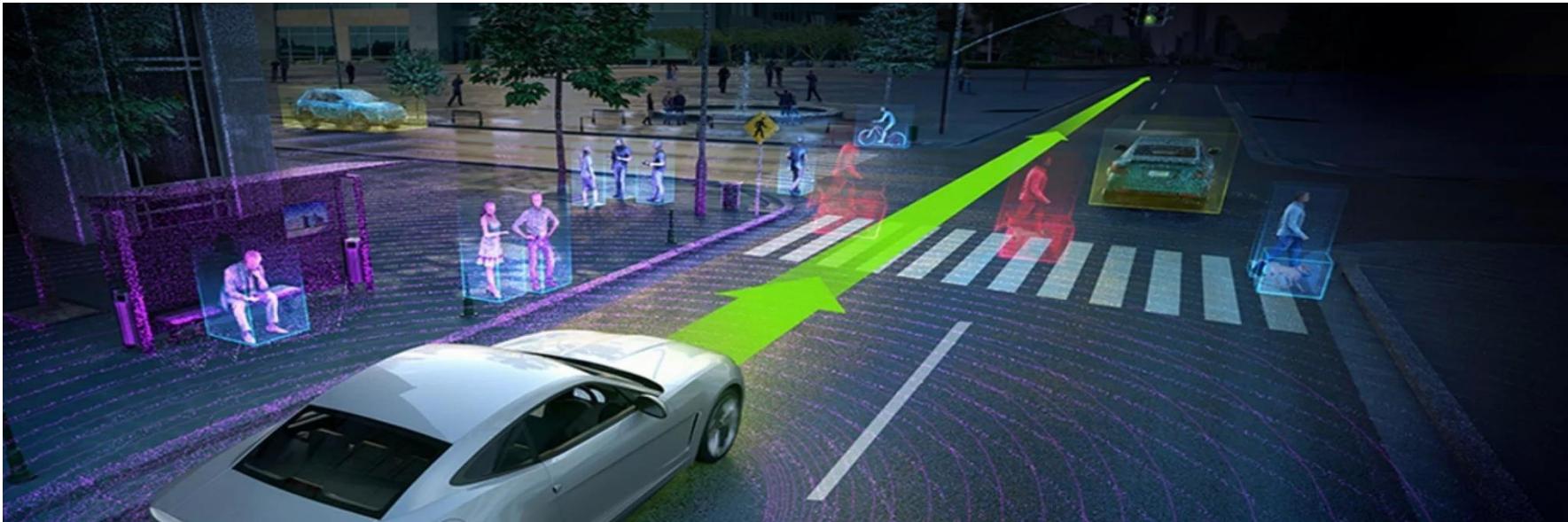
- **Medicine:**
 - Image analysis and enhancement

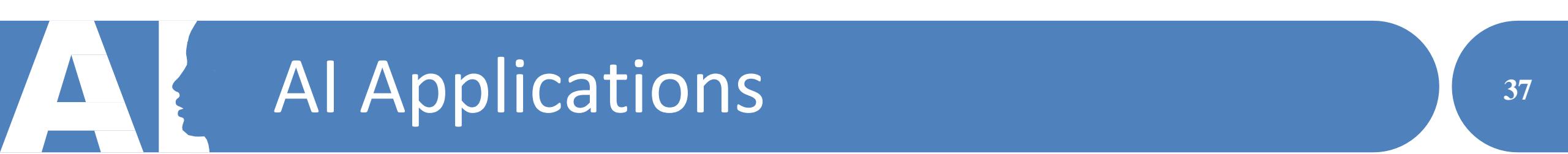


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AI Applications

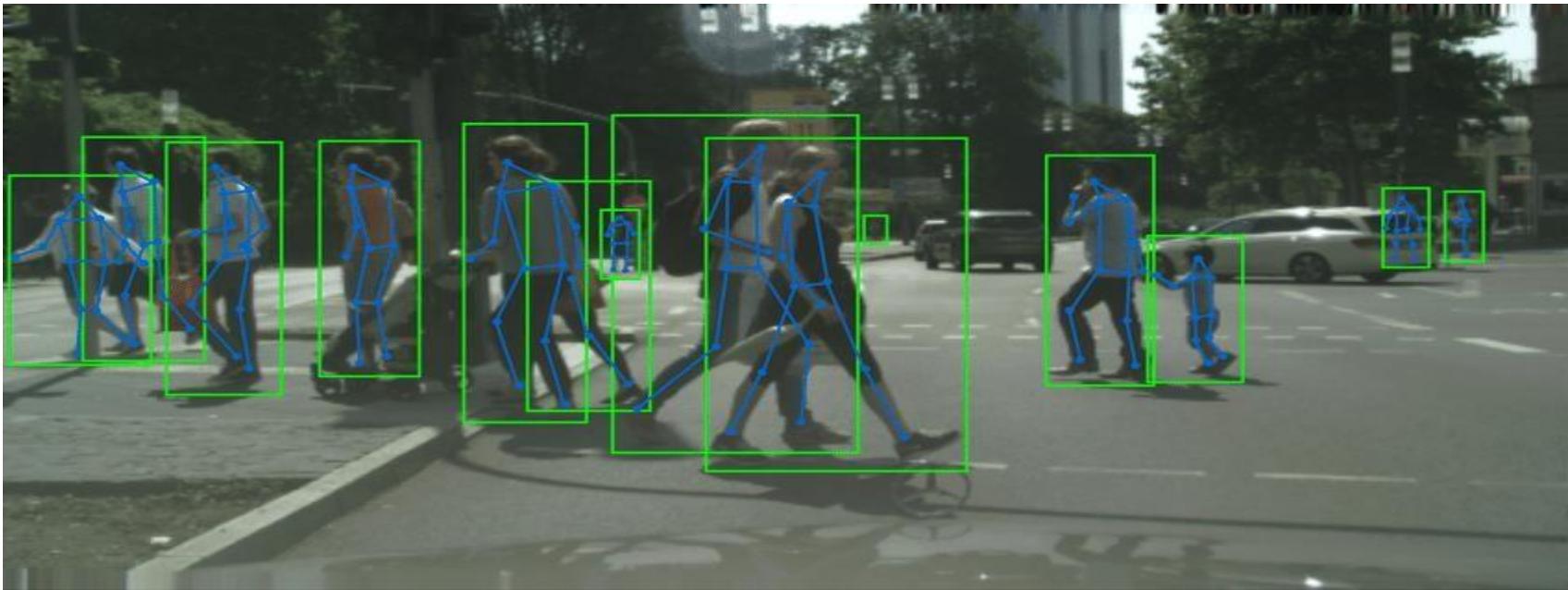
- **Transportation:**
 - Autonomous vehicle control:





AI Applications

- **Transportation:**
 - Pedestrian detection

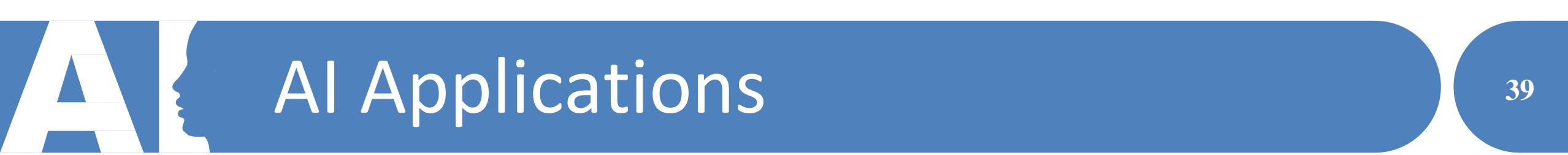


A AI Applications

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- Games:





- **Other application areas:**
- **Bioinformatics:**
 - Gene expression data analysis
 - Prediction of protein structure
- **Text classification, document sorting:**
 - Web pages, e-mails
 - Articles in the news
- **Video, image classification**
- **Music composition, picture drawing**
- **Natural Language Processing**



State of the art

Which of the following can be done at present?

- Play a decent game of table tennis
- Drive safely along a curving mountain road
- Buy a week's worth of groceries on the web
- Play a decent game of bridge
- Discover and prove a new mathematical theorem
- Design and execute a research program in molecular biology
- Write an intentionally funny story
- Give competent legal advice in a specialized area of law
- Translate spoken English into spoken Swedish in real time
- Converse successfully with another person for an hour
- Perform a complex surgical operation