

Artificial Intelligence

2025



Course Contents

06

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



Course Contents

07

- 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



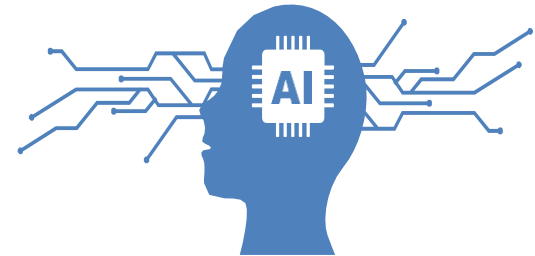


What is **AI**?

- 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 ?

12

- 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 ?

13

- 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.

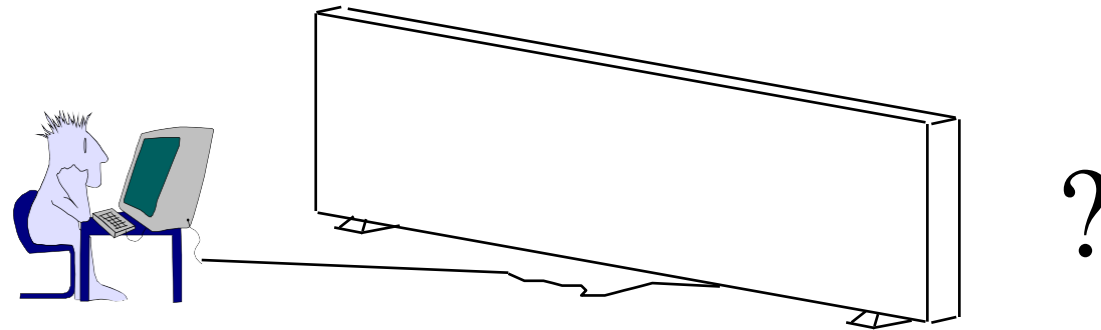


What is Artificial Intelligence ?

14

THOUGHT	Systems that think like humans	Systems that think rationally
	Systems that act like humans	Systems that act rationally
	HUMAN	RATIONAL

- 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

17

- 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

18

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



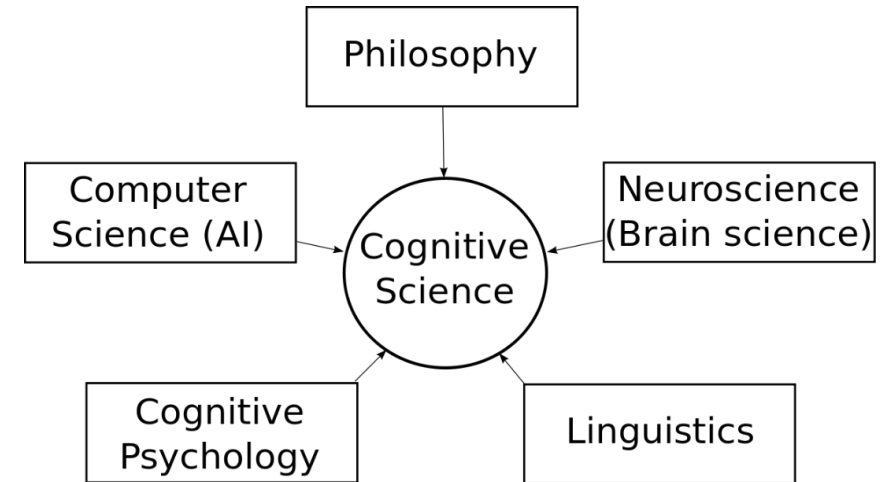
What is Artificial Intelligence ?

19

		THOUGHT	
		Systems that think like humans	Systems that think rationally
BEHAVIOUR	HUMAN	Systems that act like humans	Systems that act rationally
	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)





- 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 ?

22

THOUGHT BEHAVIOUR		Systems that think like humans	Systems that think rationally
		Systems that act like humans	Systems that act rationally
		HUMAN	RATIONAL

"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

24

- 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 ?

25

		THOUGHT	
		Systems that think like humans	Systems that think rationally
BEHAVIOUR	HUMAN	Systems that act like humans	Systems that act rationally
	RATIONAL		

- **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

- 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

- 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

30

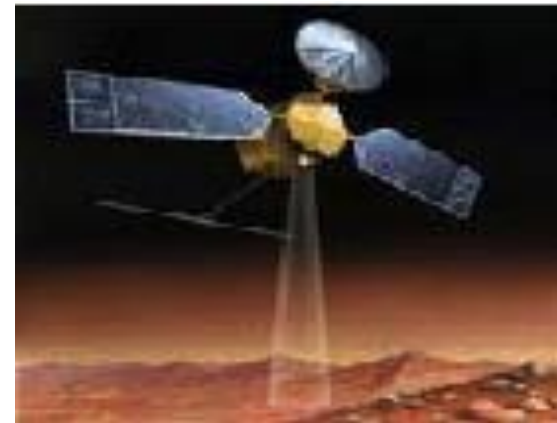
- 1943 McCulloch & Pitts: Boolean circuit model of brain
- 1950 Turing's Computing Machinery and Intelligence"
- 1950s Early AI programs, including Samuel's checkers program,
- Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
- 1956 Dartmouth meeting: "Artificial Intelligence" adopted
- 1965 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

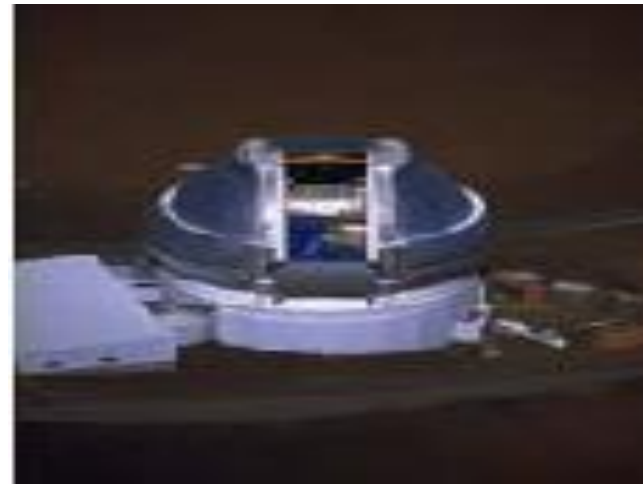
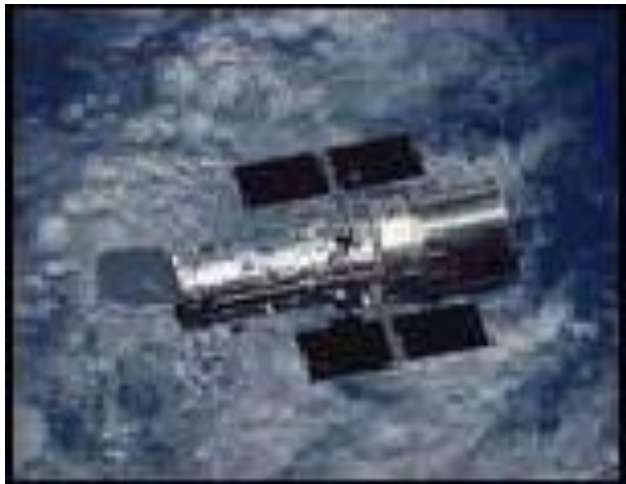
31

- Autonomous Planning & Scheduling:
 - Autonomous rovers.



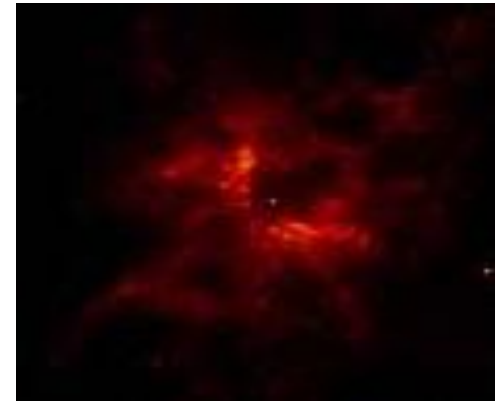
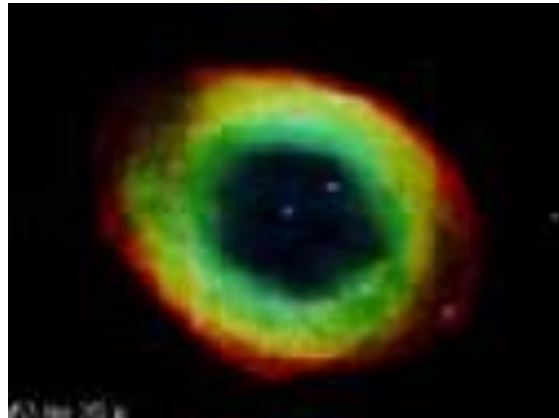


- Autonomous Planning & Scheduling:
 - Telescope scheduling





- Autonomous Planning & Scheduling:
 - Analysis of data

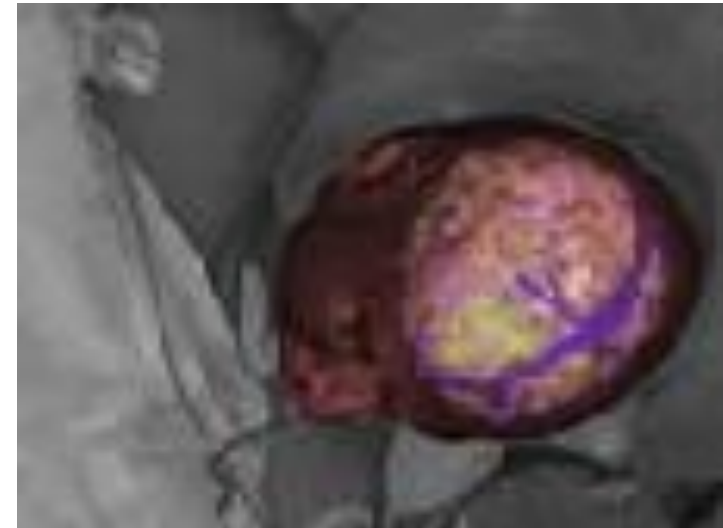




AI Applications

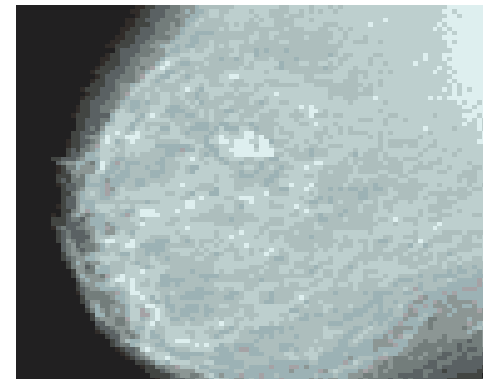
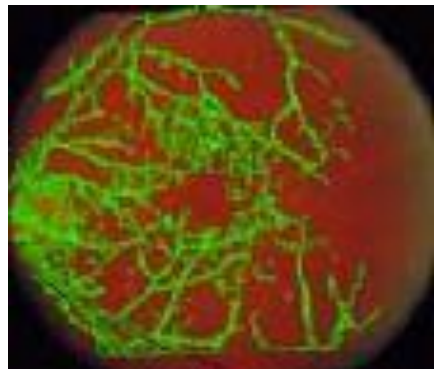
34

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





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

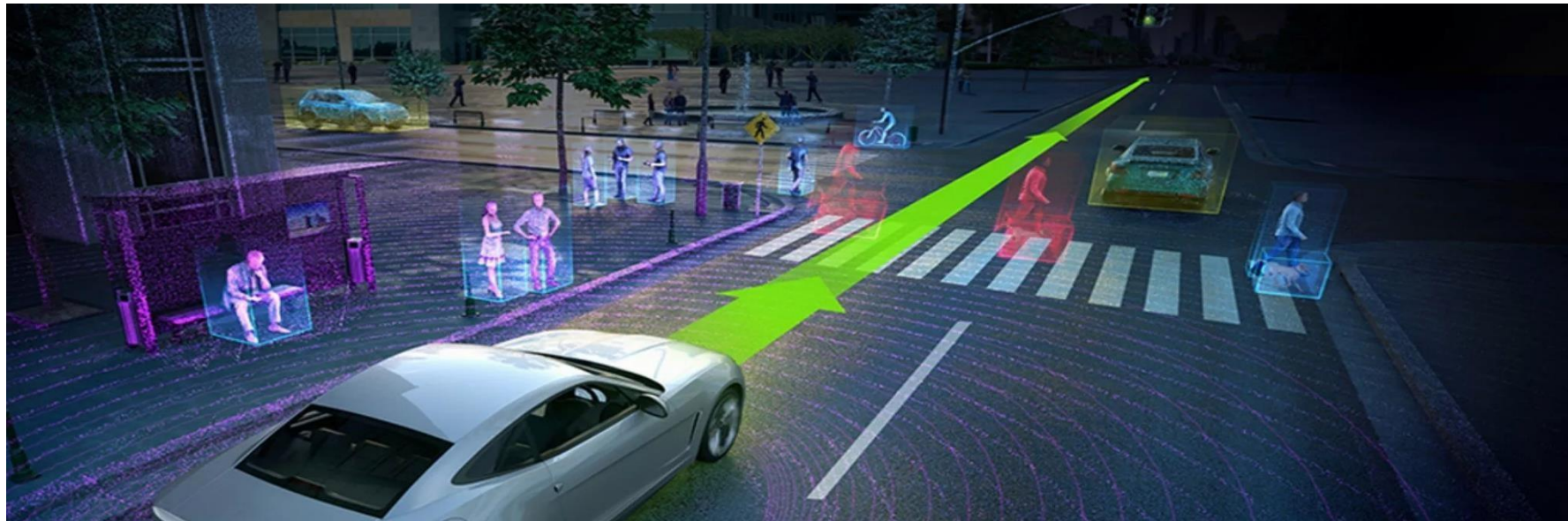




AI Applications

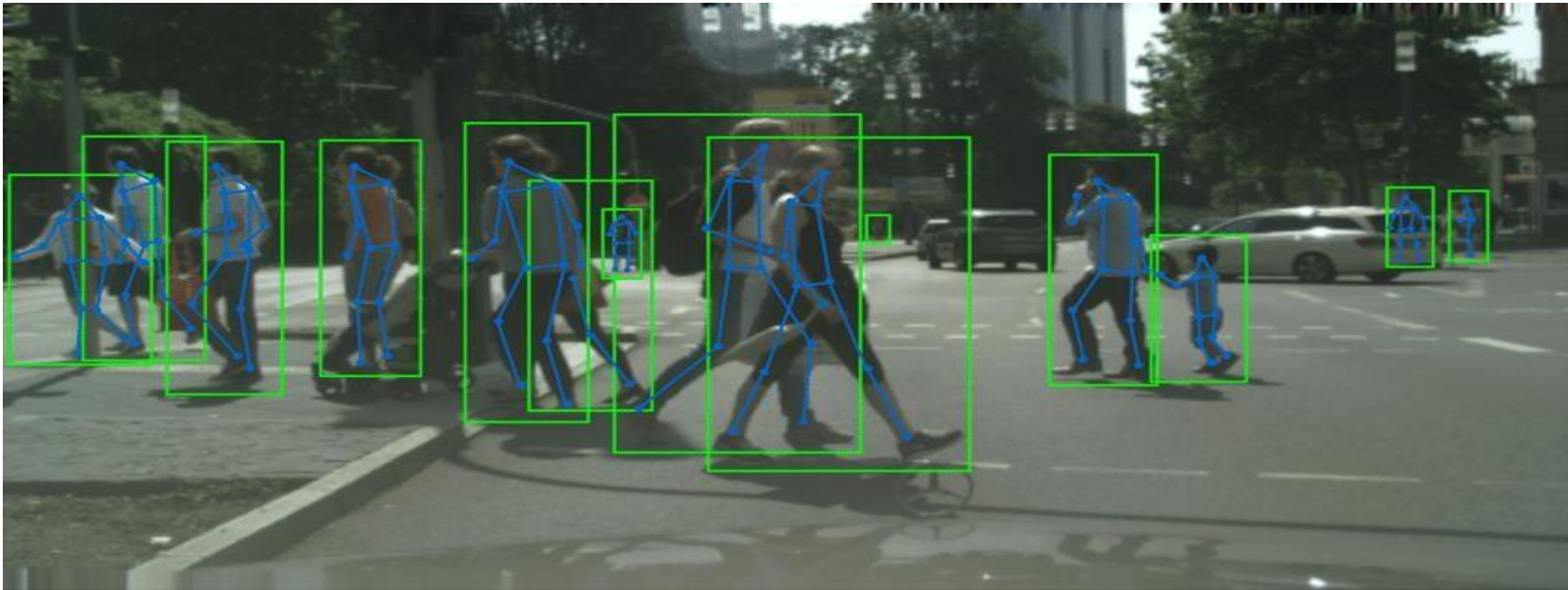
36

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





- **Transportation:**
 - Pedestrian detection





AI Applications

38

- 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**



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