

# Outline

- What is AI?
- A brief history
- The state of the art

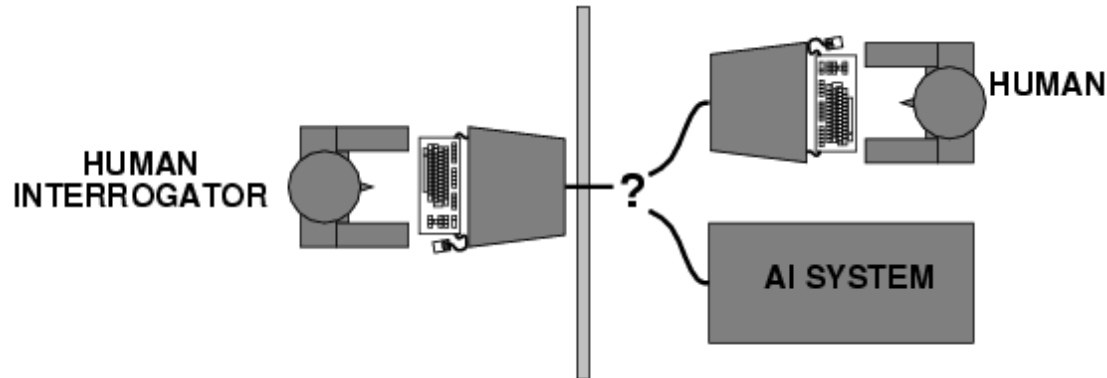
# What is AI?

Views of AI fall into four categories:

Thinking humanly	Thinking rationally
Acting humanly	Acting rationally

# Acting humanly: Turing Test

- Turing (1950) "Computing machinery and intelligence":
- "Can machines think?" → "Can machines behave intelligently?"
- Operational test for intelligent behavior: the Imitation Game



- 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
- Suggested major components of AI: knowledge, reasoning, language understanding, learning
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The computer would need to possess the following capabilities:

- **Natural language processing:** to enable it to communicate successfully in English
- **Knowledge representation:** to store what it knows or hears
- **Automated reasoning:** to use the stored information to answer questions and to draw new conclusions
- **Machine learning:** to adapt to new circumstances and to detect and extrapolate patterns

# Total Turing Test

- Includes a *video signal* – interrogator can test the subject's “*perceptual capabilities*”, as well as the opportunity to pass physical objects “through the hatch”
- To pass Total Turing Test, the computer will need:
- **Computer Vision:** to perceive the objects, and
- **Robotics:** to manipulate objects and move about.

# Thinking humanly: cognitive modeling

- 1960s "cognitive revolution": information-processing psychology
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- Requires scientific theories of internal activities of the brain
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- -- How to validate? Requires
  - 1) Predicting and testing behavior of human subjects (top-down)
  - or 2) Direct identification from neurological data (bottom-up)
- Both approaches (roughly, Cognitive Science and Cognitive Neuroscience) are now distinct from AI
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# Thinking rationally: "laws of thought"

- Aristotle: what are correct arguments/thought processes?
- Several Greek schools developed various forms of *logic: notation* and *rules of derivation* for thoughts; may or may not have proceeded to the idea of mechanization
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- Direct line through mathematics and philosophy to modern AI
- Problems:
  1. Not all intelligent behavior is mediated by logical deliberation
  2. What is the purpose of thinking? What thoughts should I have?

# Acting rationally: rational agent

- **Rational** behavior: doing the right thing
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- The right thing: that which is expected to maximize goal achievement, given the available information
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- Doesn't necessarily involve thinking – e.g., blinking reflex – but thinking should be in the service of rational action



# Rational agents

- An **agent** is an entity that perceives and acts
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- This course is about designing rational agents
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- Abstractly, an agent is a function from percept histories to actions:

$$[f. \mathcal{P}^* \rightarrow \mathcal{A}]$$

- For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance
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- Computational limitations make perfect rationality unachievable → design best **program** for given machine resources
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# 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
- Economics utility, decision theory
- Neuroscience physical substrate for mental activity
- Psychology phenomena of perception and motor control, experimental techniques
- Computer engineering building fast computers
- Control theory design systems that maximize an objective function over time
- Linguistics knowledge representation, grammar

# Abridged history of AI

- 1943 McCulloch & Pitts: Boolean circuit model of brain
- 1950 Turing's "Computing Machinery and Intelligence"
- 1956 Dartmouth meeting: "Artificial Intelligence" adopted
- 1952—69 Look, Ma, no hands!
- 1950s Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
- 1965 Robinson's complete algorithm for logical reasoning
- 1966—73 AI discovers computational complexity  
Neural network research almost disappears
- 1969—79 Early development of knowledge-based systems
- 1980-- AI becomes an industry
- 1986-- Neural networks return to popularity
- 1987-- AI becomes a science
- 1995-- The emergence of intelligent agents

# State of the art

- Deep Blue defeated the reigning world chess champion Garry Kasparov in 1997
- Proved a mathematical conjecture (Robbins conjecture) unsolved for decades
- No hands across America (driving autonomously 98% of the time from Pittsburgh to San Diego)
- During the 1991 Gulf War, US forces deployed an AI logistics planning and scheduling program that involved up to 50,000 vehicles, cargo, and people
- NASA's on-board autonomous planning program controlled the scheduling of operations for a spacecraft
- `Proverb` solves crossword puzzles better than most humans

# State of the Art

- Robotic Vehicles (STANLY, CMU'S BOSS)
- Speech Recognition (United Airlines reservation)
- Autonomous planning and scheduling (Remote Agent – Spacecraft, Mars Explorer)
- Game playing (IBM DEEP BLUE, ALPHA GO/DeepMind)
- Spam fighting
- Logistics planning (automated logistics planning and scheduling for transportation during Gulf war in 1991)
- Robotics (iRobot corporation's Roomba Vacuum Cleaner robot)
- Machine translation (Arabic to English; statistics and ML only)