

# ARTIFICIAL INTELLIGENCE

## CHAPTER 1

# Outline

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

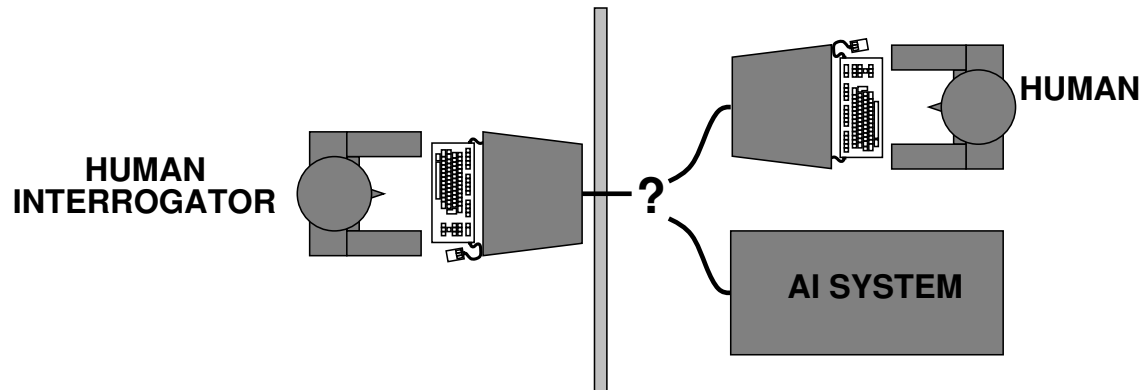
# What is AI?

Systems that think like humans	Systems that think rationally
Systems that act like humans	Systems that act rationally

# Acting humanly: The 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

Problem: Turing test is not **reproducible**, **constructive**, or amenable to **mathematical analysis**

# Thinking humanly: Cognitive Science

1960s “cognitive revolution”: information-processing psychology replaced prevailing orthodoxy of behaviorism

Requires scientific theories of internal activities of the brain

- What level of abstraction? “Knowledge” or “circuits”?
- 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

Both share with AI the following characteristic:

**the available theories do not explain (or engender)  
anything resembling human-level general intelligence**

Hence, all three fields share one principal direction!

# Thinking rationally: Laws of Thought

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;  
may or may not have proceeded to the idea of mechanization

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 out of all the thoughts (logical or otherwise) that I **could** have?

## Acting rationally

**Rational** behavior: doing the right thing

The right thing: that which is expected to maximize goal achievement, given the available information

Doesn't necessarily involve thinking—e.g., blinking reflex—but thinking should be in the service of rational action

Aristotle (Nicomachean Ethics):

**Every art and every inquiry, and similarly every action and pursuit, is thought to aim at some good**

# Rational agents

An **agent** is an entity that perceives and acts

This course is about designing **rational agents**

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

Caveat: **computational limitations make perfect rationality unachievable**

→ design best **program** for given machine resources



## Potted history of AI

- 1943 McCulloch & Pitts: Boolean circuit model of brain
- 1950 Turing's "Computing Machinery and Intelligence"
- 1952–69 Look, Ma, no hands!
- 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 busts: "AI Winter"
- 1985–95 Neural networks return to popularity
- 1988– Resurgence of probability; general increase in technical depth  
"Nouvelle AI": ALife, GAs, soft computing
- 1995– Agents, agents, everywhere . . .
- 2003– Human-level AI back on the agenda

## State of the art

Which of the following can be done at present?

◇ Play a decent game of table tennis

## 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

## 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
- ◇ Drive safely along Telegraph Avenue

## 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
- ◇ Drive safely along Telegraph Avenue
- ◇ Buy a week's worth of groceries on the web

## 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
- ◇ Drive safely along Telegraph Avenue
- ◇ Buy a week's worth of groceries on the web
- ◇ Buy a week's worth of groceries at Berkeley Bowl

## 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
- ◇ Drive safely along Telegraph Avenue
- ◇ Buy a week's worth of groceries on the web
- ◇ Buy a week's worth of groceries at Berkeley Bowl
- ◇ Play a decent game of bridge

## 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
- ◇ Drive safely along Telegraph Avenue
- ◇ Buy a week's worth of groceries on the web
- ◇ Buy a week's worth of groceries at Berkeley Bowl
- ◇ Play a decent game of bridge
- ◇ Discover and prove a new mathematical theorem



## 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
- ◇ Drive safely along Telegraph Avenue
- ◇ Buy a week's worth of groceries on the web
- ◇ Buy a week's worth of groceries at Berkeley Bowl
- ◇ Play a decent game of bridge
- ◇ Discover and prove a new mathematical theorem
- ◇ Design and execute a research program in molecular biology

## 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
- ◇ Drive safely along Telegraph Avenue
- ◇ Buy a week's worth of groceries on the web
- ◇ Buy a week's worth of groceries at Berkeley Bowl
- ◇ 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

## 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
- ◇ Drive safely along Telegraph Avenue
- ◇ Buy a week's worth of groceries on the web
- ◇ Buy a week's worth of groceries at Berkeley Bowl
- ◇ 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

## 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
- ◇ Drive safely along Telegraph Avenue
- ◇ Buy a week's worth of groceries on the web
- ◇ Buy a week's worth of groceries at Berkeley Bowl
- ◇ 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

## 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
- ◇ Drive safely along Telegraph Avenue
- ◇ Buy a week's worth of groceries on the web
- ◇ Buy a week's worth of groceries at Berkeley Bowl
- ◇ 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

## 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
- ◇ Drive safely along Telegraph Avenue
- ◇ Buy a week's worth of groceries on the web
- ◇ Buy a week's worth of groceries at Berkeley Bowl
- ◇ 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

## 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
- ◇ Drive safely along Telegraph Avenue
- ◇ Buy a week's worth of groceries on the web
- ◇ Buy a week's worth of groceries at Berkeley Bowl
- ◇ 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
- ◇ Unload any dishwasher and put everything away

## 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
- ◇ Drive safely along Telegraph Avenue
- ◇ Buy a week's worth of groceries on the web
- ◇ Buy a week's worth of groceries at Berkeley Bowl
- ◇ 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
- ◇ Unload any dishwasher and put everything away



## Unintentionally funny stories

One day Joe Bear was hungry. He asked his friend Irving Bird where some honey was. Irving told him there was a beehive in the oak tree. Joe threatened to hit Irving if he didn't tell him where some honey was. The End.

Henry Squirrel was thirsty. He walked over to the river bank where his good friend Bill Bird was sitting. Henry slipped and fell in the river. Gravity drowned. The End.

Once upon a time there was a dishonest fox and a vain crow. One day the crow was sitting in his tree, holding a piece of cheese in his mouth. He noticed that he was holding the piece of cheese. He became hungry, and swallowed the cheese. The fox walked over to the crow. The End.

# Examples of Current AI

Deep Blue - the massively parallel search computer



1996 became world champion

Why did it work?

# Examples of Current AI

Deep Blue - the massively parallel search computer

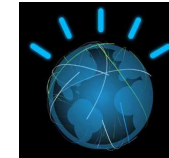
1996 became world champion





Why did it worked? - The game is a collection of challenging problems for minds and machines, but has simple rules, and so is perfect for such computer approach.

# Examples of Current AI

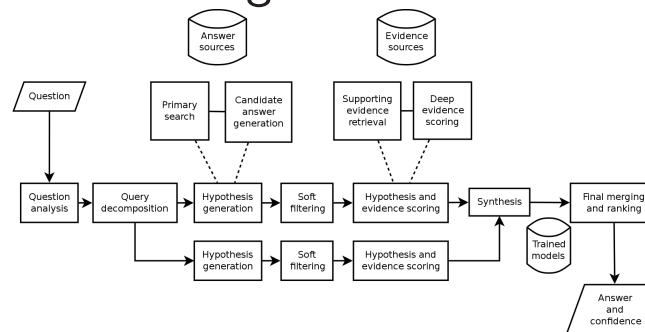


IBM - Watson (2011) Jeopardy

Question Answering Machine in Natural Language

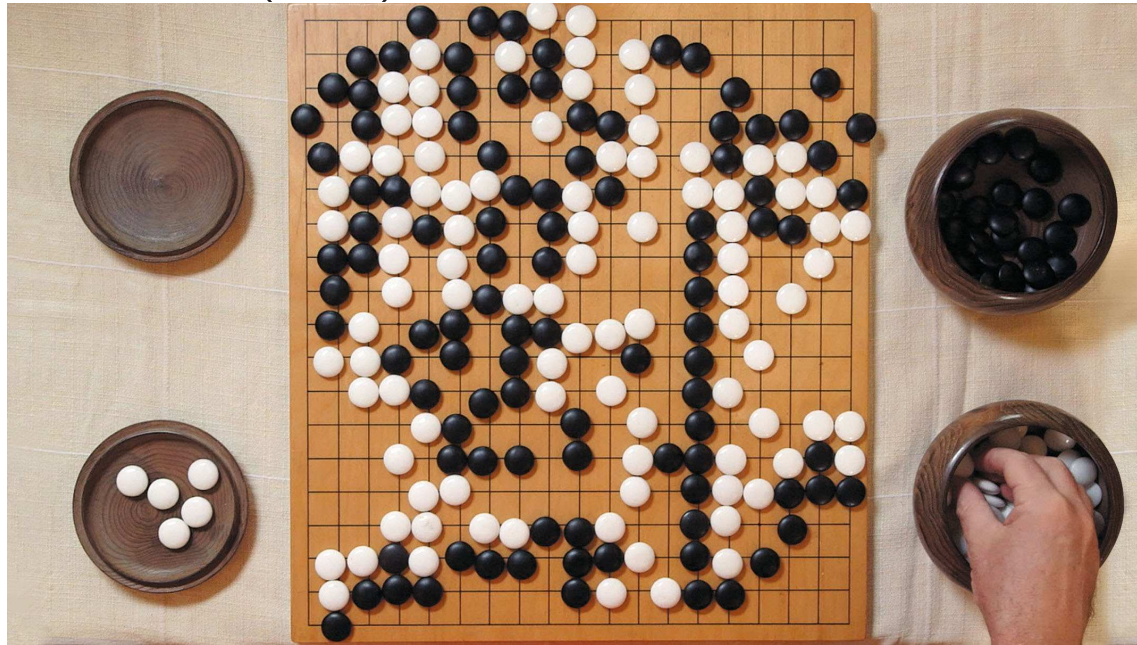
Access to 200 million of pages of structured content (4TB of data)

In 2013 Wtason is used in cancer diagnostics



# Examples of Current AI

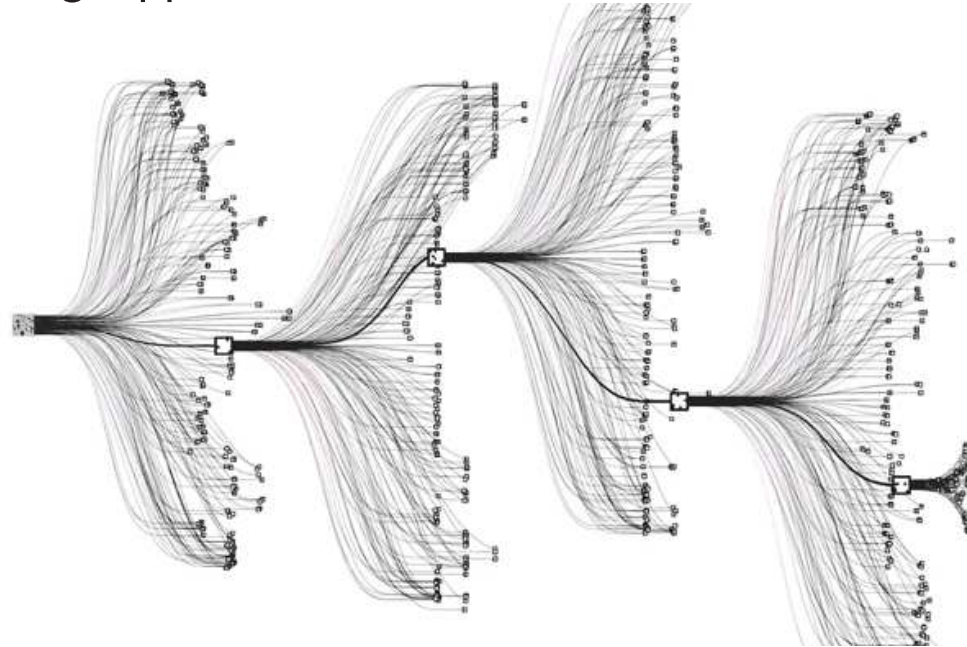
Deep Mind - AlphaGo (2016)



Why would not the Deep Blue approach have worked here?

# Examples of Current AI

Machine Learning Approach:



Why would not the Deep Blue approach have worked here? - Go is considered to be the pinnacle of game AI research. Its been the grand challenge, or holy grail if you like, of AI since Deep Blue beat Kasparov at chess. Go is a very beautiful game with extremely simple rules that lead to profound complexity. In fact, Go is probably the most complex game ever devised by humans.

(Demis Hassabis of Google DeepMind)

Go is a vastly more complex game than chess, which may have on average 35 possible moves from each turn; in comparison, Go has 250, and by exponential extension, the number of possible moves by some estimates are greater than the number of atoms in the universe.



# Examples of Current AI

## Intelligent Cars - Autonomous transportations



What are the main problems and why only now?

# Examples of Current AI

## Intelligent Cars - Autonomous transportations



What are the main problems and why only now? Real time recognition, localization and decision making. But not only that - recent accident shows that DRIVERS must be trained as well. !!!!!!!

# Examples of Current AI

Deep Learning - ANN approach to data processing

