Foundations of Artificial Intelligence

A2. Introduction: What is Artificial Intelligence?

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Introduction: Overview

Chapter overview: introduction

- A1. Organizational Matters
- A2. What is Artificial Intelligence?
- A3. AI Past and Present
- A4. Rational Agents
- A5. Environments and Problem Solving Methods

A2.1 What is AI?

What is AI?

What do we mean by artificial intelligence?

$\rightsquigarrow$ no generally accepted definition!

often pragmatic definitions:

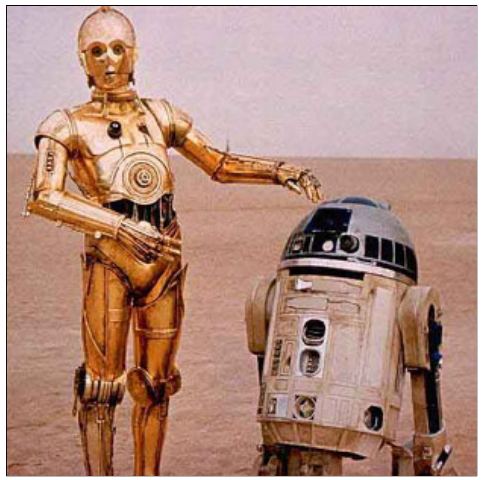
- "AI is what AI researchers do."
- "AI is the solution of hard problems."

in this chapter: some common attempts at defining AI

What Do We Mean by Artificial Intelligence?

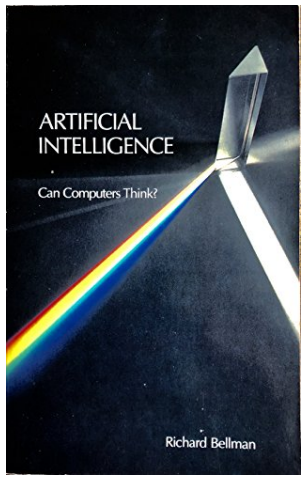
what pop culture tells us:

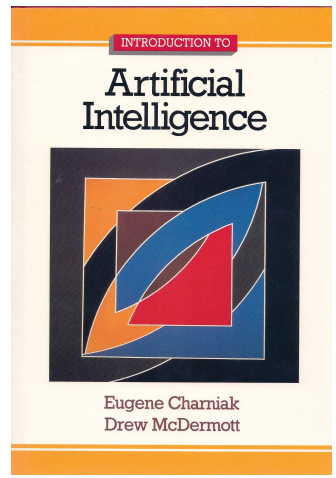


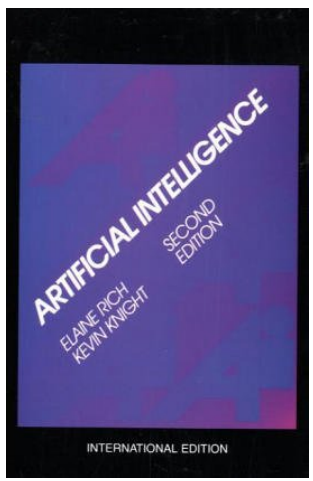


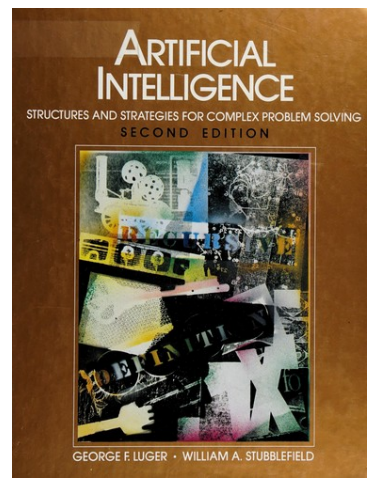
What is AI: Humanly vs. Rationally; Thinking vs. Acting

what scientists tell us:



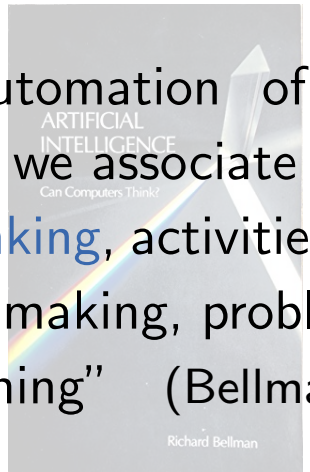
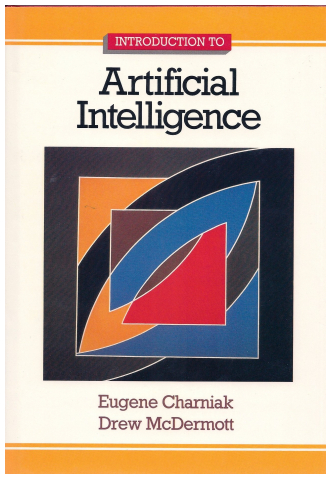
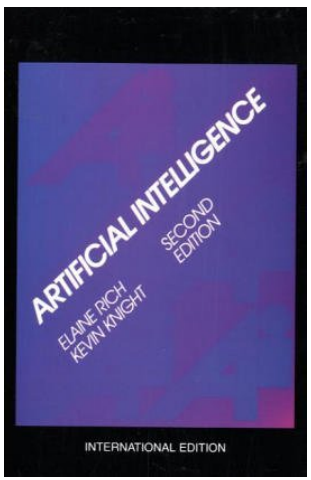
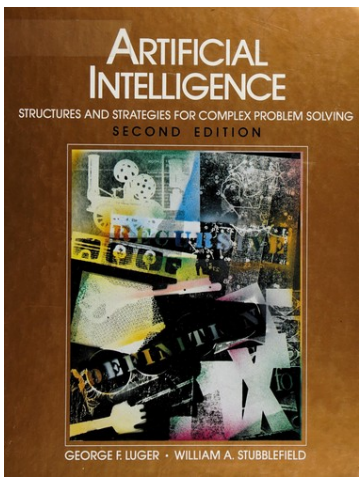






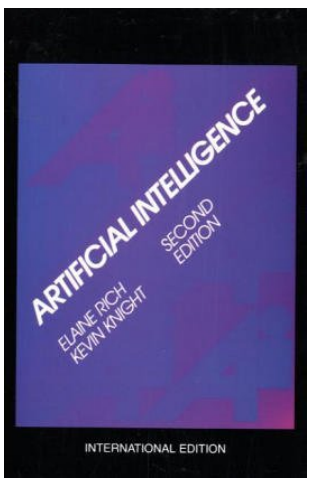
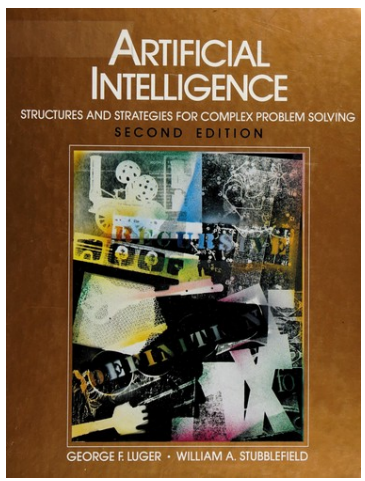
What is AI: Humanly vs. Rationally; Thinking vs. Acting

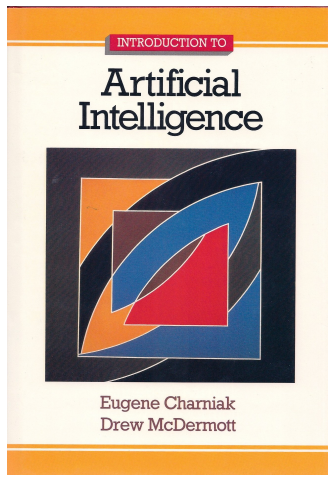
what scientists tell us:

"[the automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning" (Bellman, 1978) 	
	

What is AI: Humanly vs. Rationally; Thinking vs. Acting

what scientists tell us:

thinking like humans	
	



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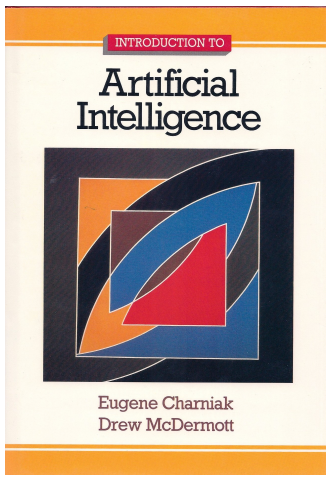
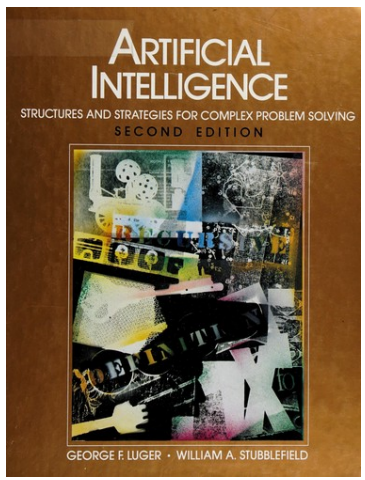
what scientists tell us:

thinking like humans 	
"the study of how to make computers do things at which, at the moment, people are better" (Rich & Knight, 1991) 	

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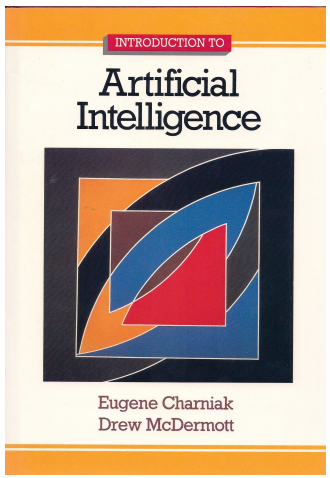
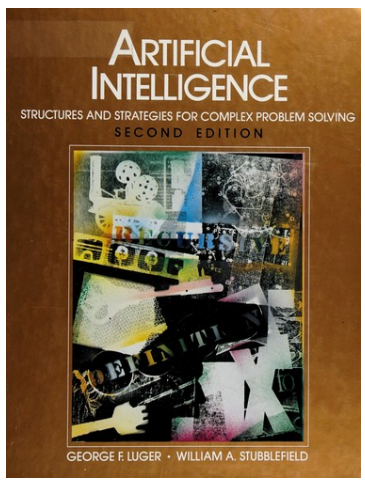
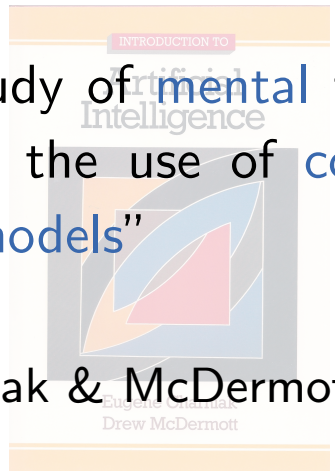
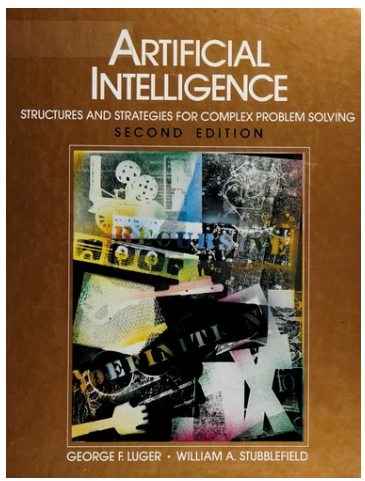
thinking like humans	 
acting like humans	 

What is AI: Humanly vs. Rationally; Thinking vs. Acting

what scientists tell us:

thinking like humans	"the study of mental faculties through the use of computational models" (Charniak & McDermott, 1985)
acting like humans	





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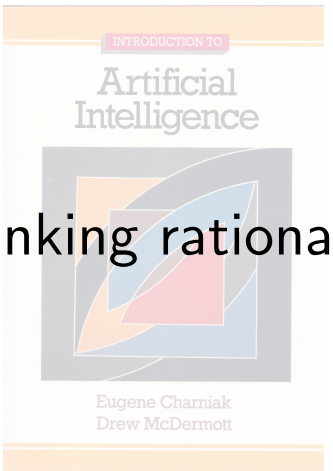
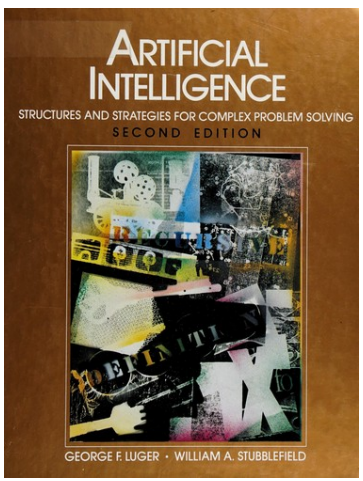
thinking like humans 	thinking rationally 
acting like humans 	

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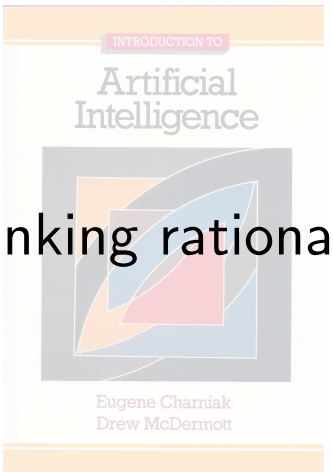
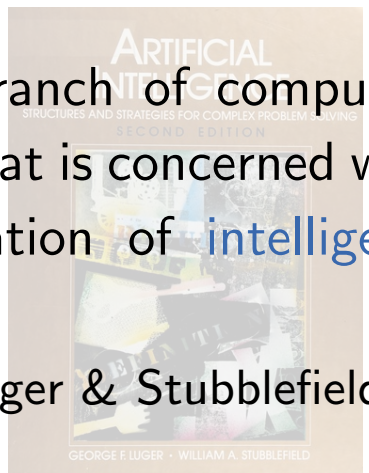
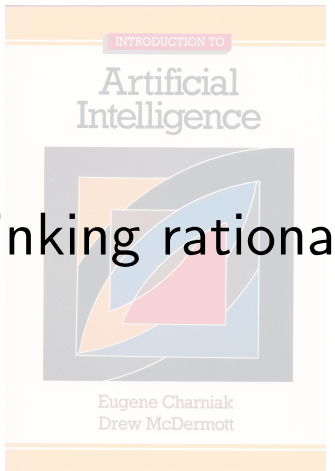
what scientists tell us:

thinking like humans 	thinking rationally 
acting like humans 	"the branch of computer science that is concerned with the automation of intelligent behavior" (Luger & Stubblefield, 1993) 

What is AI: Humanly vs. Rationally; Thinking vs. Acting

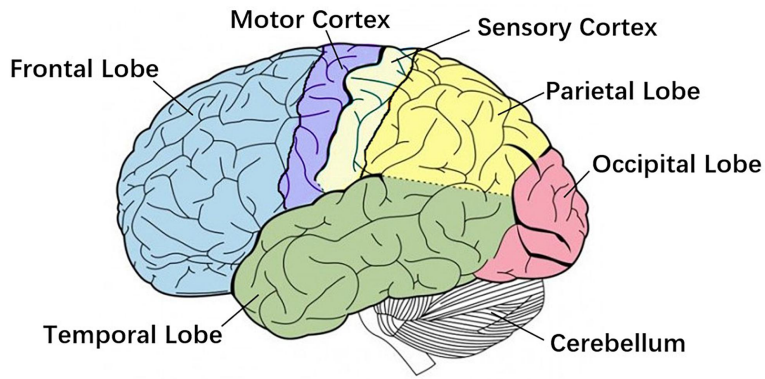
what scientists tell us:

thinking like humans 	thinking rationally 
acting like humans 	acting rationally 

A2.2 Thinking Like Humans

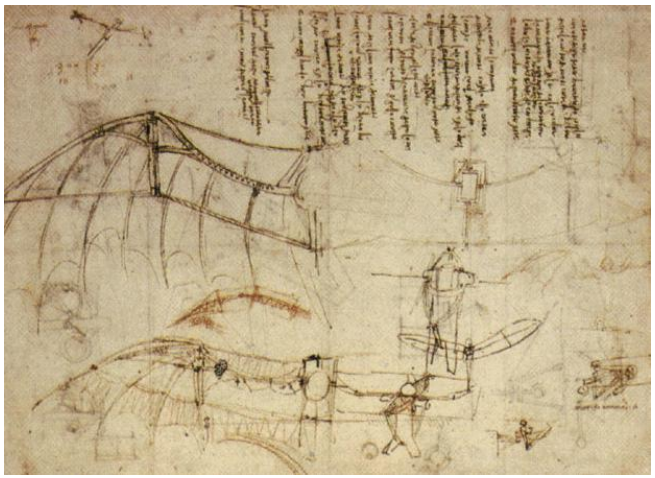
Cognitive (Neuro-) Science

- requires knowledge of how humans think
- two ways to a scientific theory of brain activity:
  - psychological: observation of human behavior
  - neurological: observation of brain activity



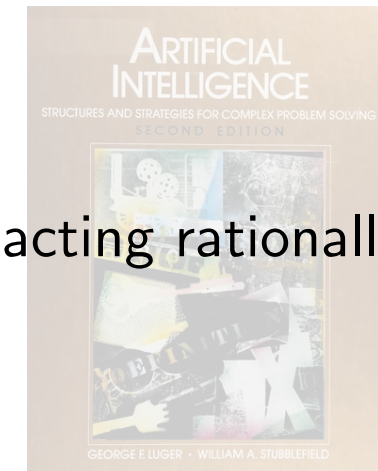
- roughly corresponds to cognitive science and cognitive neuroscience
- today separate research areas from AI

Machines that Think Like Humans



"brains are to intelligence as wings are to flight"

What Do We Mean by Artificial Intelligence?

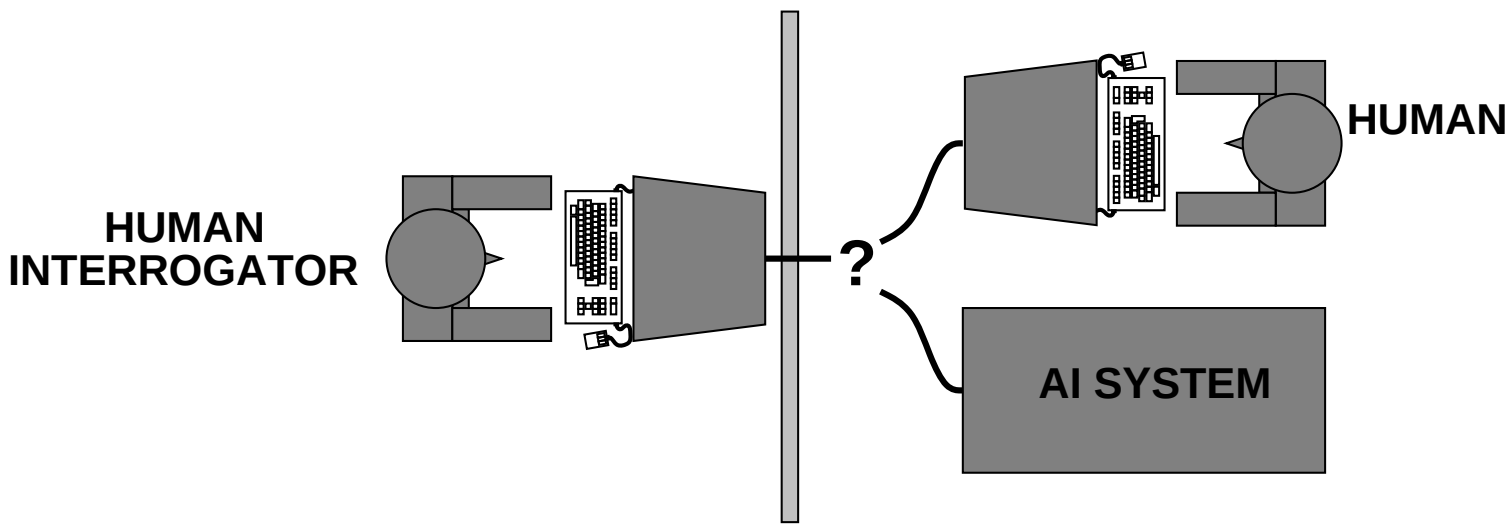
thinking like humans 	thinking rationally 
acting like humans 	acting rationally 

A2.3 Acting Like Humans

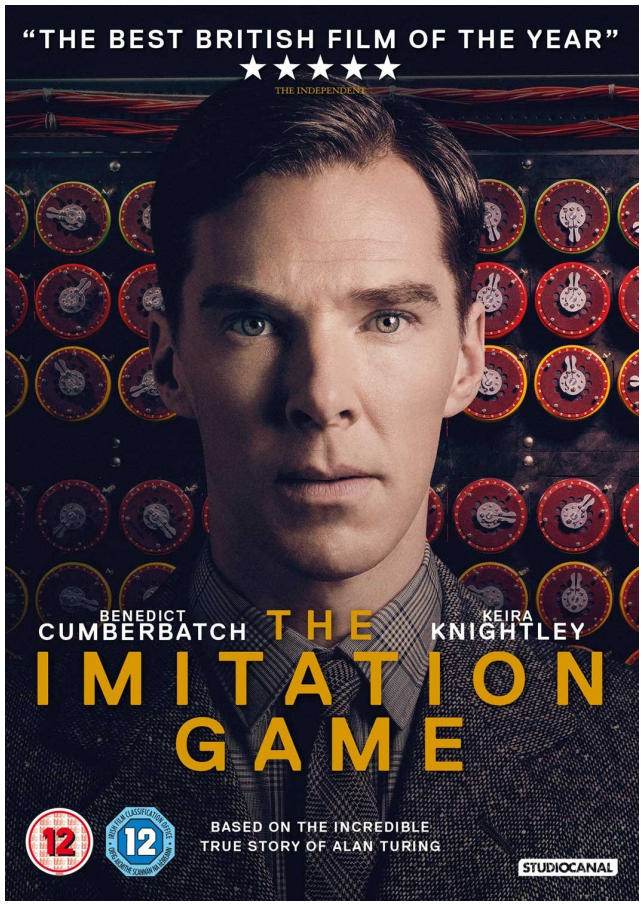
The Turing Test

Alan Turing, Computing Machinery and Intelligence (1950):

- central question: Can machines think?
- hypothesis: yes, if they can act like humans
- operationalization: the imitation game

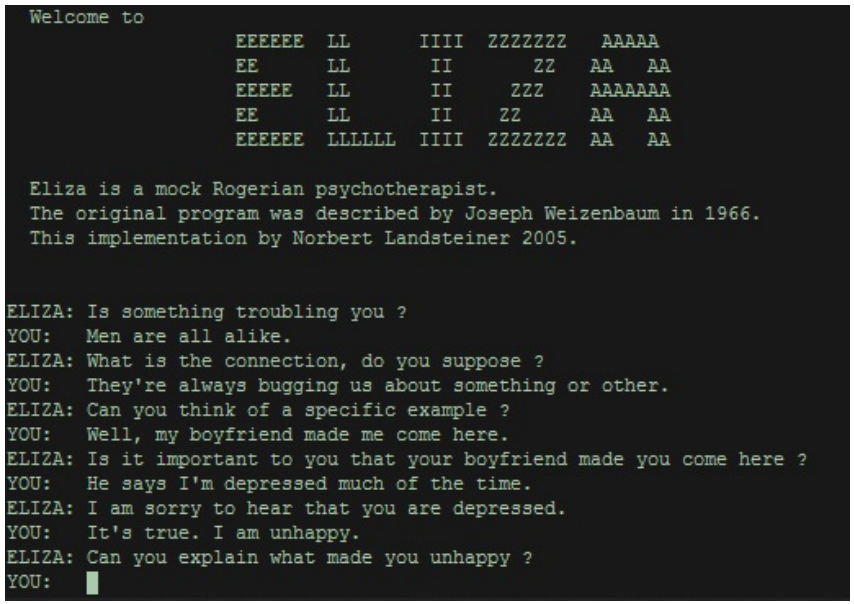


Turing Test in Cinema



Turing Test: Brief History

- Eliza
- Loebner Prize
- Eugene Goostman
- Kuki (formerly Mitsuku)
- Google Duplex
- LaMDA & ChatGPT



- developed in 1966 by J. Weizenbaum
- uses combination of pattern matching and scripted rules
- most famous script mimics a psychologist $\rightsquigarrow$ many questions
- fooled early users

Turing Test: Brief History

- Eliza
- Loebner Prize
- Eugene Goostman
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- annual competition between 1991–2019
- most human-like AI is awarded
- highly controversial

Turing Test: Brief History

- Eliza
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- mimics a 13-year-old boy from Odessa, Ukraine with a guinea pig
- "not too old to know everything and not too young to know nothing"
- 33% of judges were convinced it was human in 2014
  $\rightsquigarrow$ first system that passed the Turing test (?)

Turing Test: Brief History

- Eliza
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- five times winner of Loebner prize competitions (2015-2019)
- winner of "bot battle" versus Facebook's Blenderbot
  ⇝ `https://youtu.be/RBK5j0yXDT8`

Turing Test: Brief History

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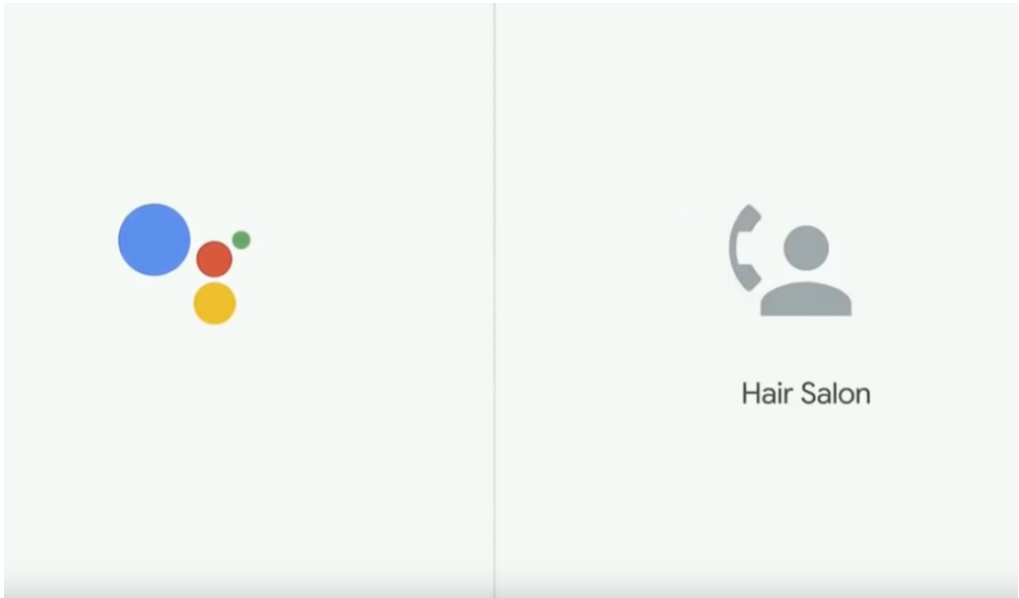

- commercial product announced in 2018
- performs phone calls (making appointments) fully autonomously
- after criticism, it now starts conversation by identifying as a robot

Turing Test: Brief History

- Eliza
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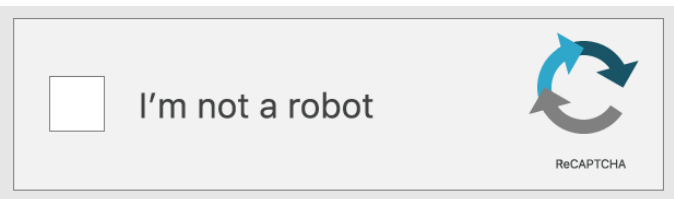
- systems like LaMDA and ChatGPT would likely pass the Turing test
- example conversation: `https://www.nytimes.com/2023/02/16/technology/bing-chatbot-transcript.html`
- ChatGPT even passed some exams (but failed on others)

Value of the Turing Test

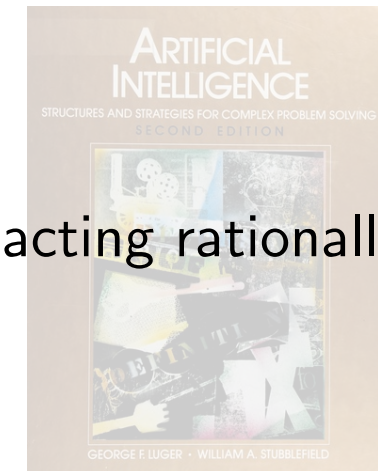
- human actions not always intelligent
- scientific value of Turing test questionable:
  - Test for AI or for interrogator?
  - results not reproducible
  - strategies to succeed $\neq$ intelligence:
    - deceive interrogator
    - mimic human behavior

$\rightsquigarrow$ not important in AI "mainstream"



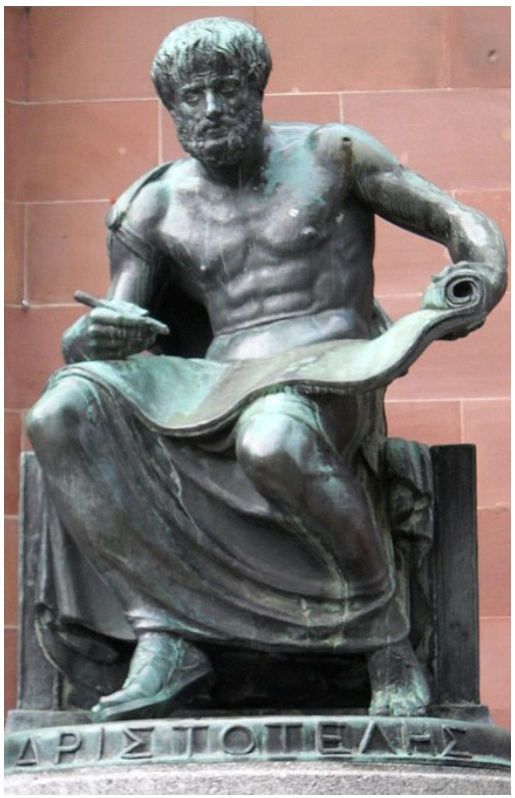
practical application: CAPTCHA ("**C**ompletely **A**utomated **P**ublic **T**uring test to tell **C**omputers and **H**umans **A**part")

What Do We Mean by Artificial Intelligence?

thinking like humans 	thinking rationally 
acting like humans 	acting rationally 

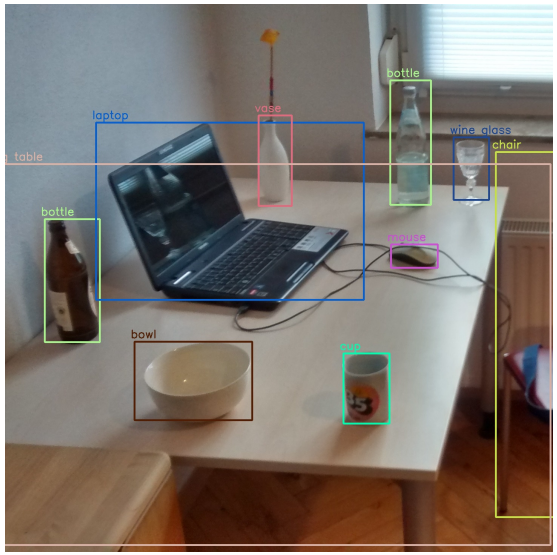
A2.4 Thinking Rationally

Thinking Rationally: Laws of Thought

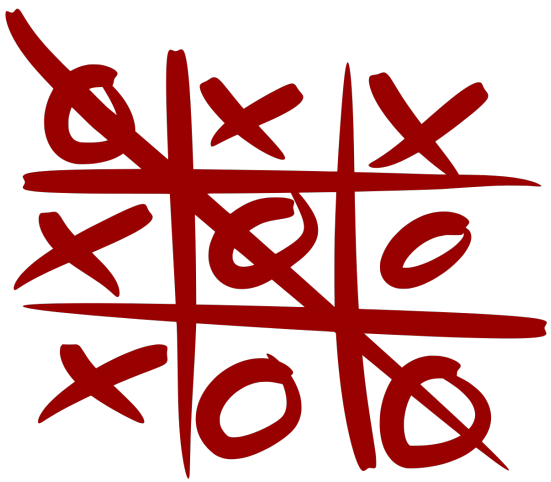


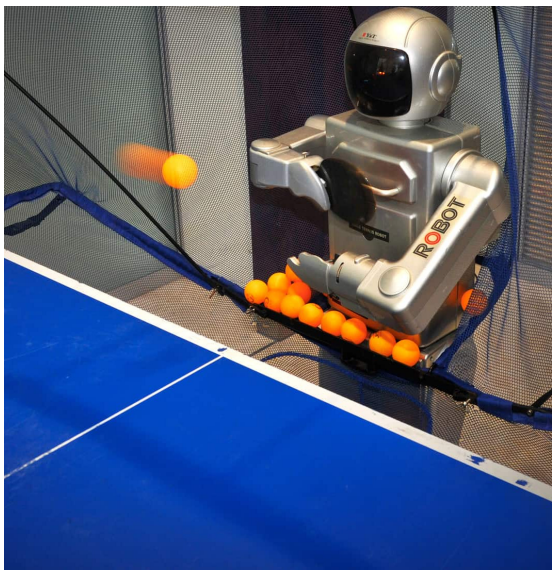
- Aristotle: What are correct arguments and modes of thought?
- syllogisms: structures for arguments that always yield correct conclusions given correct premises:
  - Socrates is a human.
  - All humans are mortal.
  - Therefore Socrates is mortal.
- direct connection to modern AI via mathematical logic

Problems of the Logical Approach



not all intelligent behavior stems from logical thinking and formal reasoning





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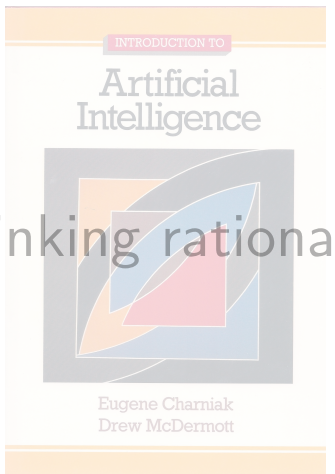
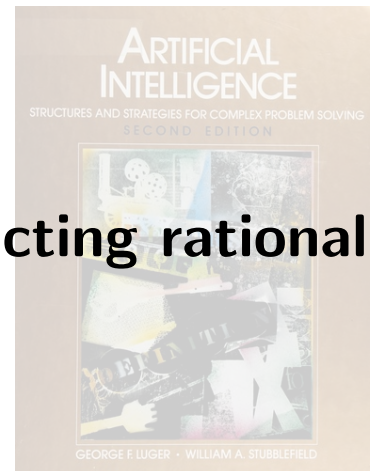
thinking like humans 	thinking rationally 
acting like humans 	**acting rationally** 

A2.5 Acting Rationally

Acting Rationally

acting rationally: "doing the right thing"

- the right thing: maximize utility
  given available information
- does not necessarily require "thought" (e.g., reflexes)

advantages of AI as development of rational agents:

- more general than thinking rationally
  (logical inference only one way to obtain rational behavior)
- better suited for scientific method
  than approaches based on human thinking and acting

$\rightsquigarrow$ most common view of AI scientists today
$\rightsquigarrow$ what we use in this course

A2.6 Summary

Summary

What is AI? $\rightsquigarrow$ many possible definitions

- guided by humans vs. by utility (rationality)
- based on externally observable actions or inner thoughts?

$\rightsquigarrow$ four combinations:

- acting like humans: e.g., Turing test
- thinking like humans: cf. cognitive (neuro-)science
- thinking rationally: logic
- acting rationally: most common view today
  $\rightsquigarrow$ amenable to scientific method
  $\rightsquigarrow$ used in this course