Introduction to Artificial Intelligence

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Instructor and TA information

- Instructor: Yongmei Liu (ymliu@mail.sysu.edu.cn)
- Research interests:
  Artificial intelligence, Knowledge representation and reasoning, Cognitive robotics, Program verification and synthesis
- TAs:

Course information

- Lectures: Mon/Wed 3-4th class in C403
  Experiments: Mon 7-8th class in 实验中心D402
- Textbook: Artificial Intelligence: A Modern Approach, by S. Russell and P. Norvig, 3rd edition, Prentice Hall, 2009. 国内影印版：清华大学出版社，2011.
  - not required
  - lectures do not necessarily follow it
- Course QQ group: 875703458，SYSU_AI_202001
  - announcements about the course will be made here
  - lecture slides will be posted here beforehand

Course evaluation

- 原理课和实验课必须同时选修
- 原理课: 4 assignments (20%) + 4 projects (12%) + class presentation (8%) + final exam (60%)
- Class presentation
  - We will provide a list of papers from recent AI conferences
  - Three students form a group and present a paper in class
  - Time: 11 minutes
- Class participation
  - Attendance: -2 for each case of being absent or late
  - Basic exercises: -2 for each case of refusing to try
- 实验课: weekly exercises (30%) + 4 projects (70%)
- Submission mailbox: ai_2020@foxmail.com

Academic honesty

- The work you submit must be your own
  - you are encouraged to discuss with each other
  - but write up and code independently
- If plagiarism is caught, all parties involved will receive 0 on the assignment/project

Outline

- Example applications of AI
- What is AI
- A brief history of AI
- Topics covered in this course

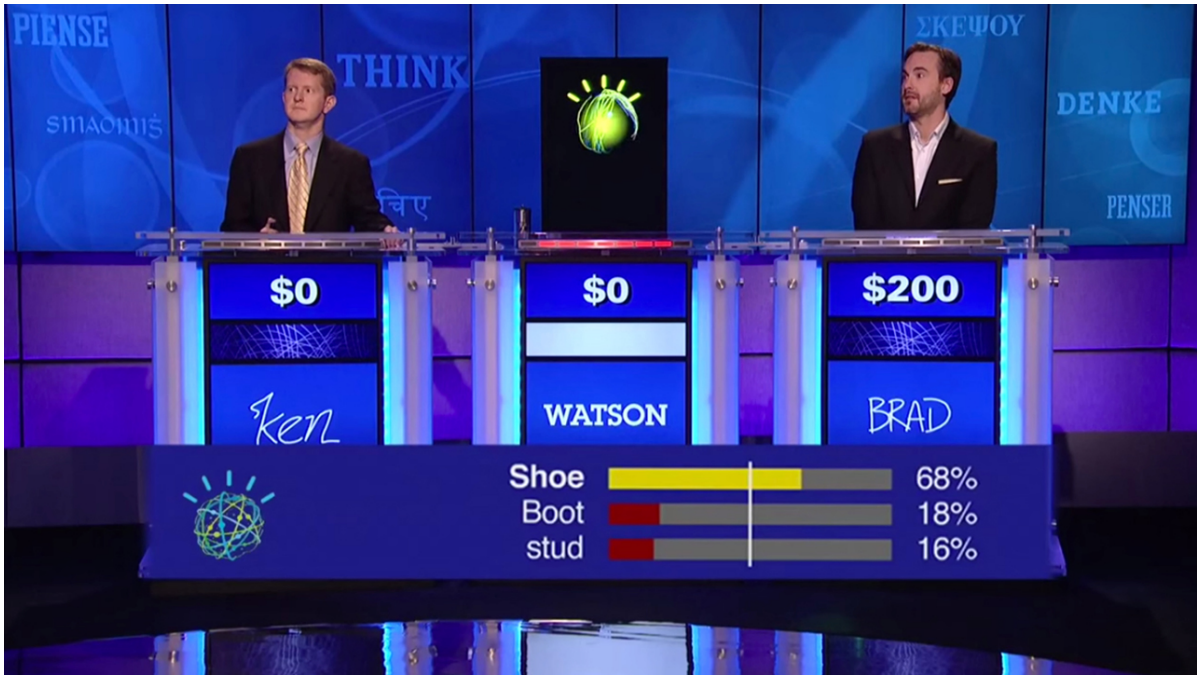
Deep Blue (1997)

In 1997, IBM's Deep Blue chess computer defeated world chess champion Garry Kasparov

AlphaGo (2016)

In 2016, Google DeepMind's AlphaGo program defeated (4-1) Lee Sedol, a 9-dan professional

IBM Watson (2011)



In 2011, IBM Watson defeated two of the biggest winners (Brad Rutter and Ken Jennings) at the quiz show Jeopardy!

Autonomous driving

- The DARPA Grand Challenge: a prize competition for driverless cars: Stanford won in 2005, CMU in 2007
- In 2009, Google started a self-driving car program, and since then, their self-driving cars have driven over 1 million miles

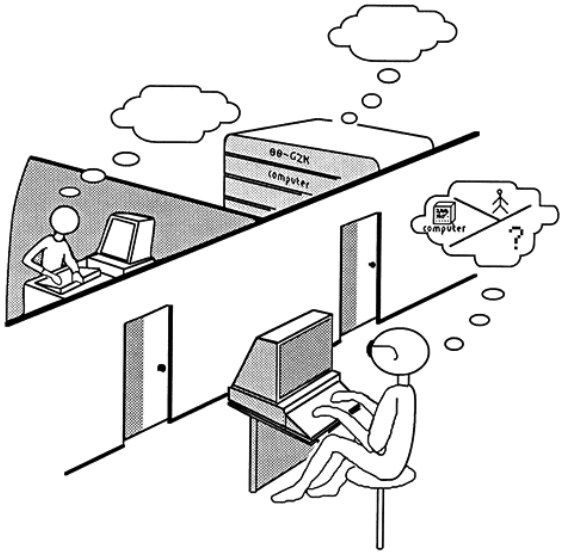
What is AI?

The study of making machines that

Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)
"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998)
"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Figure 1.1 Some definitions of artificial intelligence, organized into four categories.

What is intelligence? The Turing Test

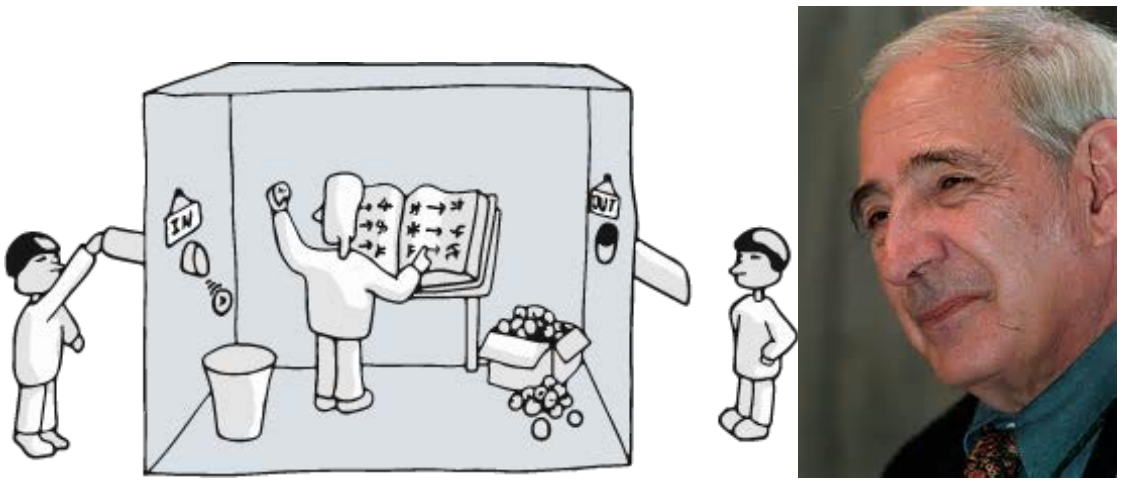


Alan Turing, 1950

- A human interrogator asks questions by typing
- Answers are displayed on a screen
- The computer passes the test if the interrogator cannot reliably decide computer / person

The Chinese Room

Is a computer who passes the Turing test intelligent?



John Searle, 1980

- Imagine a computer who behaves as if it understands Chinese and passes the Turing test
- Imagine a person who does not understand Chinese, sits in a room and runs the computer manually
- The person can behave as if he understands Chinese
- Searle argued that the person does not understand Chinese

Strong AI versus weak AI

- Strong AI: a machine with a mind in exactly the same sense human beings have minds
- Weak AI: a machine with intelligent behavior
- Artificial general intelligence (AGI): a machine with the ability to apply intelligence to any problem
- Narrow AI: AI focused on one narrow task
- All currently existing AI systems are weak AI at most

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- Connectionism（连接主义）: model mental phenomena as emergent processes of interconnected networks of simple and often uniform units, *e.g.*, neural network
- Computationalism（符号主义）: model mental activity with formal manipulation of symbols

Human intelligence

In general, there are various reasons why trying to mimic humans might not be the best approach to AI

- Computers and humans have very different architecture with quite different abilities
  - Numerical computations
  - Visual and sensory processing
  - Parallel processing
- But more importantly, we know very little about how the human brain performs its higher level processes

Rationality

- The alternative approach relies on the notion of rationality
- Roughly, a system is rational if it does the "right thing", given what it knows
- Typically there is a precise mathematical notion of what it means to do the right thing in any particular circumstances
- We will focus on acting rationally
- AI tries to understand and model intelligence as a computational process
- Thus we try to construct systems whose computation achieves or approximates the desired notion of rationality

Degrees of intelligence

- Building an intelligent system as capable as humans remains an elusive goal
- However, systems have been built which exhibit various specialized degree of intelligence
- Formalisms and algorithms have been identified as being useful in the construction of these "intelligent" systems
- Together these formalisms and algorithms form the foundation of our attempt to understand intelligence as a computational process
- In this course, we will study some of these formalisms and see how they can be used to achieve various degrees of intelligence

What is AI

The study of how to achieve rational behavior through computational means

A brief history of AI

- 1950—70: Early excitement, great expectations
  - 1952: Samuel wrote a checker program that could learn
  - 1955: Newell & Simon wrote a reasoning program: Logic Theorist, proved theorems from Principia Mathematica
  - 1956: Dartmouth meeting, birth of AI
  - 1965: Robinson's complete algorithm for logical reasoning
- 1970—90: "Knowledge is power" : knowledge-based approaches
  - 1980—88: Expert systems industry booms
  - 1988—93: The Fifth-Generation Computer System (Japan) Project failed "AI Winter"
- 1990—: rise of machine learning "AI Spring"
- 2010s: heavy industry investment in deep learning

IJCAI 2019 Awards

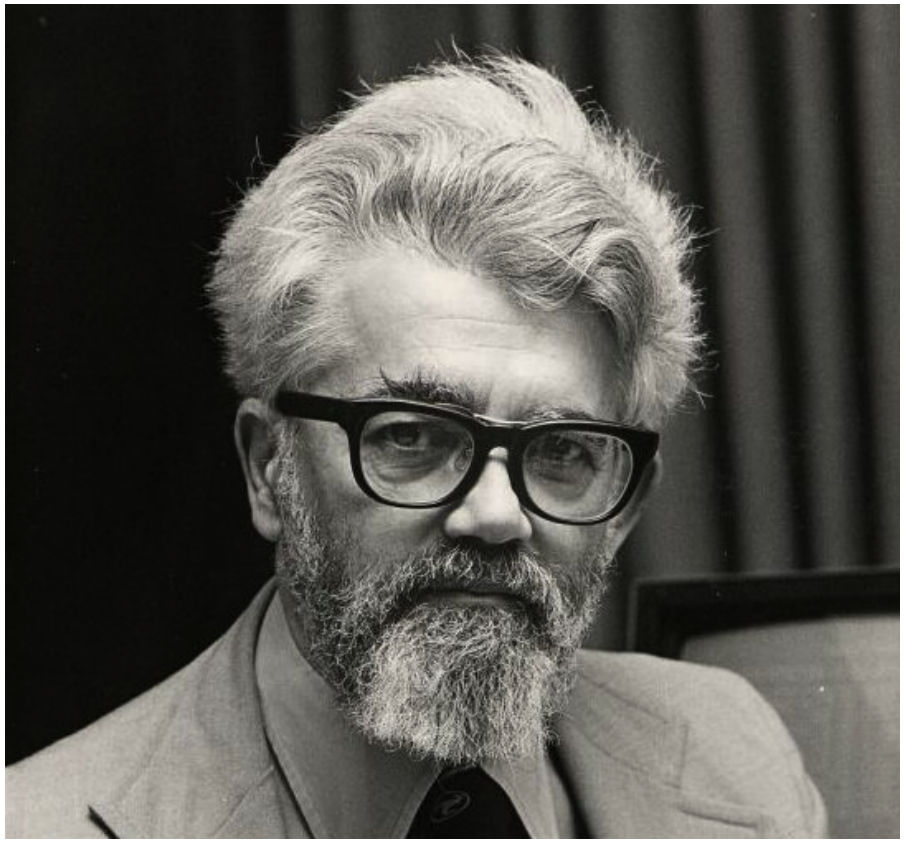
- Computers and Thought Award: Guy Van den Broeck, for his contributions to statistical and relational artificial intelligence, and the study of tractability in learning and reasoning.
- John McCarthy Award: Pedro Domingos, for contributions to machine learning and data science, and to unifying logic and probability.
- Award for Research Excellence: Yoav Shoham, for contributions to knowledge representation, multi-agent systems, and the economic foundations of AI.

John McCarthy: father of AI

received the 1971 Turing award for his contributions to AI

received the first (1985) IJCAI Award for Research Excellence

In fact, he invented the term AI



Yoav Shoham IJCAI 2019 Award Talk

- AI has made fantastic progress; thanks NNs
- We're still very far from capturing human intelligence
- If we want to get there, we need to
  - re-learn the lost art of KR-based data modeling, and
  - harmonize discrete models with NNs, which we've only begun
- This makes it the most exciting time to be an AI researcher!

Topics to be covered in the course

- Search (Chaps 3-6): how to find a sequence of actions that takes us from an initial state to a goal state
- Knowledge representation and reasoning (Chaps 7-9,12): how to represent knowledge about the world and how to reason about the represented knowledge
- Planning (Chaps 10,11): how to find a sequence of actions to achieve a goal
- Reasoning under uncertainty (Chaps 13,14): how to represent and reason about uncertain knowledge
- Machine learning (Chaps 18-21): how to improve the agents' behavior through study of their experience

Other topics

- Natural language processing: how to understand and generate human natural languages
- Vision: how to analyze visual input
- Robotics: how physical agents manipulate the physical world

中国计算机学会推荐国际学术刊物（A类）

- AI：Artificial Intelligence
- TPAMI：IEEE Trans on Pattern Analysis and Machine Intelligence
- IJCV：International Journal of Computer Vision
- JMLR：Journal of Machine Learning Research

中国计算机学会推荐国际学术会议（A类）

- AAAI: AAAI Conference on Artificial Intelligence
- CVPR: IEEE Conference on Computer Vision and Pattern Recognition
- ICCV: International Conference on Computer Vision
- ICML: International Conference on Machine Learning
- IJCAI: International Joint Conference on Artificial Intelligence
- NIPS: Annual Conference on Neural Information Processing Systems
- ACL: Annual Meeting of the Association for Computational Linguistics