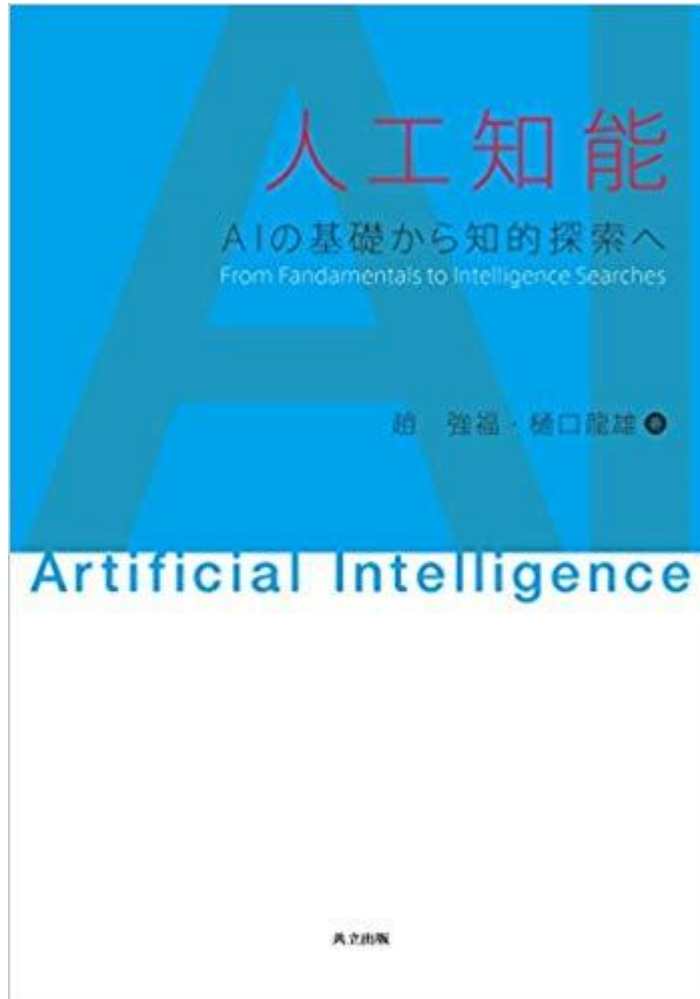


Lecture 1 of Artificial Intelligence

Introduction

Textbook for this lecture



趙 強福、樋口龍雄

人工知能：
AIの基礎から知的探索へ

A5/ 212ページ、¥2, 500
共立出版, 2017

Web pages

- Web page of Qiangfu ZHAO
 - <http://www.u-aizu.ac.jp/~qf-zhao/>
- Web page of this lecture
 - <http://web-ext.u-aizu.ac.jp/~qf-zhao/TEACHING/AI/AI.html>
- Web page of homework answers
 - <http://web-ext.u-aizu.ac.jp/~qf-zhao/AI-textbook/Homework-Answer/index.html>
 - You may also find corrections for the textbook in this web page.

Topics of this lecture

- A brief review of AI history
- What is artificial intelligence?
- Related research fields
- Scope of this course

Early work (Around 1900)

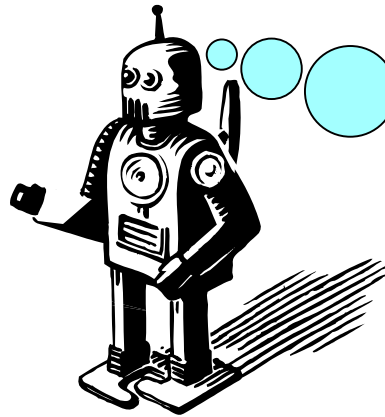
- Representatives
 - George Boole
 - Alfred North Whitehead
 - Bertrand A. W. Russell
- Main contributions
 - Boolean algebra
 - Principia Mathematica

- **PM was an attempt to describe a set of axioms and inference rules in symbolic logic from which all mathematical truths could in principle be proven.**
- **However, in 1931, Gödel's incompleteness theorem proved definitively that PM could never achieve this lofty goal.**

(from Wikipedia)

Early work (1930~)

- Representatives
 - Alan Turing
 - Claude Shannon
 - John von Neumann
- Main contributions
 - Theory of computation, Turing Machine
 - Turing test (to distinguish machine from human)
 - Information theory, application of Boolean algebra
 - von Neumann model of computing machines

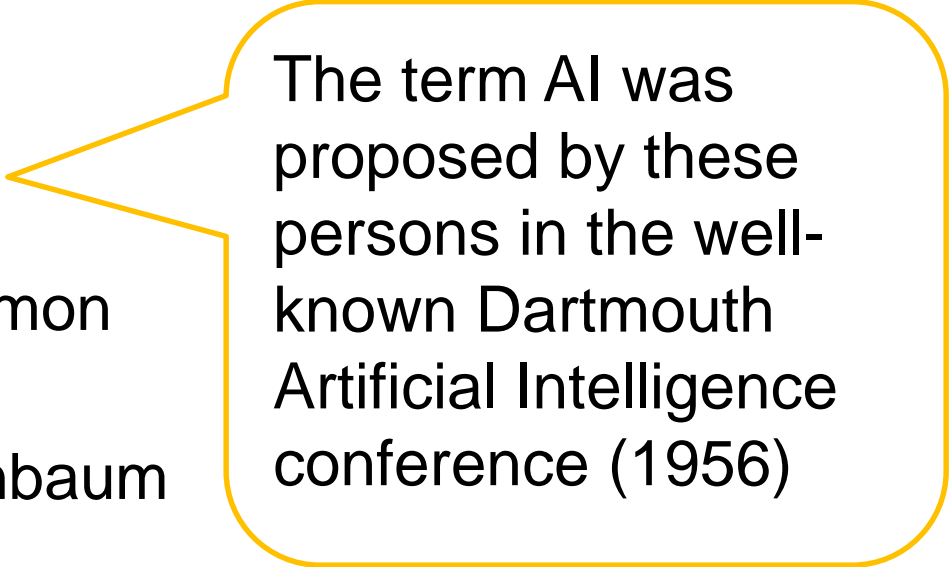


I am ZHAO.
You can ask
any questions,
and see if I
am the real
person.

The first wave (1950~)

- Representatives

- John McCarthy
- Marvin Lee Minsky
- Herbert Alexander Simon
- Allen Newell
- Edward Albert Feigenbaum



The term AI was proposed by these persons in the well-known Dartmouth Artificial Intelligence conference (1956)

- Main contributions

- LISP
- Semantic network and frame
- General problem solver and Expert systems

The second wave (1980~)

- Representatives
 - David Rumelhart
 - Lotfi Zdeh
 - John Holland
 - Lawrence Fogel
 - Ingo Rechenberg
 - John Koza
- Main contributions
 - Learning of MLP
 - Fuzzy logic
 - Genetic algorithms
 - Evolutionary programming
 - Evolution strategy
 - Genetic programming

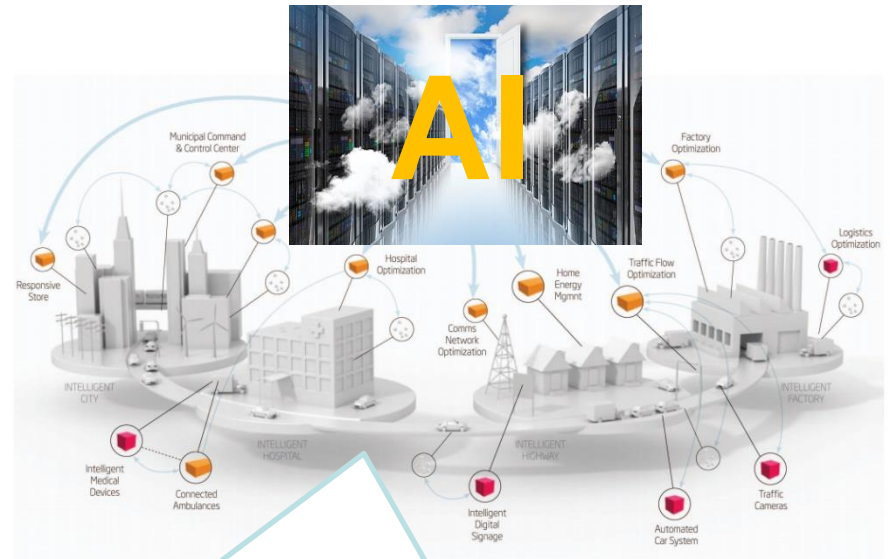
Soft computing
Human like computing and natural computing

The third wave (2000~)

- Representative technologies
 - Internet
 - Tim Berners-Lee, WWW inventor, 1989
 - Internet of things
 - Kevin Ashton, MIT Auto-ID Center, 1999
 - Cloud computing
 - Main frame (1950s), virtual machine (1970s), cloud (1990s)
 - Big data
 - John R. Masey, SGI, 1998
 - Deep learning
 - Geoffrey Hinton, UoT, 2006

A brief summary

- Early work
 - Theoretic foundations
- First wave:
 - Reasoning with given knowledge
- Second wave
 - Learning-based knowledge acquisition
- Third wave
 - Learn in the cyber-space



The same as learning inside the brain. Each brain has a “natural intelligence” that can learn using the sensor data captured by different parts of the body.

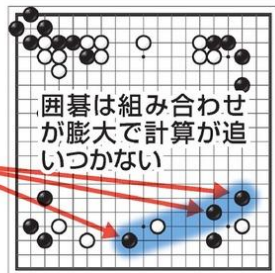
Current status of AI

- In March 2016, Alpha-Go of DeepMind defeated Lee Sedol, who was the strongest human GO player at that time.
- This is a big news that may have profound meaning in the human history.

人工知能の従来の方式と「アルファ碁」の違い

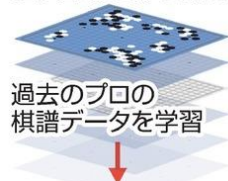
従来の方式

終局までランダムに碁石を置くシミュレーションを繰り返し、勝率が高い次手を求める

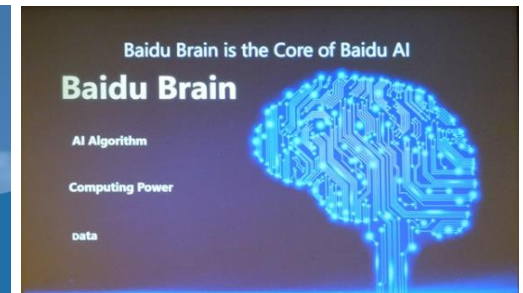
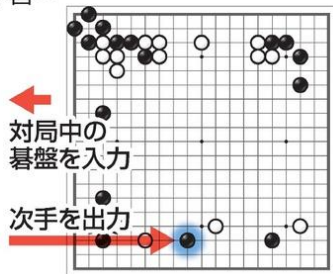


アルファ碁

まず碁碁の打ち方を学習...



得た知識をもとに自分対自分で学習し、知識を深める



Do you think AI is good or evil?



<https://www.ideapod.com/idea/When-Super-AI-Intelligence-Arrives-Will-Religion-Be-Eradicated/55cc10d8c976415e508bcc2d>



<http://www.industryweek.com/supply-chain-technology/industry-40-harnessing-power-erp-and-mes-integration>

Super-intelligence should be a tool for unifying the human beings, support them, and lives together with them!

After all, what is intelligence?

(from Wikipedia)

- Intelligence is an umbrella term used to describe a property of the mind that encompasses many related abilities, such as the capacities
 - to reason,
 - to plan,
 - to solve problems,
 - to think abstractly,
 - to comprehend ideas,
 - to use language, and
 - to learn.



Intelligence can be defined as the **ability for solving problems**

- Problem solving is to find the “best” solution in the problem space.
- Reasoning is to interpret or justify solutions or sub-solutions.
- Planning is to find ways for solving the problem.
- Thinking abstractly is to simulate the problem solving process inside the system (brain).
- Idea/language comprehension is a way (or means) for data/problem/knowledge representation;
- Learning is the process to find better ways for solving a problem (or a class of problems).

What is AI ?

- Textbooks often define artificial intelligence as “the study and design of computing systems that perceives its environment and takes actions like human beings”.
- The term was introduced by John McCarthy in 1956 in the well-known Dartmouth Conference.
- In my study, an AI is defined as a system that possesses at least one (not necessarily all) of the abilities mentioned in the previous page.

As a research area, AI studies theories and technologies for obtaining systems that are partially or fully intelligent.

A rough classification of AI

(from “Artificial Intelligence: A Modern Approach”)

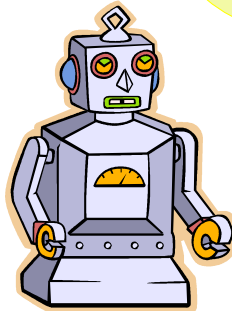
Systems that think like humans



Systems that think rationally



Systems that act like humans



Systems that act rationally



Related research fields



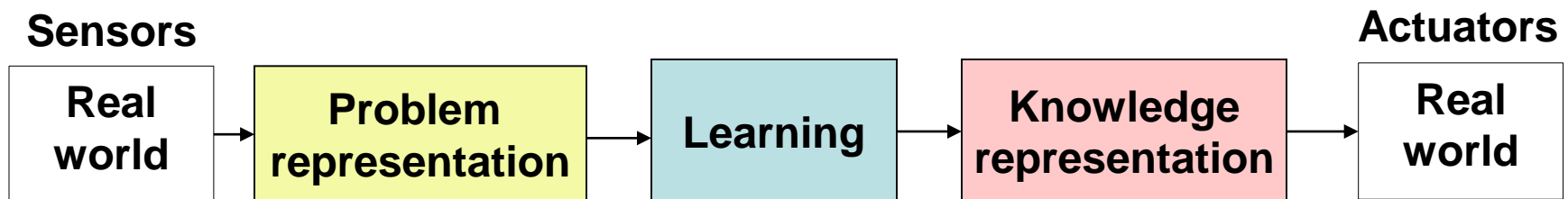
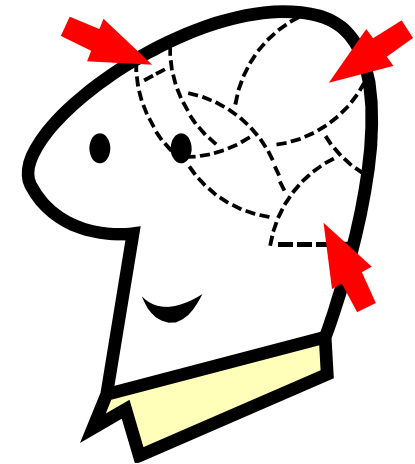
- Search and optimization
- Knowledge representation
- Reasoning and automatic proving
- Learning and understanding
- Pattern classification / recognition
- Planning
- Problem solving

Search (探索)

- Brute-force search
 - Depth-first search
 - Breadth-first search
- Heuristic Search
 - Hill climbing search
 - Best-first search
 - A* Algorithm
- Intelligent search
 - Genetic algorithms
 - Meta-heuristics
- 網羅的探索
 - 縦型(深さ優先)探索
 - 横型(幅優先)探索
- 発見的探索
 - 山登り法
 - 最良優先探索
 - A* アルゴリズム
- 知的探索
 - 遺伝的アルゴリズム
 - メターヒューリスティクス

Three MAPs for knowledge acquisition

- What is the input?
 - Map from real world to the mind model
- What is the output?
 - Map from the mind model to the real world
- What is the relation between the input and the output?
 - Abstraction of the real world



Representation methods

- Representation of the problem
 - State space representation
 - Vector representation
- Representation of knowledge
 - Production (decision) rules
 - Semantic network and ontology
 - Predicate logic
 - Fuzzy logic
 - Neural network (for tacit knowledge)

Learning models and algorithms

- Neural network learning
 - Including MLP, SVM, deep learning, etc.
- Evolutionary learning
 - GA or meta-heuristics in general
- Reinforcement learning
- Artificial immune system
- Fuzzy logic
- Decision tree
- Hybrid system



Scope of this course

- Search
 - Problem formulation and basic search algorithms
- Expert system-based reasoning
 - Production system, semantic network, and frame
- Logic based-reasoning
 - Propositional logic and predicate logic
- Soft computing based reasoning
 - Fuzzy logic and multilayer neural network

Scope of this course

- Machine learning
 - Pattern recognition
 - Self-organization
 - Neural networks
 - Decision trees
- Intelligent search (if we have time)
 - Genetic algorithm
 - Ant colony optimization

Purpose of this course

- Learn how to use the basic search methods;
- Understand the basic methods for problem formulation and knowledge representation;
- Understand the basic idea of automatic reasoning;
- Know some basic concepts related to pattern recognition and machine learning.



**Make a baby AI system
after learning this course**

Homework for lecture 1

- Write a report using about 500 words in English or 500 characters in Japanese to describe one of the key persons who made a great contribution to the AI world.
- You may choose one from those introduced in this lecture, or find someone in the internet.
- When you refer to any information taken from a paper, a report, a web-site, or any published material, please add a reference and cite it in the correct places in your report.
- Add your name, student ID, and date below the title of your report, create a pdf-file, and put the file under the specified directory.

How to submit the homework

- Make a sub-directory “**AI**” under your home directory.
- Make a sub-directory “**ex_XX**” under AI, where XX is the exercise number.
- Change the permissions of all newly created directories (and files under them) to 705 to allow the TA/SAs to check your homework.
- For example, for the homework of the “this” class, do as follows:
 - Under the directory **AI**, make a sub-directory **ex_01**.
 - Under the directory **ex_01**, edit your report **answer.txt** using any available editor, convert the file to **answer.pdf**, and change its permission to 705.
- For future homework, please do in a similar way.

Submit your answer before the exercise class of next week !

Quizzes for today

(Answer in Japanese or English, and submit after the lecture class)

- | | |
|--|--|
| <ul style="list-style-type: none">• What is AI as a research area? | <ul style="list-style-type: none">• What are the three MAPs for knowledge acquisition? |
| <ul style="list-style-type: none">• What is Search? | <ul style="list-style-type: none">• Write one learning model you have heard from the TV or other publications. |