Introduction

Textbook for this lecture
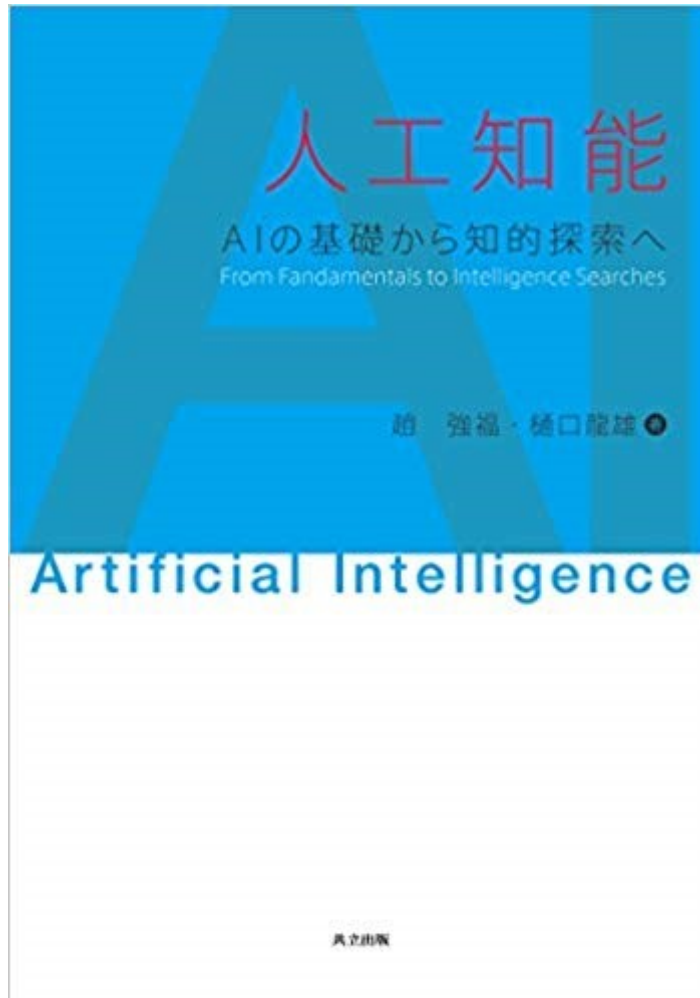
趙　強福、樋口龍雄

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
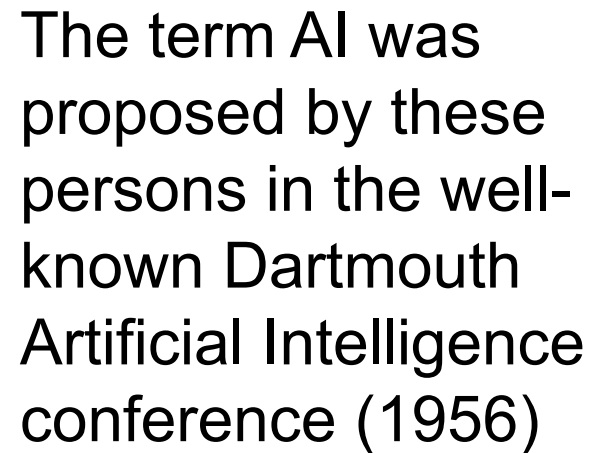 - von Neumann model of computing machines
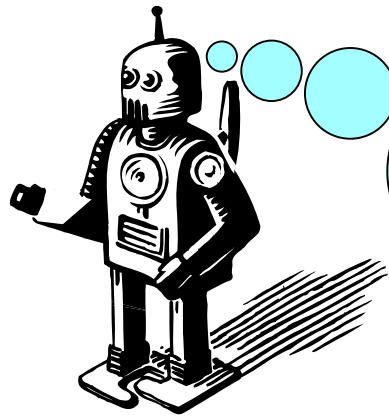
I am ZHAO. You can ask any questions, and see if I am the real person.

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 Forgel
  - Ingo Rechenber
  - 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
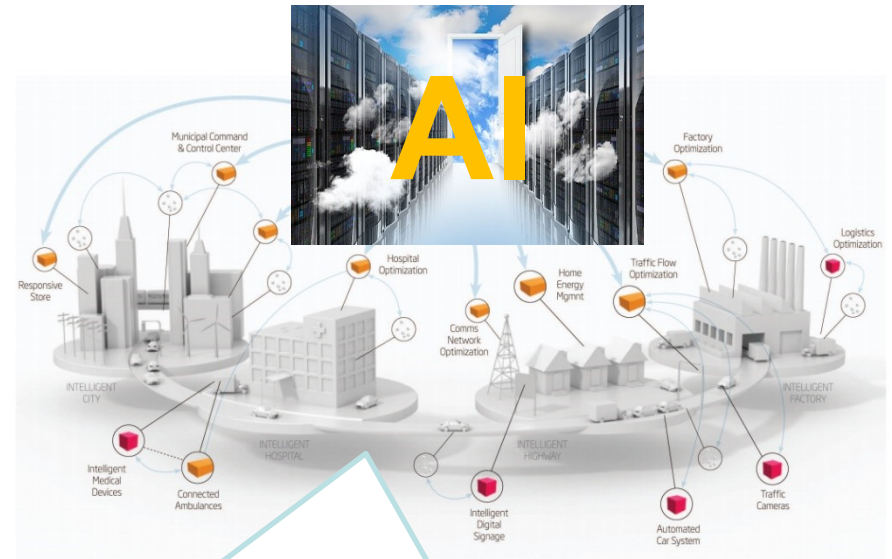
The same as learning inside the brain. Each brain has a "natural intelligence" that can learn using the sensor data captured by different parts of the body.
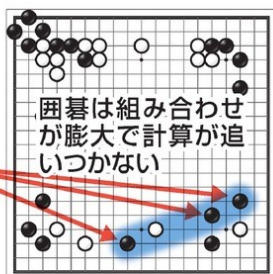
Current status of AI

- 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.
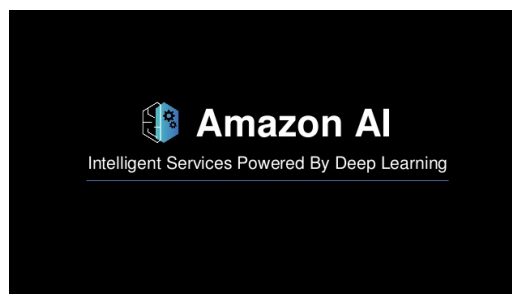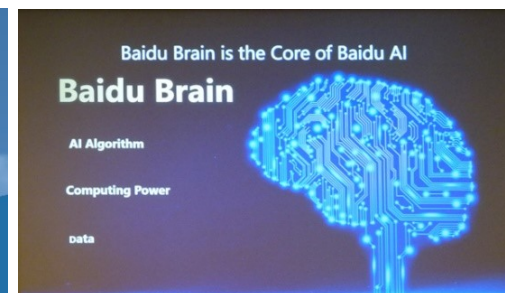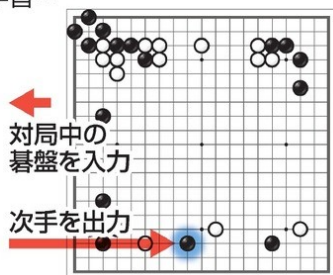
Do you think AI is good or evil?
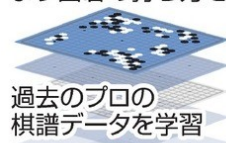

https://www.ideapod.com/idea/When-Super-AI-Intelligence-Arrives-Will-Religion-Be-Eradicated/55cc10d8c976415e508bcc2d

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
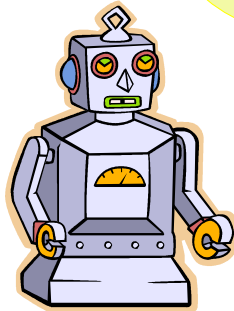## (from "Artificial Intelligence: A Modern Approach")

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

Sensors   **Actuators**

| Real world | → | Problem representation | → | Learning | → | Knowledge representation | → | Real world |
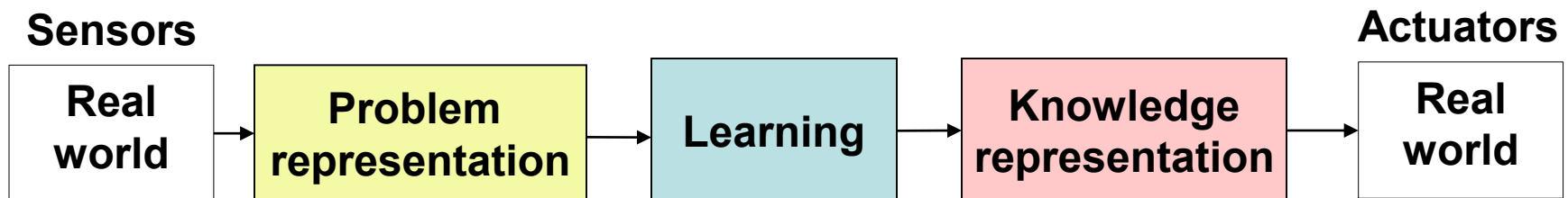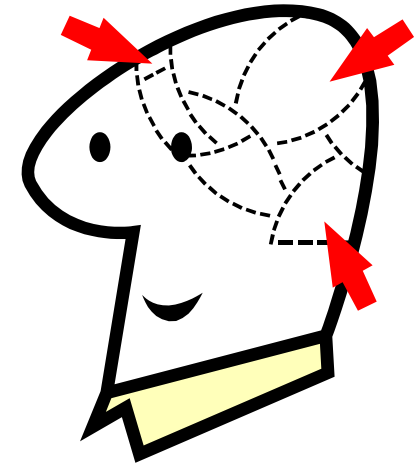
Representation methods

- 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)

- What is AI as a research area?

- What is Search?

- What are the three MAPs for knowledge acquisition?

- Write one learning model you have heard from the TV or other publications.