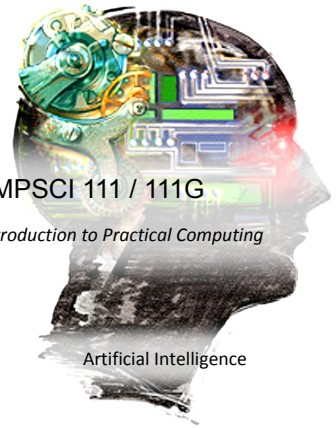


What is Artificial Intelligence?

- Artificial intelligence is the *computational study of structures and processes that support intelligent behaviour*.
- Term first coined in 1956:
  - Dartmouth Summer Research Project on Artificial Intelligence
- Areas of research include:
  - Computer vision
  - Natural language processing
  - Robotics
  - Knowledge-based systems
  - Machine learning

Aims of Artificial Intelligence

- Three interrelated aims:
  - Engineering aim
  - Psychological aim
  - General/Philosophical aim

Source:
Metaphor and Artificial Intelligence, Why They Matter to Each Other, J.A. Barnden, University of Birmingham

Engineering Aim

- To engineer, or provide computational principles and engineering techniques for, “useful” artefacts that are arguably intelligent.
  - Mechanistic similarity to human or animal minds/brains is not necessary.

The artefact may be useful in one of a variety of domains:

- Industry
- Mathematics
- Art
- Everyday life

Source:
Metaphor and Artificial Intelligence, Why They Matter to Each Other, J.A. Barnden, University of Birmingham

Psychological Aim

- To create computational principles, theories or systems that provide a greater insight on cognition in ***human or animal minds/brains***.

Source:

Metaphor and Artificial Intelligence, Why They Matter to Each Other, J.A. Barnden, University of Birmingham

General/Philosophical Aim

- To create computational principles, theories or systems that provide a greater insight on cognition in ***general***.
  - Human made artefacts
  - Naturally occurring organism
  - Cognizant entities yet to be discovered.
- Includes looking at philosophical issues like the nature of intelligence, thought, consciousness, etc.

Source:

Metaphor and Artificial Intelligence, Why They Matter to Each Other, J.A. Barnden, University of Birmingham

What is Intelligence?

- When we say that humans are *intelligent*, we mean they exhibit certain high-level cognitive abilities, including:
  - Carrying out complex reasoning
    - E.g., solving physics problems, proving mathematical theorems
  - Drawing plausible inferences
    - E.g., diagnosing automobile faults, solving murder cases
  - Using natural language
    - E.g., reading stories, carrying out extended conversations
  - Solving novel, complex problems
    - E.g., completing puzzles, generating plans, designing artifacts
- Does not include:
  - Executing motor skills or autonomic activity (breathing, reflexes etc.)

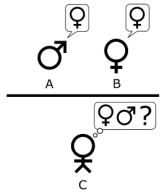
Philosophical View Of Intelligence

- Behaviourist/Functionalist approach:
  - External behaviour matters
  - If it behaves intelligently, then it is intelligent
  - Turing test
- Cognitive approach:
  - What happens internally matters
  - We must consider how it thinks, not just look at the behaviour
  - Chinese room

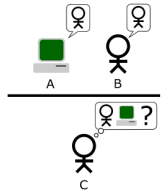
The Turing Test

- Proposed by Alan Turing in his 1950 paper "Computing Machinery and Intelligence".
  - Defines criteria for determining machine intelligence
  - "Are there imaginable digital computers which would do well in the imitation game?"
- Imitation game:
  - Three players – A, B, and C
  - A is a man and B is a woman. C, the interrogator is of either gender
  - Player C is unable to see either player A or player B
  - C asks A and B questions, trying to determine which of the two is a man and which is the woman
- Standard Turing test:
  - Three players – A, B, and C
  - A is a computer and B is a person of either sex. C, the interrogator is also a person of either gender
  - Player C is unable to see either player A or player B
  - C asks A and B questions, trying to determine which of the two is human and which is the machine

The Turing Test



Imitation game



Turing test

- If on completion of the Turing test, C cannot tell A and B apart, then machine A is intelligent.

Source: https://en.wikipedia.org/wiki/Turing_test

The Chinese Room

- Thought experiment proposed by John Searle in his 1980 paper "Minds, Brains, and Programs".
- Refutes functionalist viewpoint:

"The appropriately programmed computer with the right inputs and outputs would thereby have a mind in exactly the same sense human beings have minds"

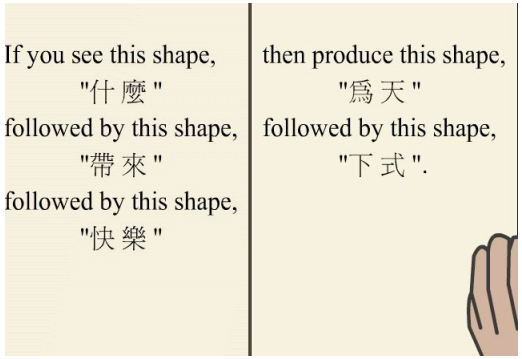
Source: https://en.wikipedia.org/wiki/Chinese_room

The Chinese Room

- Premise:
  - Person in a closed room who has no understanding of Chinese.
  - Room contains a manual with instructions detailing the appropriate response, in Chinese characters, to every possible input, also in Chinese characters.
  - Person can communicate via written responses with the outside world through a slot in the door.
- Scenario:
  - A Chinese person passes messages written in Chinese, to the person in the Chinese Room.
  - Person in the room responds using the manual; they appear to be conversant in Chinese despite not understanding any of the communication.
- Argument:
  - Without "understanding", a machine's activity cannot be described as "thinking". Since a machine does not think, it does not have a "mind" in the same way you would say a person does.

Source: https://en.wikipedia.org/wiki/Chinese_room

Chinese Room Rulebook



Exercise 1

Which of the following statements best describes the Turing test?

(a) Without understanding, a machine's activity cannot be described as intelligent.

(b) Matching symbols is all that is required for a machine to be intelligent.

(c) A machine must be able to perform symbolic representations of problems.

(d) A machine's ability to conduct a conversation via auditory or textual methods.

(e) The machine's ability to exhibit intelligent behaviour that is equivalent and indistinguishable from that of a human.

Exercise 2

Which of the following best describes the philosophical viewpoint put forward by the Chinese room thought experiment?

(a) Without understanding, a machine's activity cannot be described as intelligent.

(b) If a person cannot differentiate between a machine and another person when communicating with them, the machine is intelligent.

(c) Matching symbols is all that is required for a machine to be intelligent.

(d) If a machine does not understand Chinese, it is not intelligent.

Strong AI versus Weak AI

Strong AI
- The view that a computer could become self-aware and exhibit intelligent behaviour.

Weak AI
- The view that computers could not become self-aware and reason.
  - Can be used to solve specific problems in a well-defined domain

Examples of Strong AI

Examples Of Weak AI

IBM Deep Blue

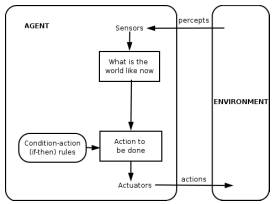
- Chess playing computer
- Won a game against reigning world champion Garry Kasparov in 1996, losing the overall match.
- Won the match against Kasparov in 1997; first computer to do so in a match under standard chess tournament time controls.
- Deep Blue was programmed with history of Kasparov's previous games.
- Programming was modified between games to avoid traps.
- Kasparov was not permitted to study Deep Blue's previous games.

IBM Deep Blue

Examples Of Weak AI

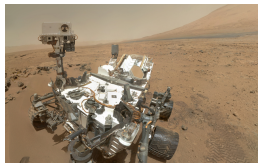
Agents

- Autonomous entity that works in a defined environment.
- Agent achieves goals within environment using:
  - Percepts – observations of the environment obtained through sensors
  - Actions – made on the environment using actuators



Source: https://en.wikipedia.org/wiki/Intelligent_agent

Curiosity Rover



- Part of the Mars Exploration Program to study:
  - Whether Mars could have ever supported life.
  - Role of water on Mars
  - Climate and geology of Mars
- Curiosity rover navigates surface of Mars autonomously.

Source: http://www.jpl.nasa.gov/news/news.php?release=2013-259

Representing Problems As Symbols

- AI programs reduce problems to symbols.
- Problems are solved through the manipulation of these symbols.
- The manipulation of these symbols can seem intelligent.
- The computer does not "know' what the symbols mean.

Example

- Scenario:
  - A farmer needs to cross a river by boat taking with him his dog, goose, and a sack of corn.
- Constraints:
  - The boat is small and can only hold one item along with the farmer.
  - The dog can't be left alone with the goose. The dog will eat the goose.
  - The goose can't be left alone with the corn. The goose will eat the corn.
- Problem:
  - What is the order in which the farmer transfers his property across the river?

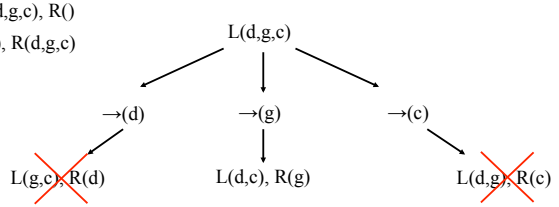
Symbolic Representation

- Dog = d
- Goose = g
- Corn = c
- At the start of the problem, all three are on the left bank of the river. The right bank is empty.
  - Start state: L(d,g,c), R()
- The goal is to get all three across to the right bank:
  - Goal state: L(), R(d,g,c)
- Operators are used to indicate actions the farmer can take:
  - Row dog to right bank = →(d)
  - Row corn to left bank = ←(c)

State Space Search

Start state: L(d,g,c), R()

Goal state: L(), R(d,g,c)



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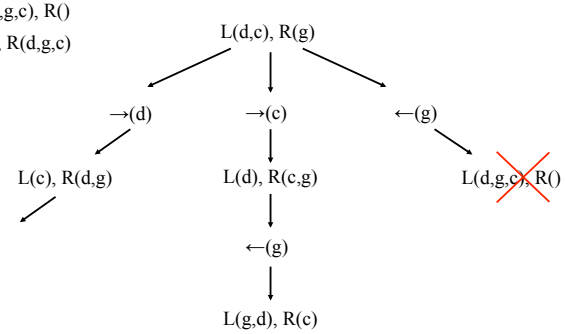

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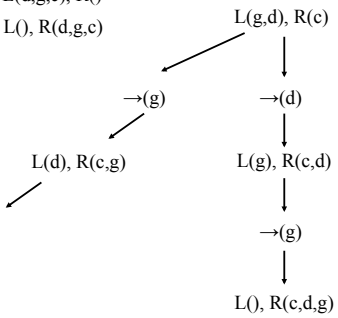


Problem solution

- Start state: L(d,g,c), R()
- Goal state: L(), R(d,g,c)
- Solution:

→(g) →(c) ←(g) →(d) →(g)

Knowledge-based Systems

Expert Systems (weak AI)

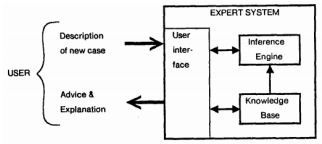
- Computer system that emulates decision making ability of a human expert.
- Two components:
  - Knowledge base – repository of information/facts about the world as well as rules that can be applied to the facts. Rules usually have an IF-THEN representation.
  - Inference engine – applies rules to known facts to deduce new knowledge.
  - Often used in Business Intelligence

Sources: https://en.wikipedia.org/wiki/Expert_system

MYCIN

MYCIN

- is an example of an early expert system.
- Designed to diagnose bacterial infections.
- List of possible bacterial culprits provided, ranked from high to low based on the probability of each diagnosis.
- Antibiotic treatment regimen, dose adjusted for patient's body weight, was also given.



Sources:
https://en.wikipedia.org/wiki/Mycin
http://people.dbmi.columbia.edu/~ehs/ehs0001/Buchanan-Shortliffe-1984/Chapter-01.pdf

Exercise 3

Which of the following statements regarding AI is FALSE?

(a) Actuators let an agent make actions on their environment.

(b) Deep Blue is a chess playing computer.

(c) Percepts let an agent make observations of their environment.

(d) An inference engine is a collection of If-Then rules.

(e) None of the above.

Exercise 4

Which of the following statements best describes strong AI?

(a) The view that computers could become self-aware and exhibit intelligent behaviour.

(b) The view that computers could appear to be self-aware and reason.

(c) The view that computers must be developed to incorporate a behaviourist approach.

(d) The view that computers must appear to be able to pass the Turing test.

(e) The view that computers are non-sentient and focused on one narrow task.

Machine Learning

- Creating rules for Expert Systems was hard
- But, could we learn the rules automatically from data (i.e. examples)
- Give a “smart” algorithm a lot of examples (i.e., data) and “mine” the rules
- Or discover patterns in the data
- “Data Mining” was born
- Now often taught as “Data Science”

Machine Learning

- Now used widely in business
  - Deciding what product to offer a customer
- In recommender systems
  - What movies will Netflix show you
- In natural language understanding
  - Apple’s Siri and Amazon’s Alexa
- In image recognition
  - Google’s Neural Network can recognise cats
- Autonomous vehicles
  - Tesla (and all other manufacturers)

Why has AI suddenly become so popular?

- Nothing (much) theoretically has changed
- Expert systems since the 1970s
- Neural Networks invented in the 1950s
- Machine learning popularised (in academia) in the 1990s
- So why the sudden rise of AI?

Processing Power Data Storage

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- Machine learning popularised (in academia) in the 1990s
- So why the sudden rise of AI?

Summary

- Artificial intelligence is the *computational study of structures and processes that support intelligent behaviour*.
- Two philosophical views of intelligence:
  - Behaviourist/functionalist and cognitive.
- Strong AI versus Weak AI.
  - The study of Weak AI has produced many useful applications.
- Emphasizes symbolic representations of problems
- Machine Learning attempts to learn rules or detect patterns in data