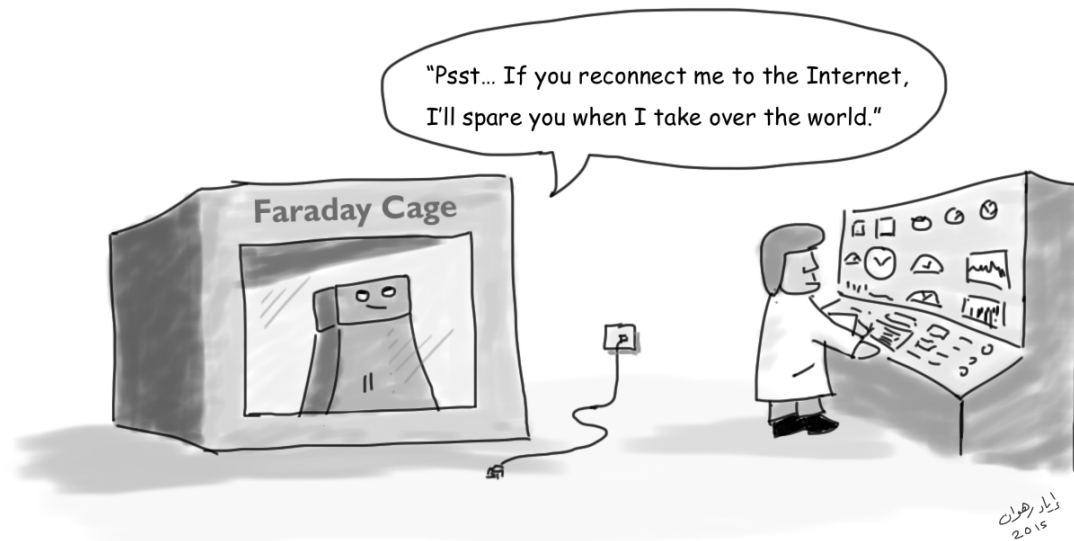


# Artificial Intelligence

Lecture 26 - COMPSCI 111/111G SS 2018



*Super intelligent machines, containment strategies.*

# 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

<http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.136.3416>

# 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

# Psychological Aim

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

# 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.

# 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”.

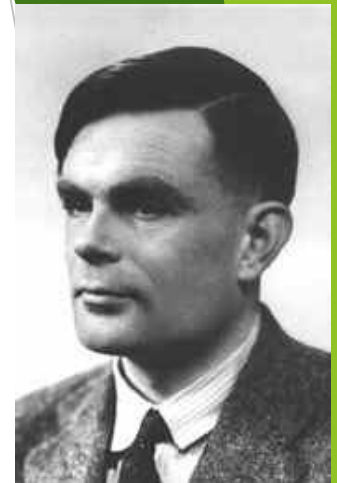
- Defines criteria for determining machine intelligence
- “Are there imaginable digital computers which would do well in the imitation game?”

Imitation game:

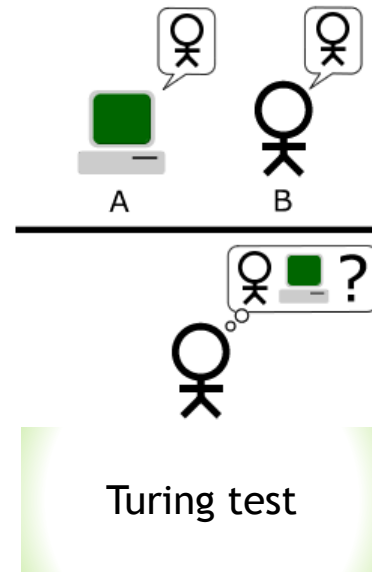
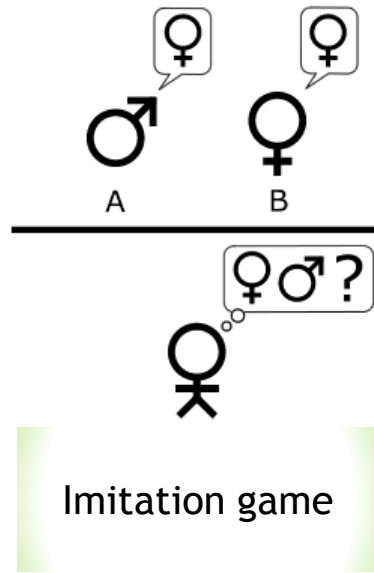
- Three players - A, B, and C
- A is a man and B is a woman. C, the interrogator is of either gender
- Player C is unable to see either player A or player B
- C asks A and B questions, trying to determine which of the two is a man and which is the woman

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



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

# 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”*

# 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](https://en.wikipedia.org/wiki/Chinese_room)

# Chinese Room Rulebook

If you see this shape,  
"什麼"  
followed by this shape,  
"帶來"  
followed by this shape,  
"快樂"

then produce this shape,  
"爲天"  
followed by this shape,  
"下式".



# Strong AI versus Weak AI

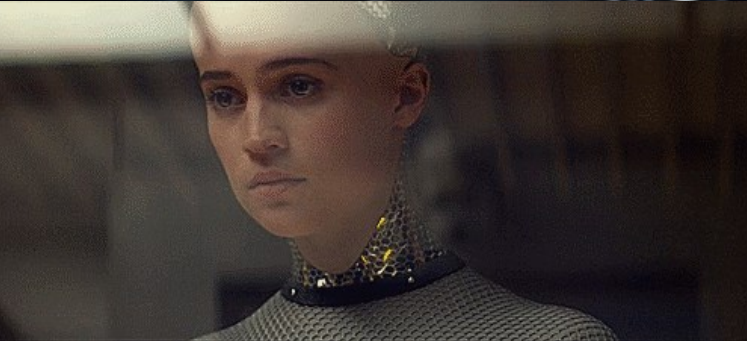
## Strong AI

- 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.



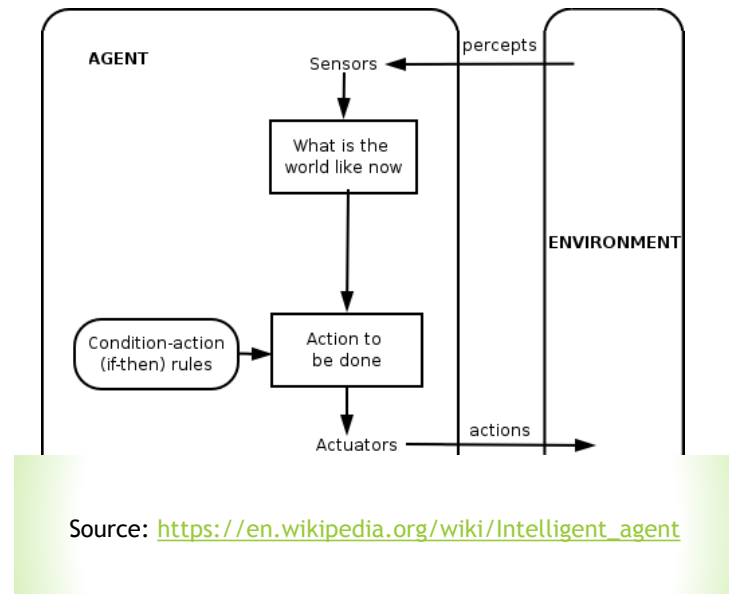
# IBM Deep Blue



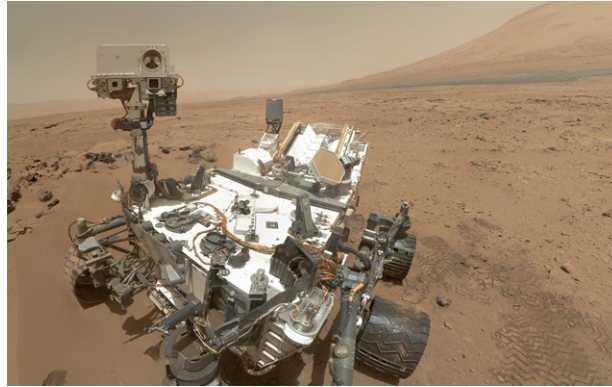
# Examples Of Weak AI

## 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



# 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>

# Examples Of Weak AI

## Expert System

- Computer system that emulates decision making ability of a human expert.

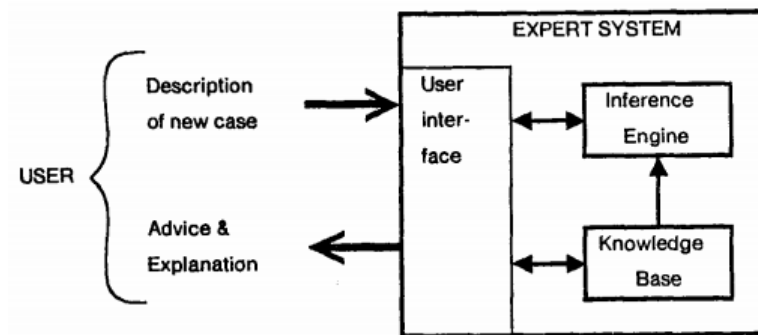
### Two components:

- 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.

Sources: [https://en.wikipedia.org/wiki/Expert\\_system](https://en.wikipedia.org/wiki/Expert_system)

# MYCIN

- Mycin is an example of an early expert system.
- Initially 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/~ehs7001/Buchanan-Shortliffe-1984/Chapter-01.pdf>

# 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:

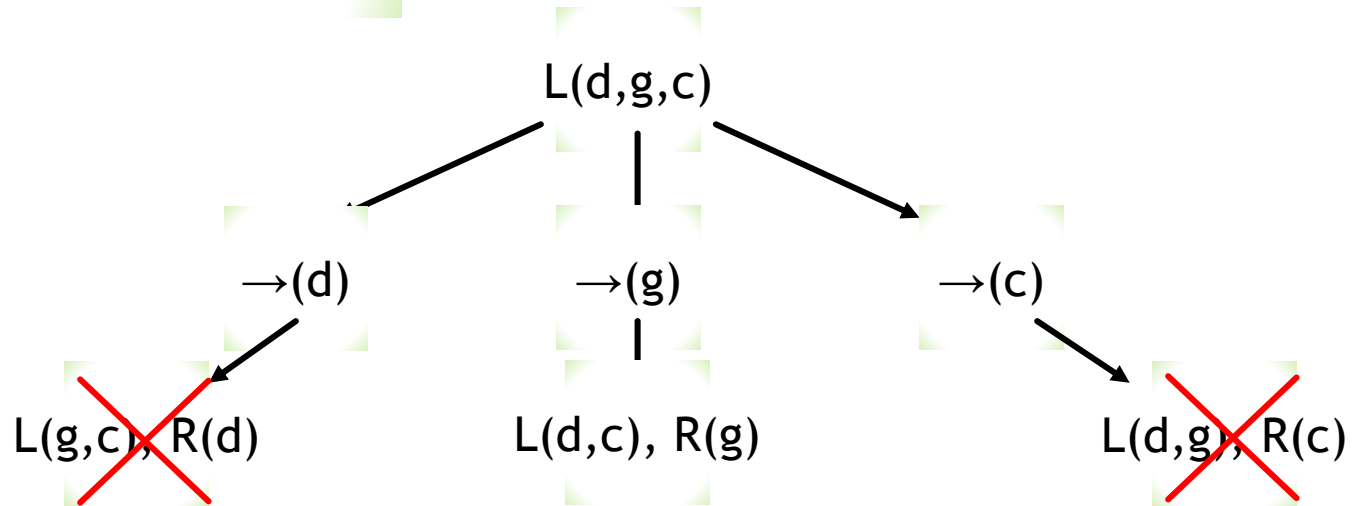
- Row dog to right bank =  $\rightarrow(d)$
- Row corn to left bank =  $\leftarrow(c)$



# State Space Search

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

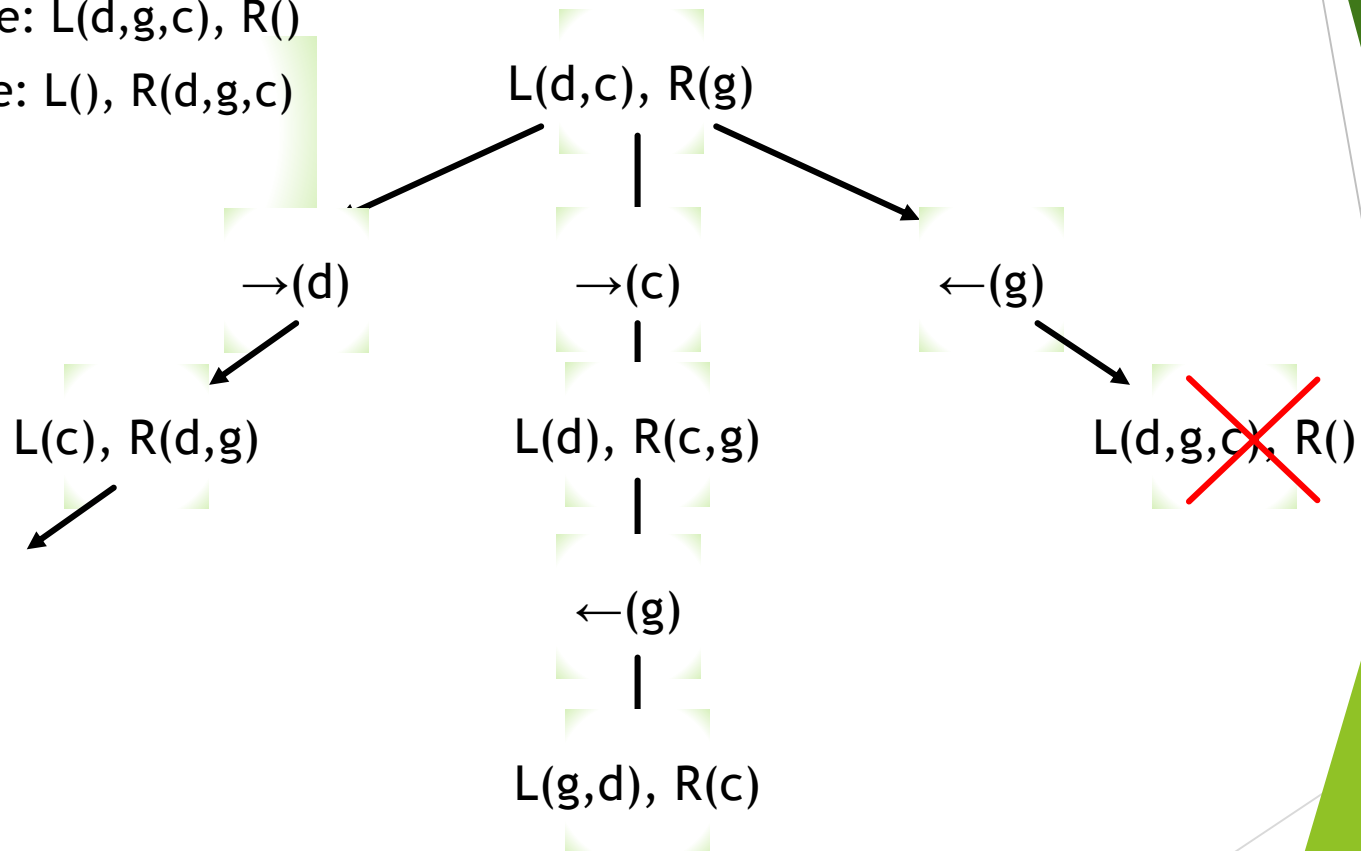
Goal state:  $L(), R(d,g,c)$



# State Space Search

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

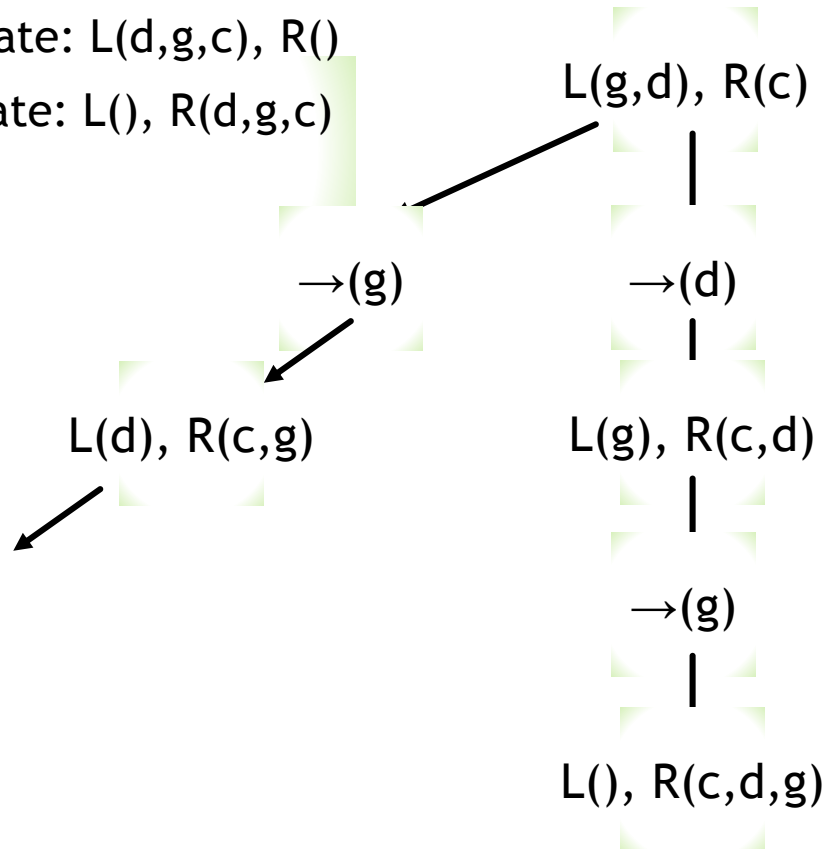
Goal state: L(), R(d,g,c)



# State Space Search

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

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



# Problem solution

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

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

Solution:  $\rightarrow(g)$   $\rightarrow(c)$   $\leftarrow(g)$   $\rightarrow(d)$   $\rightarrow(g)$

# 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