

TDT4136 Introduction to Artificial Intelligence

Lecture 1: Introduction (Chapter 1 in the textbook)

Pinar Öztürk

Norwegian University of Science and Technology
Fall 2023

Course topic overview

Intelligent agents
Problem solving by Searching
Adversarial Search
Constraint Satisfaction Problems
Logical systems
Knowledge representation
Planning
Game Theory
Ethical issues in AI

Today's outline

What is AI?

A brief history

The state of the art

What is AI?

There are no crisp definitions. Here is one from [John McCarthy](#), (Father of the phrase *Artificial Intelligence*)

Question: What is artificial intelligence?

Answer: It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.

Question: Yes, but what is intelligence?

Answer: Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines.

see <http://www.formal.Stanford.EDU/jmc/whatisai/>

What is AI? - cont

"AI is the science of making machines to do things that would require intelligence if done by men." [Marvin Minsky](#)

"The study of mental faculties through the use of computational models"
[Eugen Charniak](#)

In short: There is no formal definition covering all aspects of intelligence

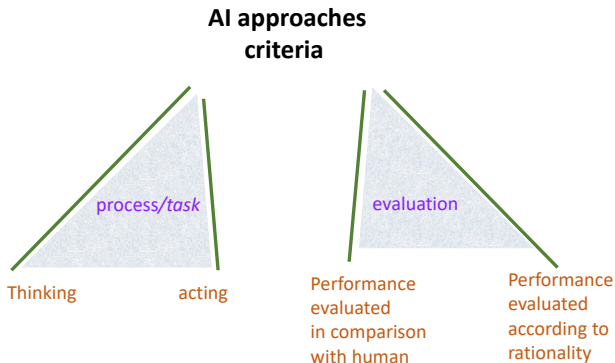
Can machines be Intelligent?

- *Symbolic system hypothesis* (Newell and Simon)
 - Intelligence is substrate neutral
 - A *physical symbol system* has necessary and sufficient means for general intelligent action.
- Biological substrate only (John Searle, philosopher)
 - Intelligence is substrate dependent.
 - The material humans are made of is fundamental for our intelligence.
 - Thinking is possible only in special machines - living ones made of proteins.

What is AI?

Russell and Norvig's definition of AI

Two dimensions:



How R&N define AI

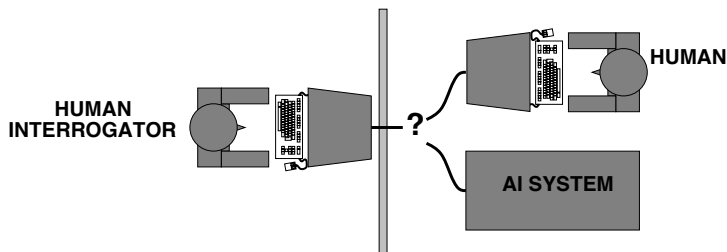
humanly vs. rationally

thinking
vs.
acting

Systems that think like humans	Systems that think rationally
Systems that act like humans	Systems that act rationally Rational Agents

Acting humanly

Alan Turing designed an operational test for intelligence -1950



- Can machines think?"
- Computer would need:
 - natural language processing
 - knowledge representation
 - automated reasoning
 - machine learning
- Total Turing test requires interaction with the external world, would require:
 - computer vision and speech recognition
 - robotics

- One of the most famous early AI programs: Eliza, the computer psychotherapist, created by Joseph Weizenbaum in 1966 at MIT.
- Eliza functions by "twisting the statements of her 'patients' back at them in the classic manner of a non-directive psychotherapist."
- The fact that it understands the subject's statements is an illusion.
- Surprisingly, many users were taking its performance quite seriously.

Acting Humanly - Eliza 2

young woman: Men are all alike.

eliza: In what way?

young woman: They're always bugging us about something specific or other.

eliza: Can you think of a specific example?

young woman: Well, my boyfriend made me come here.

eliza: Your boyfriend made you come here?

young woman: He says I'm depressed much of the time.

eliza: I am sorry to hear you are depressed.

young woman: It's true. I'm unhappy.

eliza: Do you think coming here will help you not to be unhappy?

young woman: I need some help, that much seems certain.

eliza: What would it mean to you if you got some help?

young woman: Perhaps I could learn to get along with my mother.

eliza: Tell me more about your family.

young woman: My mother takes care of me.

eliza: Who else in your family takes care of you?

young woman: My father.

eliza: Your father.

young woman: You are like my father in some ways.

eliza: What resemblance do you see?

young woman: You are not very aggressive but I think you don't want me to notice that.

eliza: What makes you think I am not very aggressive?

young woman: You don't argue with me.

eliza: Why do you think I don't argue with you?

young woman: You are afraid of me.

eliza: Does it please you to believe I am afraid of you?

young woman: My father is afraid of everybody.

eliza: What else comes to mind when you think of your father?

young woman: Bullies.

eliza: Does that have anything to do with the fact that your

> Hello. My name is Eliza. How may I help you?

Eliza Chat bot

Is she a Rogerian psychotherapist, a semi intelligent chat bot, or just a toy?



Eliza, one of the original chatbots, is now ready to talk to you.

She is programmed to talk like a Rogerian psychotherapist, an interesting example of the limitations of early artificial intelligence programs.

If Eliza (or you, or your web browser) gets stuck, [refresh the page](#). To start a new session with the therapist [reload the page](#).

- Cognitive modelling approach
- Learn about how humans think
 - introspection
 - psychological experiments
 - brain imaging
- Cognitive Science promising

Thinking rationally

- Aristotle: what are correct thought processes - Laws of Thought?
Formalize “correct” reasoning using a mathematical model
Syllogism (as a law of thought) codifies the patterns for argument structures.
- Theory of probability

Thinking rationally



Thinking rationally



Thinking rationally

Problems:

- General deductive inference is computationally intractable
- It does not generate intelligent *behaviour*

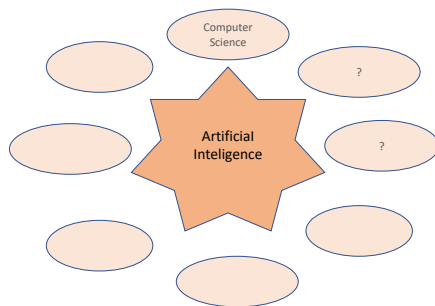
Acting rationally: Rational Agents approach

- Rational behavior: doing the right thing
- The right thing: that which is expected to maximize goal achievement, given the available information and computational abilities
- Doesn't necessarily involve thinking—e.g., blinking reflex—but thinking should be in the service of rational action
- Two advantages:
 - Not limited to "laws of thought" in order to achieve rationality
 - Rationality is mathematically well-defined - more operationable

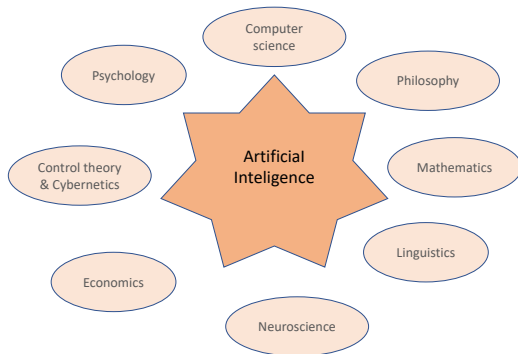
Foundations of AI

Computer Science is the main discipline underlying AI

Can we think which other disciplines AI is grounded on?



Foundations of AI



Foundations of AI

Philosophy	logic, methods of reasoning mind as physical system foundations of learning, knowledge and action
Mathematics	formal logic, computation, algorithms, probability theory learning from data
Psychology	behaviourism cognitive psychology

Economics	formal theory of rational decisions, utility
Linguistics	knowledge representation grammar, syntax, semantics
Neuroscience	neurons as information processing units synapse as learning mechanism
Control theory	homeostatic systems, stability simple optimal agent designs, maximize objective function
Computer science	engineering, hardware computational complexity theory

Birth of AI field

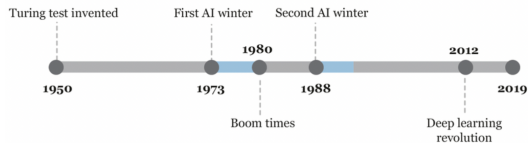
A Summer Research Project in the Dartmouth College, in 1956 was the birth of the AI research field.



(From left: Trenchard More, John McCarthy, Marvin Minsky, Oliver Selfridge, and Ray Solomonoff)

From the project proposal: "...to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it."

AI Seasons



Brief history of AI

- 1943 McCulloch & Pitts: Boolean circuit model of brain
- 1950 Turing's "Computing Machinery and Intelligence"
- 1952-69 Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
- 1956 Dartmouth meeting: "Artificial Intelligence" adopted
- 1962 Rosenblatt's Perceptron for training simple neural networks
- 1965 Robinson's complete algorithm for logical reasoning
- 1972 The logic programming language PROLOG is created.
- 1966-74 Disappointment: AI discovers computational complexity
Neural network research almost disappears

Brief history of AI -cont.

1969–79	Early development of knowledge-based systems
1980–88	Expert systems industry booms
1988–93	Expert systems industry busts: “AI Winter”
1985–95	Backpropagation learning returns neural networks to popularity
1988–	Resurgence of probability; general increase in technical depth “Nouvelle AI”: ALife, GA
1995–	Agents, agents, everywhere . . .
2003–	Human-level AI back on the agenda
2005–2010	AI disappoints again, AI is not much appreciated
2012 -	Deep learning and a very hot AI summer since then

Example from Early History of AI

1943 McCulloch & Pitts: Boolean circuit model of brain

BULLETIN OF
MATHEMATICAL BIOPHYSICS
VOLUME 5, 1943

A LOGICAL CALCULUS OF THE IDEAS IMMANENT IN NERVOUS ACTIVITY

WARREN S. MCCULLOCH AND WALTER PITTS

FROM THE UNIVERSITY OF ILLINOIS, COLLEGE OF MEDICINE,
DEPARTMENT OF PSYCHIATRY AT THE ILLINOIS NEUROPSYCHIATRIC INSTITUTE,
AND THE UNIVERSITY OF CHICAGO

Because of the "all-or-none" character of nervous activity, neural events and the relations among them can be treated by means of propositional logic. It is found that the behavior of every net can be described in these terms, with the addition of more complicated logical means for nets containing circles; and that for any logical expression satisfying certain conditions, one can find a net behaving in the fashion it describes. It is shown that many particular choices among possible neurophysiological assumptions are equivalent, in the sense that for every net behaving under one assumption, there exists another net which behaves under the other and gives the same results, although perhaps not in the same time. Various applications of the calculus are discussed.

1. Introduction

Theoretical neurophysiology rests on certain cardinal assumptions. The nervous system is a net of neurons, each having a soma and an axon. Their adjunctions, or synapses, are always between the axon of one neuron and the soma of another. At any instant a neuron has some threshold, which excitation must exceed to initiate an impulse. This, except for the fact and the time of its occurrence, is determined by the neuron, not by the excitation. From the point of excitation the impulse is propagated to all parts of the neuron. The velocity along the axon varies directly with its diameter, from less than one meter per second in thin axons, which are usually short, to more than 150 meters per second in thick axons, which are usually long. The time for axonal conduction is consequently of little importance in determining the time of arrival of impulses at points unequally remote from the same source. Excitation across synapses oc-

Goal: to understand how the brain produces complex thoughts ("propositions") by using (simple) neurons

- model of a neuron, axon, dendrode - "MCP neuron"
- network of neurons
- transfer of information through on/off mechanism of neurons

McCulloch and Pitts 1943 - "Bird example"

Assume a bird will "decide" to eat/not an object (e.g., blue berry, orange, basketball, daisy).

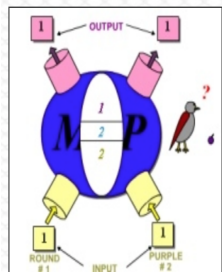
It receives/perceives two pieces of information about the object:

- shape: round or not
- colour: purple or not

Decision: eat only if round purple object (e.g., blue berry)

Example from: http://www.mind.ilstu.edu/curriculum/mcp_neurons/mcp_neuron_1.php?modGUI=212&compGUI=1749&itemGUI=3018

Bird example - cont.



- two inputs (each takes value 0 or 1)
- threshold T
- output is a function of inputs and T
- **IF**(sum(inputs)) $\geq T$
THEN Output=1

Object	Purple?	Round?	Eat?
Blueberry	1	1	1
Golf ball	0	1	0
Violet	1	0	0
Hot Dog	0	0	0

Object	Purple?	Round?	Total	Greater than or equal to threshold of 1?	Eat?
Blueberry	1	1	2	Yes	1
Golf ball	0	1	1	Yes	1
Violet	1	0	1	Yes	1
Hot Dog	0	0	0	No	0

Some killer apps in AI history

1991 During the Gulf War, US forces deployed an AI logistics planning and scheduling program that involved up to 50,000 vehicles, cargo, and people. Saved the US more money than spent on all AI research since 1950

1997 Deep Blue (IBM) defeated world chess champion Gerry Kasparov

2011 Watson (IBM) beat human champions on “Jeopardy”

2012 Google car obtains driver's license in Nevada, US.

2017 DeepMind's Alphago AND Elon Musk's A.I. Destroys Champion Gamer!

2022 Open AI's. ChapGPT, language model/text generation.

- **Lethal autonomous weapons** - Don't require human supervision. Scalability
- **Surveillance and Persuasion** - Security personnel vs AI. Scalability
- **Biased decision making** - related to hiring, evaluating bank loan and parole
- **Impact on employment** - Machine vs human
- **Safety critical applications** – Difficult formal verification. Technical and technical standards lack.
- **Cybersecurity** - Cyberattack vs detection of Cyberattack

Next Lecture: Intelligent Agents (chapter 2 in R&N book)

How humany is Sofia (Hong Kong Kong firm Hanson Robotics)?

<https://www.youtube.com/watch?v=suRuQbDXcrc>

Computers with common sense(Doug Lenat):

https://www.youtube.com/watch?v=2w_ekB08ohU

Artificial Intelligence: The Common Sense Problem (Hubert Dreyfus)

<https://www.youtube.com/watch?v=SUZUbYCBtGI>

AI Boom (Rodney Brooks):

<https://www.youtube.com/watch?v=ovbzjLobiDo>

IBM Watson : https://www.youtube.com/watch?v=_Xcmh1LQB9I

Jeopardy : https://www.youtube.com/watch?v=WFR3l0m_xhE

State of the art AI (Minsky):

https://www.youtube.com/watch?v=aODnFdU_hds

John McCarthy talks about AI:

<https://www.youtube.com/watch?v=0zipf13jRr4>