PAT 463/563 (Fall 2025)

Music & AI

Lecture 2: AI & ML Fundamentals

Instructor: Hao-Wen Dong

UNIVERSITY OF MICHIGAN

What is Artificial Intelligence?

Can you? (I, Robot, 2004)

youtu.be/siHfHUm3HGE

What is Artificial Intelligence?

AI is the study of how to make computers **do things at which, at the moment, people are better**.

– Elaine Rich and Kevin Knight, 1991

1997

(Source: Britannica)

2016

(Source: The Guardian)

20??

(Source: SC2HL)

Elaine Rich and Kevin Knight, *Artificial Intelligence.* United Kingdom: McGraw-Hill, 1991.
britannica.com/topic/Deep-Blue
theguardian.com/technology/2016/mar/15/alphago-what-does-google-advanced-software-go-next
youtube.com/watch?v=PFMRDm_H9Sg

What is Artificial Intelligence?

The exciting new effort to **make computers think** … ***machines with minds***, in the full and literal sense (Haugeland, 1985)

The **automation of activities that we associate with human thinking**, activities such as decision-making, problem solving, learning … (Bellman, 1978)

Systems that think like humans

The study of **mental faculties through the use of computational models** (Charniak & McDermott, 1985)

The study of the computations that **make it possible to perceive, reason, and act** (Winston, 1992)

Systems that think rationally

Systems that act like humans

The art of creating machines that **perform functions that require intelligence when performed by people** (Kurzweil, 1990)

The study of how to make computers **do things at which, at the moment, people are better** (Rich & Knight, 1991)

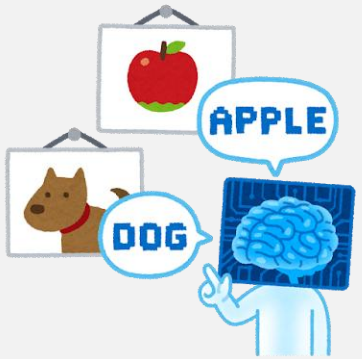
Systems that act rationally

A field of study that seeks to **explain and emulate intelligent behavior in terms of computational processes** (Schalkoff, 1990)

The branch of computer science that is concerned with the **automation of intelligent behavior** (Luger & Stubblefield, 1993)

What is Artificial Intelligence?

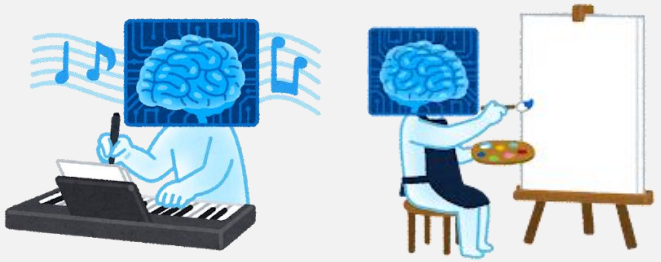
Systems that think like humans



Systems that think rationally

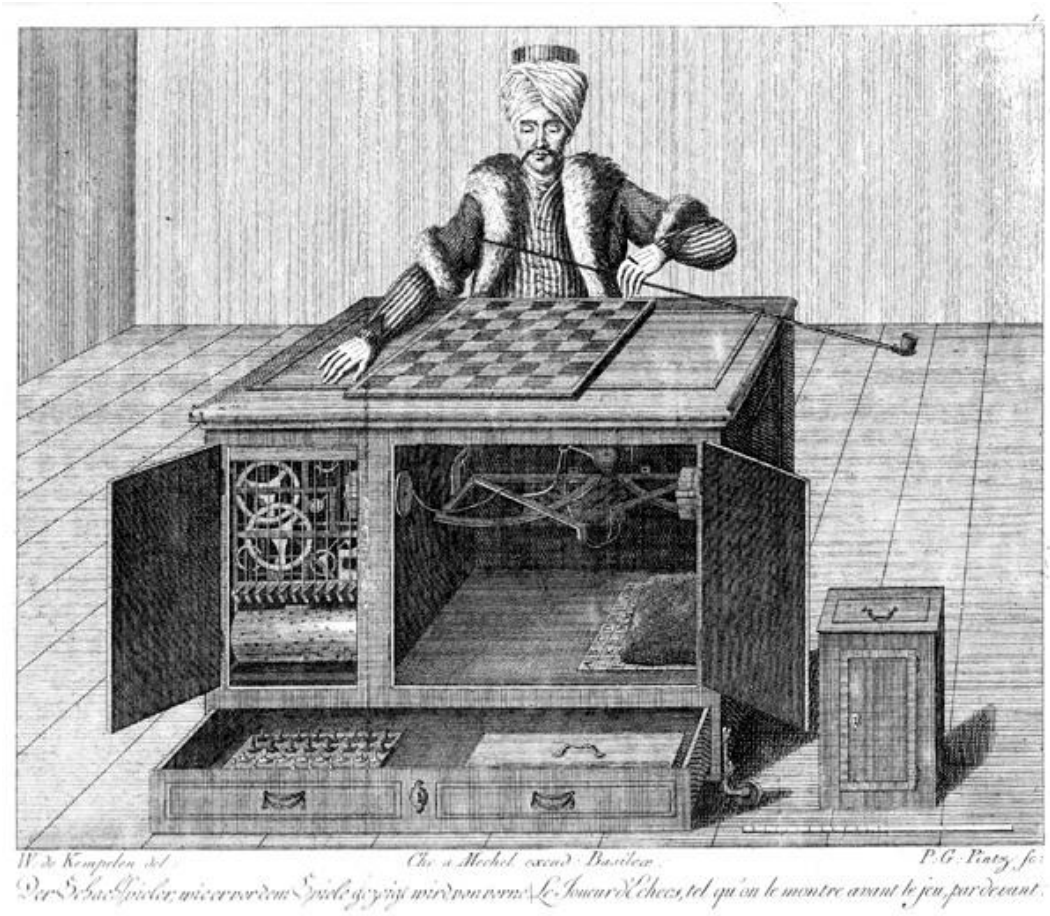
Systems that act like humans

Systems that act rationally



Thinking vs Acting

Thinking vs Acting: The Turk (1770)



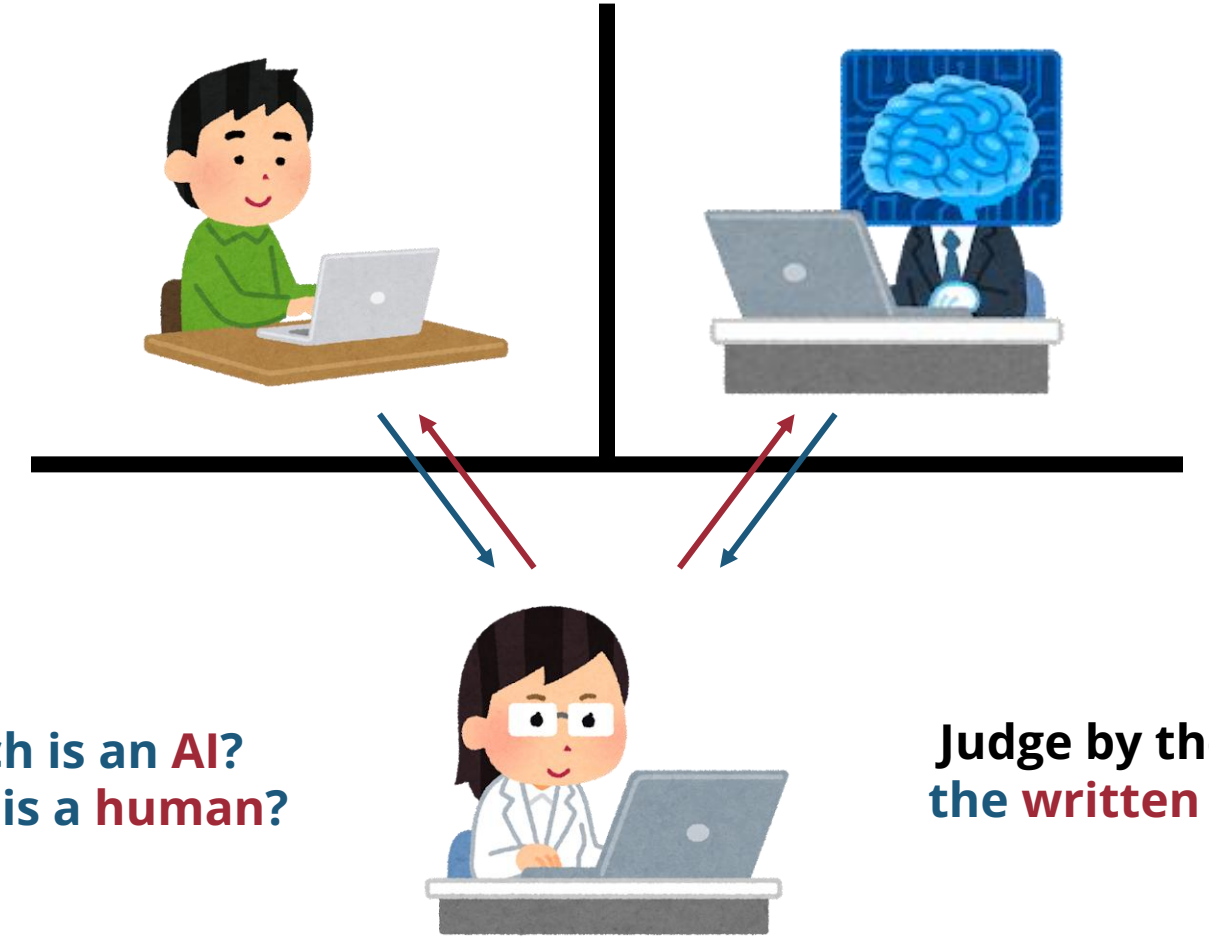
(Source: Wikimedia)

youtu.be/7W_kQsO6MPc

Thinking vs Acting: The Turk (1770)

youtu.be/Xosn4ManeD4

Thinking vs Acting: Turing Test (1950)



Which is an AI?
Which is a human?

Interrogator

Judge by the responses to the written questions only

Thinking vs Acting: The Chinese Room (1980)

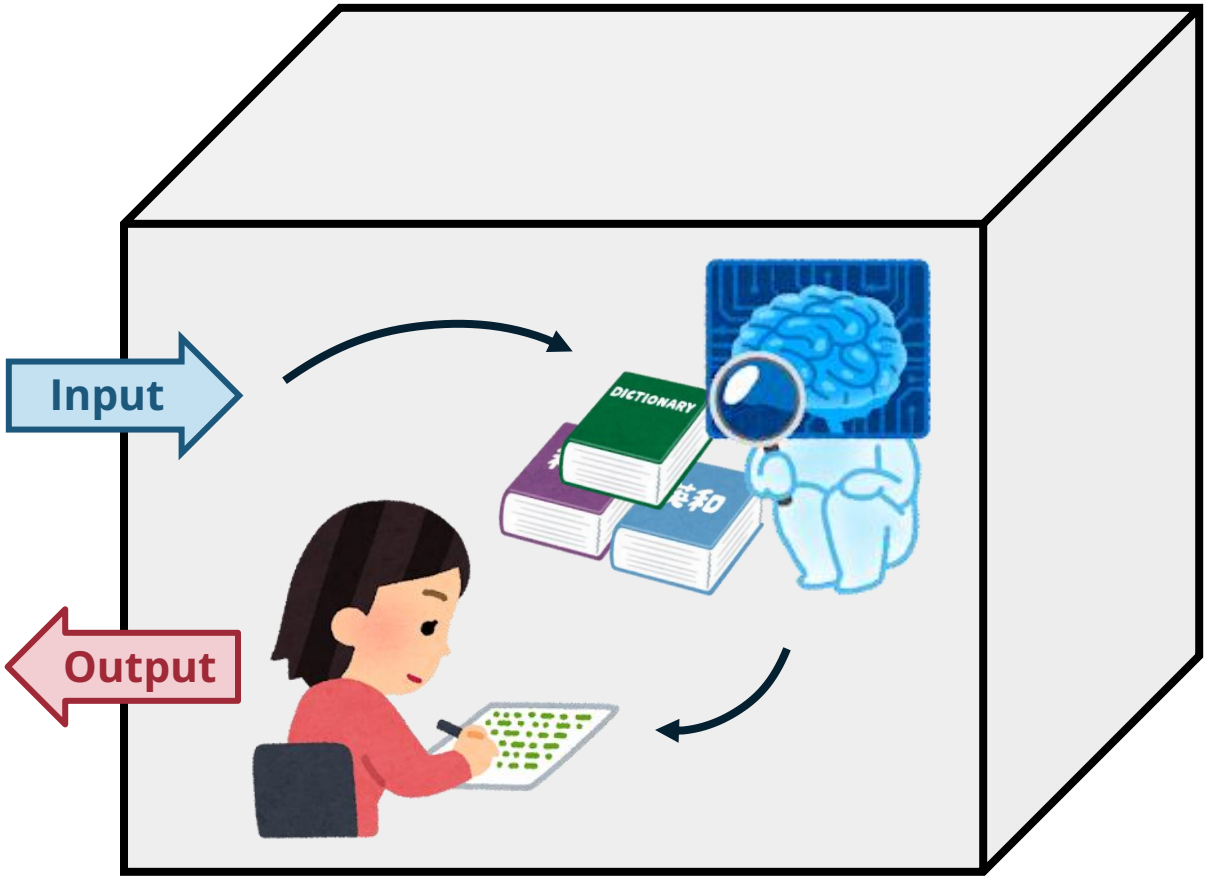
你會說中文嗎？
(Do you speak Chinese?)

會哦，我中文很流利！
(Yep, I speak fluent Chinese!)

你知道人工智慧是什麼嗎？
(Do you know what AI is?)

不知道耶，人工智慧是什麼？
(I don't know. What is AI?)

⋮



Is this considered intelligence?

Thinking vs Acting: The Chinese Room (1980)

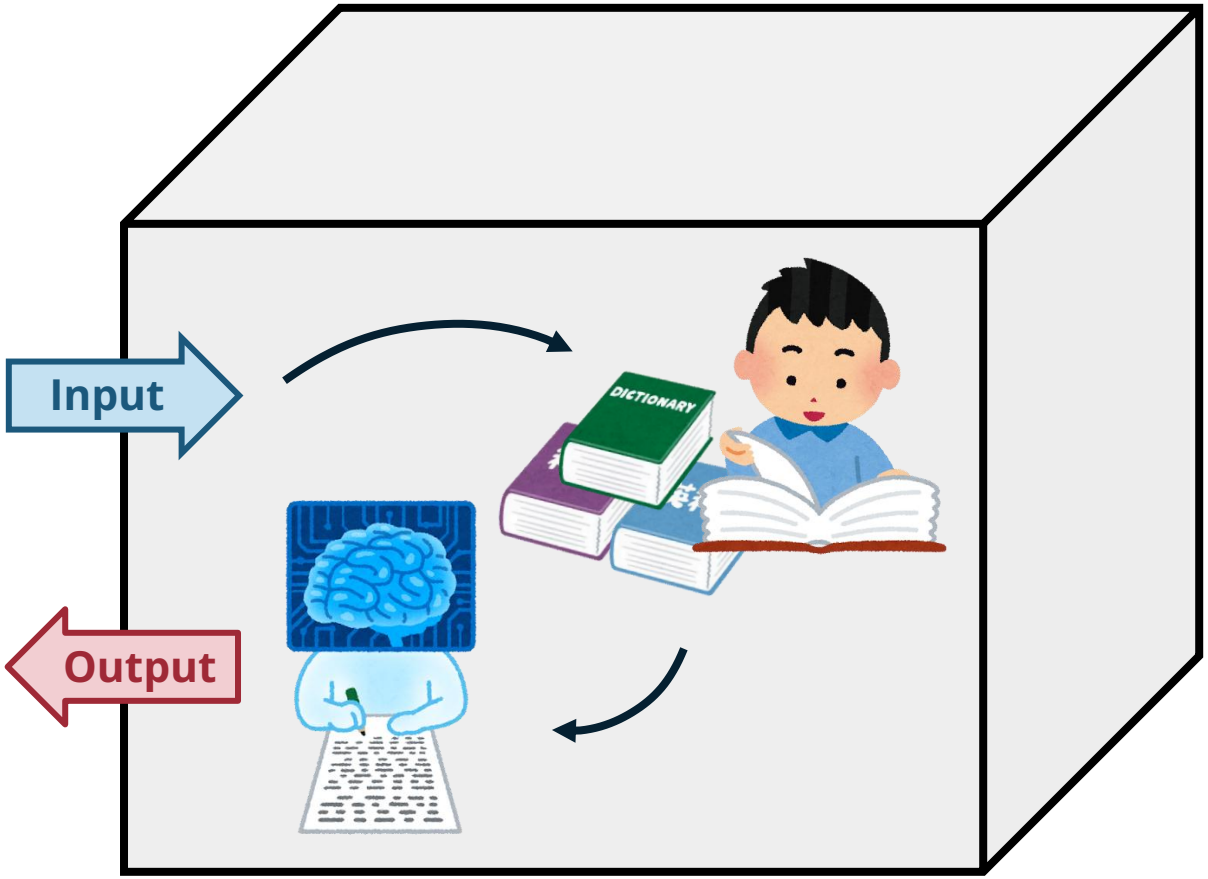
你會說中文嗎？
(Do you speak Chinese?)

會哦，我中文很流利！
(Yep, I speak fluent Chinese!)

你知道人工智慧是什麼嗎？
(Do you know what AI is?)

不知道耶，人工智慧是什麼？
(I don't know. What is AI?)

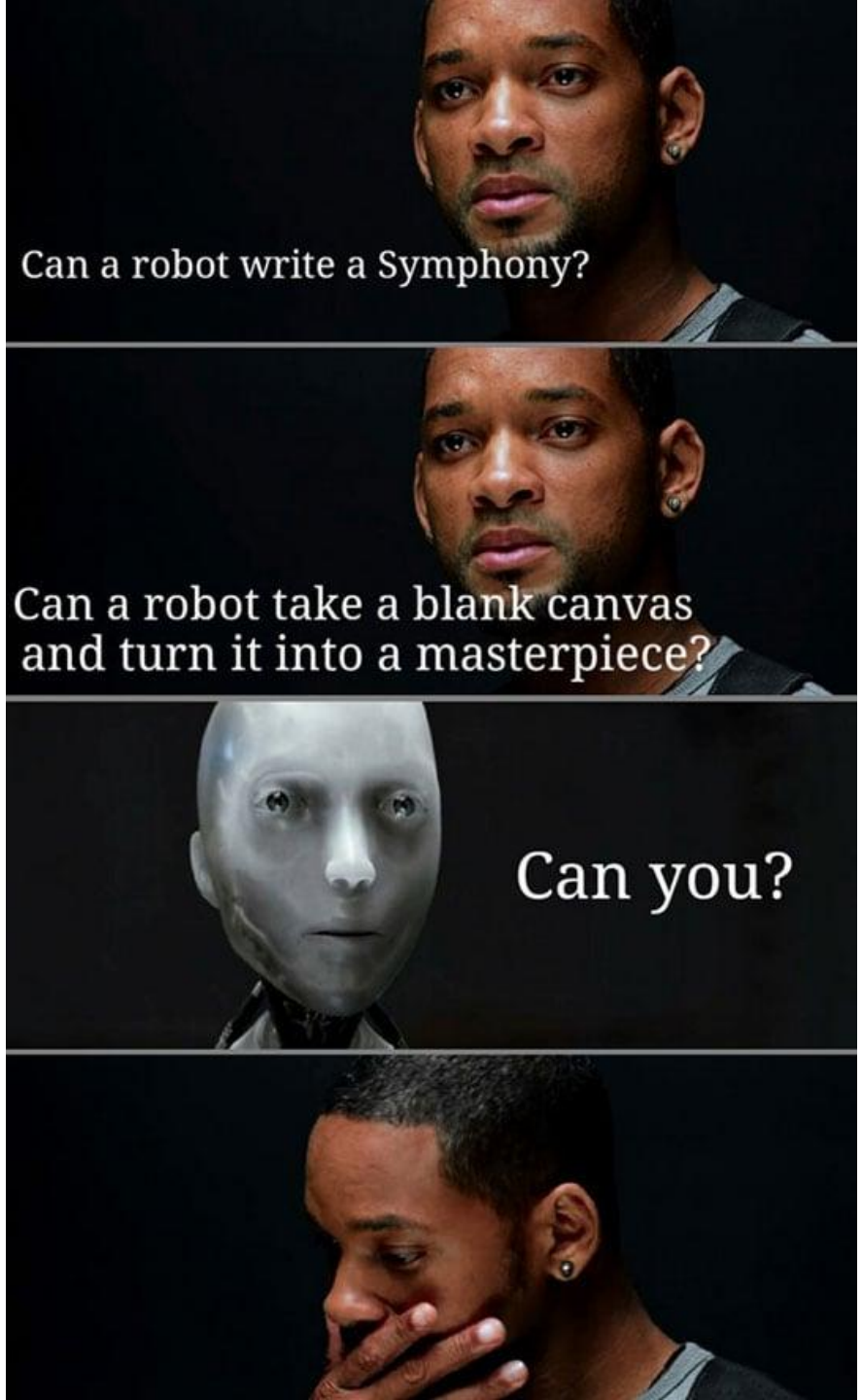
⋮



Isn't this like the Turk?

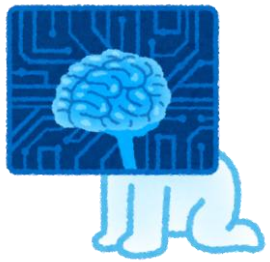
Human vs AI

Can you? (I, Robot, 2004)



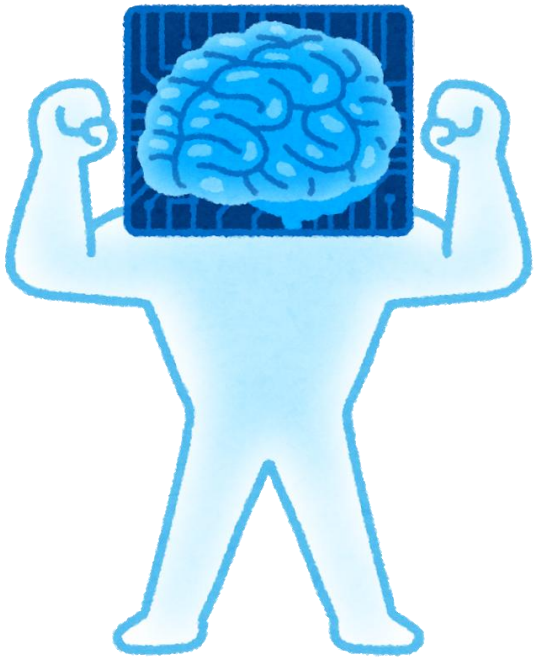
Human vs AI: Weak AI vs Strong AI

Performs a single task
Cannot learn from experience
Cannot reason



Artificial General Intelligence (AGI)

Reaches human-level intelligence
Have a self-aware consciousness
Solve multiple tasks
Can learn and plan



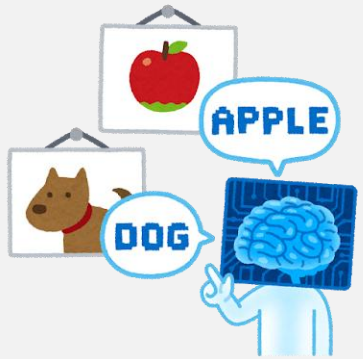
Human vs AI: The Many AGI Tests

- **The Coffee Test** (Steve Wozniak, 2010)
  - Can the AI make a cup of coffee after entering an average home: find the coffee machine and coffee, add water, find a mug, and brew the coffee by pushing the proper buttons?
- **The Robot College Student Test** (Ben Goertzel, 2012)
  - Can the AI enroll in a university, take classes like humans, and earn its degree?
- **The IKEA Test** (Gary Marcus, 2015)
  - Can the AI control a robot to assemble an IKEA furniture correctly by reading the instructions?
- **The Modern Turing Test** (Mustafa Suleyman, 2023)
  - Can the AI make $1M on a retail web platform in a few months with a $100K investment?

Victoria Turk, "The Plan to Replace the Turing Test with a 'Turing Olympics'," VICE, January 28, 2015.
Ben Goertzel, "What counts as a conscious thinking machine?, "New Scientist, September 5, 2012.
Michael Shick, "Wozniak: Could a Computer Make a Cup of Coffee?," Fast Company, March 3, 2010.
Mustafa Suleyman, "Mustafa Suleyman: My new Turing test would see if AI can make $1 million," MIT Technology Review, July 14, 2023.

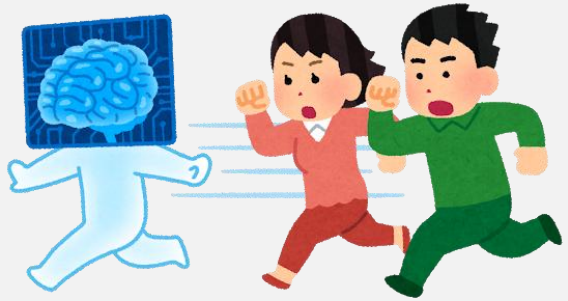
What is Artificial Intelligence?

Systems that think like humans

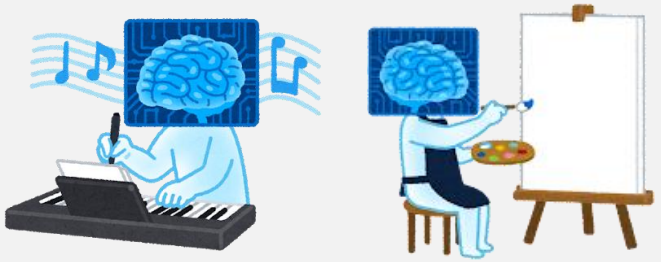


Systems that think rationally

Systems that act like humans



Systems that act rationally



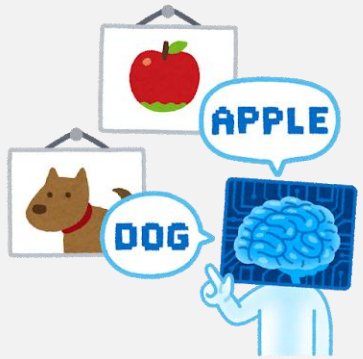
🤔 What is your expectation of a Real AI?

- **Thinking vs Acting**
  - An AI **needs to know how to think** **(Votes: 0)**
  - An AI **doesn't need to know how to think** **(Votes: 3)**

- **Human vs AI**
  - An AI **needs to behave like a human** **(Votes: 0)**
  - An AI **doesn't need to behave like a human** **(Votes: 3)**

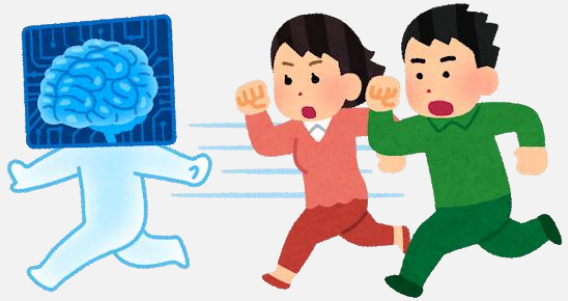
What is Artificial Intelligence?

Systems that think like humans

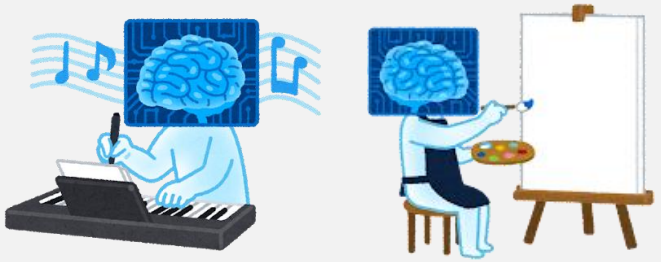


Systems that think rationally

Systems that act like humans

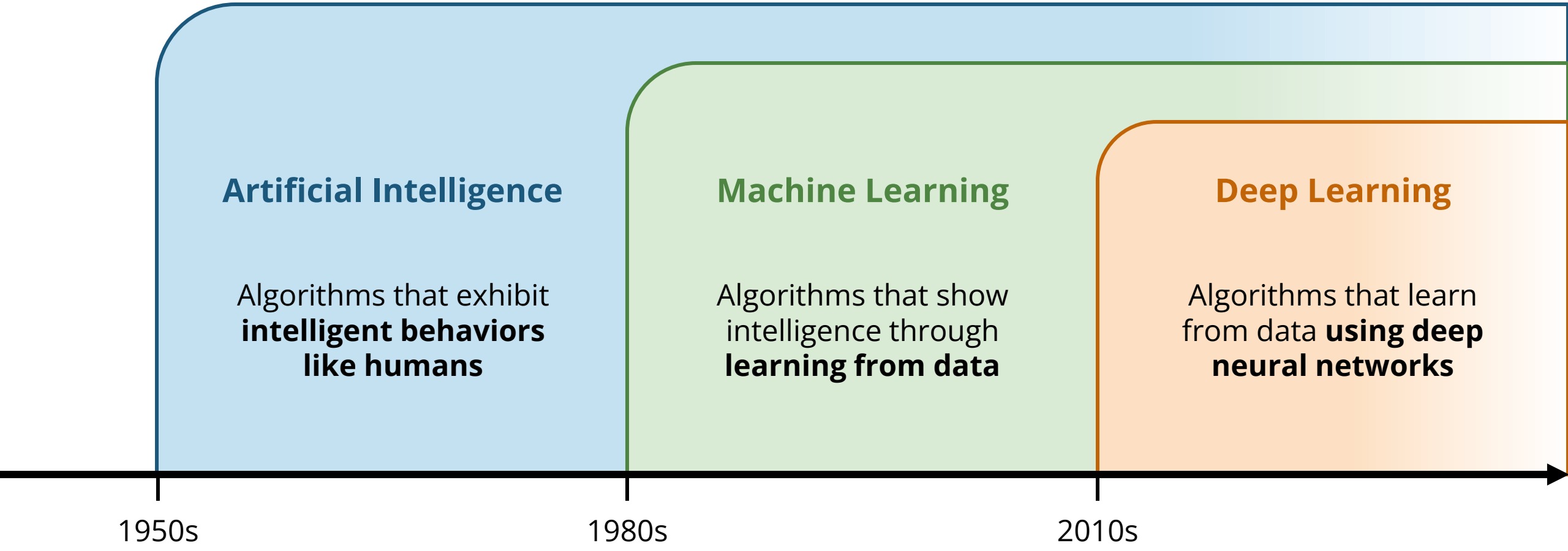


Systems that act rationally



What is Machine Learning?

AI vs ML vs DL


Artificial Intelligence
Algorithms that exhibit **intelligent behaviors like humans**
Machine Learning
Algorithms that show intelligence through **learning from data**
Deep Learning
Algorithms that learn from data **using deep neural networks**
1950s
1980s
2010s

What is Machine Learning?

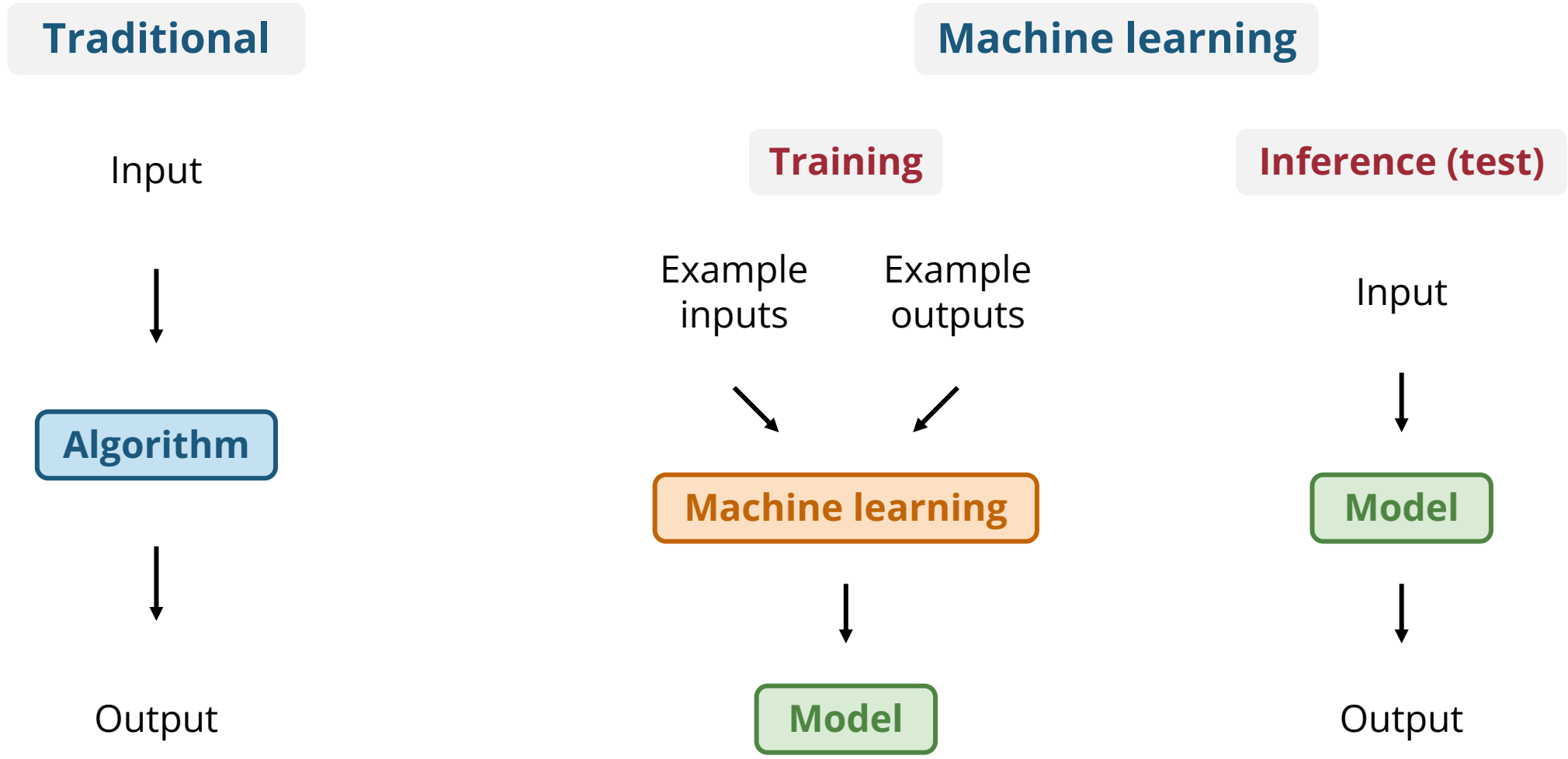
Machine Learning is a field of study that gives computers the ability to **learn without being explicitly programmed**.

– Attributed to Arthur Samuel

A computer program is said to learn from **experience E** with respect to some **class of tasks T** and **performance measure P** if ***its performance at tasks in T, as measured by P, improves with experience E***.

– Tom M. Mitchell, 1997

Machine Learning



Components of a Machine Learning Model

Improve on task T,
with respect to performance metric P,
based on experience E

• **Task T**	**Animal classification**
• **Performance metric P**	Percentage of correct predictions
• **Experience E**	Animal images with labels

Components of a Machine Learning Model

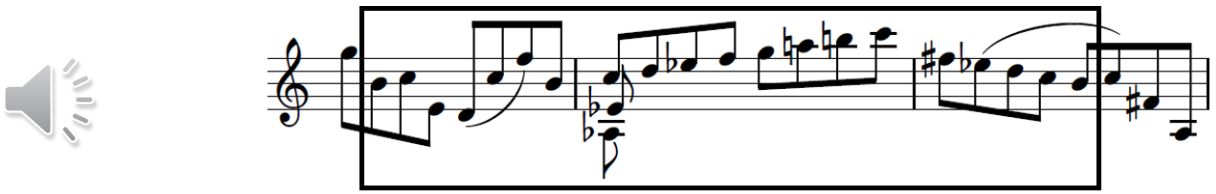
Improve on task T,
with respect to performance metric P,
based on experience E

- **Task T** — **Stock price prediction**
- **Performance metric P** — Difference between predicted and actual price
- **Experience E** — History stock price

Components of a Machine Learning Model

Improve on task T,
with respect to performance metric P,
based on experience E

- **Task T** — **Violin transcription**
- **Performance metric P** — Percentage of correctly predicted notes
- **Experience E** — Recordings with sheet music

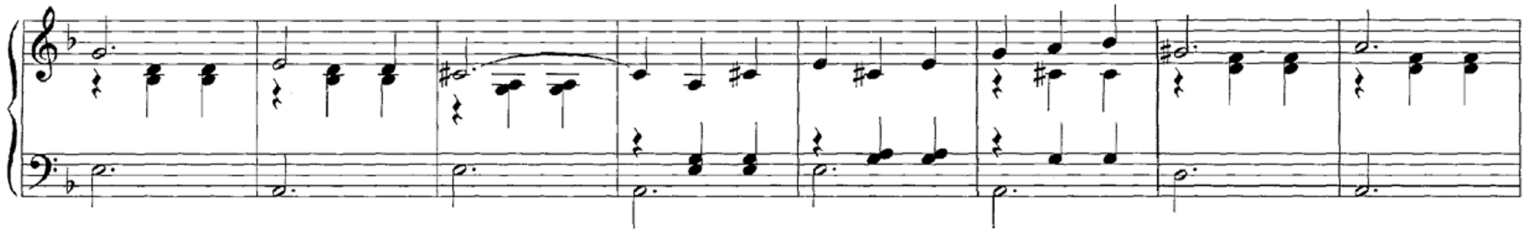


Hao-Wen Dong, Cong Zhou, Taylor Berg-Kirkpatrick, and Julian McAuley, "Deep Performer: Score-to-Audio Music Performance Synthesis," ICASSP, 2022.

Components of a Machine Learning Model

Improve on task T,
with respect to performance metric P,
based on experience E

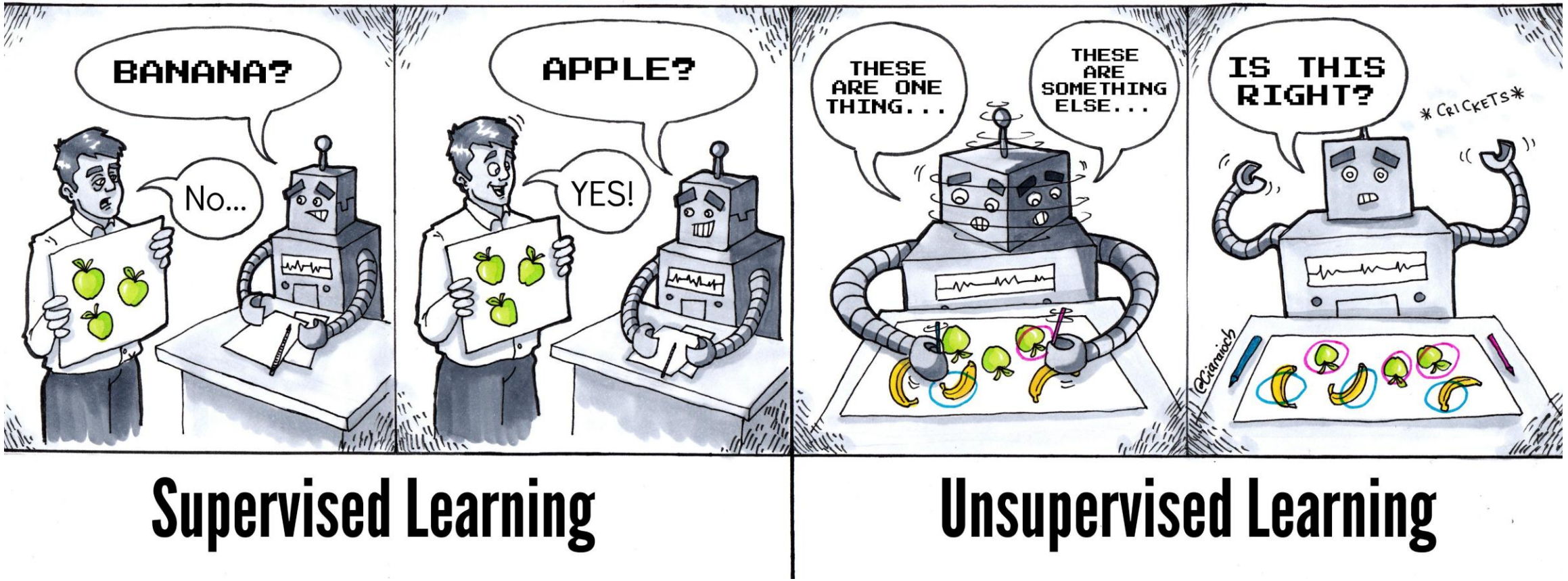
• **Task T**	**Beat tracking**
• **Performance metric P**	Average difference from actual timings
• **Experience E**	Recordings with beat timestamps



(Source: Müller)

audiolabs-erlangen.de/resources/MIR/FMP/C6/C6S3_BeatTracking.html
Meinard Müller, "Fundamentals of Music Processing – Using Python and Jupyter Notebooks," *Springer Verlag*, 2021.
Meinard Müller and Frank Zalkow, "FMP Notebooks: Educational Material for Teaching and Learning Fundamentals of Music Processing," *ISMIR*, 2019.

Supervised vs Unsupervised Learning

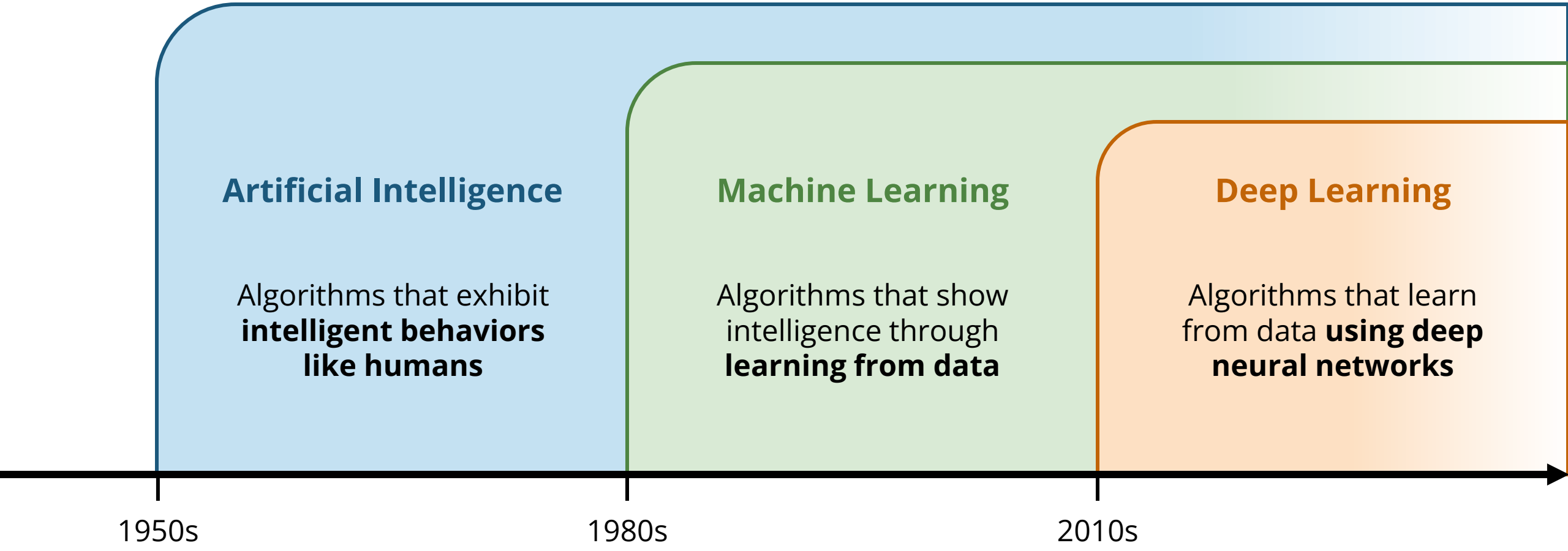


(Source: Ciaraioch)

medium.com/@jervisaldanha/a-tale-of-two-learning-paradigms-unraveling-the-magic-of-supervised-and-unsupervised-learning-in-6acb8099c09a

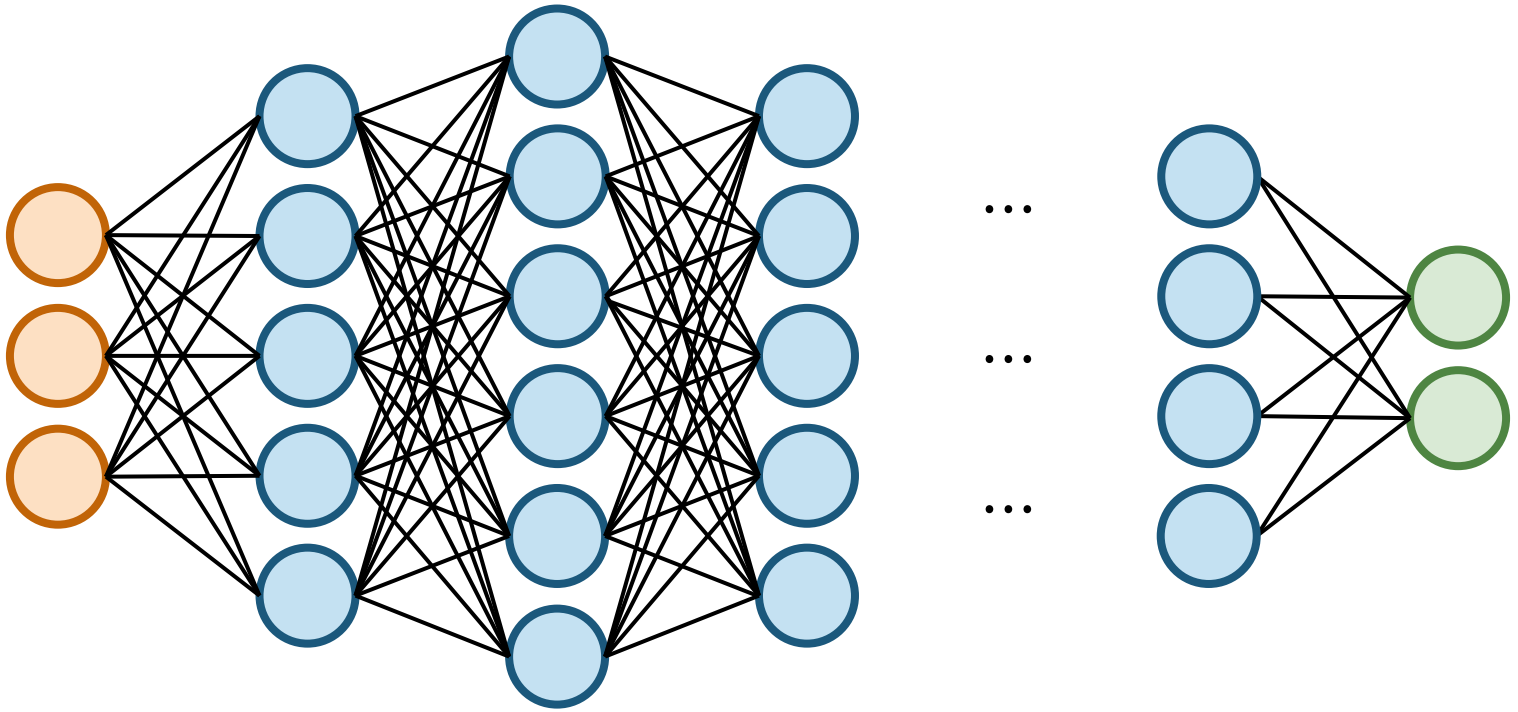
What about Deep Learning?

AI vs ML vs DL


Artificial Intelligence
Algorithms that exhibit **intelligent behaviors like humans**
Machine Learning
Algorithms that show intelligence through **learning from data**
Deep Learning
Algorithms that learn from data **using deep neural networks**
1950s
1980s
2010s

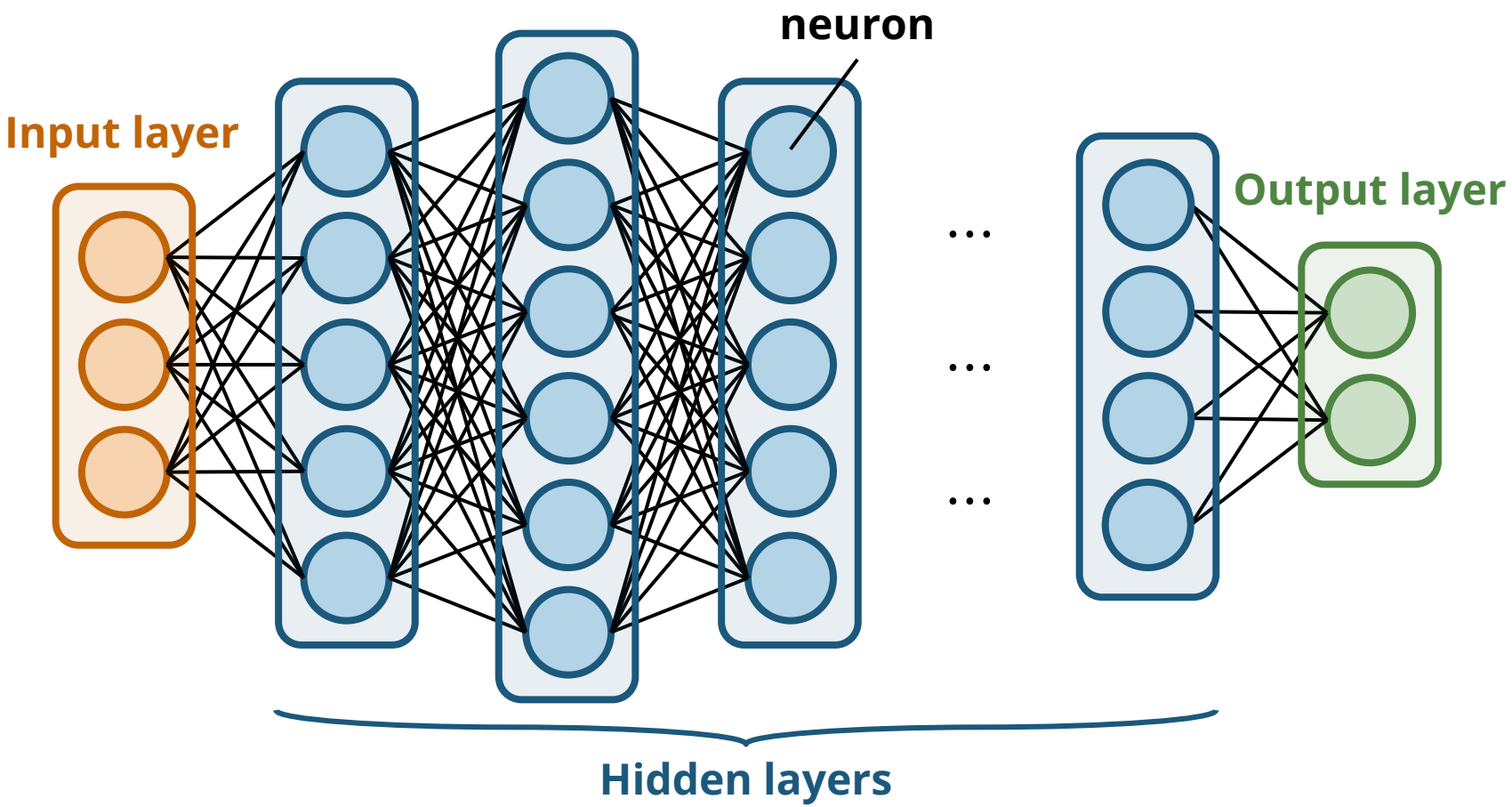
What is Deep Learning?

- A type of machine learning that uses **deep neural networks**



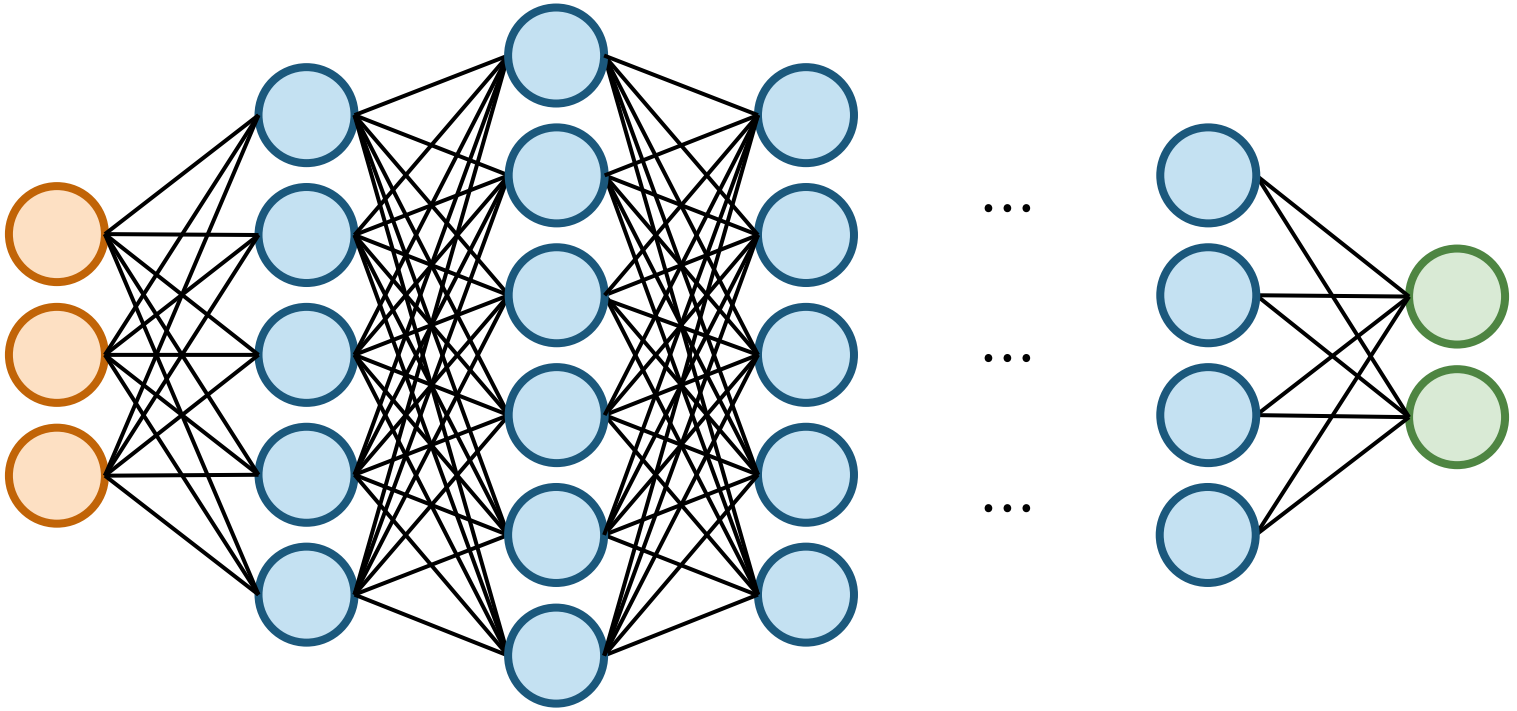
What is Deep Learning?

- A type of machine learning that uses **deep neural networks**



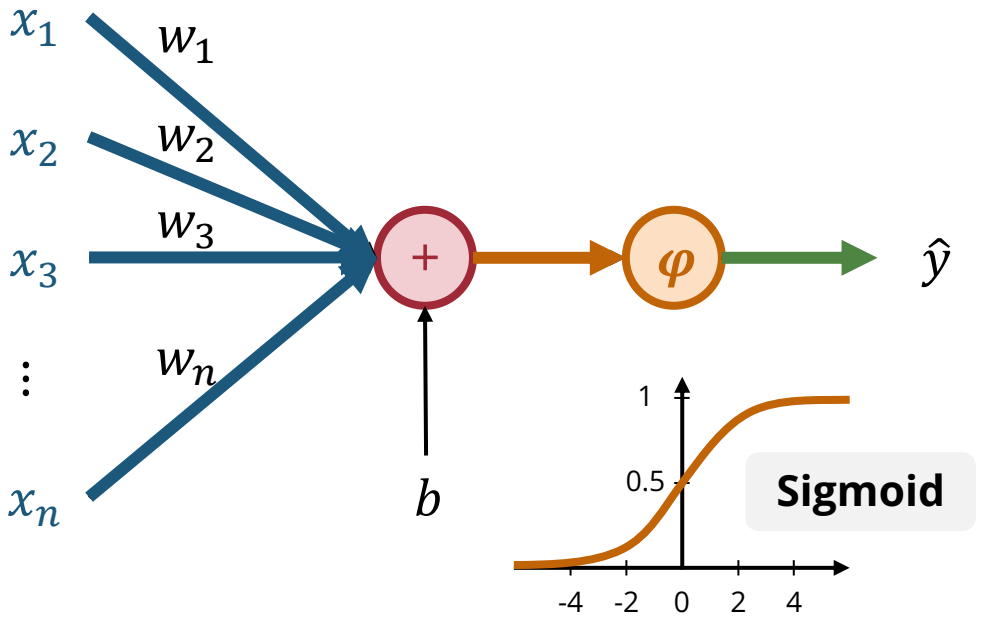
What is Deep Learning?

- A type of machine learning that uses **deep neural networks**

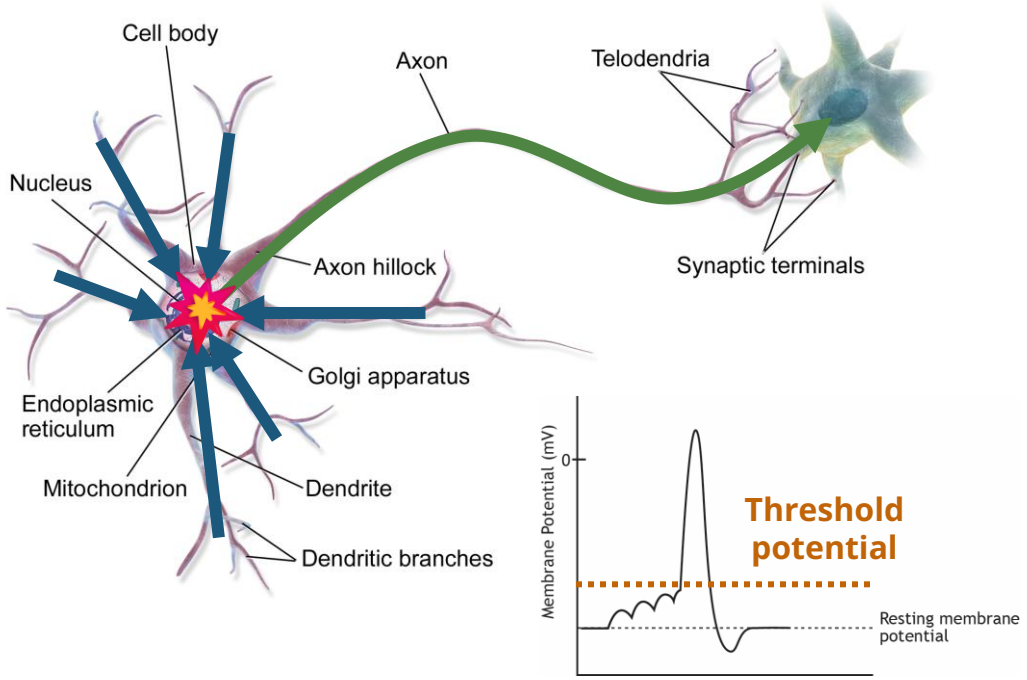


Artificial vs Human Neuron

Artificial neuron

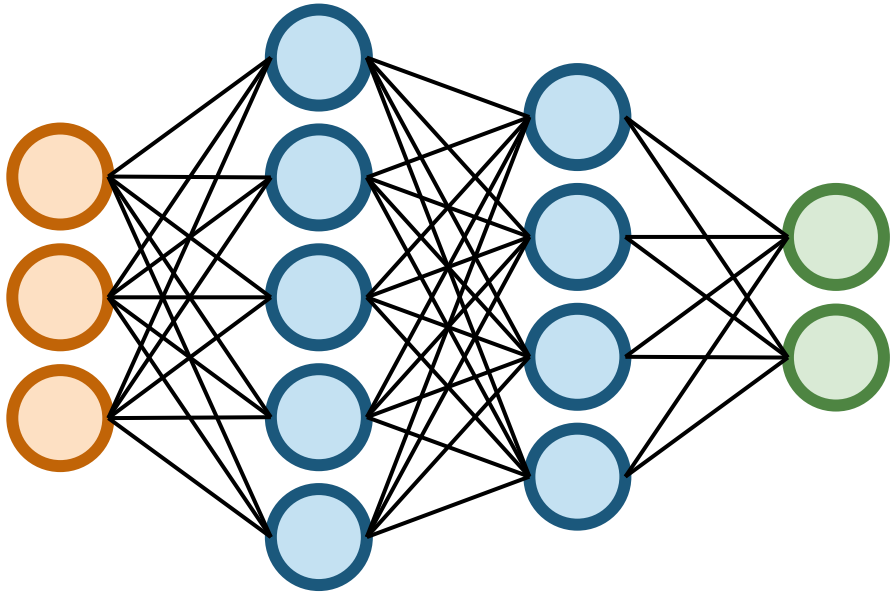


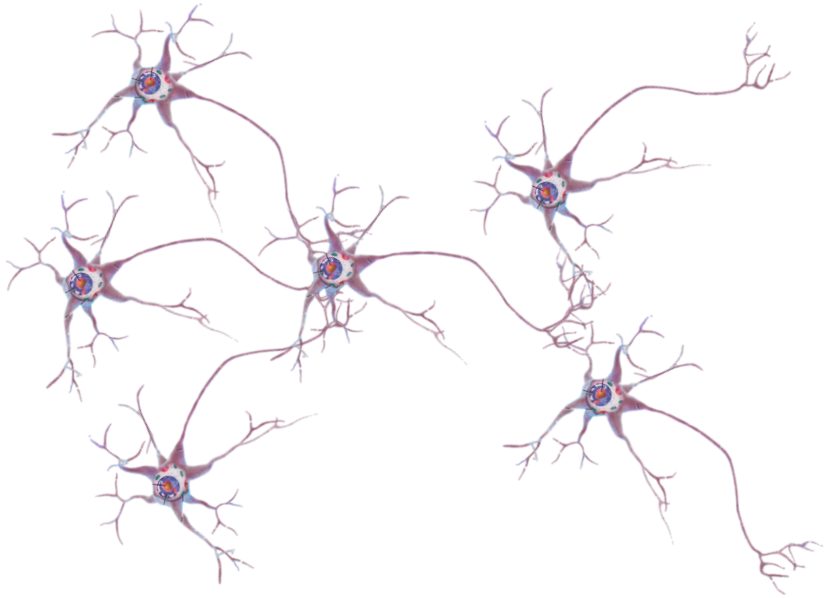
Human neuron



Artificial Neural Networks

- Although inspired by human neural networks, artificial neural networks nowadays **don't really work like human brains**





Building Blocks of Deep Learning Systems

Data

×

Model

×

Use Case

Key difference from traditional ML

Analytic AI vs Generative AI

Created with Adobe Firefly

This is NOT Morgan Freeman (2021)

youtu.be/oxXpB9pSETo

This is NOT Morgan Freeman (2021)

youtu.be/F4G6GNFz0O8

Generative AI for Visual Arts

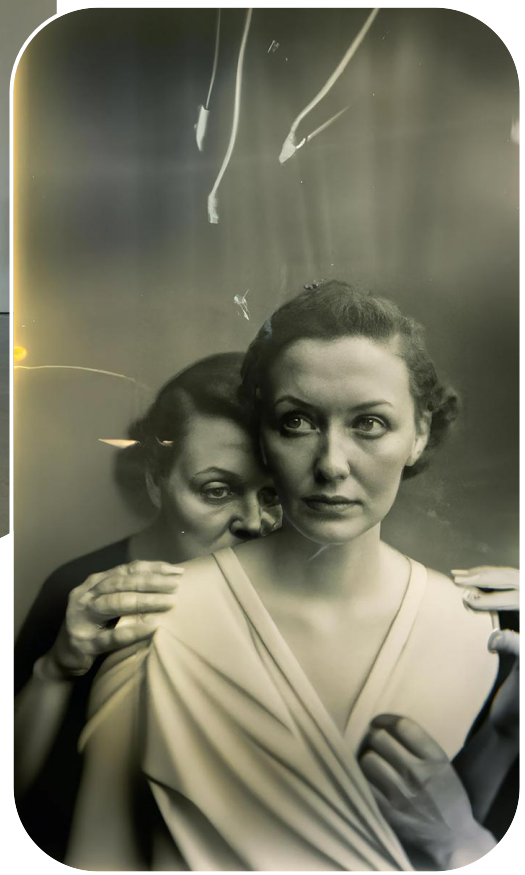
(Source: Cosmopolitan)

First Prize in Digital arts at Colorado State Fair Fine Arts Competition

(Source: CNN Business)

(Source: MoMA Magazine)

Sony World Photography Award in Creative Open Category



(Source: CNN)

Gloria Liu, "The World's Smartest Artificial Intelligence Just Made Its First Magazine Cover," *Cosmopolitan*, June 21, 2022.
Rachel Metz, "AI won an art contest, and artists are furious," *CNN Business*, September 3, 2022.
Refik Anadol , "Refik Anadol on AI, Algorithms, and the Machine as Witness," *MoMA Magazine*, December 20, 2022.
Lianne Kolirin, "Artist rejects photo prize after AI-generated image wins award," *CNN*, April 18, 2023.

Generative AI for Video Generation

OpenAI, Sora: Creating video from text, openai.com/sora, Feb 15, 2024.

🔥 **HW 1**: Real or Fake!?

🔥 **HW 1**: Real or Fake!?

- Instructions will be sent by **emails** and released on the **course website**
- **Don’t worry! You’ll be graded by completion (instead of correctness)!**
- Have fun!

Recap

What is Artificial Intelligence?

AI is the study of how to make computers **do things at which, at the moment, people are better**.

– Elaine Rich and Kevin Knight, 1991

1997

(Source: Britannica)

2016

(Source: The Guardian)

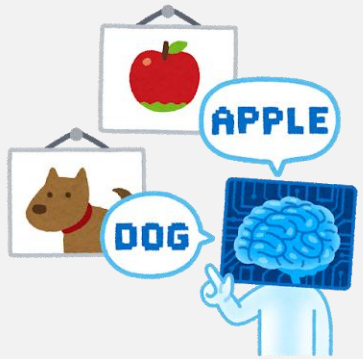
20??

(Source: SC2HL)

Elaine Rich and Kevin Knight, *Artificial Intelligence.* United Kingdom: McGraw-Hill, 1991.
britannica.com/topic/Deep-Blue
theguardian.com/technology/2016/mar/15/alphago-what-does-google-advanced-software-go-next
youtube.com/watch?v=PFMRDm_H9Sg

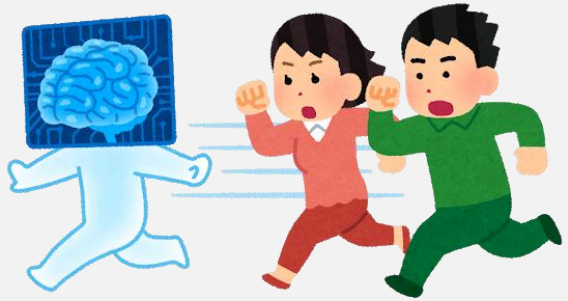
What is Artificial Intelligence?

Systems that think like humans

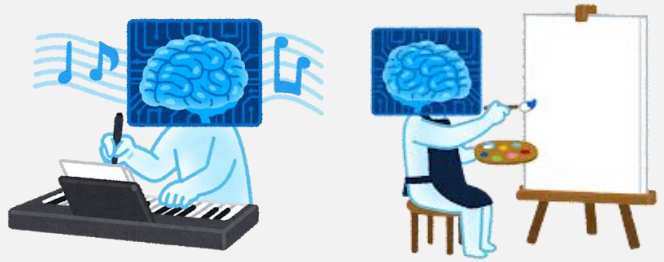


Systems that think rationally

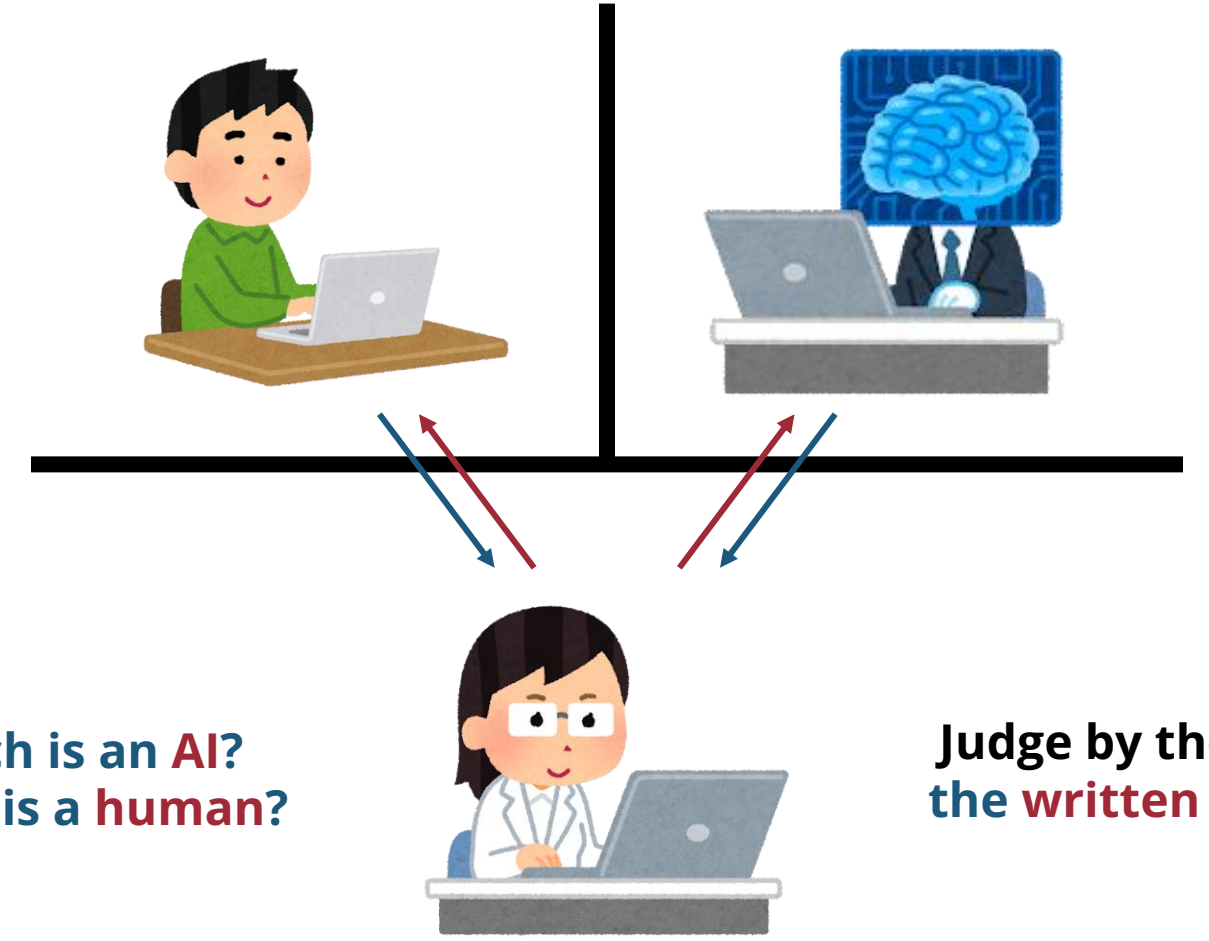
Systems that act like humans



Systems that act rationally



Thinking vs Acting: Turing Test (1950)

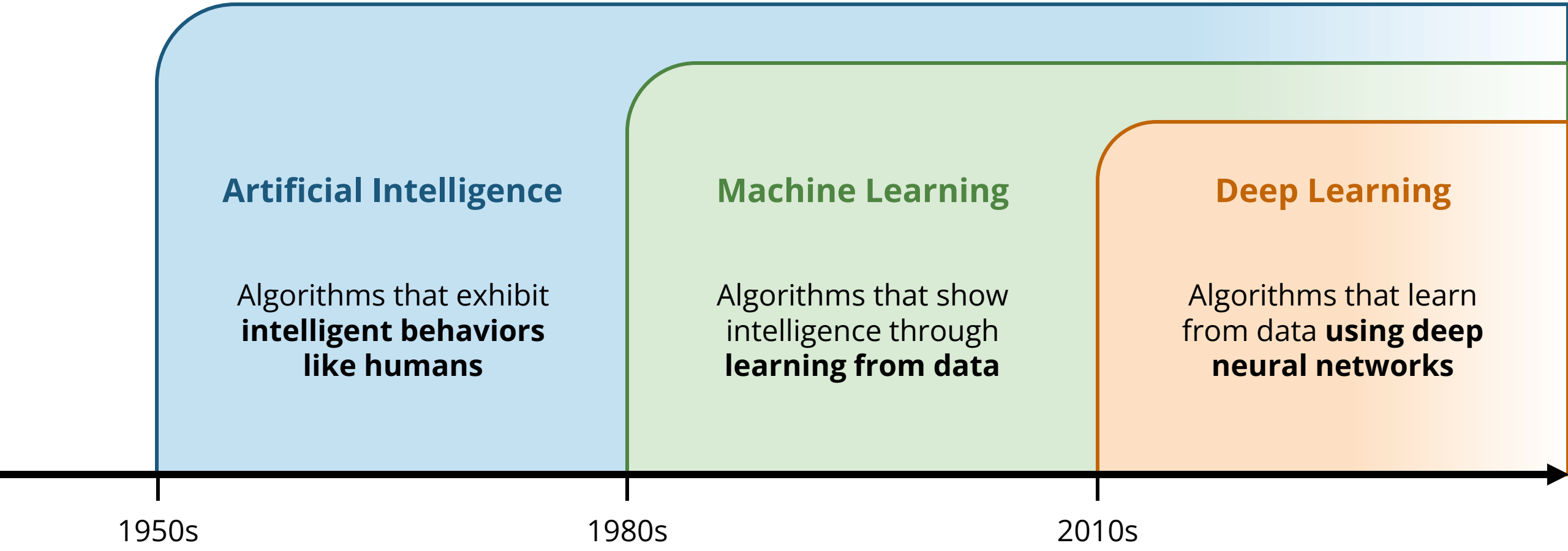


Which is an AI?
Which is a human?

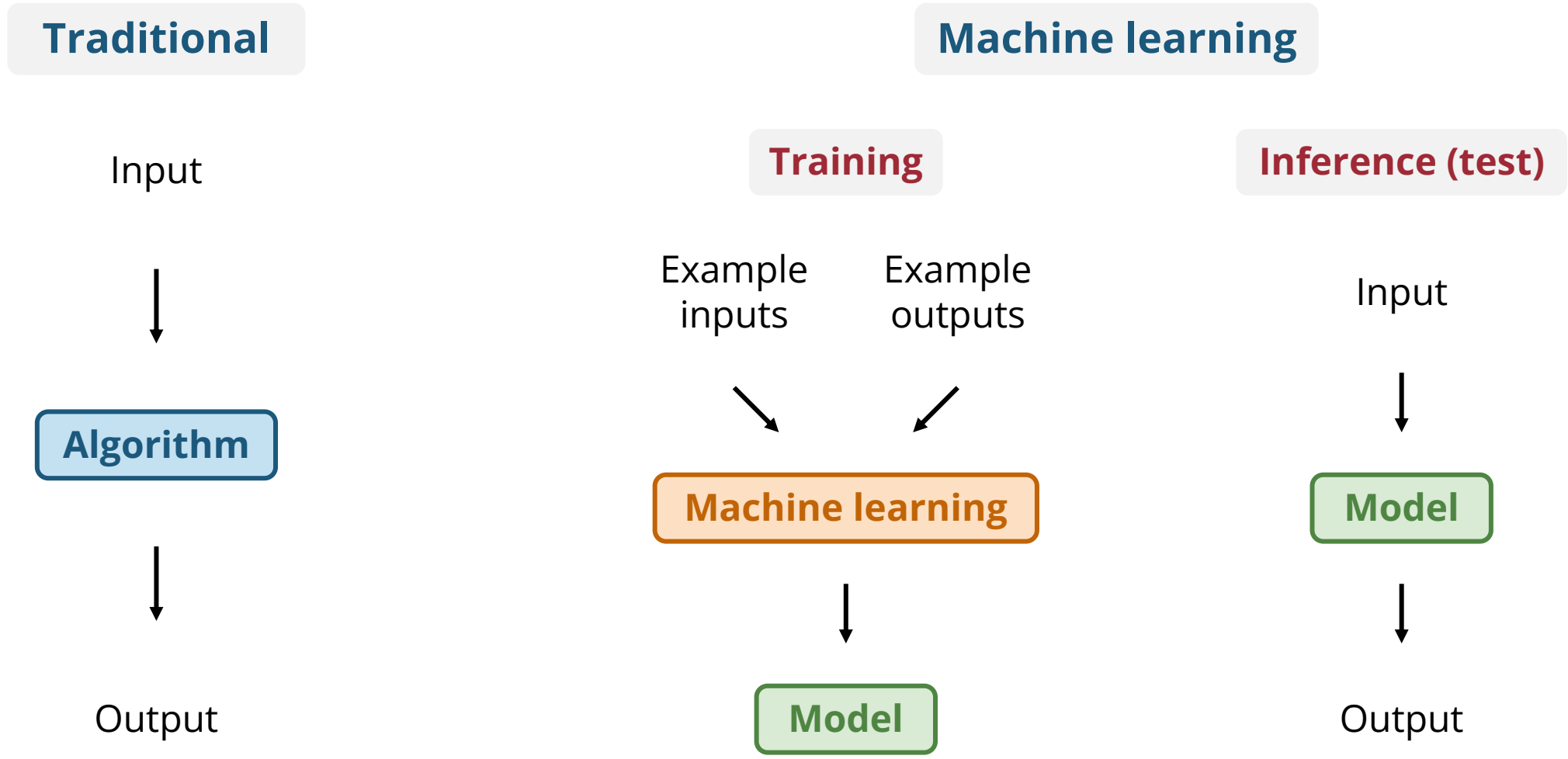
Judge by the responses to the written questions only

Interrogator

AI vs ML vs DL


Artificial Intelligence
Algorithms that exhibit **intelligent behaviors like humans**
Machine Learning
Algorithms that show intelligence through **learning from data**
Deep Learning
Algorithms that learn from data **using deep neural networks**
1950s
1980s
2010s

Machine Learning



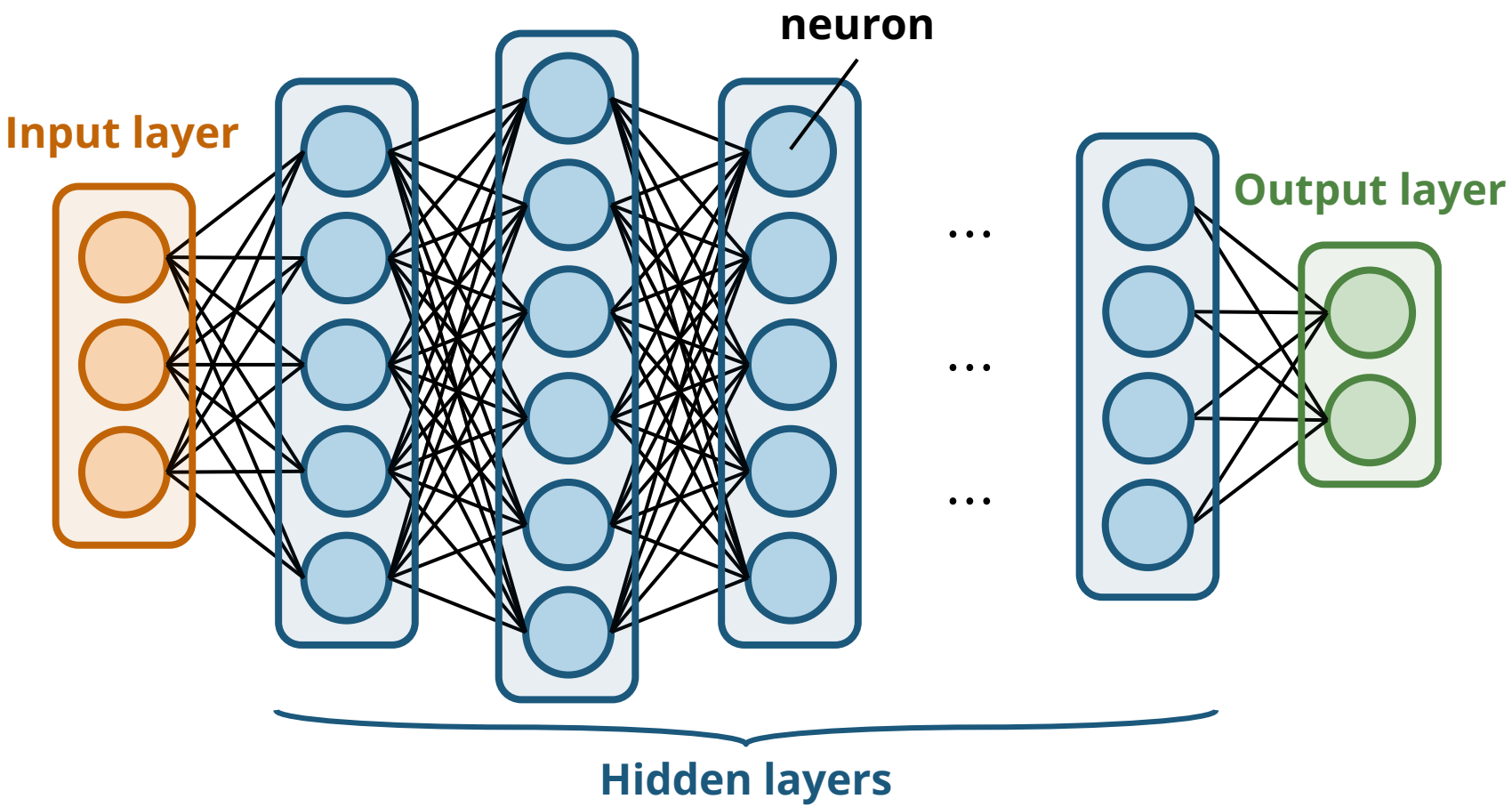
Components of a Machine Learning Model

Improve on task T,
with respect to performance metric P,
based on experience E

• **Task T**	**Animal classification**
• **Performance metric P**	Percentage of correct predictions
• **Experience E**	Animal images with labels

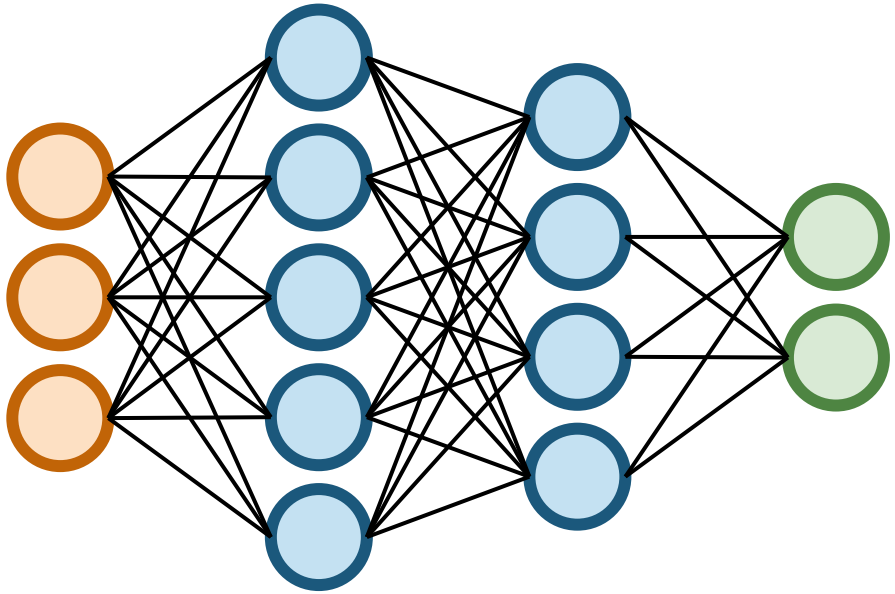
What is Deep Learning?

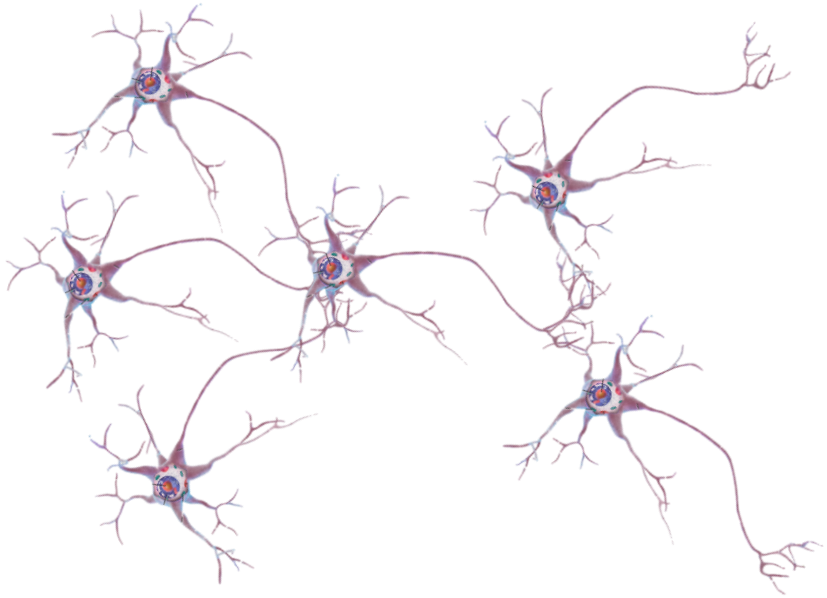
- A type of machine learning that uses **deep neural networks**



Artificial Neural Networks

- Although inspired by human neural networks, artificial neural networks nowadays **don't really work like human brains**

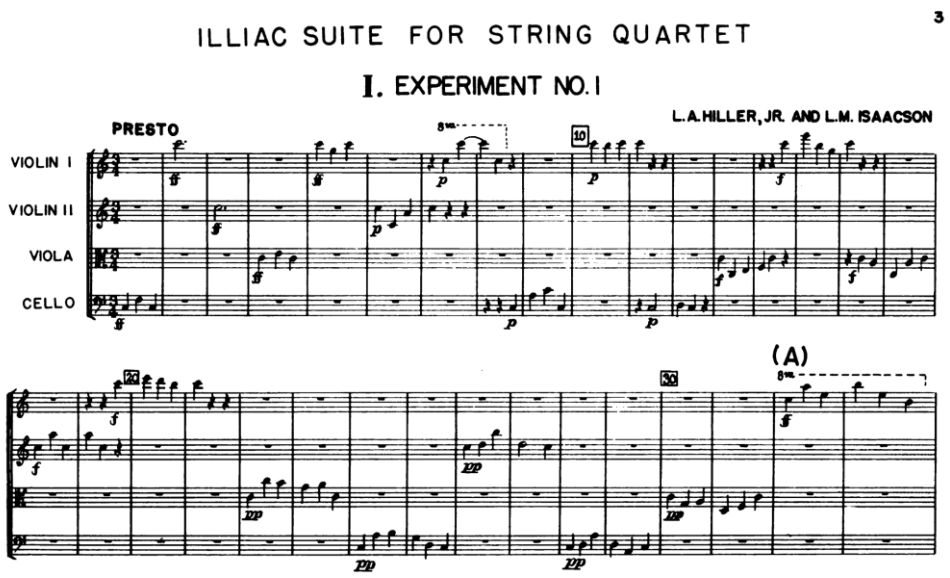




🔥 **HW 1**: Real or Fake!?

Next Lecture

AI & Music



(Source: Illinois Distributed Museum)