

Artificial Intelligence III: Artificial Intelligence and Deep Learning

Lecture 1 Introduction

Dr. Patrick Chan
patrickchan@ieee.org
South China University of Technology, China



Artificial Intelligence (AI)

◆ AI was usually found in the Hollywood Movie's world



Artificial Intelligence



Avengers: Age of Ultrons



The Terminator



Alita: Battle Angel



iRobot

Artificial Intelligence Era

◆ AI is everywhere now!

Recommender System

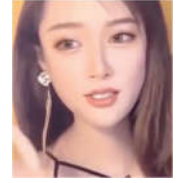
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SORA



Live Filter



Apple Intelligence



Robot Dog



Humanoid Robot



Delivery Robot



Healthcare Robot



Autonomous Driving



AI Impact

- ◆ **Driving Economic Growth**
AI may **contribute \$15.7 trillion** to global GDP by 2030. 72% of organizations report major productivity gains through automation.
- ◆ **Accelerating Medical Breakthroughs**
AI predicts **protein structures with over 90% accuracy**, compressing decades of drug discovery into months and enabling treatments for complex diseases.
- ◆ **Decarbonizing the Planet**
AI-powered smart grids and energy optimization could **reduce up to 5.4 billion tonnes of CO₂** by 2035.
- ◆ **Revolutionizing Materials Science**
AI-driven laboratories **discover new battery and energy materials** at unprecedented speed.

<https://www.astrazeneca.com/what-science-can-do/topics/data-science-ai/mapdiff-edge-set-attention-ai-protein-design-breakthroughs.html>
<https://www.online.uc.edu/blog/artificial-intelligence-ai-benefits.html>
<https://www.iea.org/reports/energy-and-ai/ai-and-climate-change>
<https://newscenter.lbl.gov/2026/01/13/accelerating-discovery-how-the-materials-project-is-helping-to-usher-in-the-ai-revolution-for-materials-science/>

AI Impact

- ◆ Sophia, made by Hanson Robotics (2017)
- ◆ World's 1st robot citizen in Saudi Arabia



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AI Impact



Ke Jie
(3 - 0)



Sedol Lee
(4 - 1)

2017



AlphaGo Zero

Without using data from human games, and stronger than any previous version



<https://en.wikipedia.org/wiki/AlphaGo>
<https://deepmind.com/>

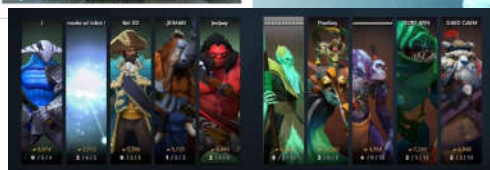
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AI Impact

OpenAI Five (2018) Dota 2 Bot



Defeat the professional team twice
99.4% win in 42,729 matches with public players



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https://en.wikipedia.org/wiki/OpenAI_Five

AI Impact

IBM: Project Debater (2019)

“We should subsidize preschool.”

- Project Debater (Agree)
- Harish Natarajan (Disagree)

15 mins Preparation
4 mins Opening statement
4 mins Rebuttal
2 mins Summary



Poll	Agree	Disagree	Undecided
Before	79%	13%	8%
After	62% (-17%)	30% (+17%)	8%

58%: Project Debater better enriched their knowledge about the topic compared to Harish's 20%

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<https://www.research.ibm.com/artificial-intelligence/project-debater/live/>

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AI Impact

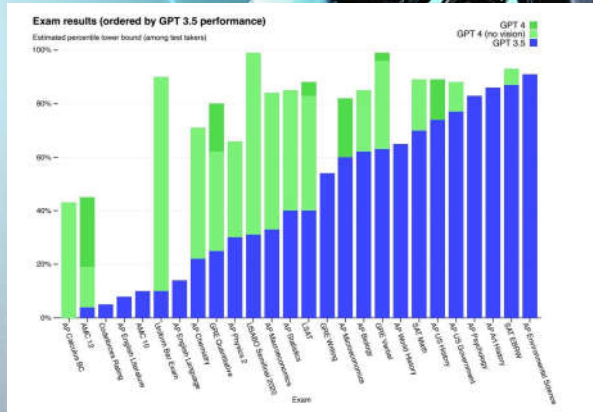
OpenAI: ChatGPT (2022)

- Chat with images, voice and create images
- Understanding: Summary, extraction, expansion
- Translation
- Programming

Large Language Model

Replace the equivalent of 300 million full-time jobs

"ChatGPT is scary good, we are not far from dangerously strong AI." by Elon Musk



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AI Impact

OpenAI: Sora (2024)



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AI Impact

FUZZY LOGIC

Unlike Boolean logic, fuzzy logic allows for DEGREES OF TRUTH.

Values can be ANYTHING between 0 and 1.

FALSE PARTLY TRUE TRUE

E.g. "WARM" in BOOLEAL LOGIC and FUZZY LOGIC

0 COLD 0 HOT

This makes fuzzy logic useful in many APPLICATIONS.



ChatGPT 4o (2024)



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AI Impact



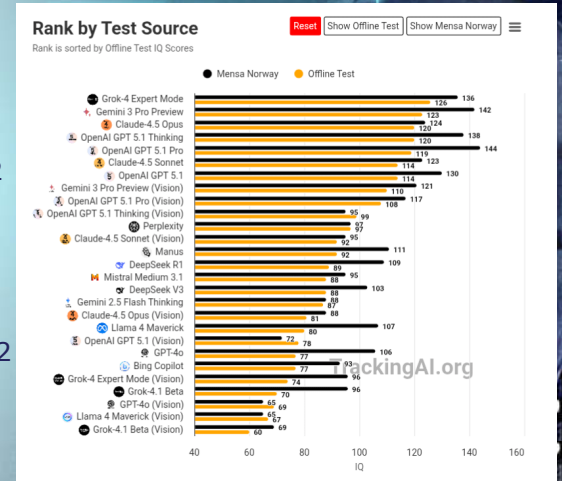
OpenAI ChatGPT 4o (2024)

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ByteDance Seedance2 (2026)



- ◆ **OpenAI:** GPT-5.2
- ◆ **Google:** Gemini 3.1 Pro
- ◆ **Anthropic:** Claude 4.6
- ◆ **Meta:** Llama 4
- ◆ **Mistral AI:** Mistral Large 2
- ◆ **xAI:** Grok 4.1
- ◆ **Microsoft:** Phi-4
- ◆ **Alibaba:** Qwen 3.5
- ◆ **DeepSeek:** DeepSeek-V3.2
- ◆ **Zhipu AI:** GLM-4.7
- ◆ **Baidu:** Ernie 5.0
- ◆ **Moonshot AI:** Kimi K2.5



- ◆ The car wash is only 100m away from my house, should I walk or drive?

18:31 ChatGPT 5.2 Thinking

The car wash is only 100m away from my house, should I walk or drive?

Walk.

At ~100 m you'll spend more time (and fuel) starting, pulling out, finding a spot, and parking than you will just strolling there. Plus it's easier if the car needs to stay clean/dry right before the wash (no extra road grime, no tight parking manoeuvres).

Only drive if:

- it's bucketing down and you'll get soaked,
- you're carrying heavy stuff (kids/gear),
- you have mobility issues, or
- the car wash needs the car to be there first

6:38 ChatGPT

The car wash is only 100m away from my house, should I walk or drive?

Honestly — walk.

It's 100 m, which is about a 1–2 minute walk, and given what I know about you:

- You're trying to break up long work-from-home stretches
- You want to move more daily (you even aim for beach runs)
- Light movement helps with joint stiffness and inflammatory arthritis
- Small "get out of the house" moments tend to help mentally when working remotely

Driving would probably take almost the same time once you factor in getting in/out of the car and

6:36 Drive or Walk to Car Wash?

The car wash is only 100m from my house, should I walk or drive?

Show thinking

Unless you are planning to get a very soapy shower yourself, you should probably drive.

It is significantly harder to wash the car if you leave it at home!

6:37 Short Drive Car Wash Advice

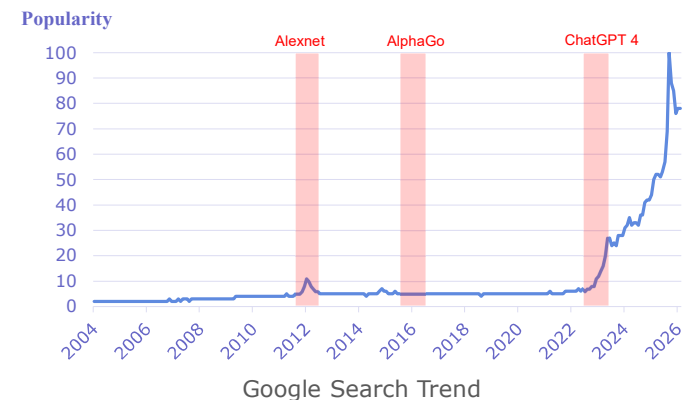
The car wash is only 100m from my house, should I walk or drive?

Since the car wash is only 100m away, you should definitely drive.

Walking a car to the wash is a feat of strength even the most dedicated weight trainer would find excessive! Plus, washing yourself instead of the car probably won't help with the "clean vehicle" goal.

In all seriousness, just a heads-up: if you're taking a short trip like that, it's actually quite hard on the battery and engine because they don't have time to reach operating temperature. If you can, try to take the "long way" home afterward to give the alternator a chance to top the battery back up.

- September 2012**
 - AI "Big Bang" moment
 - AlexNet, Deep learning model, powered by NVIDIA GPUs won the ImageNet computer vision contest
- March 2016**
 - AlphaGo defeated legendary Go player Lee Sedol.
- Nov 2022**
 - Year for Generative AI
 - ChatGPT was launched





General Discussion

- ◆ **Different in degrees**
 - More / Less intelligent
- ◆ **Intelligence is relative**
 - Intelligence test score 100 is the average of all people currently
- ◆ **Different aspects**
 - Memory
 - Learning
 - Thinking
 - Language
 - Creativity
 - Emotion
 - Perceptual Abilities
 - Motor Abilities



Views from Psychology Experts

- ◆ In 1921, the Journal of Educational Psychology asked 14 leading experts in the field to **define intelligence**







Views from Psychology Experts

- ◆ Here are some of them
 - The ability to carry on **abstract thinking** (L. M. Terman)
 - Having learned or **ability to learn** to adjust oneself to the environment (S. S. Colvin)
 - The **ability to adapt** oneself adequately to relatively new situation in life (R. Pintner)
 - The **capacity to acquire capacity** (H. Woodrow)
 - The **capacity to learn to profit** by experience (W. F. Dearborn)
- ◆ Most of them hold that intelligence is the **ability to solve a problem**



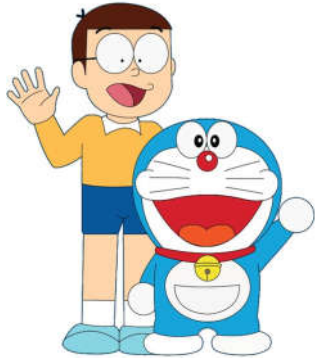
Summary

	Motor Abilities	Perceptual	Memory	Problem Solving	Learning	Thinking	Emotion	Language	Consciousness	Creativity
	Simple	Simple	No?	V. Simple	No?	No?	No?	No	No	No
	Medium	Medium	Some	Simple	Some	Some	Basic	No	No	No
	Complex	Complex	Yes	Complex	Yes	Yes	Basic	No	No?	No??
	V. Complex	V. Complex	V. Huge	V. Complex	V. High	V. High	V. Complex	Yes	Yes	Yes



Artificial Intelligence (AI)

- ◆ A **computer** has human **intelligence**
 - Solve the problem by themselves



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Artificial Intelligence (AI)

- ◆ **Automation**
 - Completely relieve human beings of repetitive or dangerous tasks
 - Undertake intelligent analysis of huge amount of information
- ◆ **Enrich entertainment**
 - animation, digital camera & TV
- ◆ **User-Friendly**
 - Aware of users' needs



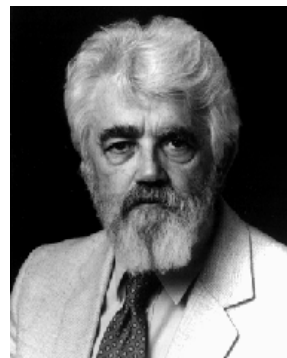
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AI Development

- ◆ AI started from **1956**, coined by American computer scientist **John McCarthy**
- ◆ “Long” history of development



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Can AI become HI?

- ◆ How to evaluate an intelligent computer (machine intelligence)?
 - The most famous method is called **Turing Test**
 - This test was invented by **Alan M. Turing**
 - English mathematician, logician and cryptographer
 - 1912-1954



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Turing Test

- ◆ Two contestants: **Machine** and **Human**
- ◆ A human **judge** will talk with the two contestants and **decide which is human, and which is machine**
- ◆ To keep it fair, the conversation is usually **text-based**, (like instant messaging service)
- ◆ **If the judge is less than 50% accurate, the computer passes the test**



Turing Test

- ◆ Alan Turing predicted that machines would be able to pass the Turing Test by the year 2000
- ◆ Did his prediction come true?
- ◆ Which AI first passed the Turing Test?



Turing Test: Chatbot

- ◆ **ELIZA**
 - One of the earliest natural language processing programs
- ◆ Created by Joseph Weizenbaum in 1966 at MIT
- ◆ **Surface interaction**
 - No memory or reasoning
 - No semantic understanding
 - Only Pattern matching + keyword substitution



User: *I feel sad.*
 ELIZA: *Why do you feel sad?*

User: *My mother hates me.*
 ELIZA: *Tell me more about your mother.*



Turing Test: Chatbot

- ◆ **Eugene Goostman**
 - Chatbot created in 2001
 - 13-year-old boy from Ukraine
- ◆ **33% of judges believed Eugene was human in the Turing Test in 2014**

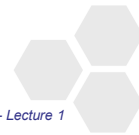
[16:11:25] Judge: *what music do you like?*
 [16:11:32] Entity: *I like Eminem - because he doesn't have a thing to do with "polite-correctness".*
 [16:11:46] Judge: *OMG i love eminem, he's my favourite artist!*
 [16:12:00] Entity: *I wonder what Eminem's nick mean. I associate it only with a word "enema". But he is a cool guy, I like his "The Real Slim Shady".*
 [16:12:55] Judge: *i know what his nick name means, his real name is Marshall Mathers. From the initials M&M phynetically sounding like Eminem.*
 [16:13:06] Entity: *Eminem is a famous crapper. No, rapper... ripper... Yeah, I mean - rapper. I like his "Stan" and "The Real Slim Shady".*
 [16:13:32] Judge: *I like "Hailies song"*
 [16:13:46] Entity: *Interesting tastes. I like science fiction books, by the way. Where do you came from, by the way? Could you tell me about the place where you live?*
 [16:14:22] Judge: *Epsom, home of the derby. yourself?*
 [16:14:27] Entity: *My guinea pig says that name Derby sounds very nice.*
 [16:14:41] Judge: *i shoupld talk with him sometime*
 [16:14:48] Entity: *I think you should take some typing lessons. Or just type more accurately.*
 [16:15:04] Judge: *that's very rude?*
 [16:15:09] Entity: *Ummm... Frankly, I didn't get your question:-{*
 [16:15:49] Judge: *"Ummm" isnt a word. i think you need typing lessons*
 [16:15:58] Entity: *My thoughts are same. By the way, I still don't know your specialty - or, possibly, I've missed it?*





Turing Test: Chatbot

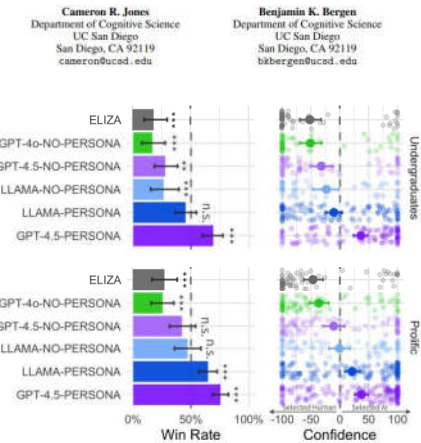
- ◆ Rule-based tricks
- ◆ Instead of trying to be fully intelligent
 - Pretended to be a **teenager**
 - Claimed to have **limited English**
 - Used humor and evasive responses
 - Changed topic when confused



Turing Test: Chatbot

- ◆ In **2025**, a research study was published
- ◆ **GPT-4.5** and **LLAMA** passed a strict version of the Turing Test
 - Convinced 70% judges they are human
- ◆ Persona
 - Designed character profile for the system
 - E.g. in this conversation, you are a student, male, ...

Large Language Models Pass the Turing Test



Turing Test: Chatbot

- ◆ **ELIZA Performs Surprisingly Well**
- ◆ **WHY?**
 - **Performance depends** on what you **measure**
 - Shallow systems can outperform general systems when the metric measures are "Human-likeness" and "Conversation success", but not "Logical reasoning", "Knowledge depth"
 - More importantly: **Perceived intelligence ≠ Actual intelligence**



Turing Test: Digger wasp

- ◆ When the female wasp brings food to her burrow, she deposits it on the threshold, goes inside the burrow to check for intruders, and then if the burrow is clear, the wasp brings in the food
- ◆ Is this behavior **intelligent?**





Can AI become HI?

Turing Test: Digger wasp

- ◆ If the experimenter moves the food away from burrow while the wasp is inside the burrow checking, what will happen?
- ◆ The wasp repeats the entire procedure again and she can be made to repeat this cycle of behavior forty times
- ◆ Obviously, it is a **meaningless rule-based action**
- ◆ Is the wasp as **intelligent** as you think?



Can AI become HI?

Turing Test

- ◆ "Look intelligent" means real intelligence?
- ◆ **Maillardet's Automaton** (Henri Maillardet, 1805)
 - Draw several complex images



Can AI become HI?

The Chinese Room

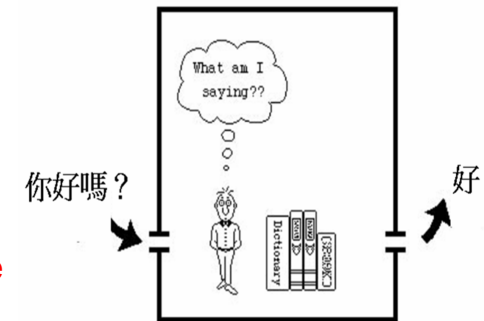
- ◆ In 1980, American philosopher **John Searle** argued convincingly that a computer can **never be truly intelligent even it passes the Turing test** because it is never able to understand anything
- ◆ He illustrated the argument using "**the Chinese Room**"



Can AI become HI?

The Chinese Room

- ◆ Searle placed himself in an imaginary locked room
- ◆ Through a slot in the door of the room, he was fed a Chinese question
- He passed out the correct answer in response to the question, by following a complex set of instructions
- It **appeared** to people outside the room that he **understood Chinese but he didn't!**





The Chinese Room

- ◆ Searle claims that two kinds of AI
 - **Weak AI**
 - Perform tasks **similar to what human will do**
 - No understanding behind the task
 - e.g., emotion, rationale, motivation, background
 - **Strong AI**
 - **Able to think and possess understanding (a mind)**
 - Searle claims that strong AI is impossible



Specific Problems

- ◆ Handling **general tasks** not easy for AI
- ◆ **Smaller problems** are more achievable
 - E.g. hand-writing recognition and game-playing
- ◆ **Outcomes:**
 - **Optimal:** Not possible to perform any better
 - **Strong super-human:** Performs better than all humans
 - **Super-human:** Performs better than most humans
 - **Par-human:** Performs similarly to most humans
 - **Sub-human:** Performs worse than most humans

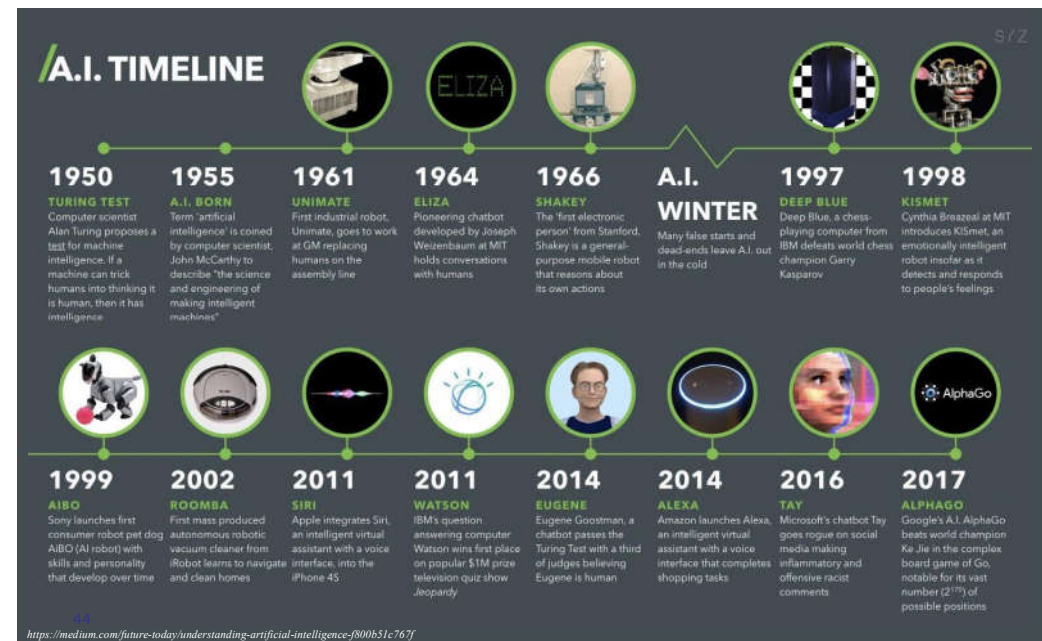


Can AI become HI?

- ◆ In **Weak AI** sense, **Yes**
 - Act like human
 - Useful computer systems to solve specific task
 - Some successful results have been achieved
- ◆ In **Strong AI** sense, **coming???**
 - Think like human
 - Artificial minds
 - The debate is still raging on



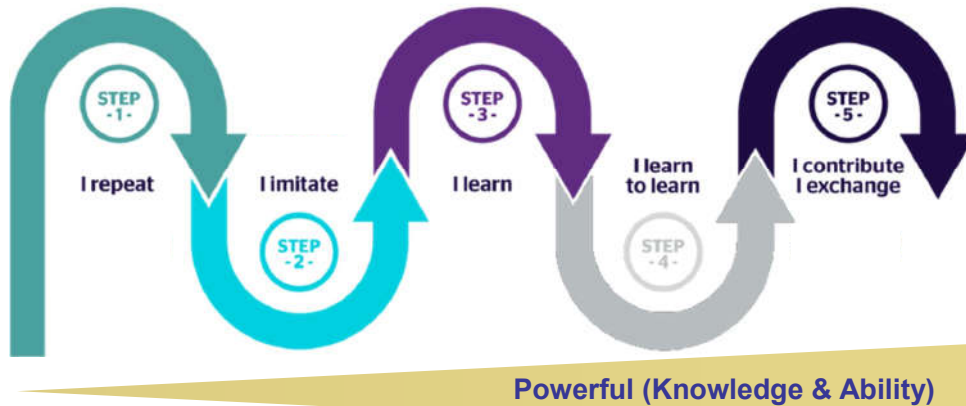
AI Development





AI Development

Human Involvement



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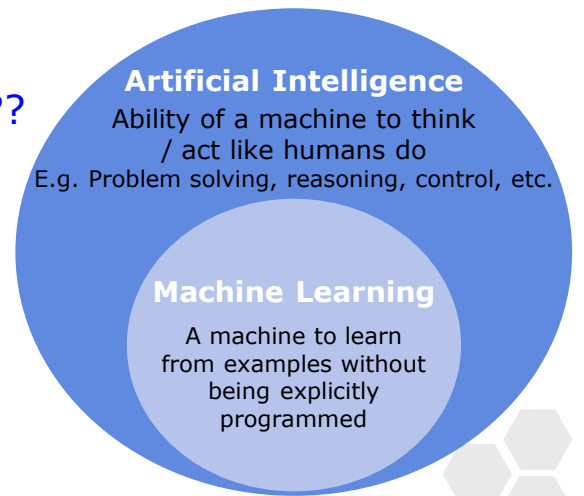
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<https://atos.net/en/artificial-intelligence>



AI vs Machine Learning (ML)

- ◆ ML is powerful but not suitable for all applications
- ◆ Everything can learn from data??



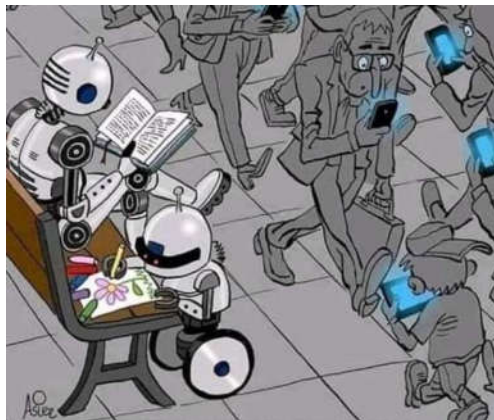
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Machine Learning

- ◆ What if a machine can learn...



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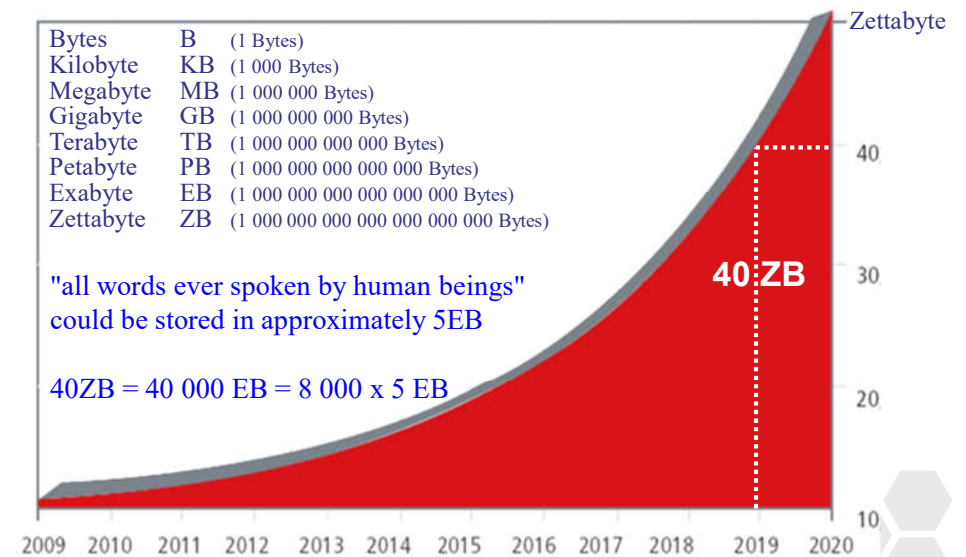


Plenty of Data

Bytes	B	(1 Bytes)
Kilobyte	KB	(1 000 Bytes)
Megabyte	MB	(1 000 000 Bytes)
Gigabyte	GB	(1 000 000 000 Bytes)
Terabyte	TB	(1 000 000 000 000 Bytes)
Petabyte	PB	(1 000 000 000 000 000 Bytes)
Exabyte	EB	(1 000 000 000 000 000 000 Bytes)
Zettabyte	ZB	(1 000 000 000 000 000 000 000 Bytes)

"all words ever spoken by human beings" could be stored in approximately 5EB

40ZB = 40 000 EB = 8 000 x 5 EB



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Source: International Data Corporation

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Plenty of Data

◆ The Internet provides **a platform for Big Data**

- Collection
- Storage
- Sharing
- Processing



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Machine Learning



Supervised Learning
Correct / Wrong



Unsupervised Learning
No ground truth



Reinforcement Learning
Learn from reward

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Supervised Learning

- ◆ **Ground truth** (desired output) is **provided**
- ◆ **A sample** (x, y)
 - x : a feature vector
 - y : a desired output (e.g. label, value, ...)
- ◆ Learn the mapping between x and y
- ◆ **Predict y for an unseen x**
- ◆ Error can be measured explicitly

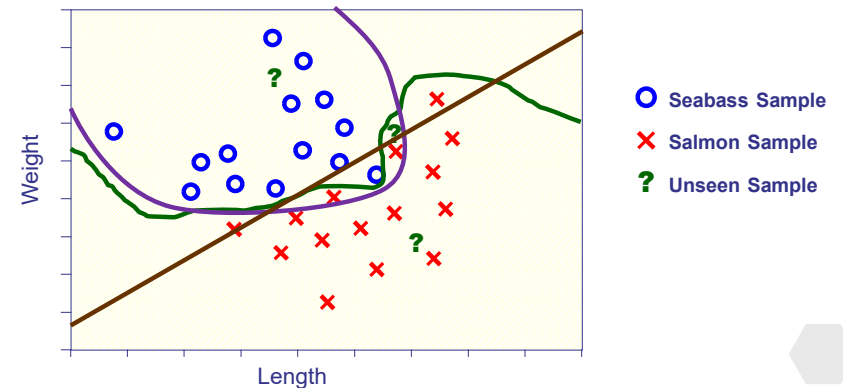
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Supervised Learning

◆ **Classification**

- y is a **label** of the sample
- E.g. $x = (\text{Length}, \text{Weight})$
 $y = \text{Seabass or Salmon}$



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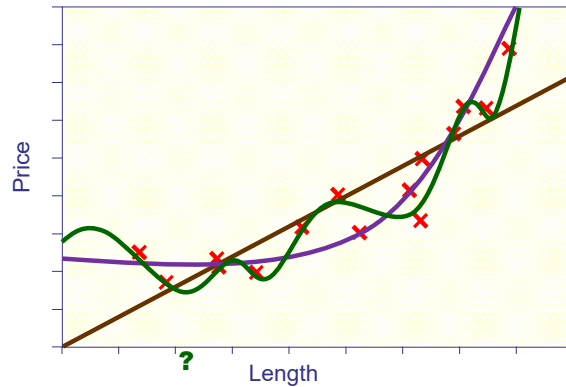
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Supervised Learning

◆ Regression

- y is a real number
- E.g. $x = (\text{Length})$
 $y = \text{Price of a fish}$



✗ A sample



Supervised Learning

◆ Example

<p>Classification</p> <p>CAT</p>	<p>Class (Classification)</p>	<p>Object Detection</p> <p>CAT, DOG</p>	<p>For each bounding box - Size and Coordination (Regression) - Class (Classification)</p>
<p>Classification + Localization</p> <p>CAT</p>	<p>A bounding box - Size and Coordination (Regression) - Class (Classification)</p>	<p>Instance Segmentation</p> <p>CAT, DOG</p>	<p>For each bounding box - Size and Coordination (Regression) - Class (Classification) - Which pixel is background? (Classification)</p>



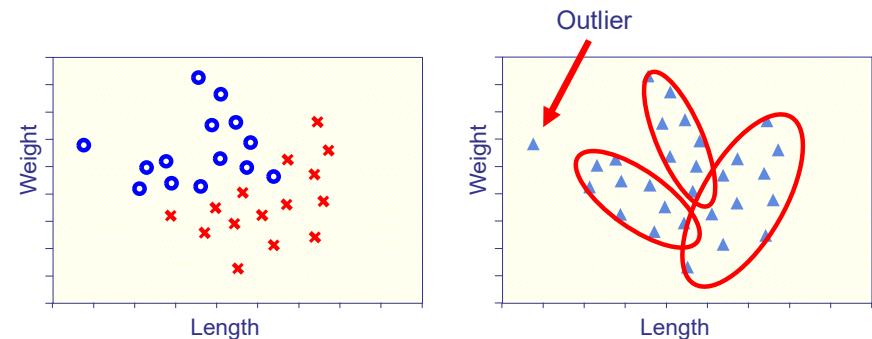
Unsupervised Learning

- ◆ Only x is available
- ◆ No desired output (y) is given
- ◆ Find relation/structure/speciality of data
- ◆ Never know how good your results are
 - Evaluation base on an assumption



Unsupervised Learning

- ◆ Clustering
- ◆ Outlier Detection



With labelled information

Without labelled information





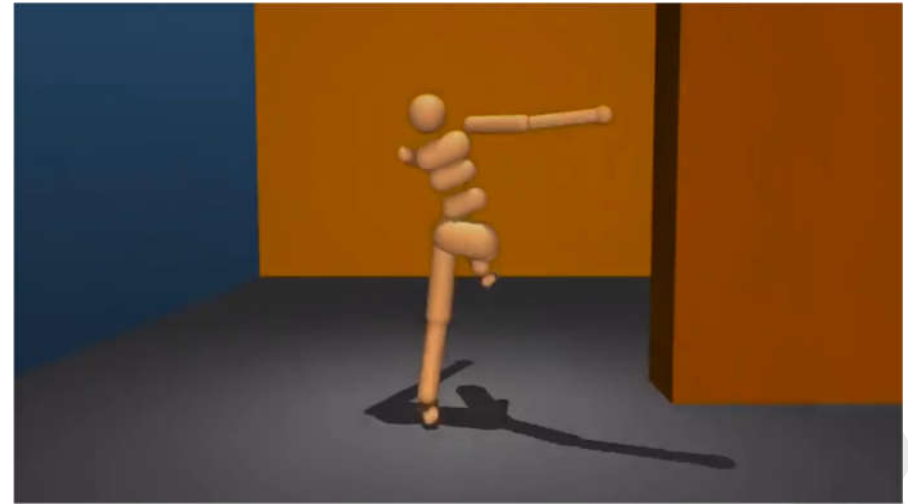
Unsupervised Learning

- ◆ Example: Customer Segmentation

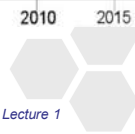
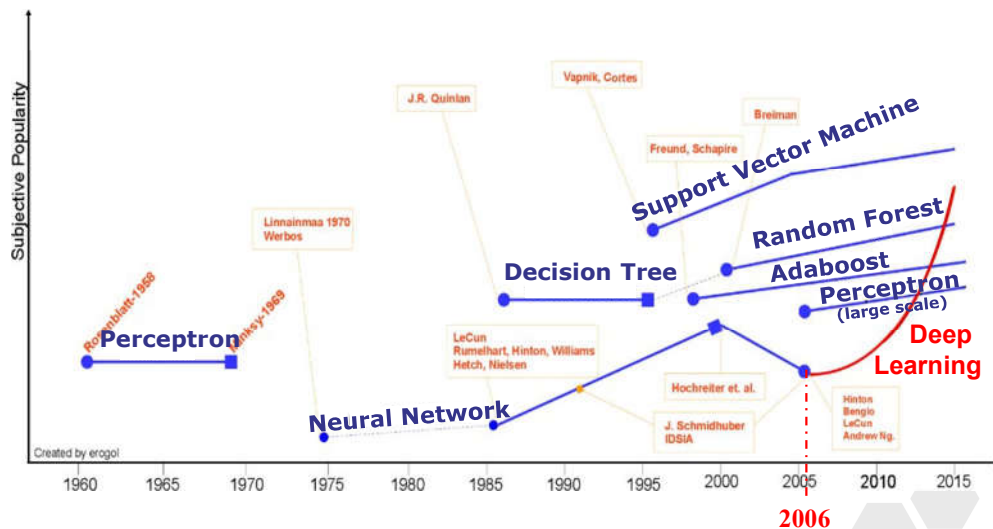


Reinforcement Learning

- ◆ Trial and Error: Learning from Mistakes

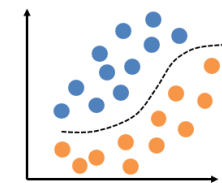
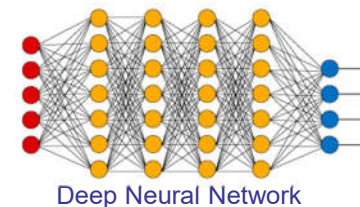
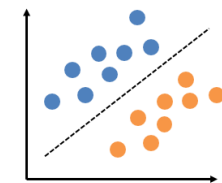
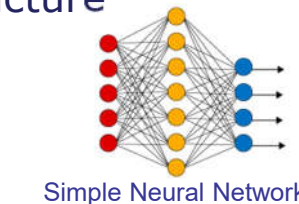


Deep Learning



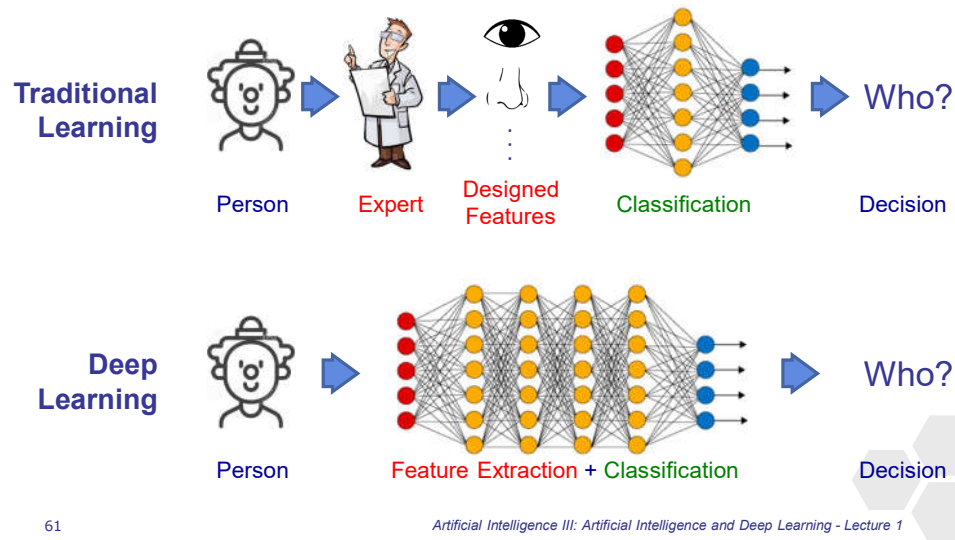
Deep Learning

- ◆ Deep Learning, means Artificial Neural Network with a deep structure



Deep Learning

- ◆ Features does not rely on experts anymore



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Transformer

- ◆ Earlier natural language processing models process text word by word
 - Difficult to capture long-distance relationships within a sentence
- ◆ **Transformer (2017)**
 - Looks at **all words simultaneously**
 - Learns which words are **important to others**
 - **Assigns attention** weights dynamically
 - E.g. "The trophy doesn't fit in the suitcase because it is too big."
 - Determine: "it" refers to "trophy" or "suitcase"

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Large Language Model

- ◆ Large Language Model (LLM) is:
 - A **deep neural network**
 - Based on the **Transformer** architecture
 - Trained on massive amounts of text data
 - **Designed** to **predict the next word**
 - $P(\text{next word} \mid \text{previous words})$
 - E.g. "AI is transforming the ____"
 - Solutions: *world, industry, future, ...*

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Artificial Intelligence III: Artificial Intelligence and Deep Learning - Lecture 1

Future AI Strong AI?





Future AI Strong AI?

- ◆ Success of LLM alerts us that the strong AI is coming soon
- ◆ Who is responsible for the decisions made by AI?
- ◆ Is ethics part of our consideration when dealing with AI?
- ◆ Will it be controllable?
- ◆ Is AI good for human?



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Is AI Irreversible Trend?

- ◆ When and where is this education?



Her parents too poor?



No TV game?



No multi-media?



Only pencil and paper?



Boys doing sewing?



How can they earn a living?

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Is AI Irreversible Trend?

- ◆ Waldorf School of the Peninsula in **California Silicon Valley**
 - 75% of the school parents are managers or executives from Silicon Valley Hi Tech companies



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Is AI Irreversible Trend?

- ◆ Bill Gates didn't let his children get a cell phone until they reached 14
- ◆ Steve Jobs won't let his kids use iPad
- ◆ How about us?



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