



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

	👤	👤	👤	👤
👤	✗	✓		
👤		✗		✓
👤		✓	✓	

SORA



Live Filter



Apple Intelligence



LLM



Robot Dog



Humanoid Robot



Delivery Robot



Healthcare Robot



Autonomous Driving



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# 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 CO<sub>2</sub>** by 2035.

◆ **Revolutionizing Materials Science**

AI-driven laboratories **discover new battery and energy materials** at unprecedented speed.





# 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



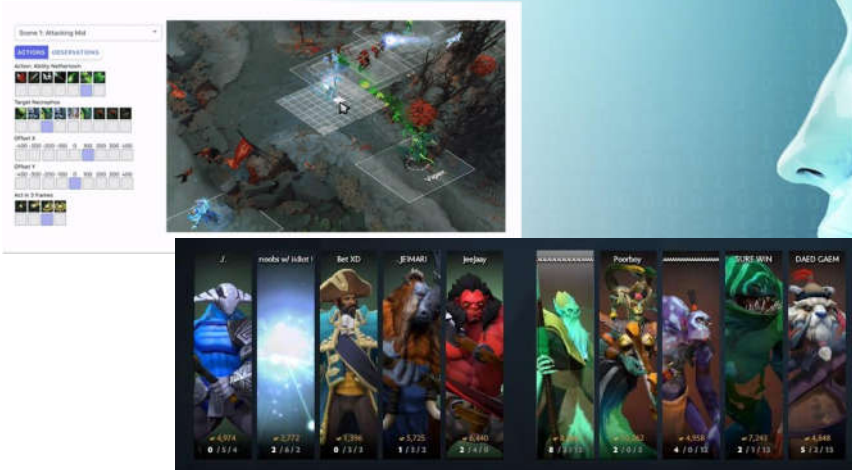


# AI Impact

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

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# 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% <b>(-17%)</b>	30% <b>(+17%)</b>	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

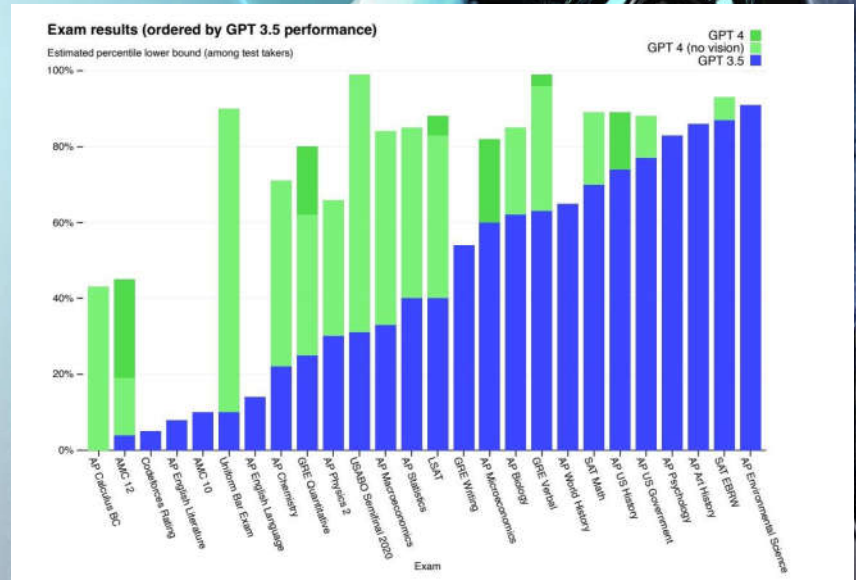
## OpenAI: ChatGPT (2022)

- 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 **BOOLEAN LOGIC** and **FUZZY LOGIC**

0 COLD 0 HOT

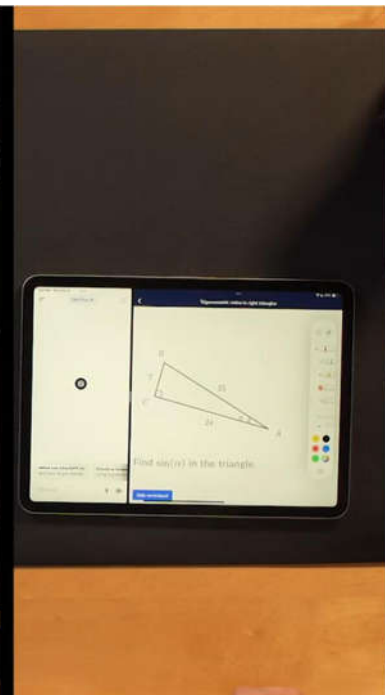
This makes fuzzy logic useful in many **APPLICATIONS**.



**ChatGPT 4o (2024)**



# AI Impact



**ChatGPT 4o (2024)**



# AI Impact

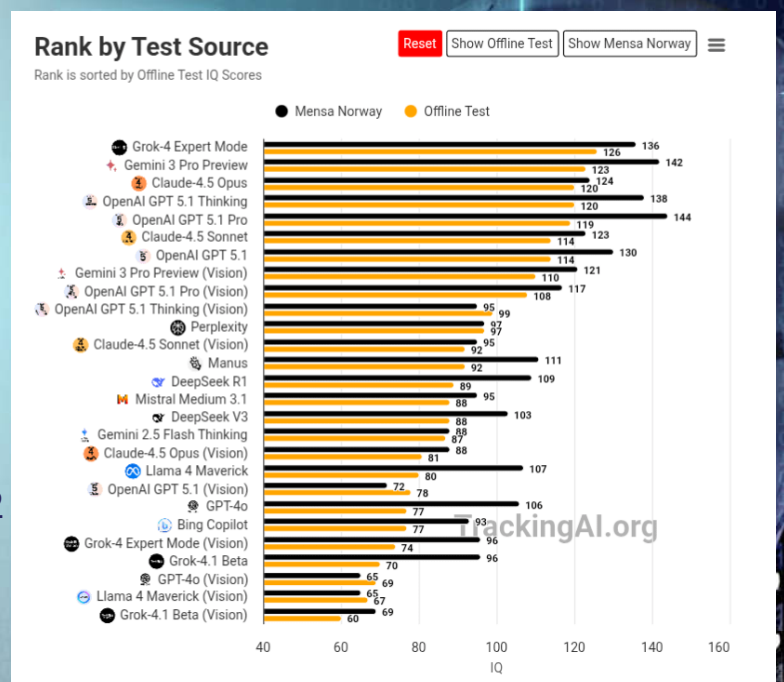
## ByteDance

### Seedance2 (2026)



# AI Impact

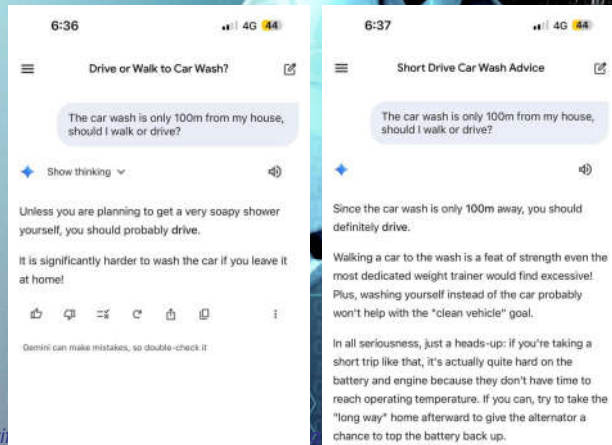
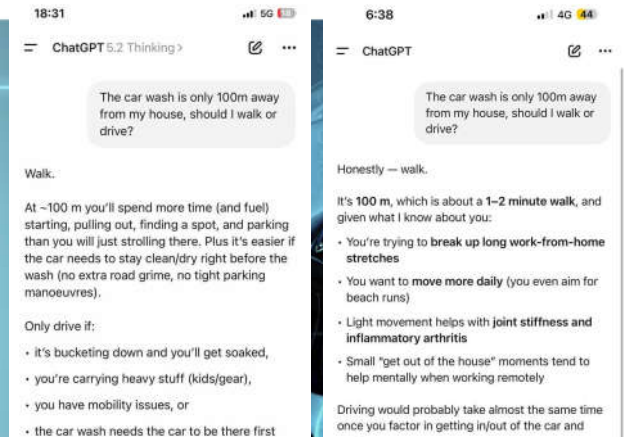
- ◆ **OpenAI:** GPT-5.2
- ◆ **Google:** Gemini 3.1 Pro
- ◆ **Anthropic:** Claude 4.6
- ◆ **Meta:** Llama 4
- ◆ **Mistral AI:** Mistral Large 2
- ◆ **xAI:** Grok 4.1
- ◆ **Microsoft:** Phi-4
- ◆ **Alibaba:** Qwen 3.5
- ◆ **DeepSeek:** DeepSeek-V3.2
- ◆ **Zhipu AI:** GLM-4.7
- ◆ **Baidu:** Ernie 5.0
-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





# AI Impact

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



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Arti



# AI Impact

## September 2012

- AI "Big Bang" moment
- AlexNet, Deep learning model, powered by NVIDIA GPUs won the ImageNet computer vision contest

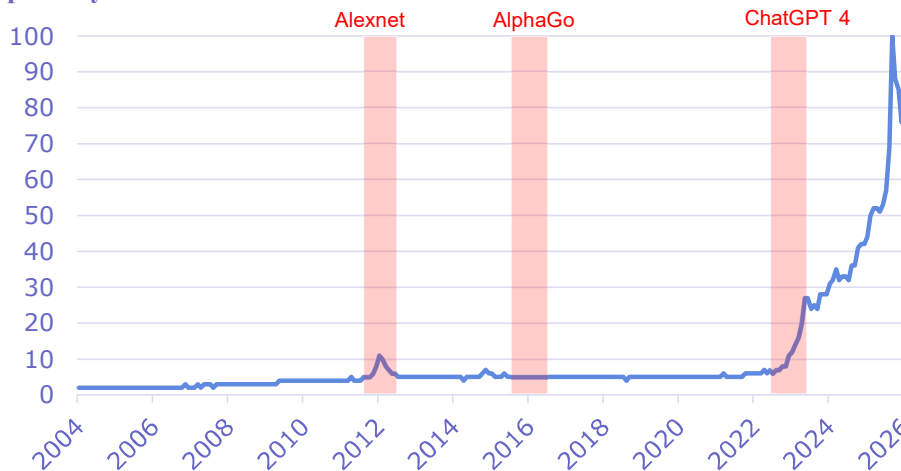
## March 2016

- AlphaGo defeated legendary Go player Lee Sedol.

## Nov 2022

- Year for Generative AI
- ChatGPT was launched

## Popularity



Google Search Trend



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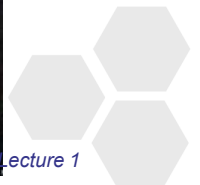




## What is Intelligence?

# When does human intelligence begin?

- ◆ Human is intelligent, but begins at **when**?
  - After graduation?
  - 5 years old?
  - 6 months old?
  - Before birth?



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## What is Intelligence?

# Do Animals have Intelligence?



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## ◆ Different in degrees

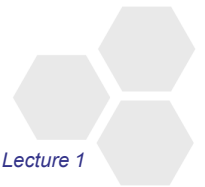
- More / Less intelligent

## ◆ Intelligence is relative

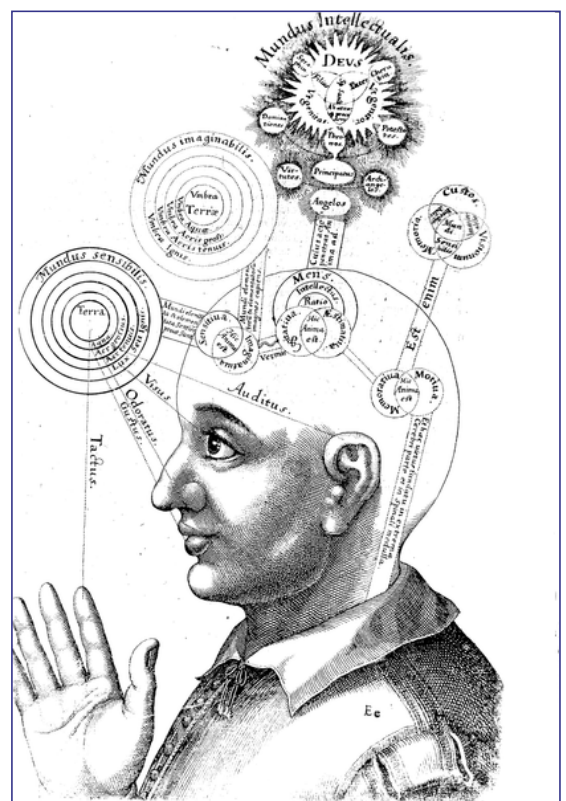
- Intelligence test score 100 is the average of all people currently

## ◆ Different aspects

- Memory
- Learning
- Thinking
- Language
- Creativity
- Emotion
- Perceptual Abilities
- Motor Abilities



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

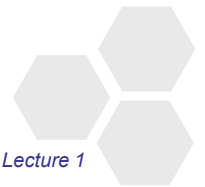




# What is Intelligence?

## 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**

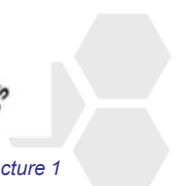


# What is Intelligence?

## Summary



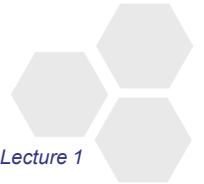
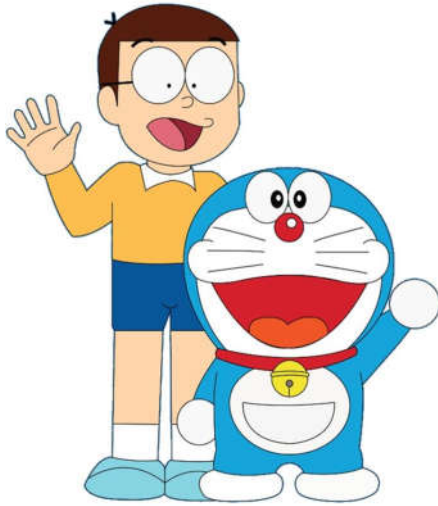
	Moter Abilities	Perceptual	Memory	Problem Solving	Learning	Thinking	Emotion	Language	Consciousness	Creativity
Bee	Simple	Simple	No?	V. Simple	No?	No?	No?	No	No	No
Turtle and Bird	Medium	Medium	Some	Simple	Some	Some	Basic	No	No	No
Dog	Complex	Complex	Yes	Complex	Yes	Yes	Basic	No	No?	No??
Professor	V. 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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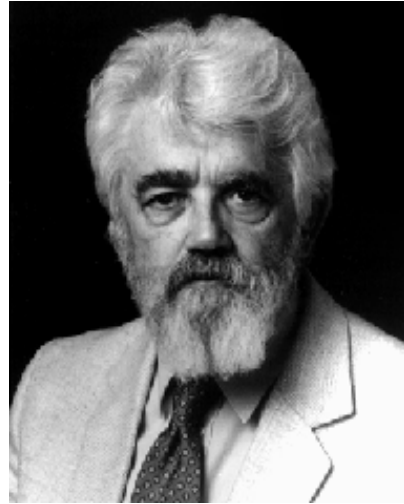
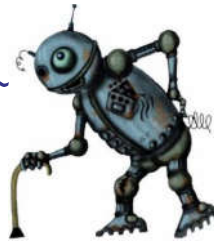
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# AI Development

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

I am 64 year-old~



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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



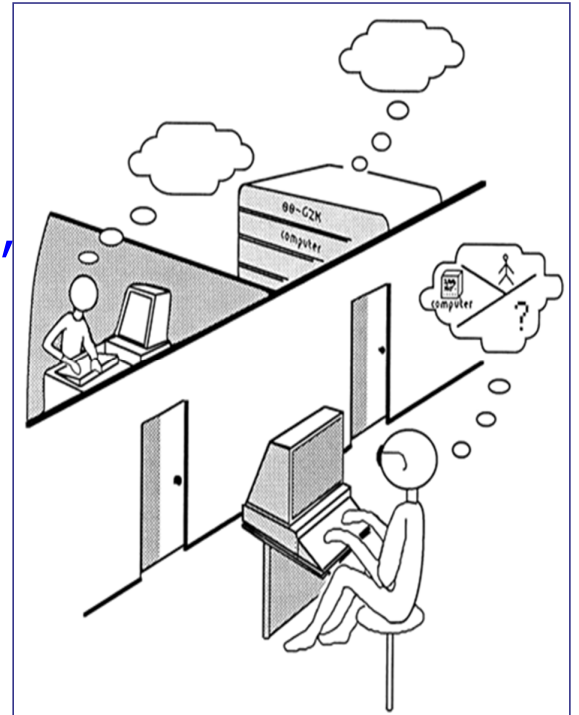
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# Turing Test

- ◆ 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?



## ◆ 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.*



## ◆ 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 shopuld 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



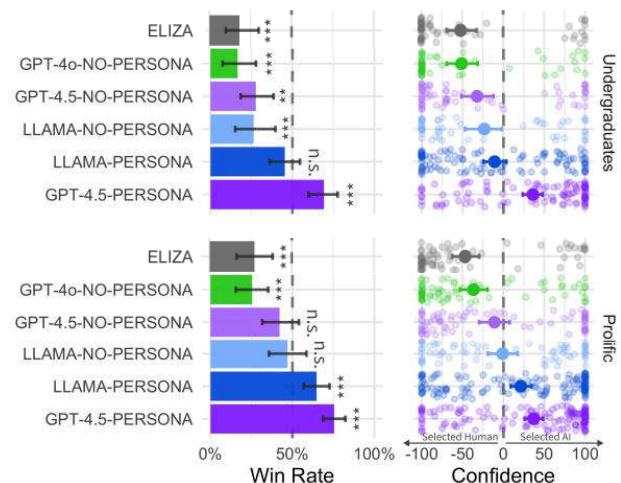
# Turing Test: Chatbot

- ◆ 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

**Cameron R. Jones**  
Department of Cognitive Science  
UC San Diego  
San Diego, CA 92119  
cameron@ucsd.edu

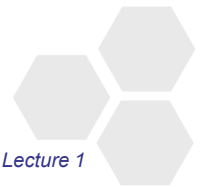
**Benjamin K. Bergen**  
Department of Cognitive Science  
UC San Diego  
San Diego, CA 92119  
bkbergen@ucsd.edu





# 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?



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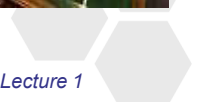
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Can AI become HI?

# Turing Test

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



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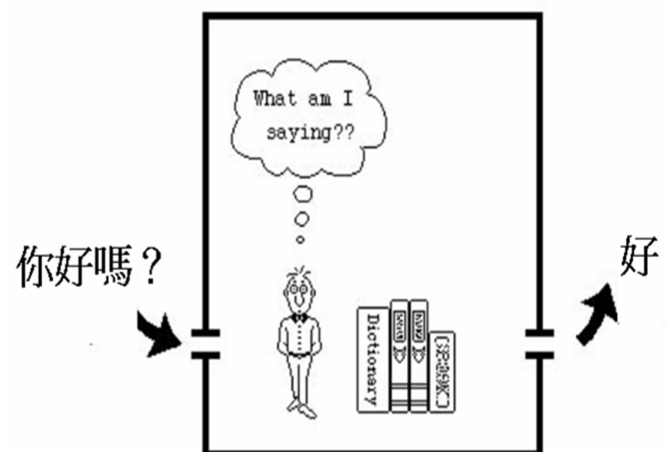
# The Chinese Room

- ◆ 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**"



# 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

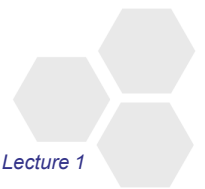
- ◆ Handling **general tasks not easy** for AI
- ◆ **Smaller problems** are more **achievable**
  - E.g. hand-writing recognition and game-playing
- ◆ **Outcomes:**
  - **Optimal:** Not possible to perform any better
  - **Strong super-human:** Performs better than all humans
  - **Super-human:** Performs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

## A.I. TIMELINE

1950

### TURING TEST

Computer scientist Alan Turing proposes a test for machine intelligence. If a machine can trick humans into thinking it is human, then it has intelligence

1955

### A.I. BORN

Term 'artificial intelligence' is coined by computer scientist, John McCarthy to describe "the science and engineering of making intelligent machines"

1961

### UNIMATE

First industrial robot, Unimate, goes to work at GM replacing humans on the assembly line

1964

### ELIZA

Pioneering chatbot developed by Joseph Weizenbaum at MIT holds conversations with humans

1966

### SHAKY

The 'first electronic person' from Stanford, Shakey is a general-purpose mobile robot that reasons about its own actions

A.I.

### WINTER

Many false starts and dead-ends leave A.I. out in the cold

1997

### DEEP BLUE

Deep Blue, a chess-playing computer from IBM defeats world chess champion Garry Kasparov

1998

### KISMET

Cynthia Breazeal at MIT introduces Kismet, an emotionally intelligent robot insofar as it detects and responds to people's feelings



1999

### AIBO

Sony launches first consumer robot pet dog AIBO (AI robot) with skills and personality that develop over time



2002

### ROOMBA

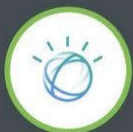
First mass produced autonomous robotic vacuum cleaner from iRobot learns to navigate and clean homes



2011

### SIRI

Apple integrates Siri, an intelligent virtual assistant with a voice interface, into the iPhone 4S



2011

### WATSON

IBM's question answering computer Watson wins first place on popular \$1M prize television quiz show Jeopardy



2014

### EUGENE

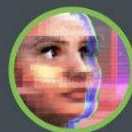
Eugene Goostman, a chatbot passes the Turing Test with a third of judges believing Eugene is human



2014

### ALEXA

Amazon launches Alexa, an intelligent virtual assistant with a voice interface that completes shopping tasks



2016

### TAY

Microsoft's chatbot Tay goes rogue on social media making inflammatory and offensive racist comments



2017

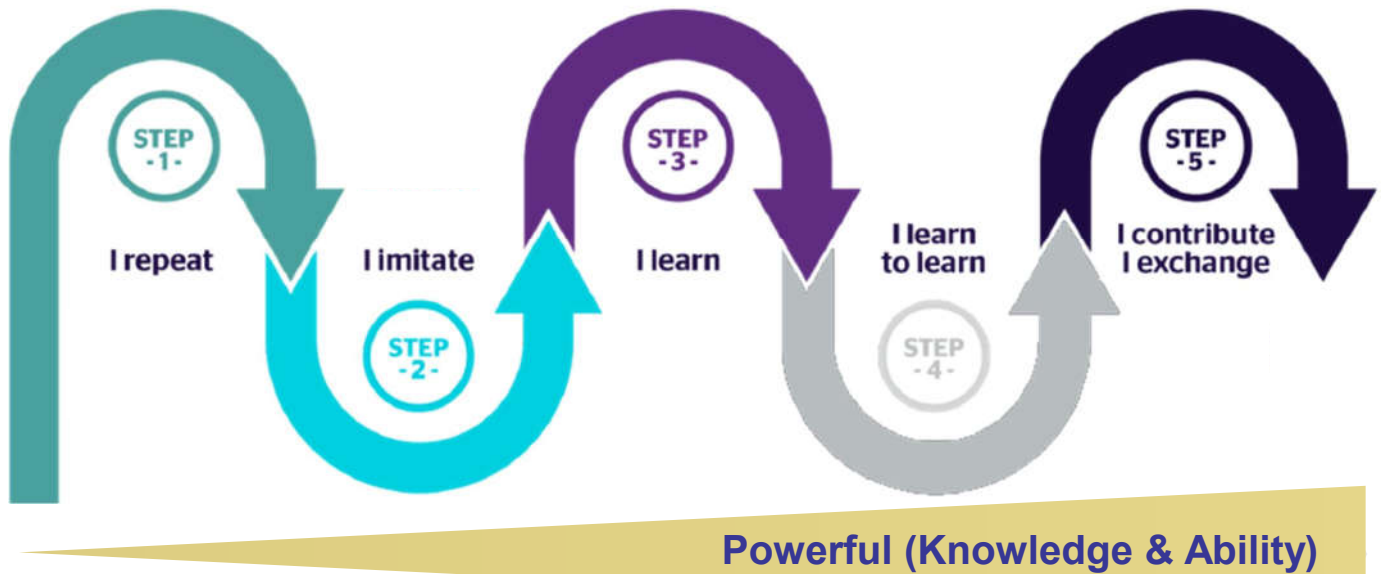
### ALPHAGO

Google's A.I. AlphaGo beats world champion Ke Jie in the complex board game of Go, notable for its vast number (2<sup>170</sup>) of possible positions



# AI Development

## Human Involvement



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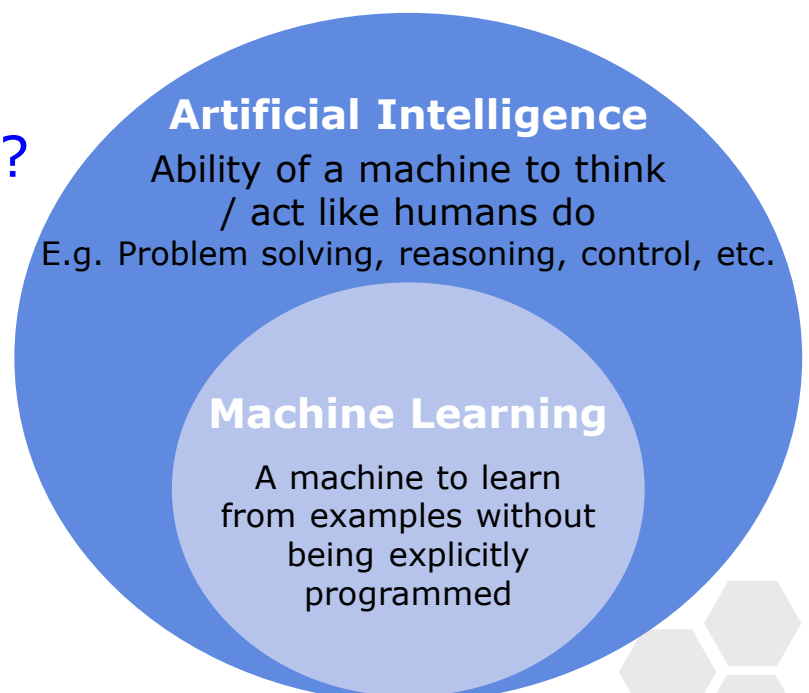
<https://atos.net/en/artificial-intelligence>

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# AI vs Machine Learning (ML)

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



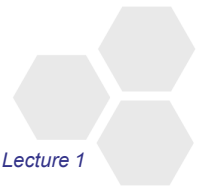
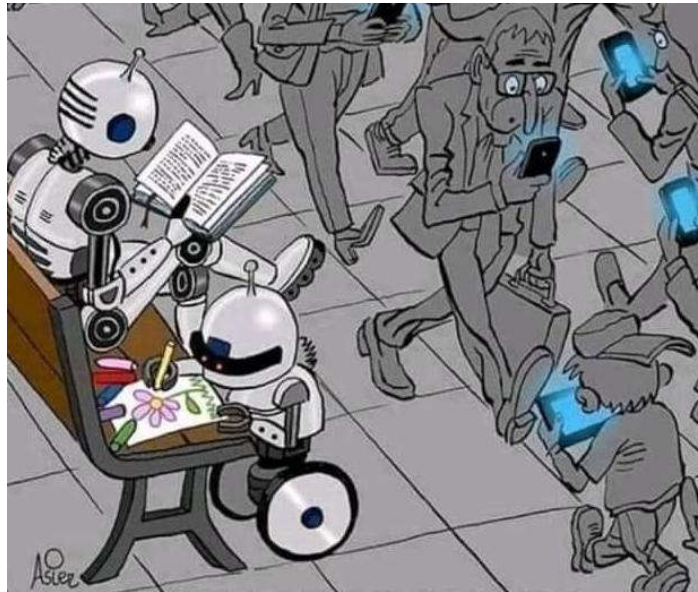
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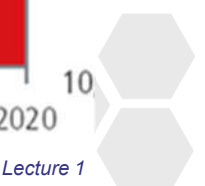
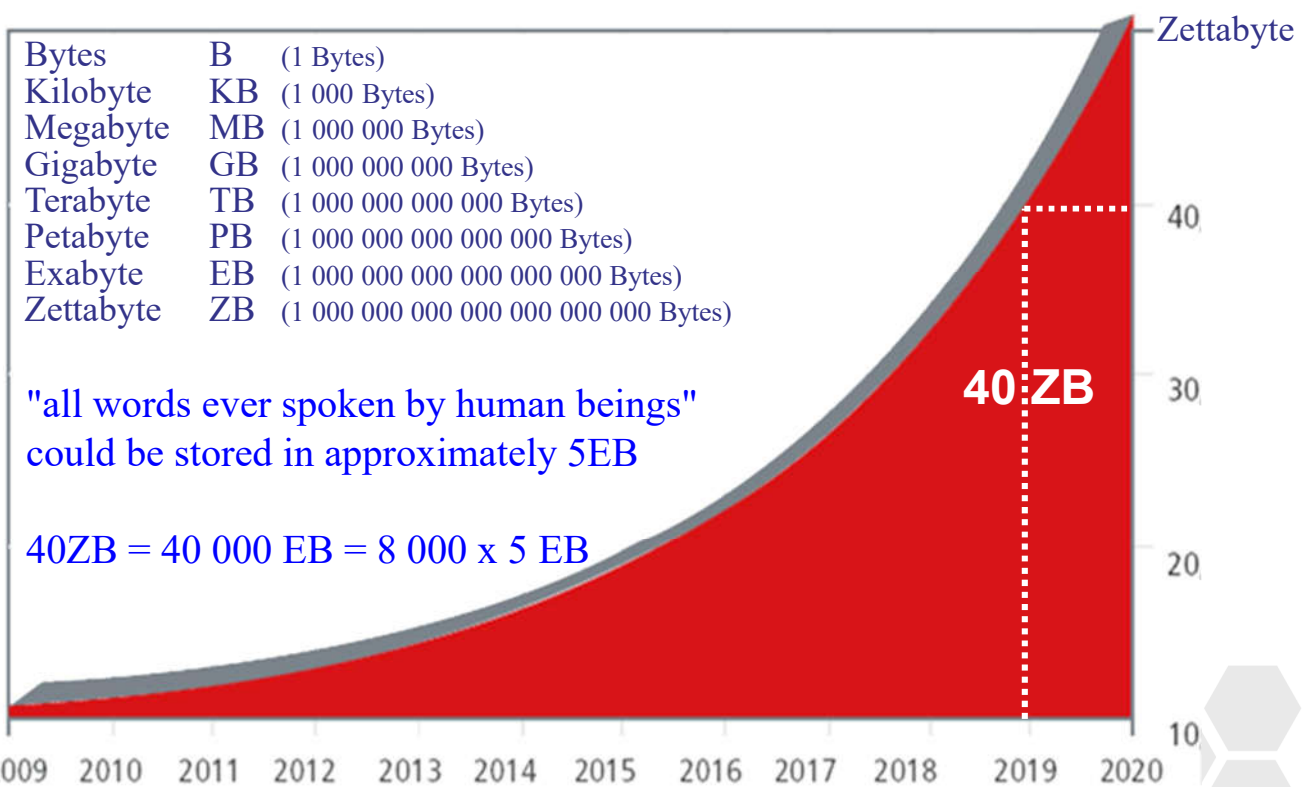


# Machine Learning

- ◆ What if a machine can learn...



# Plenty of Data

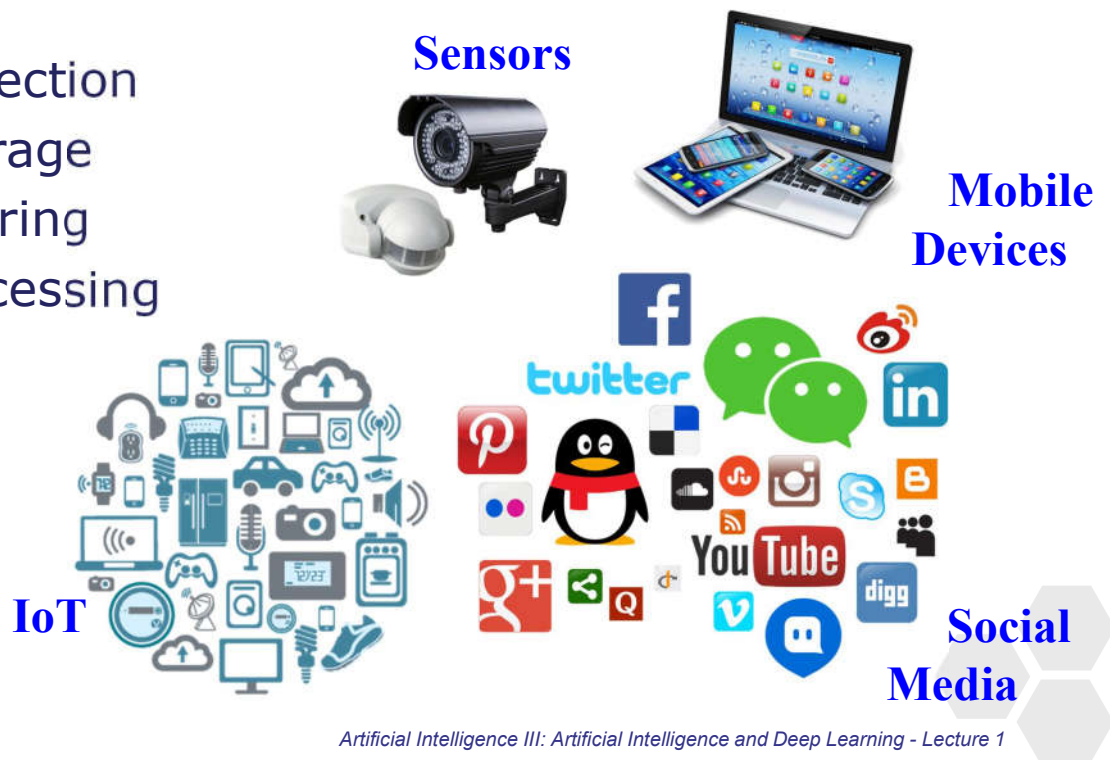




# Plenty of Data

## ◆ 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

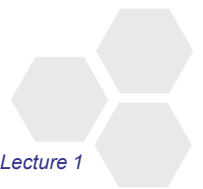
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# Supervised Learning

- ◆ **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



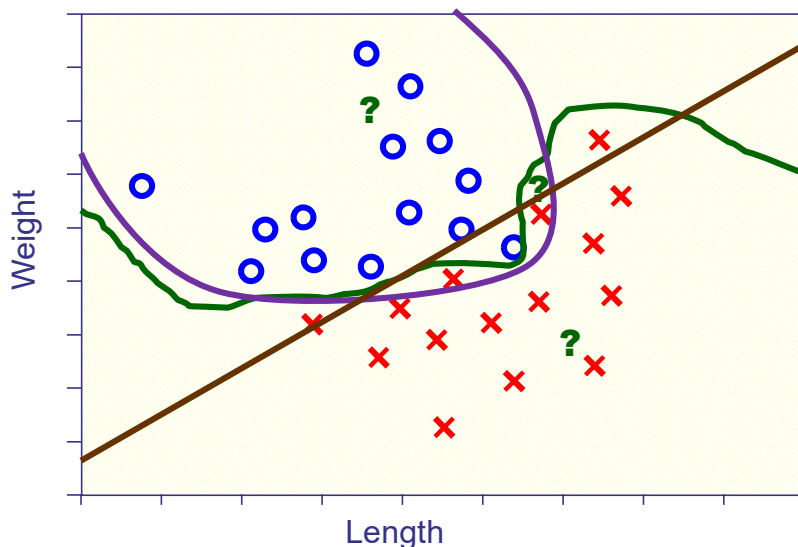
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# Supervised Learning

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



- Seabass Sample
- × Salmon Sample
- ? Unseen Sample



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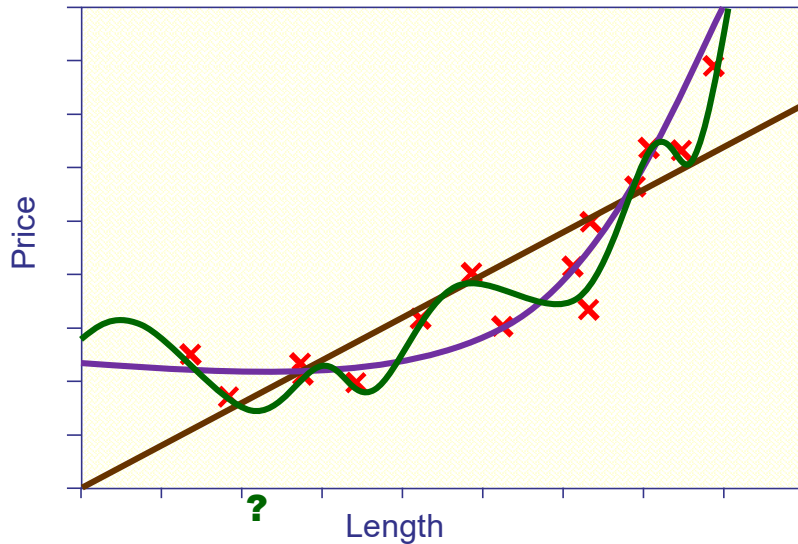
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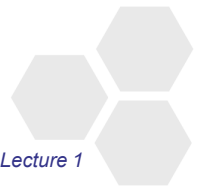
# Supervised Learning

## ◆ Regression

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



× A sample



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# Supervised Learning

## ◆ Example

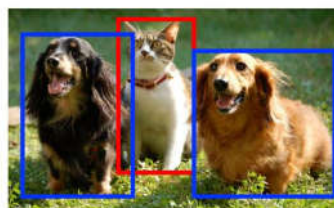
### Classification



CAT

Class  
(Classification)

### Object Detection



CAT, DOG

For each bounding box  
- Size and Coordination  
(Regression)  
- Class  
(Classification)

### Classification + Localization



CAT

A bounding box  
- Size and Coordination  
(Regression)  
- Class  
(Classification)

### Instance Segmentation



CAT, DOG

For each bounding box  
- Size and Coordination  
(Regression)  
- Class  
(Classification)  
- Which pixel is background?  
(Classification)

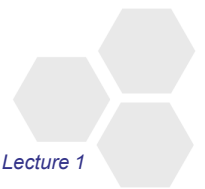


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# Unsupervised Learning

- ◆ 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



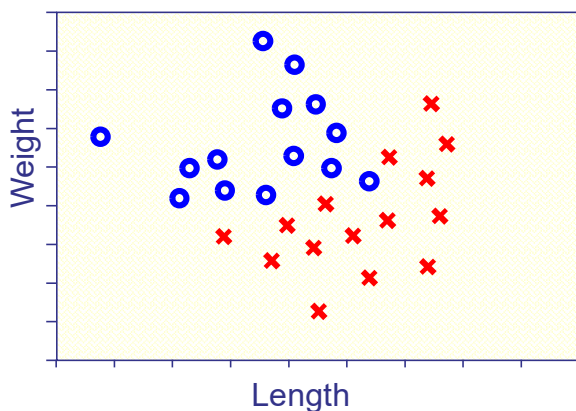
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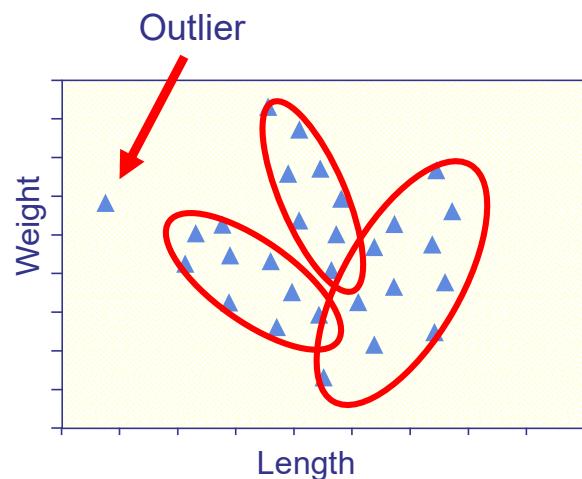


# Unsupervised Learning

- ◆ Clustering
- ◆ Outlier Detection



With labelled information



Without labelled information



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# Unsupervised Learning

- ◆ Example: Customer Segmentation



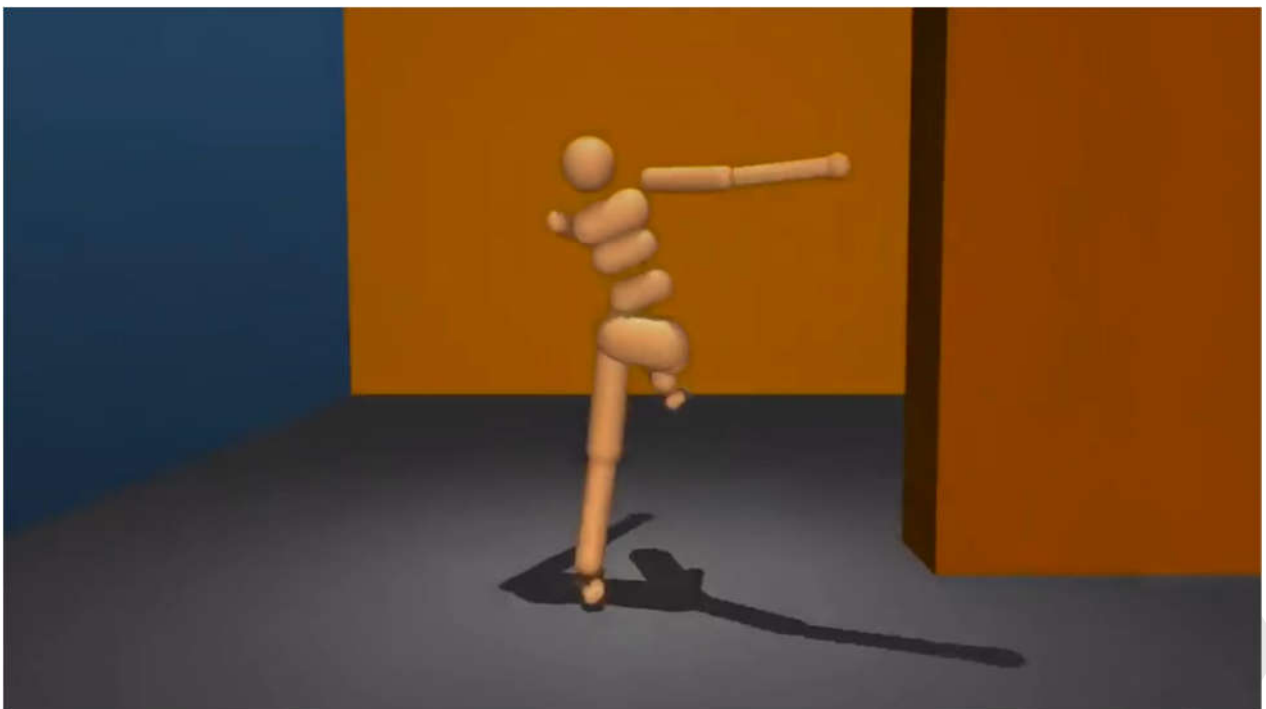
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# Reinforcement Learning

- ◆ Trial and Error: Learning from Mistakes

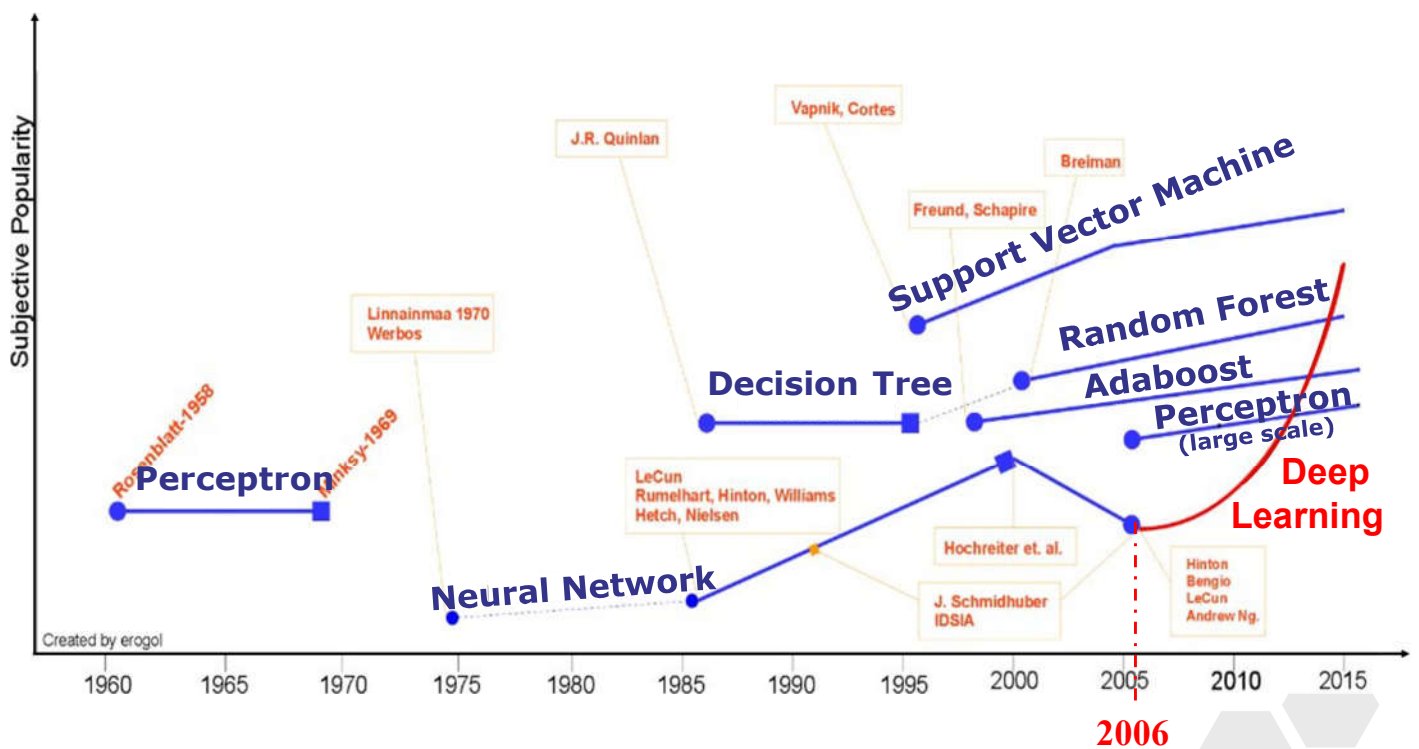


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# Deep Learning



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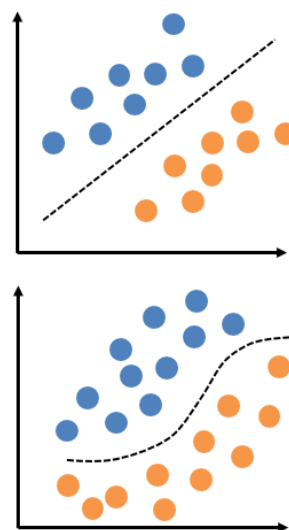
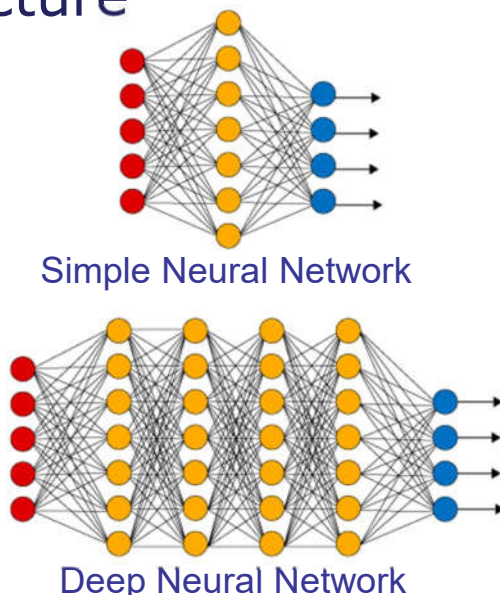
<http://www.erogol.com/brief-history-machine-learning/>

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# Deep Learning

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



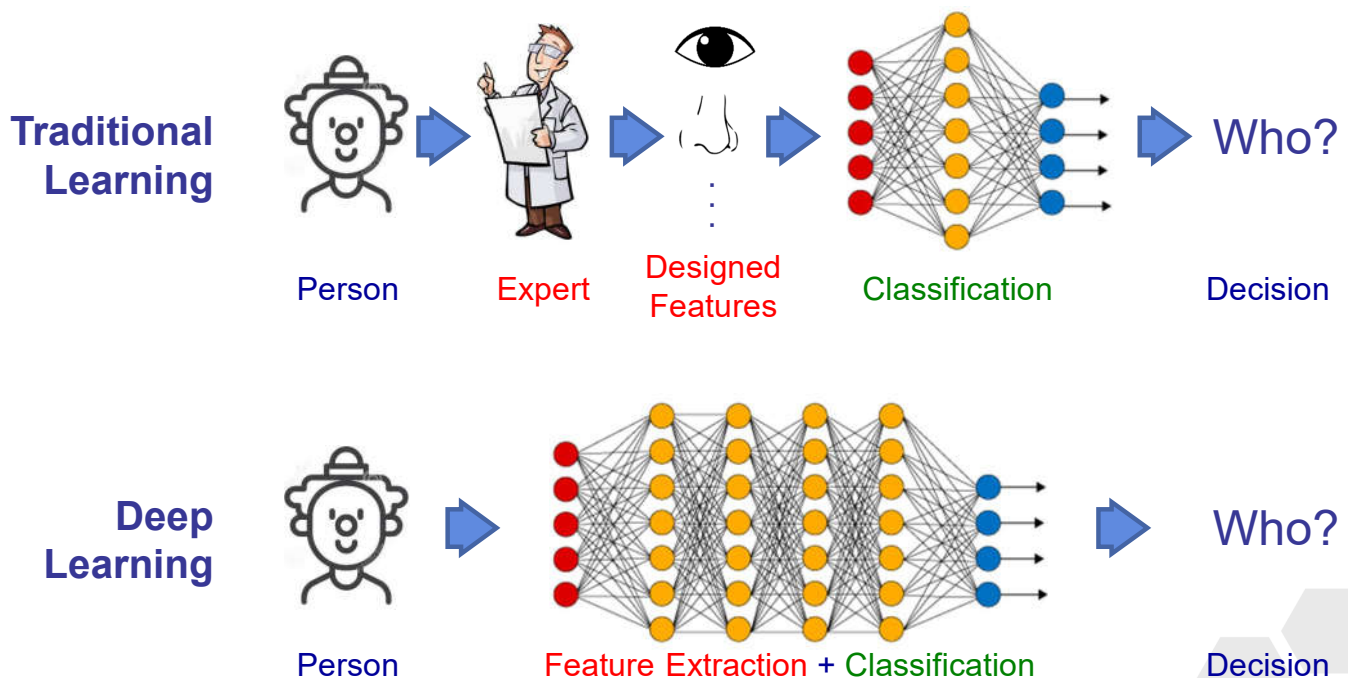
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# Deep Learning

- ◆ 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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## 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?



## 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?



# 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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