



Artificial Intelligence III:
Artificial Intelligence and Deep Learning

Lecture 1 Introduction

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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

- ◆ Companies invested **USD 26 - 39B** in AI in 2016
- ◆ AI created **USD 3.5-5.8T** in value annually in 2018

Potential incremental value from AI over other analytics techniques, %

✈️ Travel	128
🚚 Transport and logistics	89
🛒 Retail	87
🚗 Automotive and assembly	85
🔧 High tech	85
🛢️ Oil and gas	79
🧪 Chemicals	67
🎬 Media and entertainment	57
🏭 Basic materials	56
🌾 Agriculture	55
📦 Consumer packaged goods	55
🏦 Banking	50
🏥 Healthcare systems and services	44
👥 Public and social sectors	44
📶 Telecommunications	44
💊 Pharmaceuticals and medical products	39
🏠 Insurance	38
📱 Advanced electronics/semiconductors	36
🚀 Aerospace and defense	30



Artificial Intelligence Era

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



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AI Impact



2017



Ke Jie
(3 – 0)



Sedol Lee
(4 – 1)



AlphaGo Zero

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



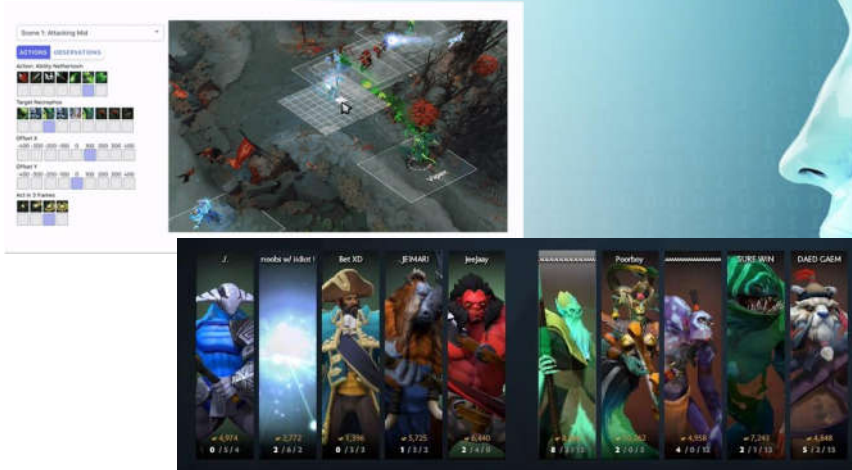


AI Impact

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

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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% (-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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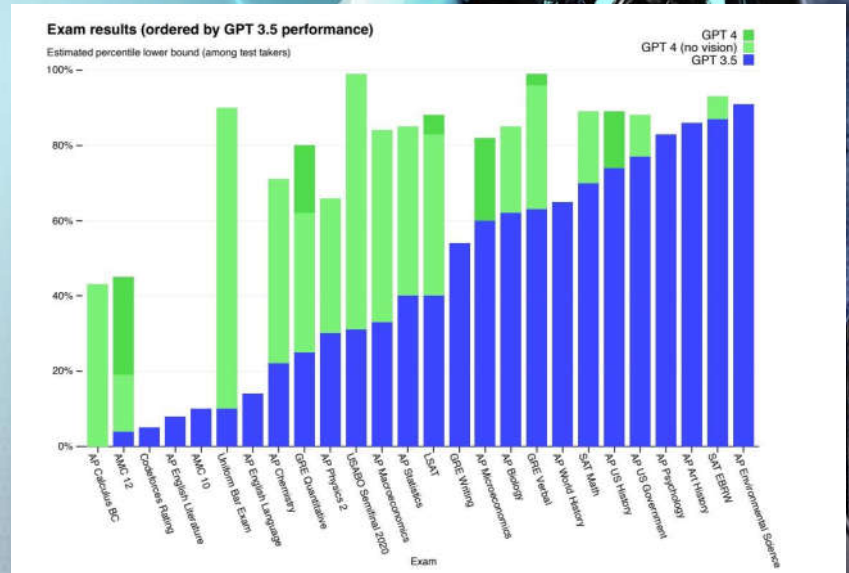
OpenAI: ChatGPT (2022)

- 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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OpenAI: Sora (2024)



Historical footage of California during the gold rush



A close up view of a glass sphere that has a zen garden within it. There is a small dwarf in the sphere who is raking the zen garden and creating patterns in the sand.





- # Artificial Intelligence
- 

what people think it is



what amateur programmers think it is
- ```
1
2 // 10,000 if-statements
3
4 if() {
5 if() {
6 if() {
7 if() {
8 if() {
9 if() {
10 if() {
11 if() {
12 if() {
13 if() {
14 if() {
```

**what actually it is**

# What is Intelligence?

- ◆ Intelligence
  - Different meaning to different people
  - Culture and situation specific
- ◆ “Intelligence”, your **first impression?**





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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# General Discussion

## ◆ Different in degrees

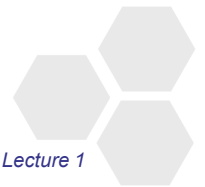
- More / Less intelligent

## ◆ Intelligence is relative

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

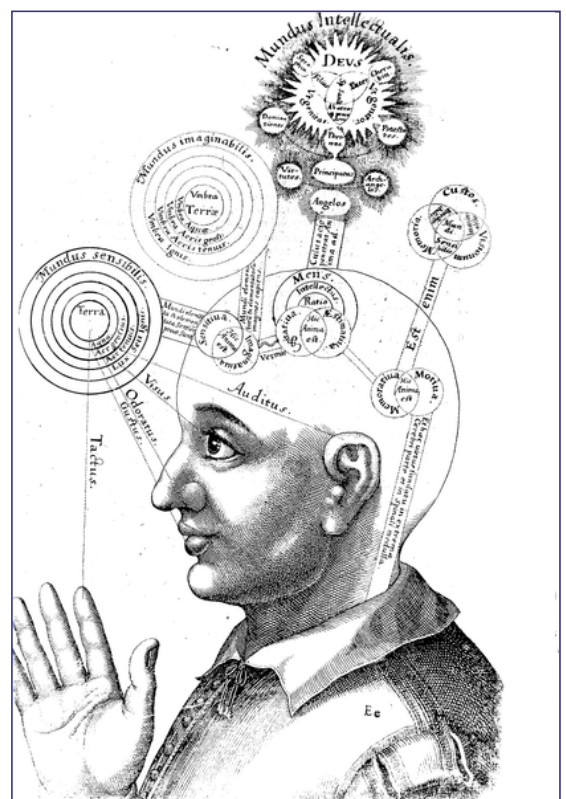
## ◆ Different aspects

- 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**





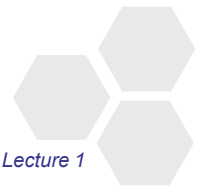
## What is Intelligence?

# 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**



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Rolf Pfeifer, Christian Scheier, "Understanding Intelligence", MIT Press, 1999

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## What is Intelligence?

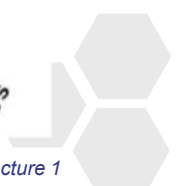
# Summary



|            | 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           |            |

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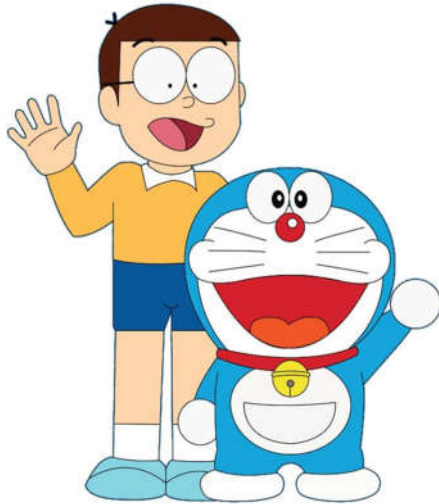
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# Artificial Intelligence (AI)

- ◆ 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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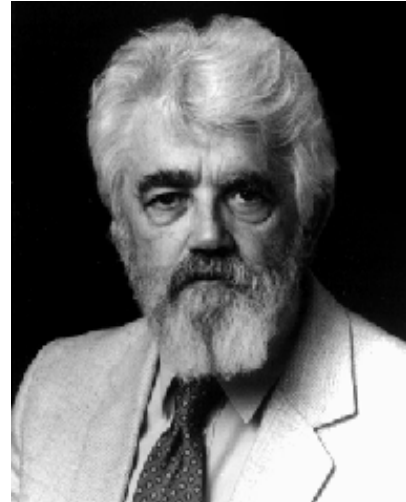
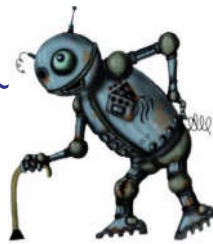
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# AI Development

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

I am 64 year-old~



## 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

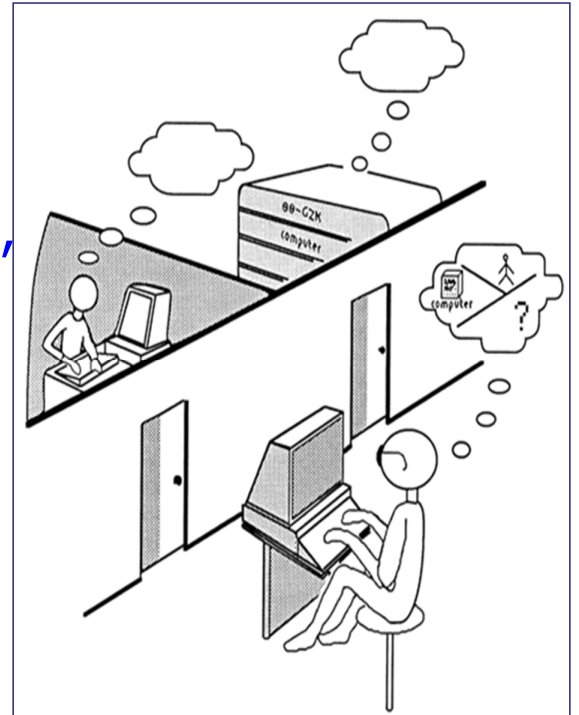




Can AI become HI?

# 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**



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Can AI become HI?

# Turing Test

- ◆ Many algorithms **achieves satisfying results in chatting with human**
  - Old generation: Cortana, Siri, Google Now, Blackberry Assistant
  - Now: LLM based assistants
- ◆ Do they **really understand you?**
- ◆ Are they **really intelligent?**



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Can AI become HI?

# 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**?



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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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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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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**”



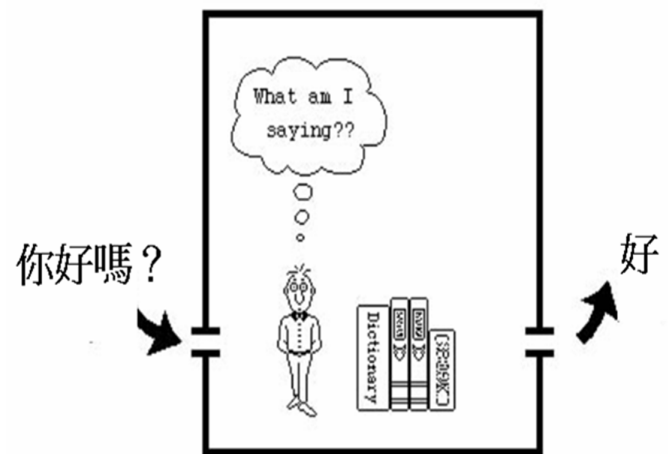
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# The Chinese Room

- ◆ 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!**



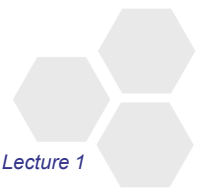
# The Chinese Room

- ◆ 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, **maybe...**
  - 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 jeopardy quiz show Jeopardy



2014

### EUGENE

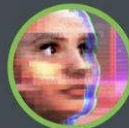
Eugene Goostman, a chatbot passes the Turing Test with a third of judges believing Eugene is human



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

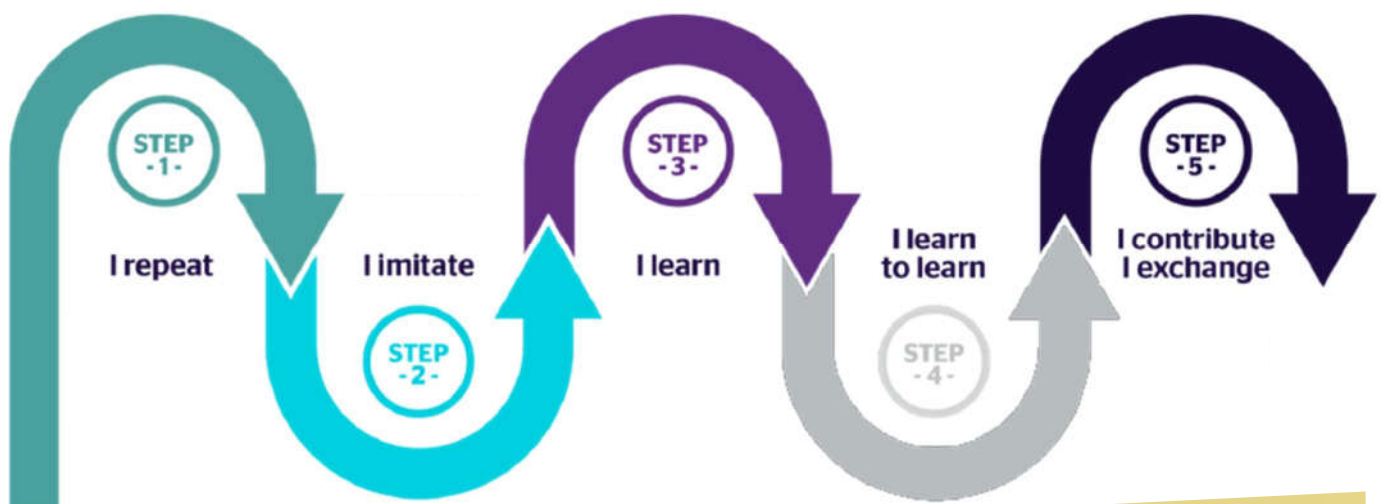
Google's A.I. AlphaGo beats world champion Ke Jie in the complex board game of Go, notable for its vast number ( $2^{170}$ ) of possible positions

<https://medium.com/future-today/understanding-artificial-intelligence-f800b51c767f>



# AI Development

## Human Involvement

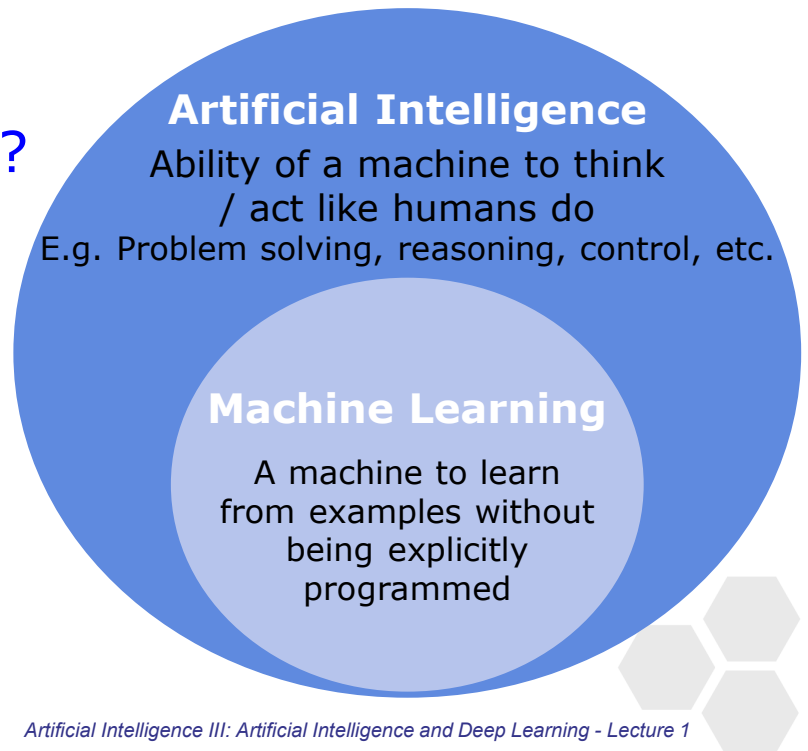


Powerful (Knowledge & Ability)



# AI vs Machine Learning (ML)

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



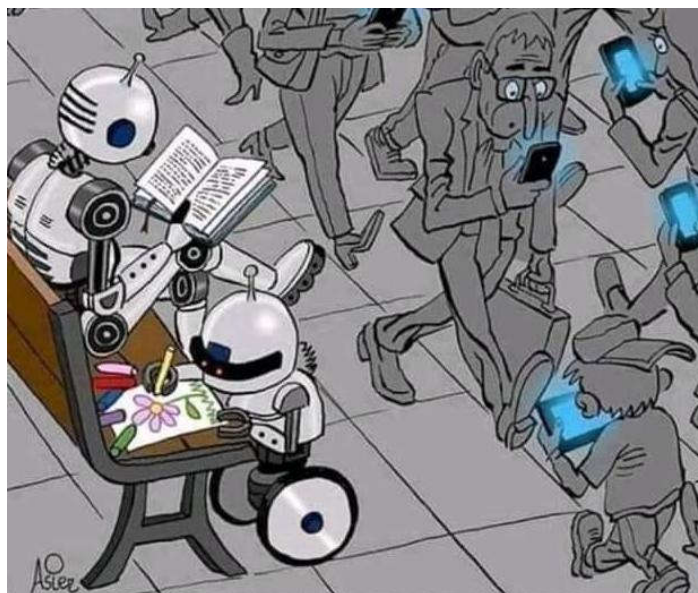
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## Machine Learning

- ◆ What if a machine can learn...

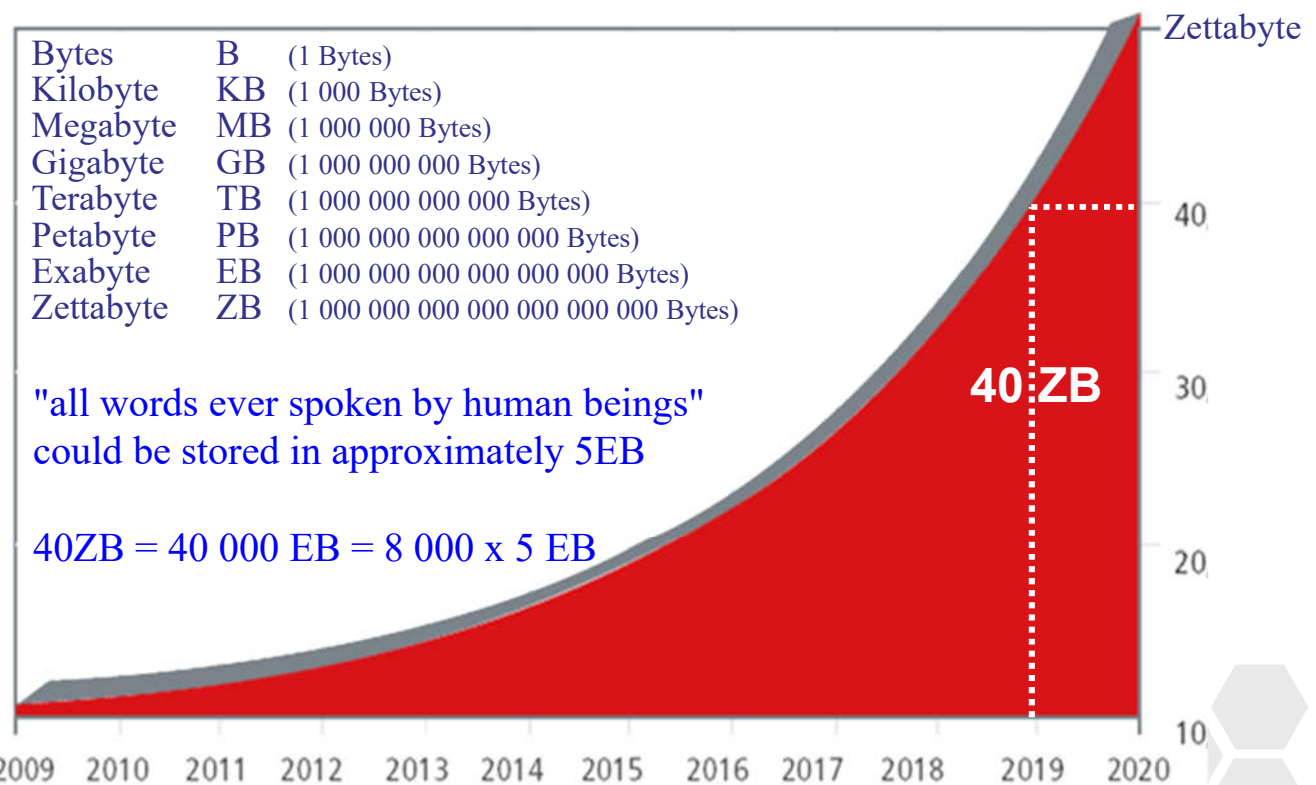


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# Plenty of Data



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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

Sensors



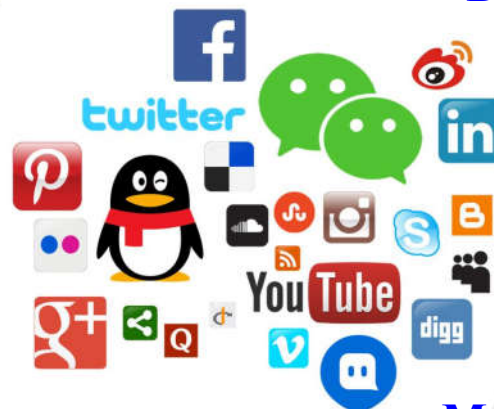
Mobile Devices



IoT



Social Media



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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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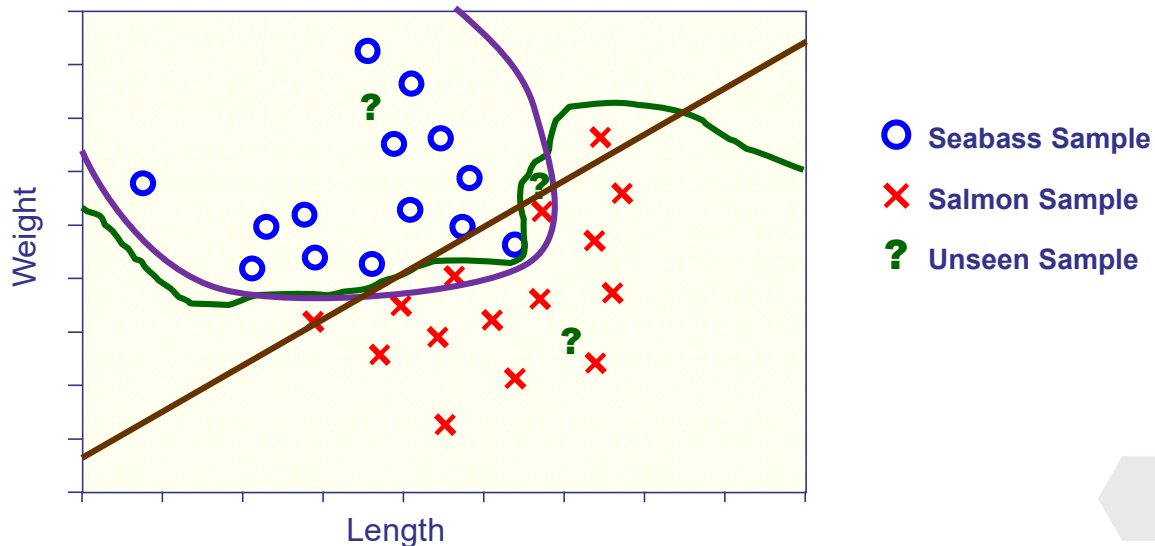
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# Supervised Learning

## ◆ Classification

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



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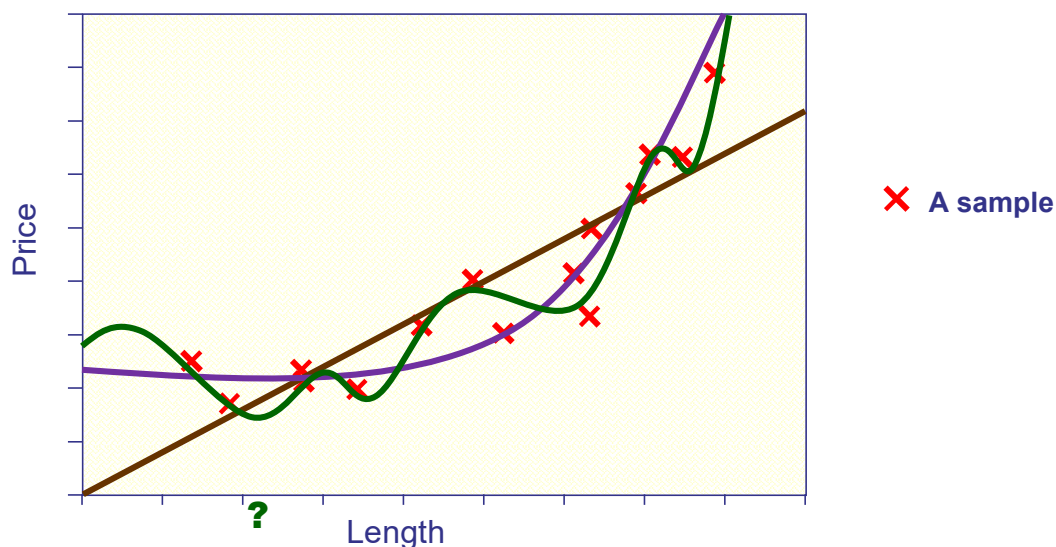
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# Supervised Learning

## ◆ Regression

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



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# Supervised Learning

## ◆ Example

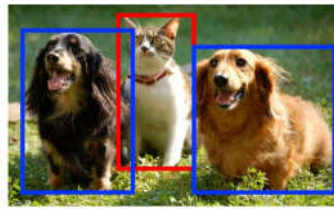
Classification



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)



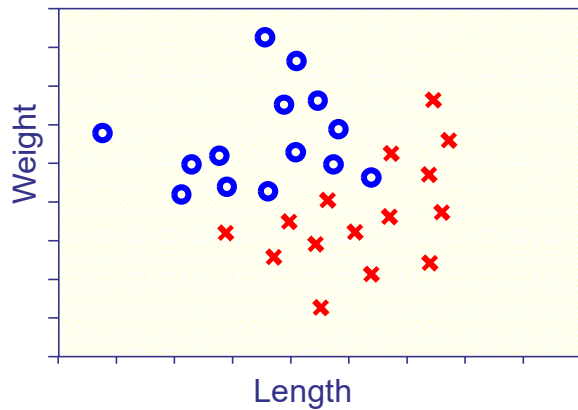
# Unsupervised Learning

- ◆ 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

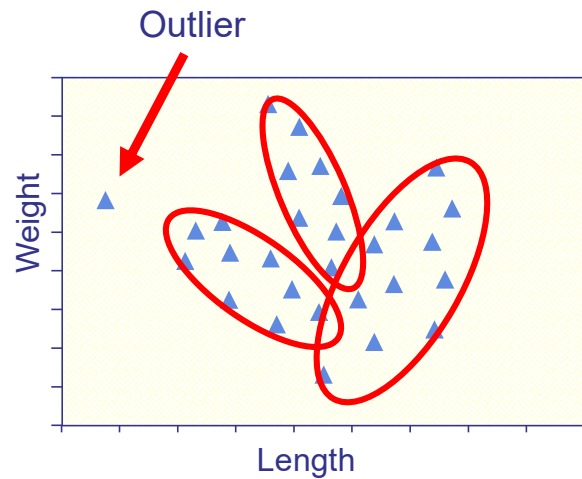


# Unsupervised Learning

- ◆ Clustering
- ◆ Outlier Detection



With labelled information



Without labelled information



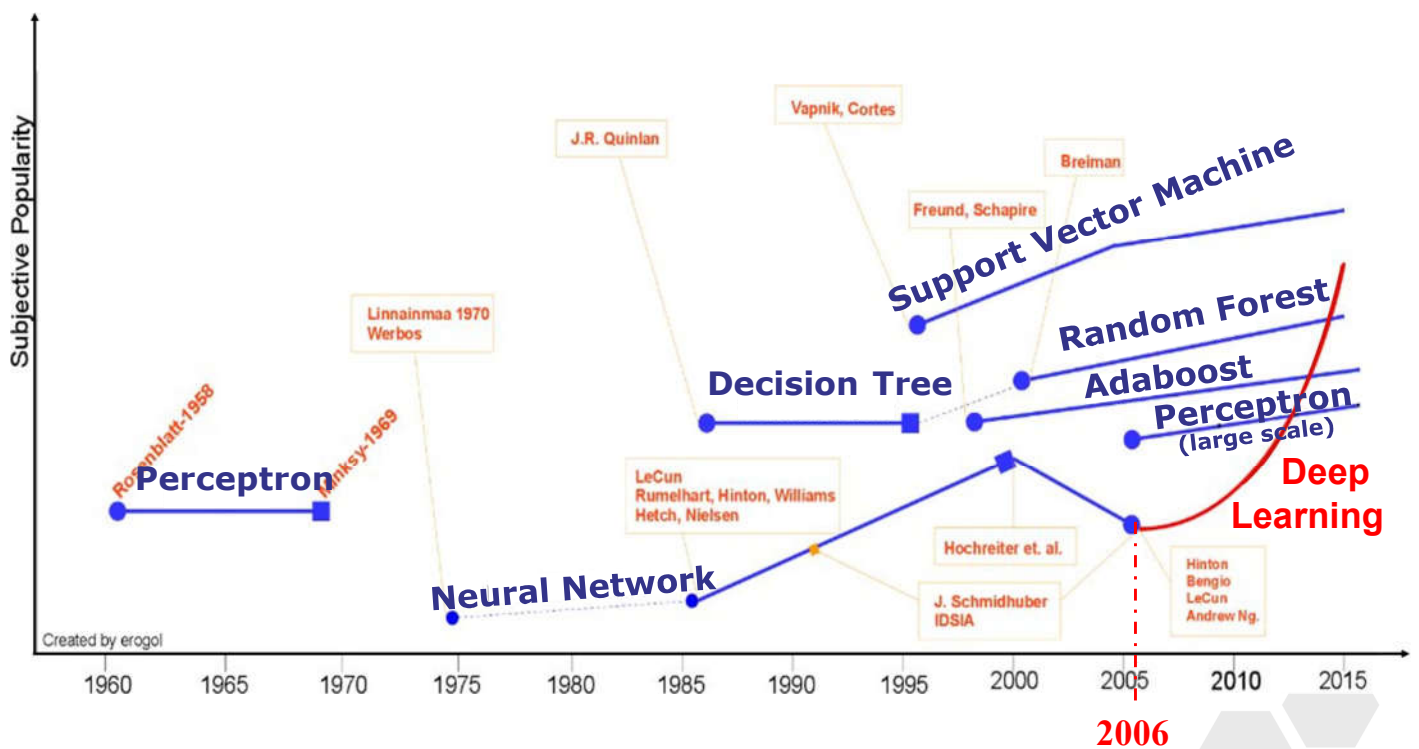
# Unsupervised Learning

- ◆ Example: Customer Segmentation





# Deep Learning



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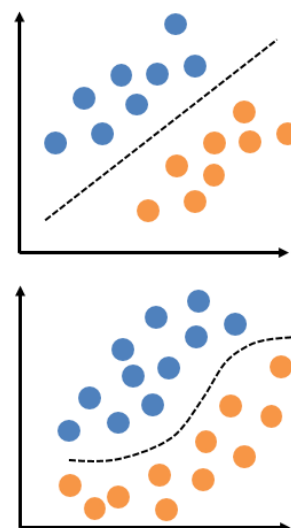
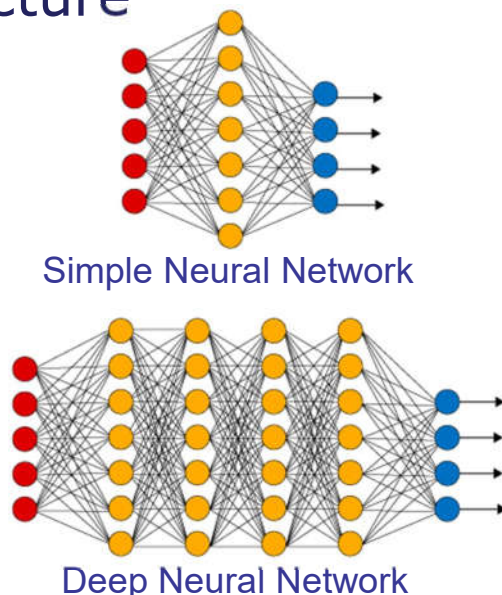
<http://www.erogol.com/brief-history-machine-learning/>

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# Deep Learning

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



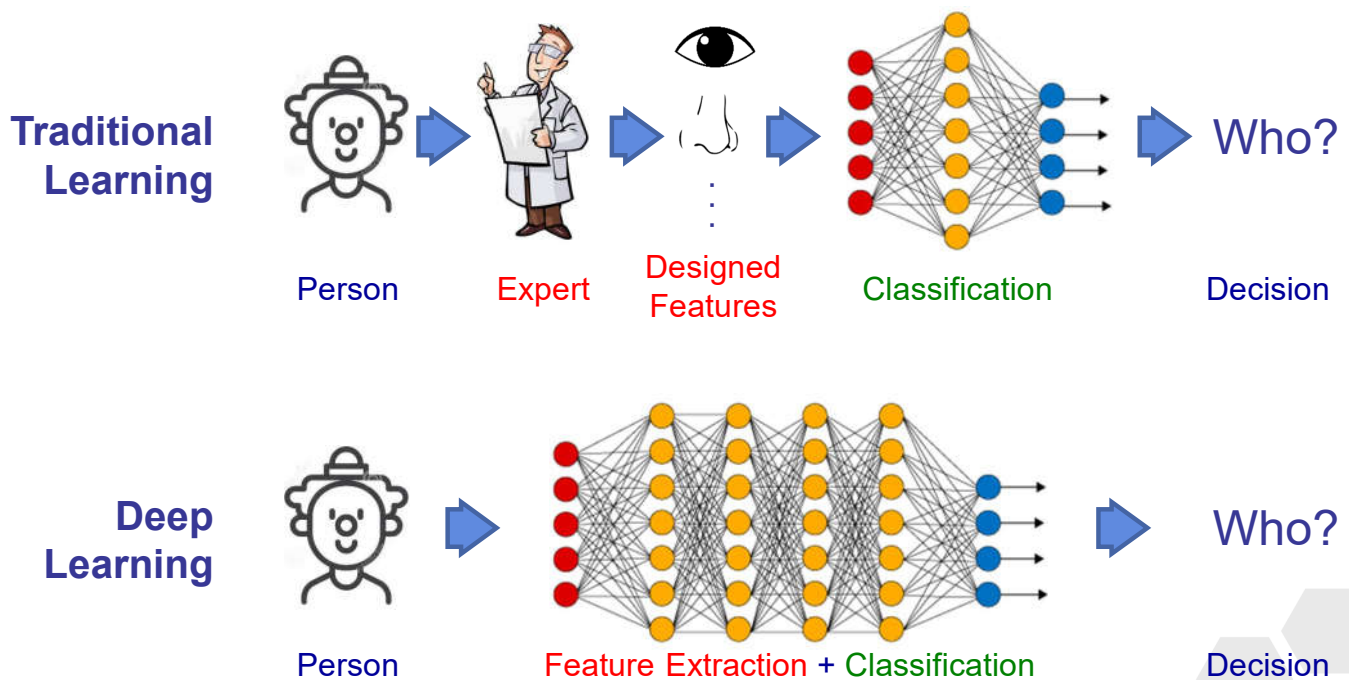
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# Deep Learning

- ◆ Features does not rely on experts anymore



## Future AI Strong AI?

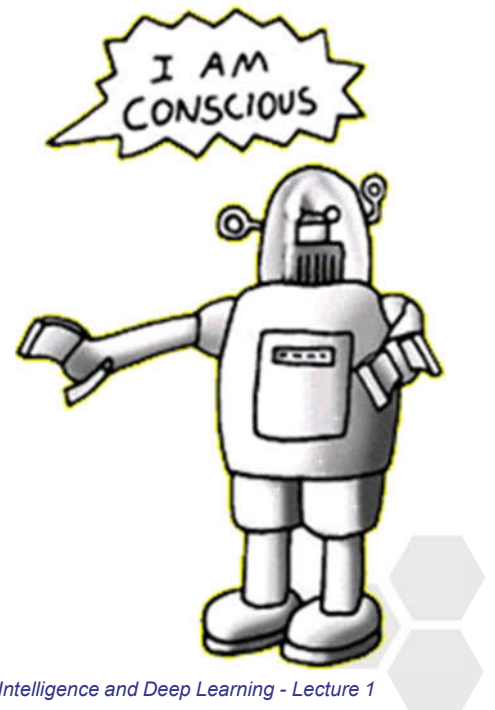




- ◆ Is LLM beneficial for students and humanity?



- ◆ 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 it 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





# 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?

