

# STMC Coding Team Training

Lesson 8: Introduction to AI, ML and their applications

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# Goal today

Today we will briefly talk about the history, development and concept of AI, the definition and examples of Machine Learning Model, we will try out two different state-of-the-art ML models.

- What is AI?
- A brief history timeline of AI
- Overview of ML
- ML model 1: Stable Diffusion
- ML model 2: GPT-4
- What's in the future?



# What is AI?

- Artificial Intelligence (AI)
- Alan Turing, the father of Theoretical Computer Science and AI
- Central Question: Can machine think and behave like a human?
- In 1950s, the field of study in AI was founded

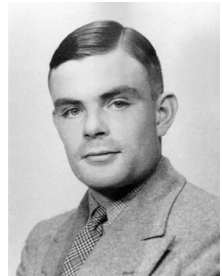
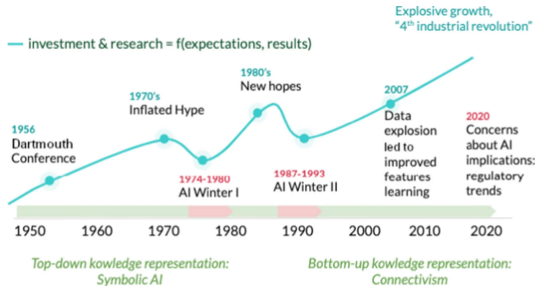


Figure 1: retrieved from: [Alan Turing, B.J. Copeland](#)



# First and Second AI Winter

- In late 1970s, development in AI slow down
- Reasons:
  - Computational Power
  - Lack of Framework
- In the 1980s, Expert System is proposed
- It failed due to similar reasons



retrieved from: The winter, the summer and the summer dream of artificial intelligence in law, Enrico Francesconi

# Rise of Machine Learning

- The concept of Machine Learning was raised in 1960s
- Central Question: Can machine learn knowledge like a human?
- But... How do we define learn? How do we prove we learnt something?
- We need a bit Mathematics to help with that



# Function: Pattern of numbers

- Imagine we are learning about the concept of even number
- It contains a set of numbers,  $\{2, 4, 6, 8, \dots\}$
- But to the machine, it is just a bunch of numbers...
- Pattern is the key!
- (mathematic) function is good for capturing pattern of numbers
- In this example, they all lies on the line  $y = 2x$



# Regression

- In general, consider you have a bunch of data
- The way we learn the data is by finding a (good) function that contain all the points
- But... There may not always exist such a function
- To make our life easier, we accept the function that is close too most of the data points
- Such technique is called Regression

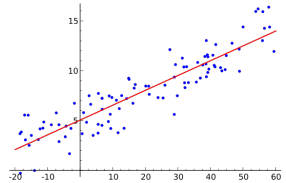


Figure 3: retrieved from: [Regression analysis, Wikipedia](#)



# Artificial Neural Network (ANN)

- Regression is good, but there's a problem...
- How do I know a function is good for my data?
- We need a more general way of representing function
- Neural Network is all you need!
- A Neural Network consist of...
  - Input Layers
  - Zero or more Hidden Layers
  - Output Layers
- Most of the function can be approximated as a Neural Network

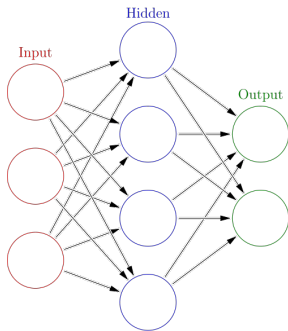


Figure 4: retrieved from: [Neural network \(machine learning\), Wikipedia](#)





# Learning, Training and Testing

- Just like we have exam in schools
- We let the function we learnt to do a test to see how close is it to our data set
- This process is called testing
- Training refers to the process of feeding in data to find the good function we need
- Usually we separate data into training set and testing set
- The process of training, testing and fine-tuning is how we conduct Machine Learning (usually)



# Deep Learning

- the technique to use multiple hidden layers for constructing complicated function
- Since numbers of layers increase, parameter increase as well
- We need a really large data set to find out which function we need

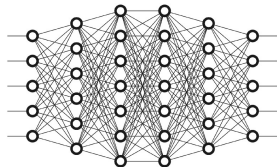
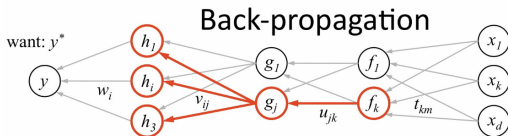


Figure 5: retrieved from: [Want to know how Deep Learning works? Here's a quick guide for everyone, Radu Raicea](#)



# Sounds simple?

- The above is an **extremely** simplified introduction to AI and ML
- As you can imagine, tons of math lies underneath are omitted
- A lot of scientists are still working hard to improve different kind of model/methods
- Let's try some really cool tools people developed



1. receive new observation  $\mathbf{x} = [x_1 \dots x_d]$  and target  $y^*$
2. **feed forward:** for each unit  $g_j$  in each layer  $1 \dots L$   
compute  $g_j$  based on units  $f_k$  from previous layer:  $g_j = \sigma \left( u_{j0} + \sum_k u_{jk} f_k \right)$
3. get prediction  $y$  and error  $(y - y^*)$
4. **back-propagate error:** for each unit  $g_j$  in each layer  $L \dots 1$

(a) compute error on  $g_j$

$$\frac{\partial E}{\partial g_j} = \sum_i \underbrace{\sigma'(h_i)}_{\text{should } g_i \text{ be higher or lower?}} \underbrace{v_{ij}}_{\text{how } h_i \text{ will change as } g_j \text{ changes}} \underbrace{\frac{\partial E}{\partial h_i}}_{\text{was } h_i \text{ too high or too low?}}$$

(b) for each  $u_{jk}$  that affects  $g_j$

(i) compute error on  $u_{jk}$  (ii) update the weight

$$\frac{\partial E}{\partial u_{jk}} = \frac{\partial E}{\partial g_j} \underbrace{\sigma'(g_j)}_{\text{do we want } g_j \text{ to be higher/lower}} f_k \quad u_{jk} \leftarrow u_{jk} - \eta \frac{\partial E}{\partial u_{jk}}$$

how  $g_j$  will change if  $u_{jk}$  is higher/lower



# Stable Diffusion

- A model that generate Images according to the text describing it
- Proposed by CompVis group at LMU Munich in 2022
- Let's try to generate a few images with your own prompt first!
- Make sure the preprocessing part is done.
- Modify the string `prompt` to generate a image you want
- Do you spot any unusual part in the generated image?
- Can you modify the prompt to fix it?



# Exercise

- Modify the code so that it asked user for a input and try to generate a image for the input
- To make it more interactive, after the image is generated, ask the user whether he/she want to generate another one
- Modify the code so that it generated multiple images and compare them
- Let the user to choose which image to save



# GPT-4

- A model that generate text-response according to the text input provided
- Proposed by OpenAi in 2023
- Let's try to Talk with the model, ask it a few questions
- The reaction might be slow, be patient with it



# What's in the future?

- Make GPT even smarter
- Application to other area: robotics, vehicle, medical-use...
- Small-Data AI, customized AI
- Quantum-based technology

