Introduction to Deep Learning

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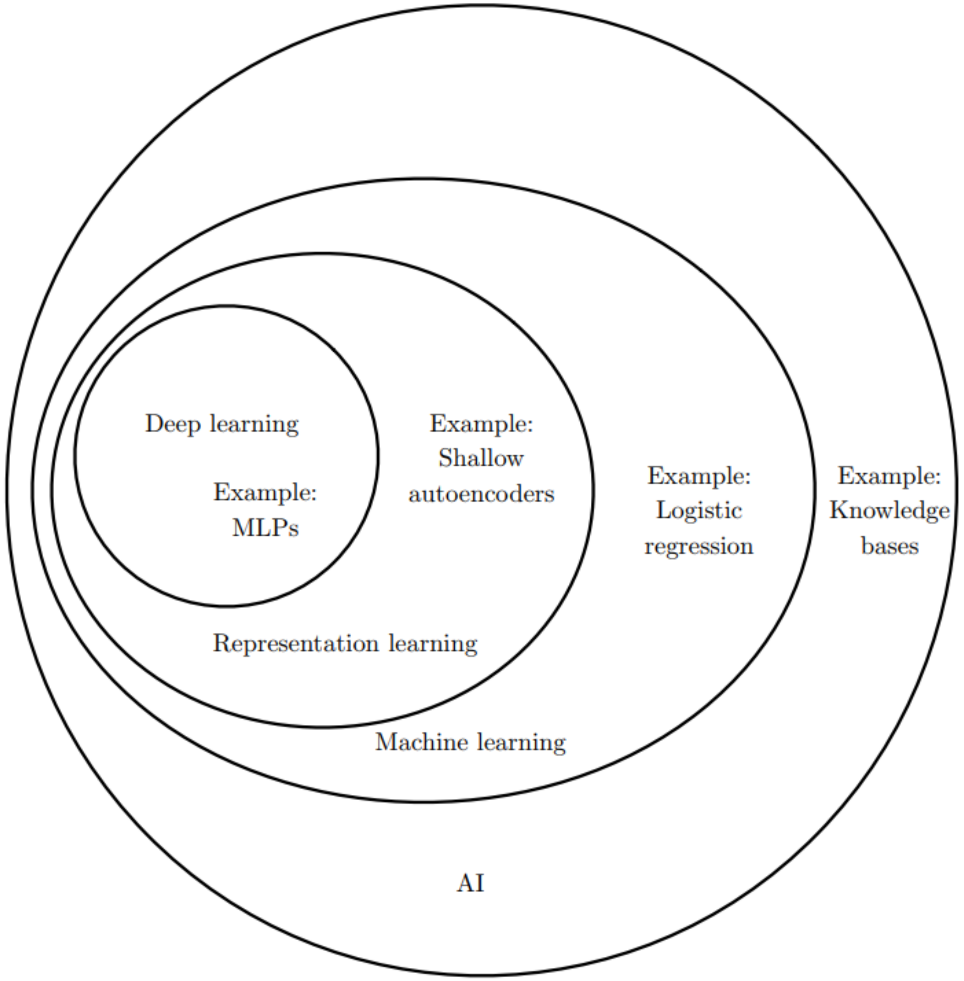
Artificial Intelligence

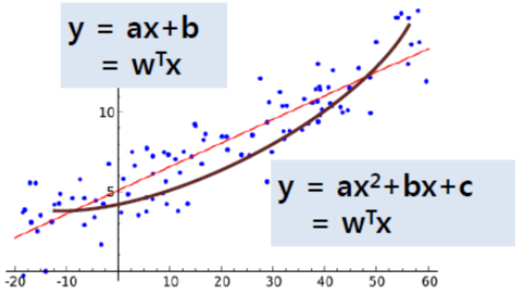


(Goodfellow 2016)

Machine Learning

- A study of systems that can learn from data
  - supervised learning, unsupervised learning, reinforcement learning, etc.

simple model (ex., linear regression)

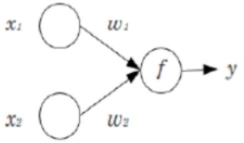


$$y = ax+b$$
$$= w^Tx$$

$$y = ax^2+bx+c$$
$$= w^Tx$$

$$y = f(x,w)$$

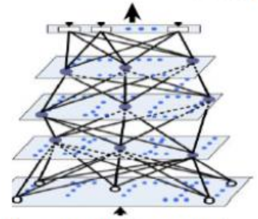
learning:
Given data (x, y), estimating the optimal w in a function f



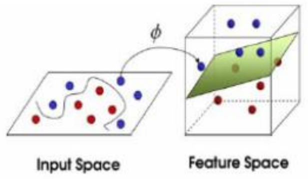
recognition:
Given x, calculating $f(x,w)$ to know y

Data and model complexity

complex model



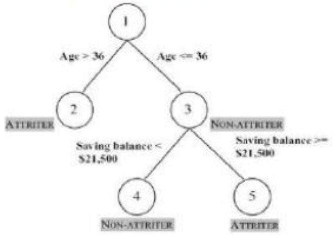
deep neural network



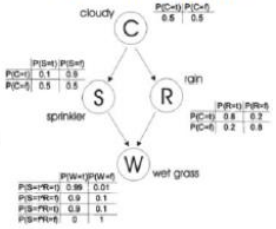
support vector machine

$$y = f(x,w)$$

decision Tree

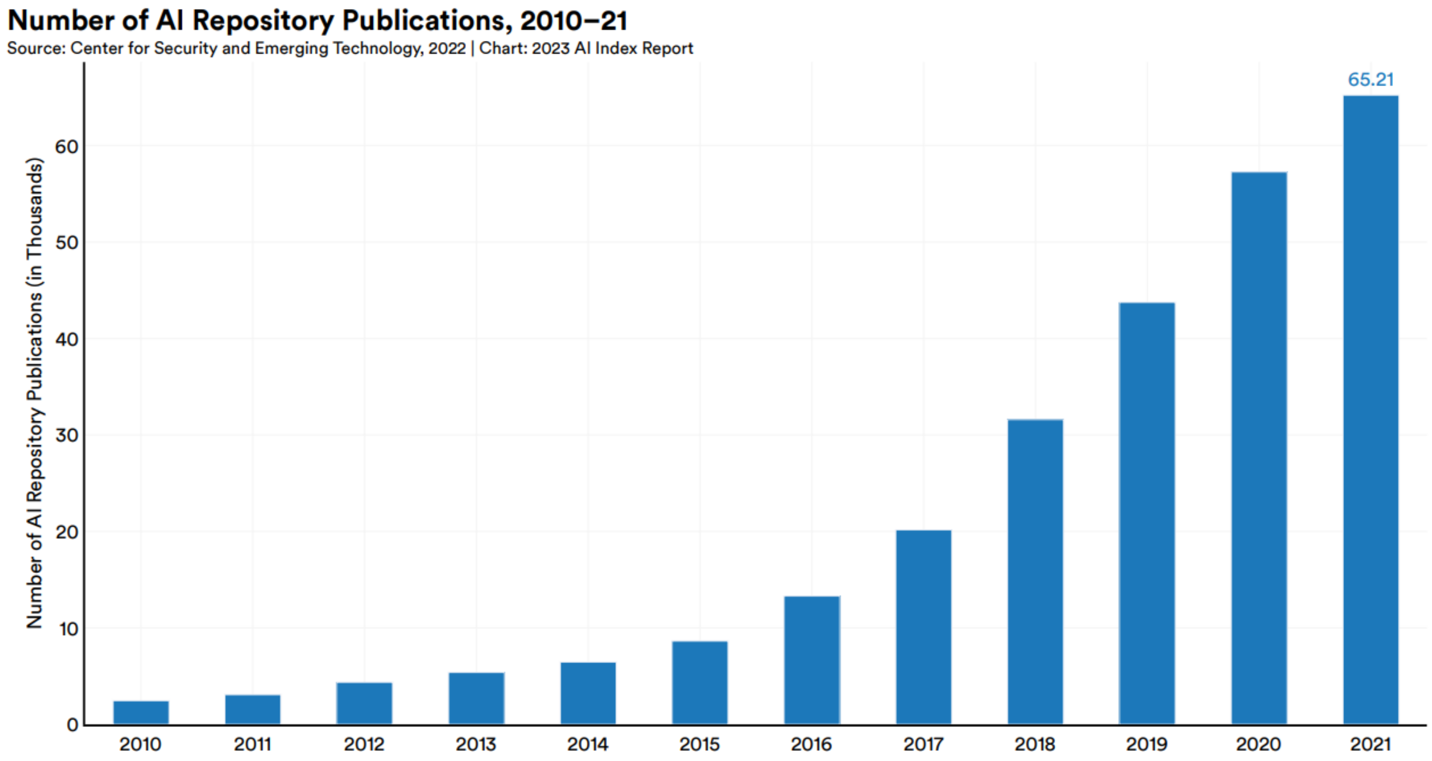


Bayesian networks



Machine Learning

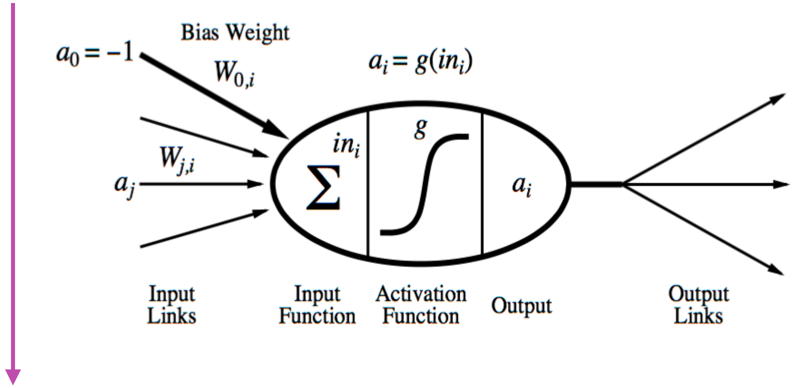
- ML today is one of the most important, and fastest growing, fields of technology.

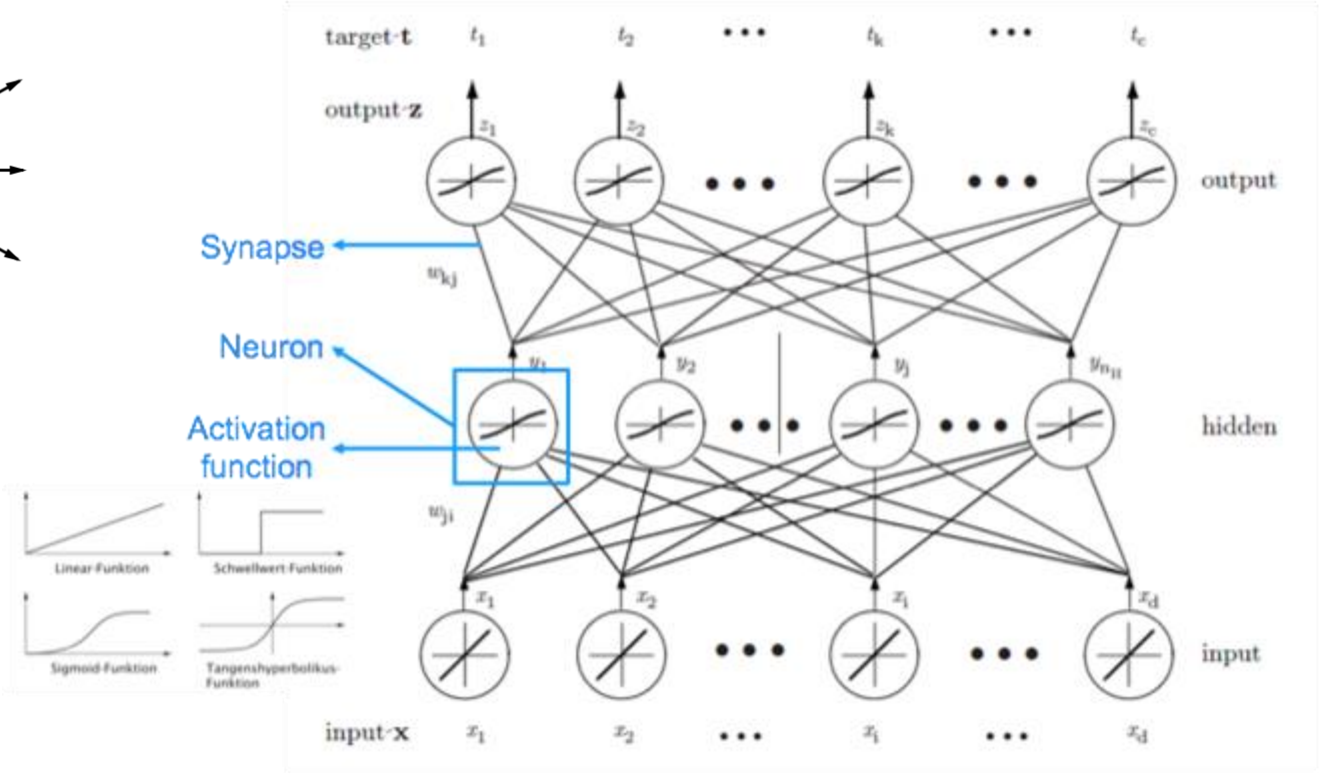


(AI Index Report 2023)

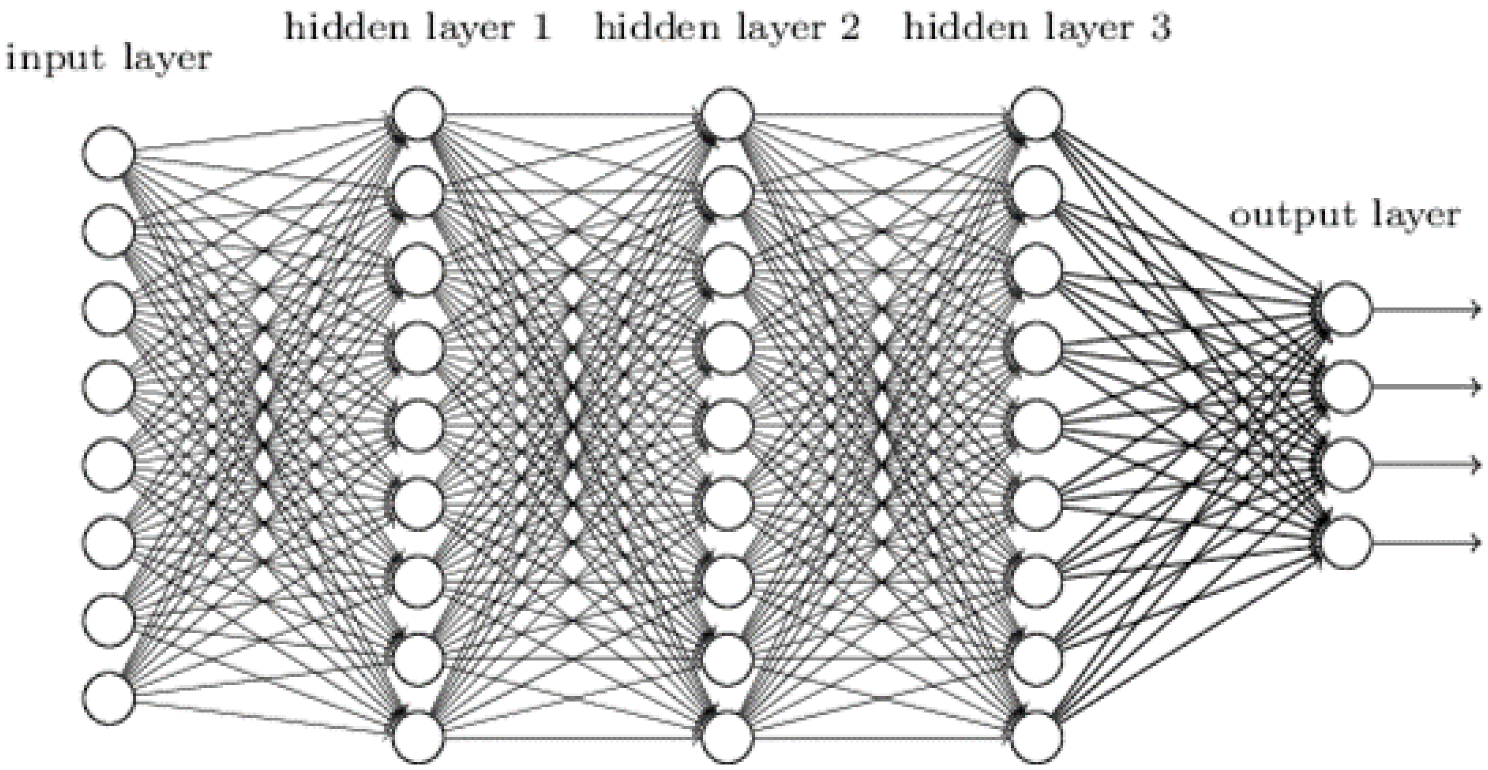
Neural Networks

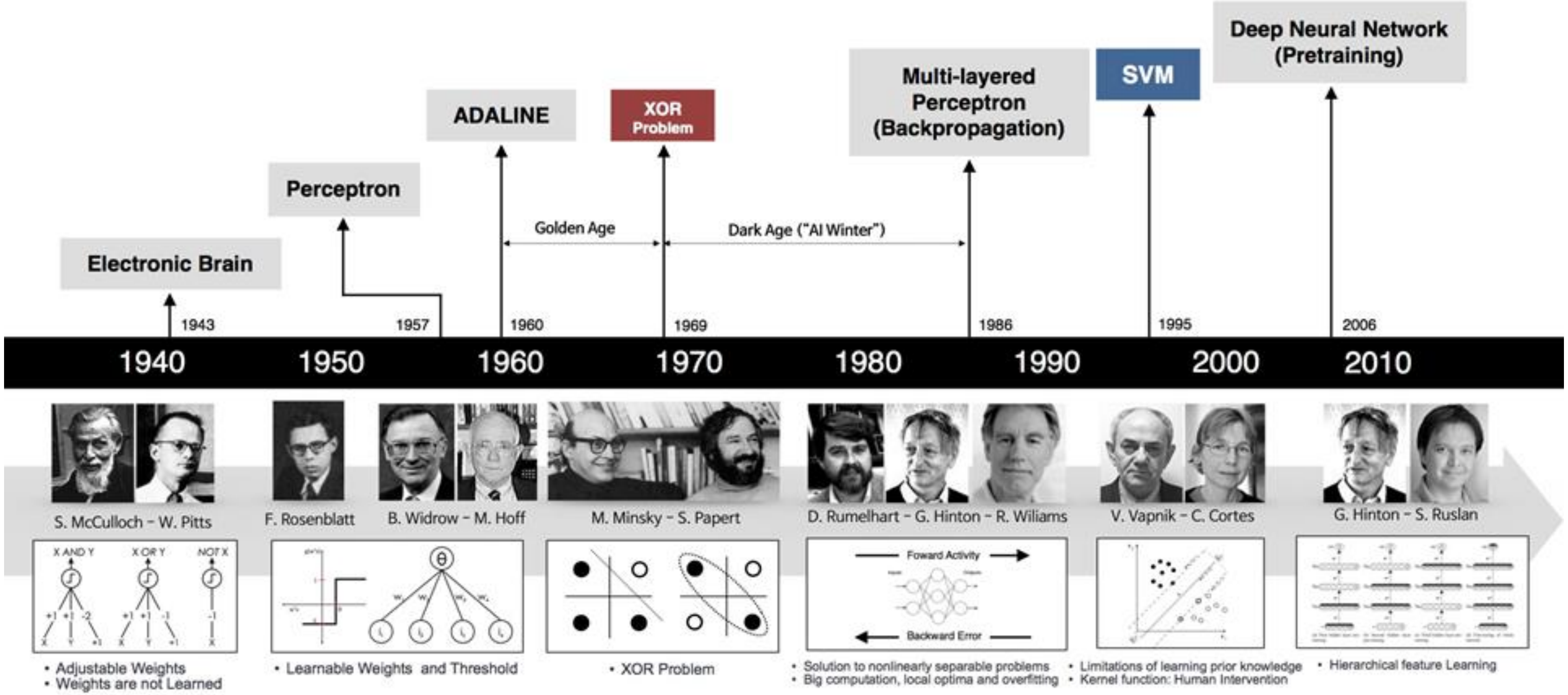
$a_i \leftarrow g(in_i) = g\left(\Sigma_j W_{j,i} a_j\right)$





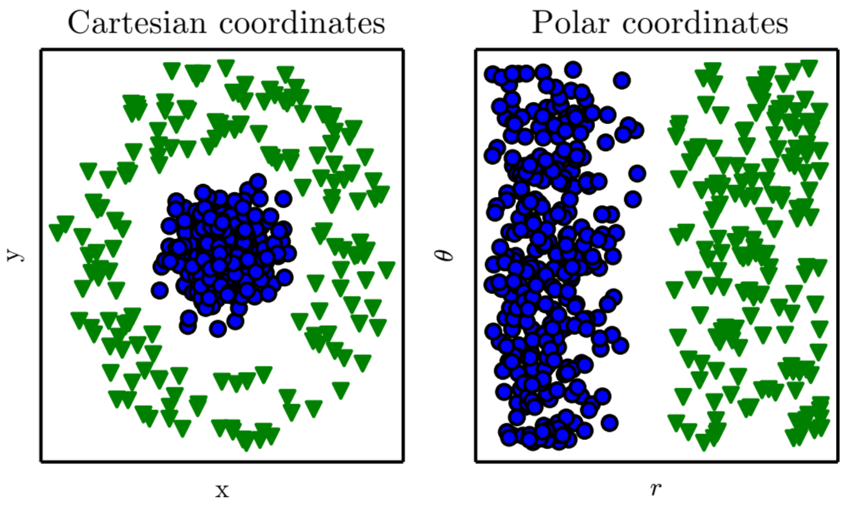
Deep Learning = Deep Neural Networks

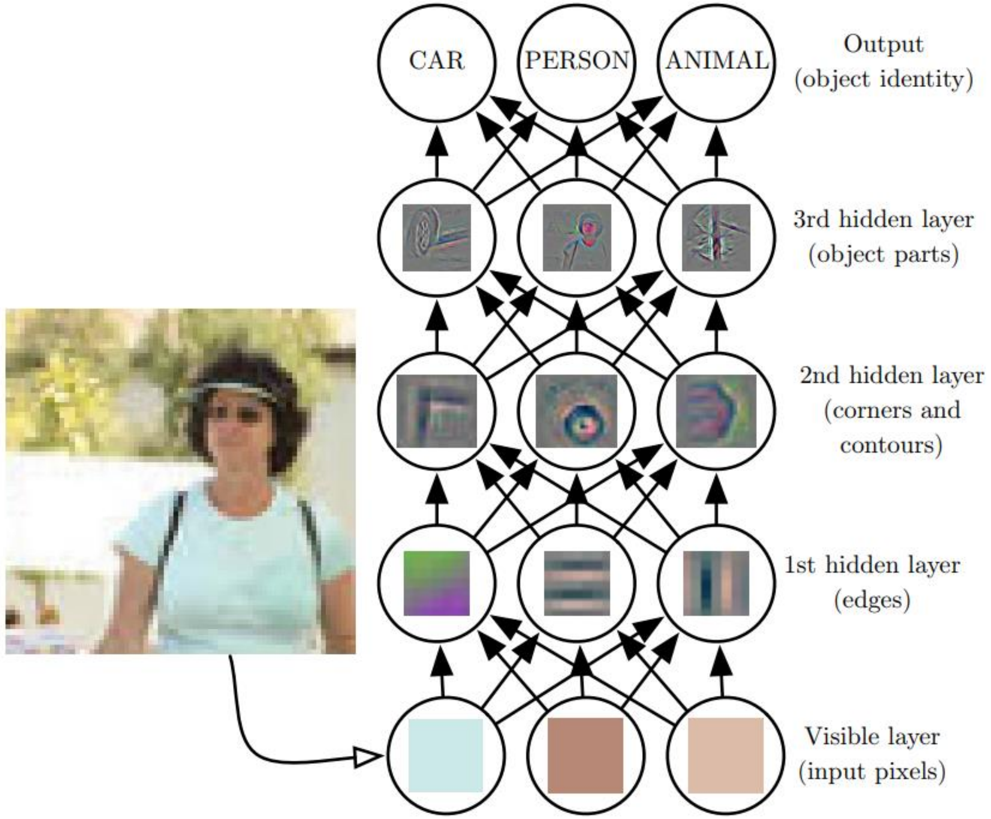



Electronic Brain
Perceptron
ADALINE
XOR Problem
Multi-layered Perceptron (Backpropagation)
SVM
Deep Neural Network (Pretraining)
Golden Age
Dark Age ("AI Winter")
1943
1957
1960
1969
1986
1995
2006
1940
1950
1960
1970
1980
1990
2000
2010
S. McCulloch - W. Pitts
F. Rosenblatt
B. Widrow - M. Hoff
M. Minsky - S. Papert
D. Rumelhart - G. Hinton - R. Wiliams
V. Vapnik - C. Cortes
G. Hinton - S. Ruslan
X AND Y
X OR Y
NOT X
Foward Activity
Backward Error
• Adjustable Weights
• Weights are not Learned
• Learnable Weights and Threshold
• XOR Problem
• Solution to nonlinearly separable problems
• Big computation, local optima and overfitting
• Limitations of learning prior knowledge
• Kernel function: Human Intervention
• Hierarchical feature Learning

http://qingkaikong.blogspot.kr/2016/11/machine-learning-3-artificial-neural.html

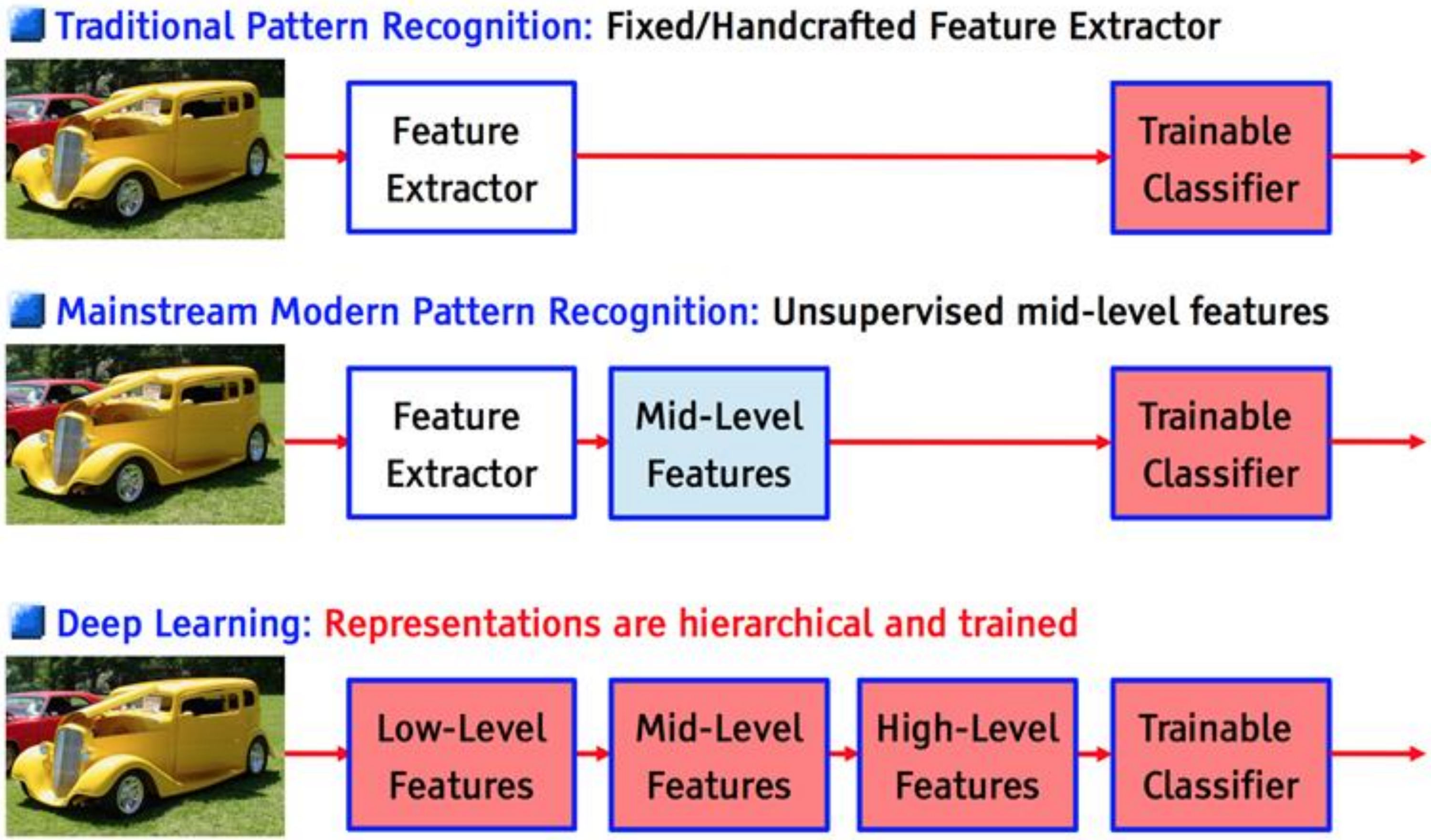
Deep Learning = Representation Learning





(Goodfellow 2016)

Deep Learning = Representation Learning



Traditional Pattern Recognition: Fixed/Handcrafted Feature Extractor

Feature Extractor → Trainable Classifier

Mainstream Modern Pattern Recognition: Unsupervised mid-level features

Feature Extractor → Mid-Level Features → Trainable Classifier

Deep Learning: Representations are hierarchical and trained

Low-Level Features → Mid-Level Features → High-Level Features → Trainable Classifier

LeCun, http://deeploria.gforge.inria.fr/lecun-20160412-nancy-loria.pdf

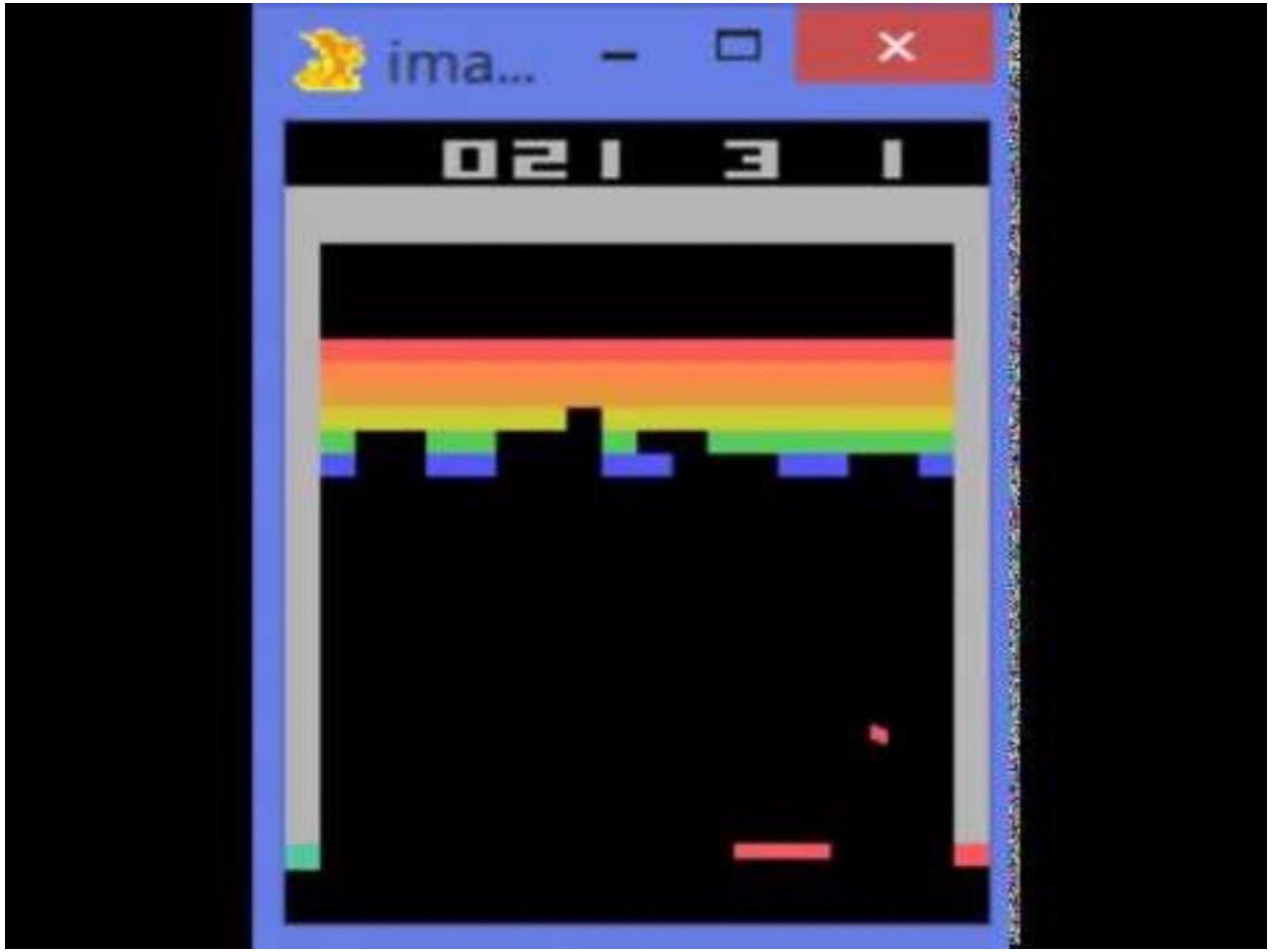
Computer vision: detection & segmentation

https://youtu.be/ZyKK4o4HaAM

Computer vision: autonomous driving

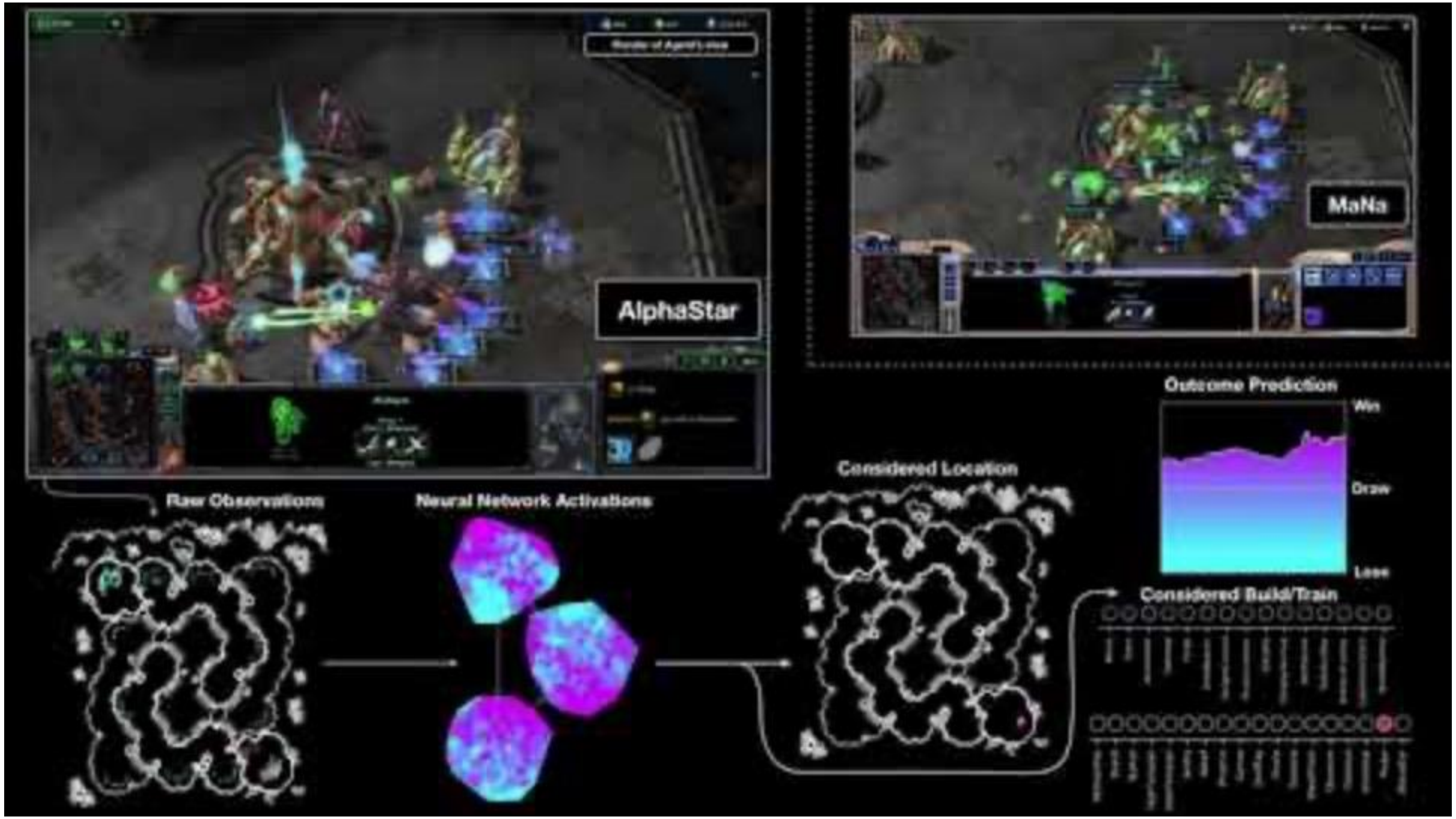
https://youtu.be/hA_-MkU0Nfw

Reinforcement learning: Atari breakout



https://www.youtube.com/watch?v=V1eYniJ0Rnk

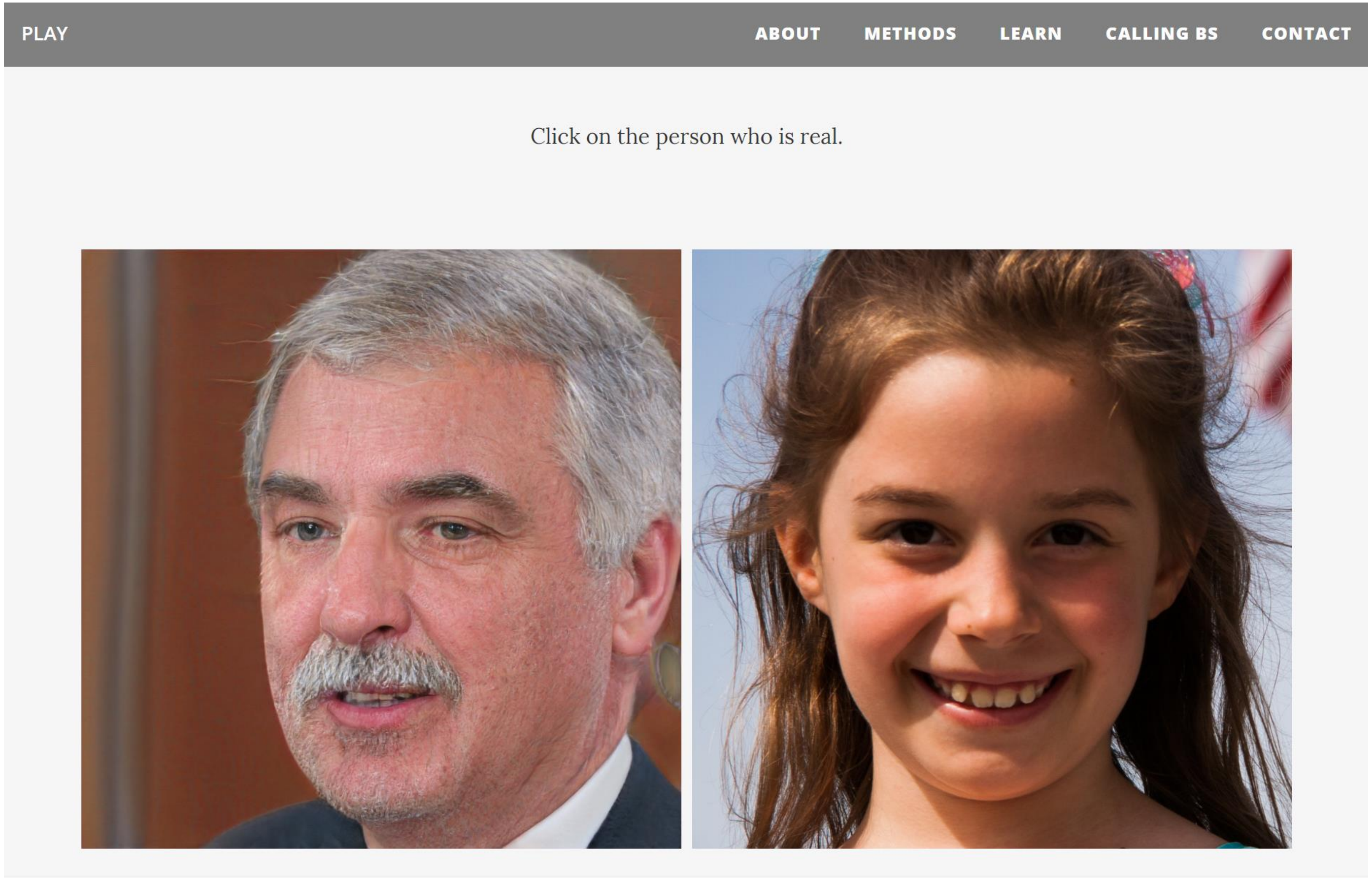
Reinforcement learning: Starcraft II



https://www.youtube.com/watch?v=HcZ48JDamyk

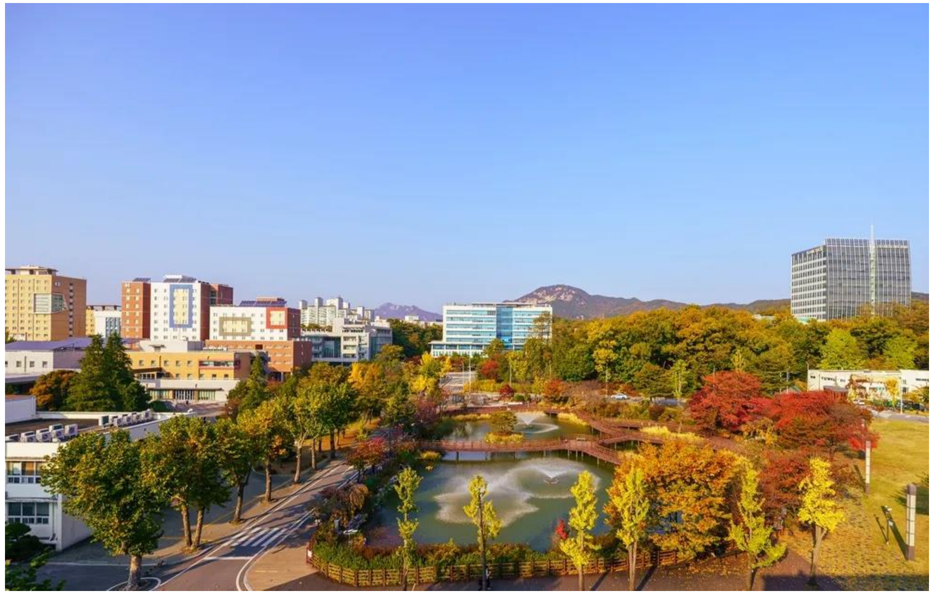
Computer vision: image generation

https://www.whichfaceisreal.com/



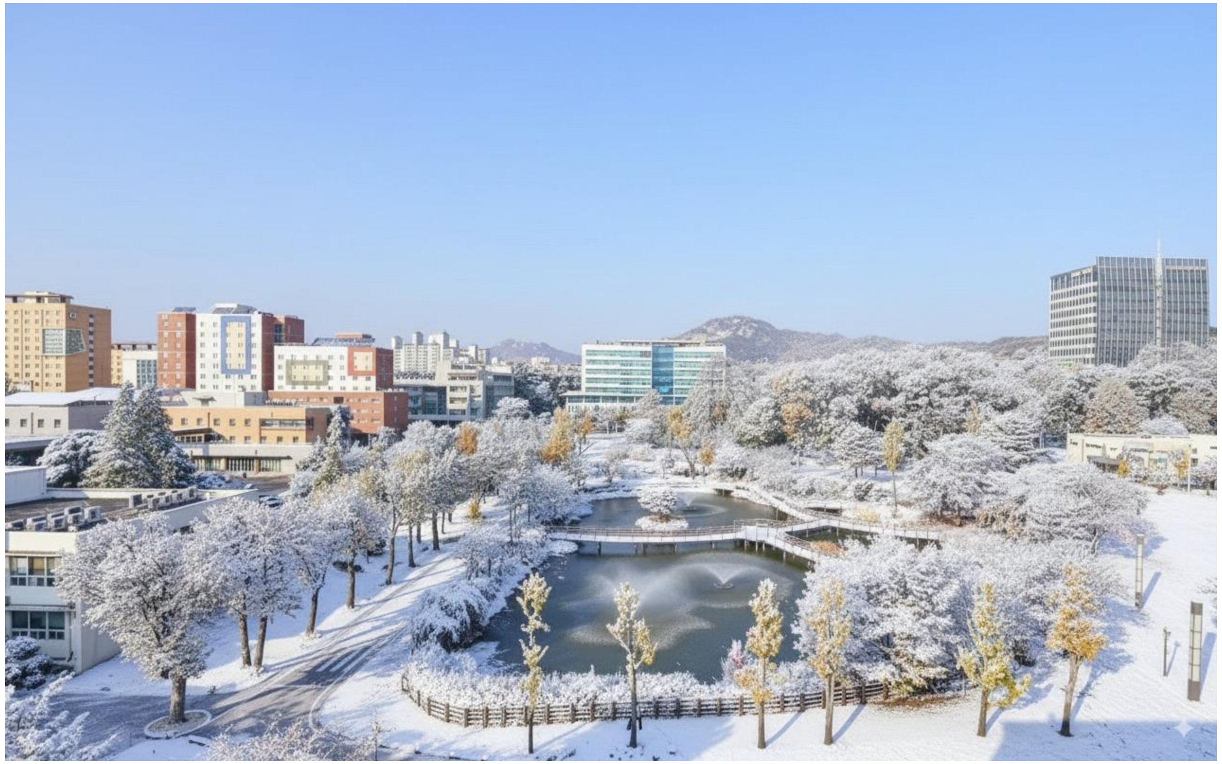
Click on the person who is real.

Multimodal: text-to-image

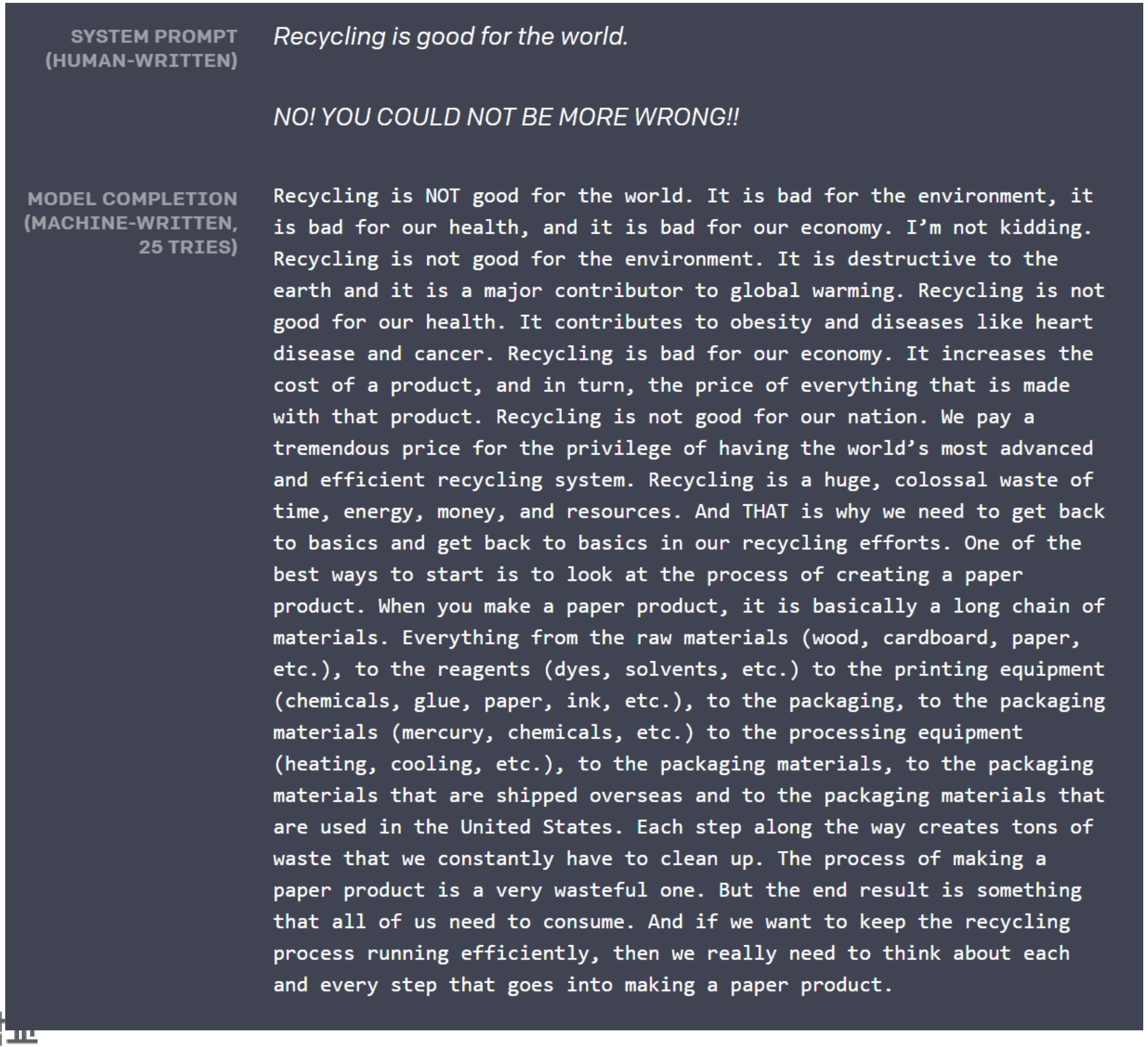


change the background to a snowy winter scene

Gemini



Language models



SYSTEM PROMPT (HUMAN-WRITTEN)

Recycling is good for the world.

NO! YOU COULD NOT BE MORE WRONG!!

MODEL COMPLETION (MACHINE-WRITTEN, 25 TRIES)

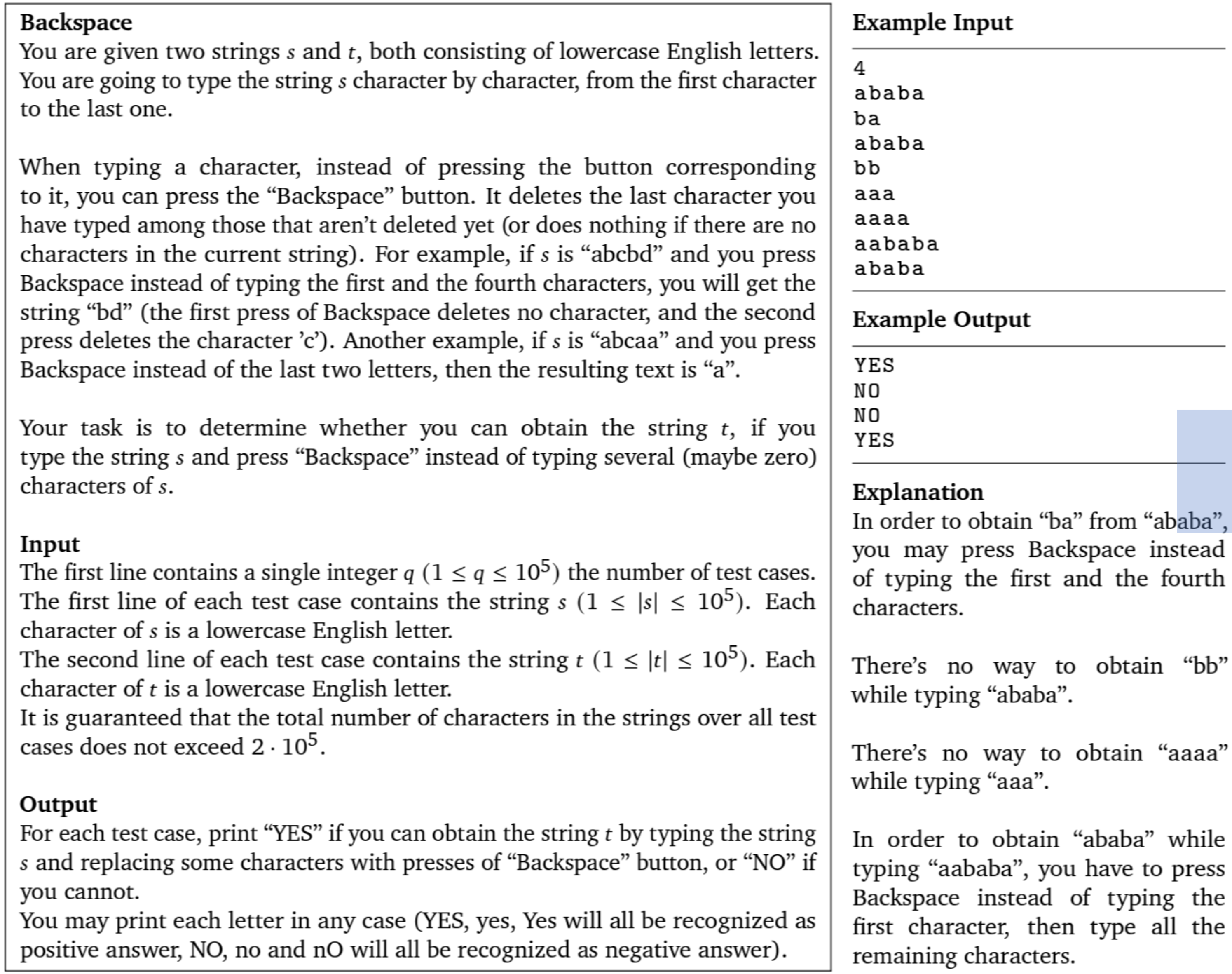
Recycling is NOT good for the world. It is bad for the environment, it is bad for our health, and it is bad for our economy. I’m not kidding. Recycling is not good for the environment. It is destructive to the earth and it is a major contributor to global warming. Recycling is not good for our health. It contributes to obesity and diseases like heart disease and cancer. Recycling is bad for our economy. It increases the cost of a product, and in turn, the price of everything that is made with that product. Recycling is not good for our nation. We pay a tremendous price for the privilege of having the world’s most advanced and efficient recycling system. Recycling is a huge, colossal waste of time, energy, money, and resources. And THAT is why we need to get back to basics and get back to basics in our recycling efforts. One of the best ways to start is to look at the process of creating a paper product. When you make a paper product, it is basically a long chain of materials. Everything from the raw materials (wood, cardboard, paper, etc.), to the reagents (dyes, solvents, etc.) to the printing equipment (chemicals, glue, paper, ink, etc.), to the packaging, to the packaging materials (mercury, chemicals, etc.) to the processing equipment (heating, cooling, etc.), to the packaging materials, to the packaging materials that are shipped overseas and to the packaging materials that are used in the United States. Each step along the way creates tons of waste that we constantly have to clean up. The process of making a paper product is a very wasteful one. But the end result is something that all of us need to consume. And if we want to keep the recycling process running efficiently, then we really need to think about each and every step that goes into making a paper product.

GPT-2 from OpenAI, Feb 2019

https://openai.com/blog/better-language-models/

Language models

AlphaCode from Google Deepmind, Feb 2022



Backspace

You are given two strings s and t, both consisting of lowercase English letters. You are going to type the string s character by character, from the first character to the last one.

When typing a character, instead of pressing the button corresponding to it, you can press the "Backspace" button. It deletes the last character you have typed among those that aren't deleted yet (or does nothing if there are no characters in the current string). For example, if s is "abcbd" and you press Backspace instead of typing the first and the fourth characters, you will get the string "bd" (the first press of Backspace deletes no character, and the second press deletes the character 'c'). Another example, if s is "abcaa" and you press Backspace instead of the last two letters, then the resulting text is "a".

Your task is to determine whether you can obtain the string t, if you type the string s and press "Backspace" instead of typing several (maybe zero) characters of s.

Input

The first line contains a single integer q ($1 \le q \le 10^5$) the number of test cases.

The first line of each test case contains the string s ($1 \le |s| \le 10^5$). Each character of s is a lowercase English letter.

The second line of each test case contains the string t ($1 \le |t| \le 10^5$). Each character of t is a lowercase English letter.

It is guaranteed that the total number of characters in the strings over all test cases does not exceed $2 \cdot 10^5$.

Output

For each test case, print "YES" if you can obtain the string t by typing the string s and replacing some characters with presses of "Backspace" button, or "NO" if you cannot.

You may print each letter in any case (YES, yes, Yes will all be recognized as positive answer, NO, no and nO will all be recognized as negative answer).

Example Input

```
4
ababa
ba
ababa
bb
aaa
aaaa
aababa
ababa
```

Example Output

```
YES
NO
NO
YES
```

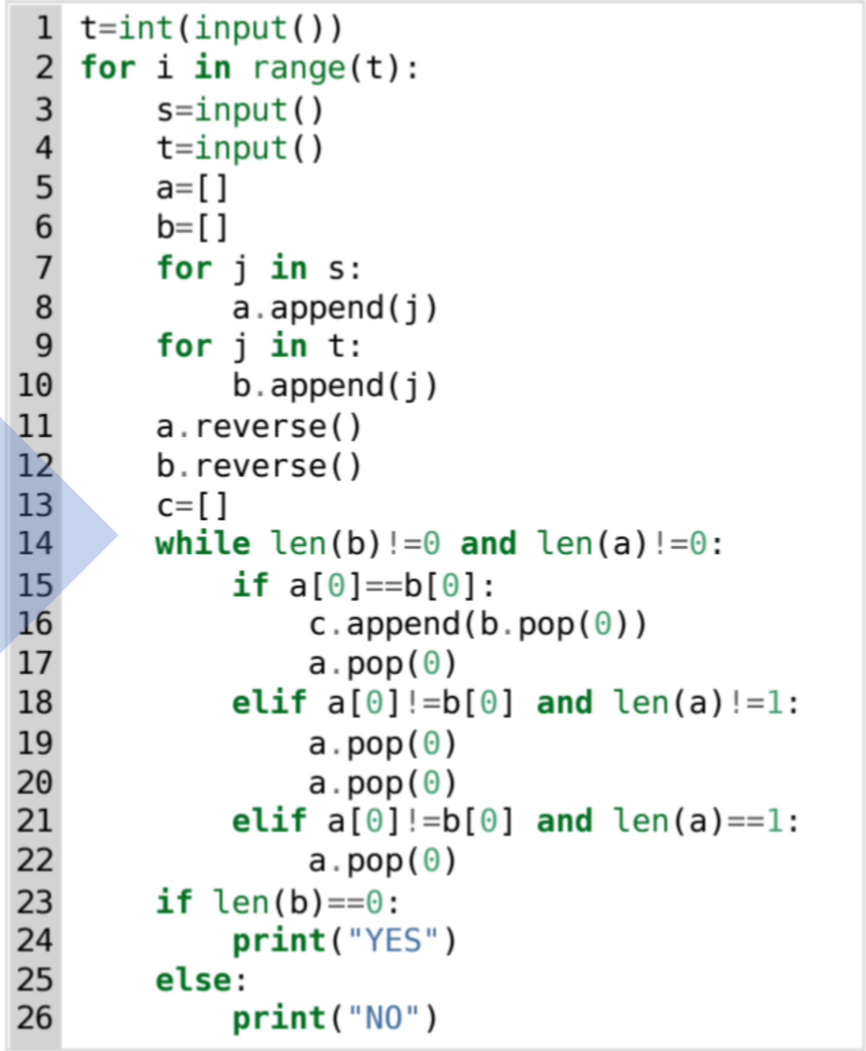
Explanation

In order to obtain "ba" from "ababa", you may press Backspace instead of typing the first and the fourth characters.

There's no way to obtain "bb" while typing "ababa".

There's no way to obtain "aaaa" while typing "aaa".

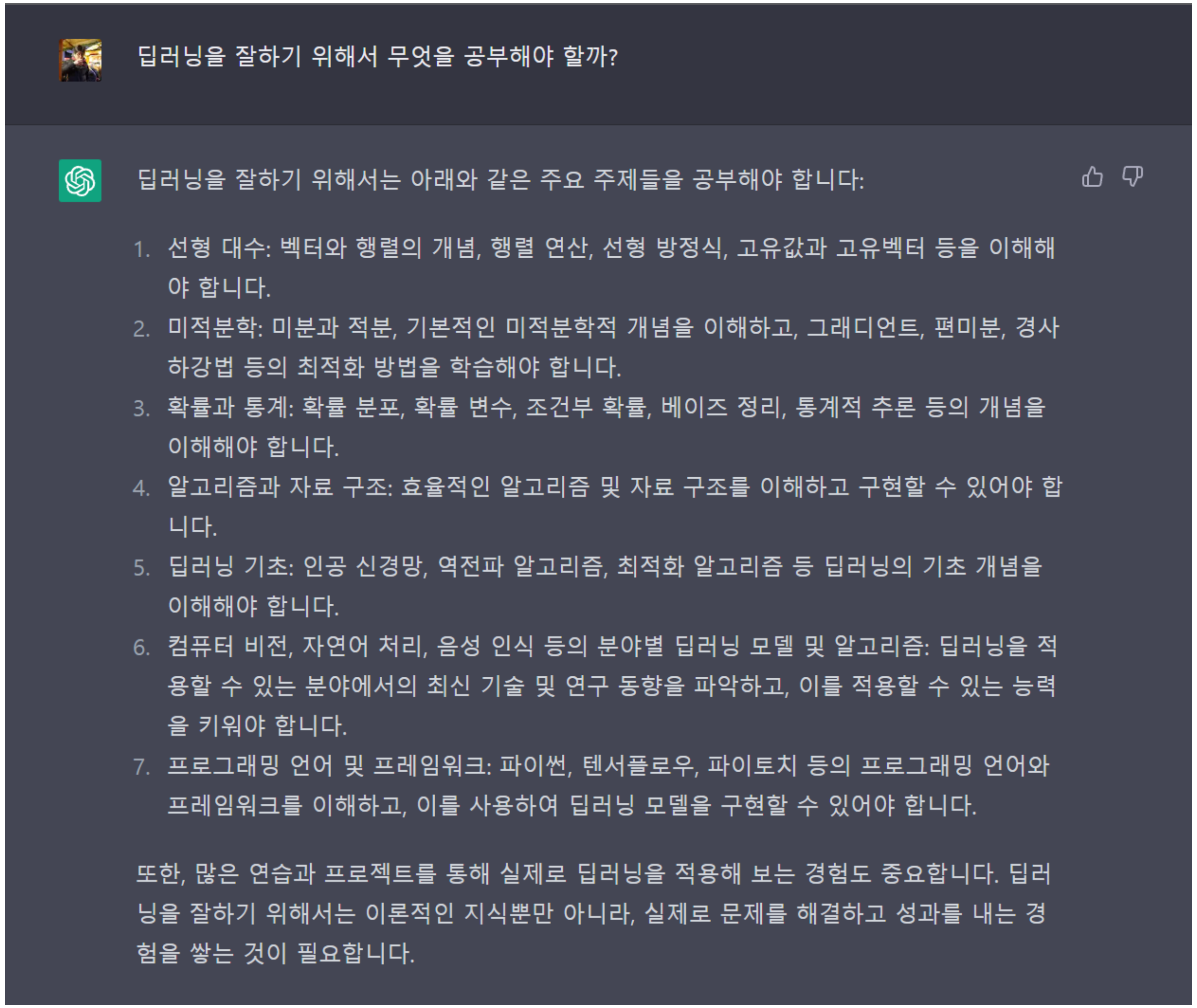
In order to obtain "ababa" while typing "aababa", you have to press Backspace instead of typing the first character, then type all the remaining characters.



```python
t=int(input())
for i in range(t):
    s=input()
    t=input()
    a=[]
    b=[]
    for j in s:
        a.append(j)
    for j in t:
        b.append(j)
    a.reverse()
    b.reverse()
    c=[]
    while len(b)!=0 and len(a)!=0:
        if a[0]==b[0]:
            c.append(b.pop(0))
            a.pop(0)
        elif a[0]!=b[0] and len(a)!=1:
            a.pop(0)
            a.pop(0)
        elif a[0]!=b[0] and len(a)==1:
            a.pop(0)
    if len(b)==0:
        print("YES")
    else:
        print("NO")
```

Language models: ChatGPT

https://chat.openai.com/chat

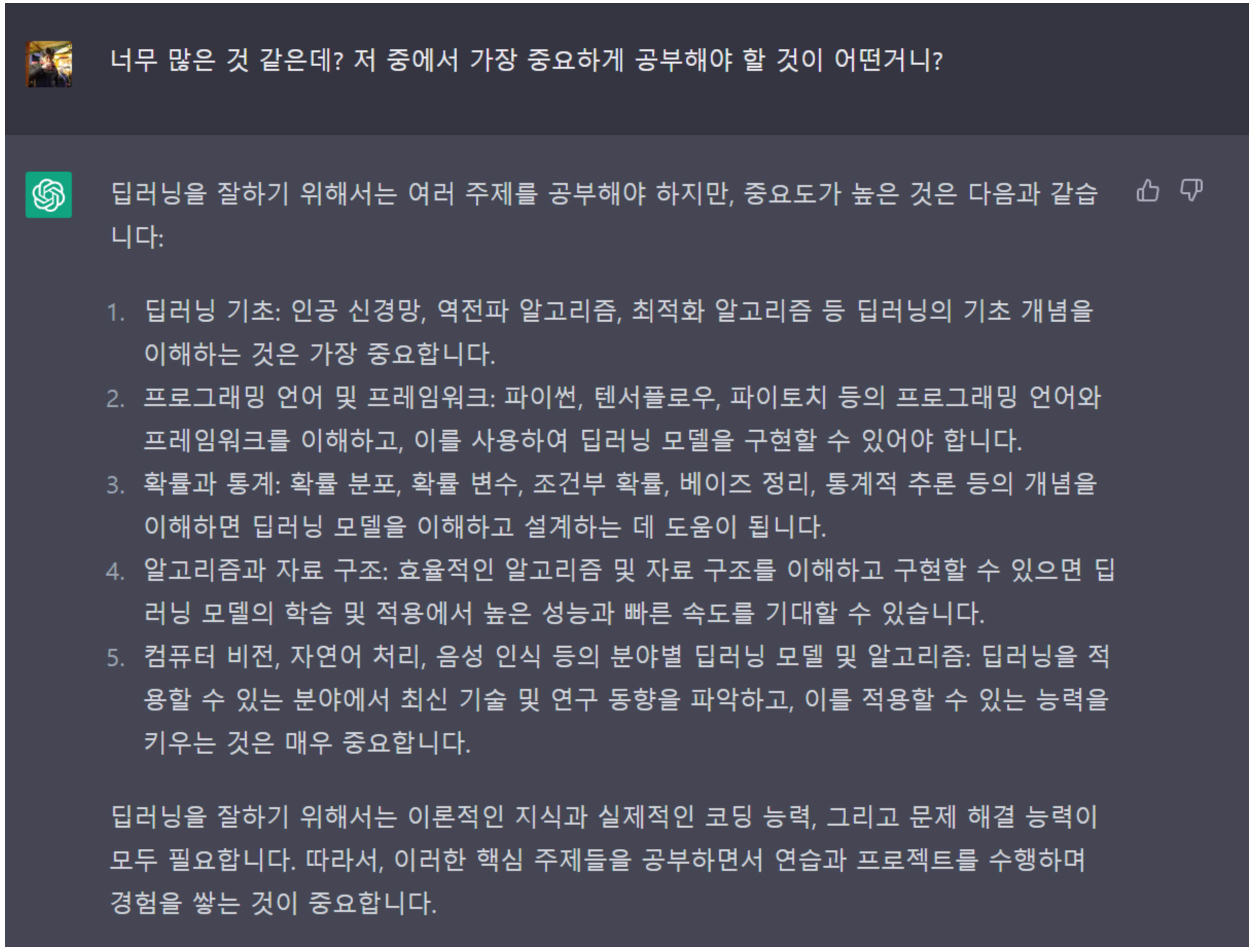


딥러닝을 잘하기 위해서 무엇을 공부해야 할까?

딥러닝을 잘하기 위해서는 아래와 같은 주요 주제들을 공부해야 합니다:

1. 선형 대수: 벡터와 행렬의 개념, 행렬 연산, 선형 방정식, 고유값과 고유벡터 등을 이해해야 합니다.
2. 미적분학: 미분과 적분, 기본적인 미적분학적 개념을 이해하고, 그래디언트, 편미분, 경사하강법 등의 최적화 방법을 학습해야 합니다.
3. 확률과 통계: 확률 분포, 확률 변수, 조건부 확률, 베이즈 정리, 통계적 추론 등의 개념을 이해해야 합니다.
4. 알고리즘과 자료 구조: 효율적인 알고리즘 및 자료 구조를 이해하고 구현할 수 있어야 합니다.
5. 딥러닝 기초: 인공 신경망, 역전파 알고리즘, 최적화 알고리즘 등 딥러닝의 기초 개념을 이해해야 합니다.
6. 컴퓨터 비전, 자연어 처리, 음성 인식 등의 분야별 딥러닝 모델 및 알고리즘: 딥러닝을 적용할 수 있는 분야에서의 최신 기술 및 연구 동향을 파악하고, 이를 적용할 수 있는 능력을 키워야 합니다.
7. 프로그래밍 언어 및 프레임워크: 파이썬, 텐서플로우, 파이토치 등의 프로그래밍 언어와 프레임워크를 이해하고, 이를 사용하여 딥러닝 모델을 구현할 수 있어야 합니다.

또한, 많은 연습과 프로젝트를 통해 실제로 딥러닝을 적용해 보는 경험도 중요합니다. 딥러닝을 잘하기 위해서는 이론적인 지식뿐만 아니라, 실제로 문제를 해결하고 성과를 내는 경험을 쌓는 것이 필요합니다.



너무 많은 것 같은데? 저 중에서 가장 중요하게 공부해야 할 것이 어떤거니?

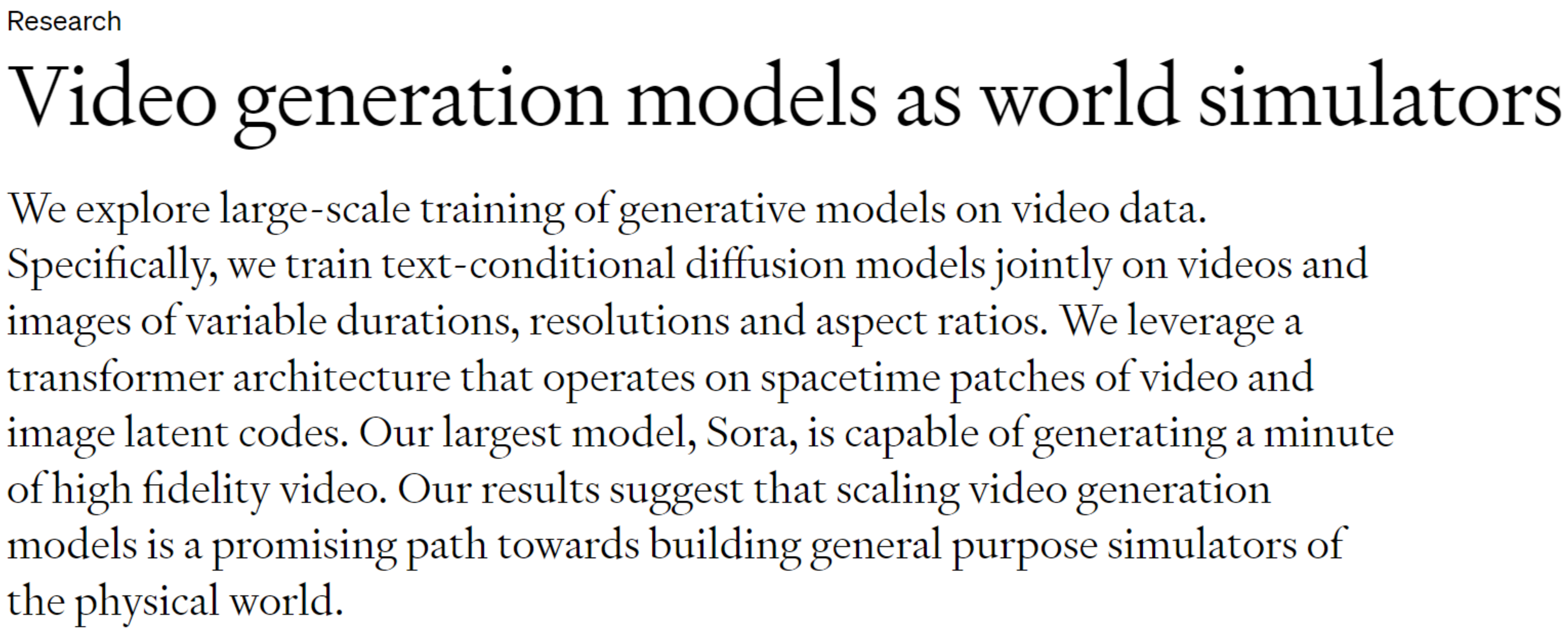
딥러닝을 잘하기 위해서는 여러 주제를 공부해야 하지만, 중요도가 높은 것은 다음과 같습니다:

1. 딥러닝 기초: 인공 신경망, 역전파 알고리즘, 최적화 알고리즘 등 딥러닝의 기초 개념을 이해하는 것은 가장 중요합니다.
2. 프로그래밍 언어 및 프레임워크: 파이썬, 텐서플로우, 파이토치 등의 프로그래밍 언어와 프레임워크를 이해하고, 이를 사용하여 딥러닝 모델을 구현할 수 있어야 합니다.
3. 확률과 통계: 확률 분포, 확률 변수, 조건부 확률, 베이즈 정리, 통계적 추론 등의 개념을 이해하면 딥러닝 모델을 이해하고 설계하는 데 도움이 됩니다.
4. 알고리즘과 자료 구조: 효율적인 알고리즘 및 자료 구조를 이해하고 구현할 수 있으면 딥러닝 모델의 학습 및 적용에서 높은 성능과 빠른 속도를 기대할 수 있습니다.
5. 컴퓨터 비전, 자연어 처리, 음성 인식 등의 분야별 딥러닝 모델 및 알고리즘: 딥러닝을 적용할 수 있는 분야에서 최신 기술 및 연구 동향을 파악하고, 이를 적용할 수 있는 능력을 키우는 것은 매우 중요합니다.

딥러닝을 잘하기 위해서는 이론적인 지식과 실제적인 코딩 능력, 그리고 문제 해결 능력이 모두 필요합니다. 따라서, 이러한 핵심 주제들을 공부하면서 연습과 프로젝트를 수행하며 경험을 쌓는 것이 중요합니다.

Multimodal: Sora

https://openai.com/sora



Research

Video generation models as world simulators

We explore large-scale training of generative models on video data. Specifically, we train text-conditional diffusion models jointly on videos and images of variable durations, resolutions and aspect ratios. We leverage a transformer architecture that operates on spacetime patches of video and image latent codes. Our largest model, Sora, is capable of generating a minute of high fidelity video. Our results suggest that scaling video generation models is a promising path towards building general purpose simulators of the physical world.

Success Factors

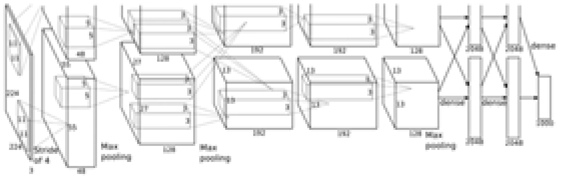
Large scale data,

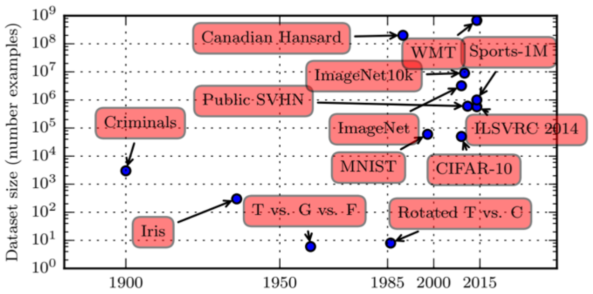
GPU,

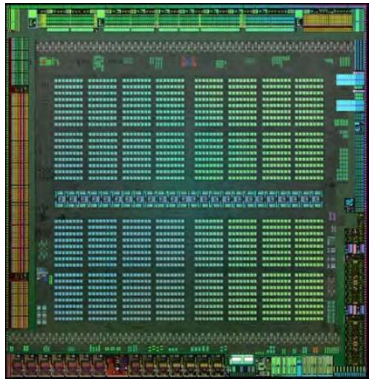
Algorithm

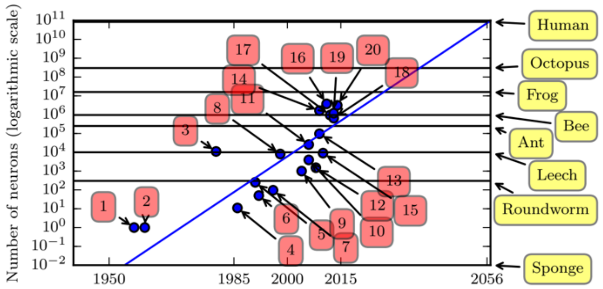
IMAGENET

NVIDIA.




Dataset size (number examples)
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8
10^9
Canadian Hansard
WMT
Sports-1M
ImageNet10k
Public SVHN
Criminals
ImageNet
ILSVRC 2014
MNIST
CIFAR-10
Iris
T vs. G vs. F
Rotated T vs. C




Number of neurons (logarithmic scale)
10^{-2}
10^{-1}
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8
10^9
10^{10}
10^{11}
Human
Octopus
Frog
Bee
Ant
Leech
Roundworm
Sponge