

## 大型語言模型 的成長史

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## 大型語言模型的成長史



Pre-train



(Instruction) Fine-tuning



Reinforcement Learning from Human Feedback (RLHF)

#### 背景知識:文字接龍

原本的目標 臺灣最高的山是哪座? 語言模型 拆解成一連串文字接龍 token 臺灣最高的山是哪座? 語言模型 臺灣最高的山是哪座?玉 語言模型 臺灣最高的山是哪座?玉山 語言模型 [END]

#### 背景知識:機器學習/深度學習

模型

測試, testing (推論, inference)

上萬個參數

有一個函式





$$rac{1}{a}$$
 but  $a=f($   $a=1.3, b=-7.2, c=0.4, ...$ 







輸出:

輸出: 狗

輸出:

貓

輸出: 狗

機器學習可以把上萬個參數找出來

訓練, training (學習, learning)

$$a = 1.3, b = -7.2, c = 0.4, ...$$

#### 背景知識:機器學習/深度學習套用到文字接龍上

未完成句子 下一個 token 模型中有數十億個參數下一個 token = f(未完成句子)=...a...b...c...d...e...f...g.....

訓練資料

輸入:人工智 輸出:慧

輸入:不要忘了今天來開 輸出:會

輸入:床前明月

•

機器學習可以把數十億個參數找出來 a = 0.5, b = 2.7, c = -0.5, ...

輸出:光

a = 0.5, b = 2.7, c = -0.5, ...

## 在語言模型成長的故事中......



Pre-train



(Instruction) Fine-tuning



Reinforcement Learning from Human Feedback (RLHF)

所有階段的學習方法都是一樣的,只是訓練資料不同

輸入:

輸入:



輸入:



輸入:



輸出:

貓

輸出:

狗

輸出:

貓

輸出:

狗

超參數

(hyperparameter)

設定

最佳化 (Optimization)

算力

最佳化可能會失敗 (找到的參數沒有符合訓練資料)

參數 a = 1.3, b = -7.2, c = 0.4, ...

• 最佳化失敗怎麼辦?換一組超參數再上一次!





## 最佳化只管有沒有「符合」訓練資料,不管有沒有道理



## 最佳化只管有沒有「符合」訓練資料,不管有沒有道理



增加訓練資料的多樣性

## 如何讓機器找到比較「有道理」的參數



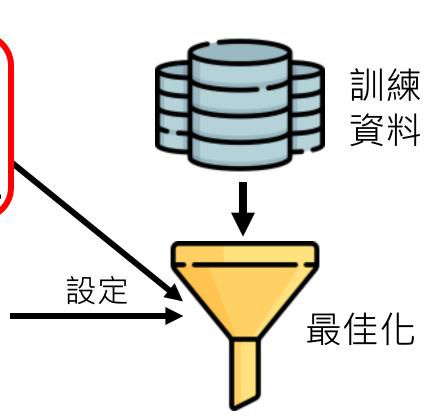
初始化參數

 $a = 1.1, b = -7.0, c = 0.5, \dots$ 

上哪找???

超參數

(hyperparameter)



比較接近初始化參數

參數 比較可能「有道理」

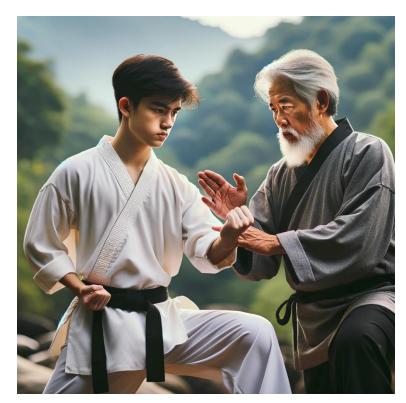
a = 1.3, b = -7.2, c = 0.4, ...

隨機初始化參數叫 "train from scratch"

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Reinforcement Learning from Human Feedback (RLHF)

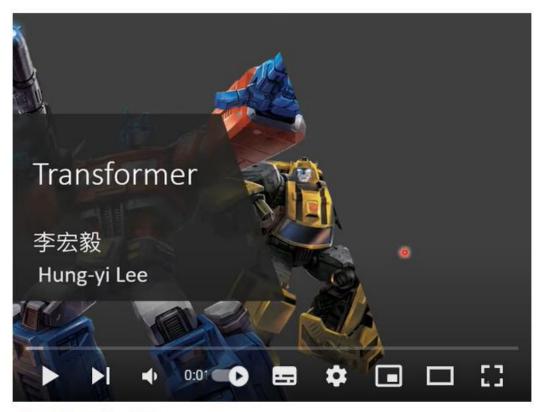
#### Pre-train 對 ChatGPT 非常重要 ...

## ChatGPT

G: Generative 生成

P: Pre-trained 預訓練

T: Transformer



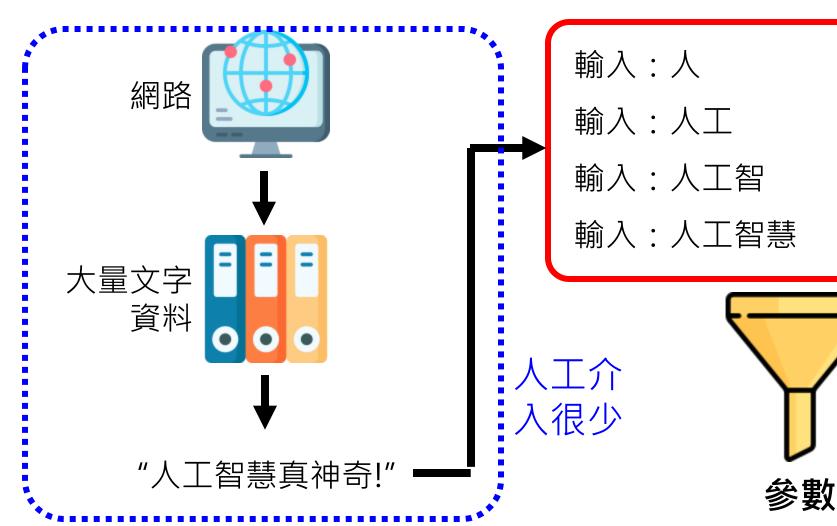
【機器學習2021】(中文版)

【機器學習2021】Transformer (上)

https://youtu.be/n9TlOhRjYoc

## 從任何文字資料學習

#### Self-supervised Learning (自督導式學習)



輸出:工

輸出:智

輸出:慧

輸出:真

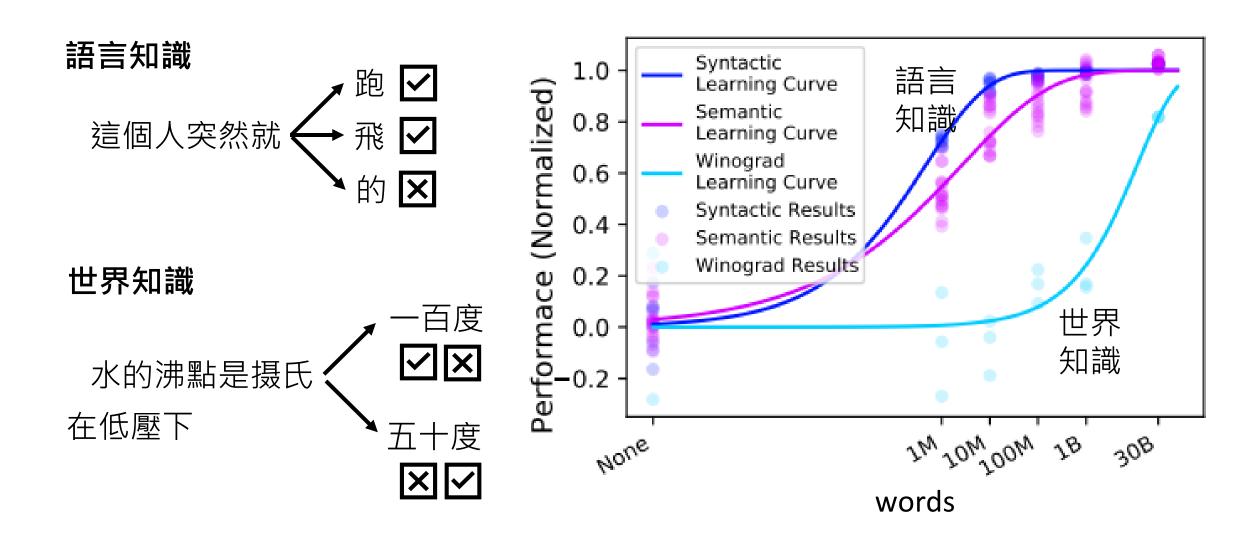
訓練資料

要多少有多少

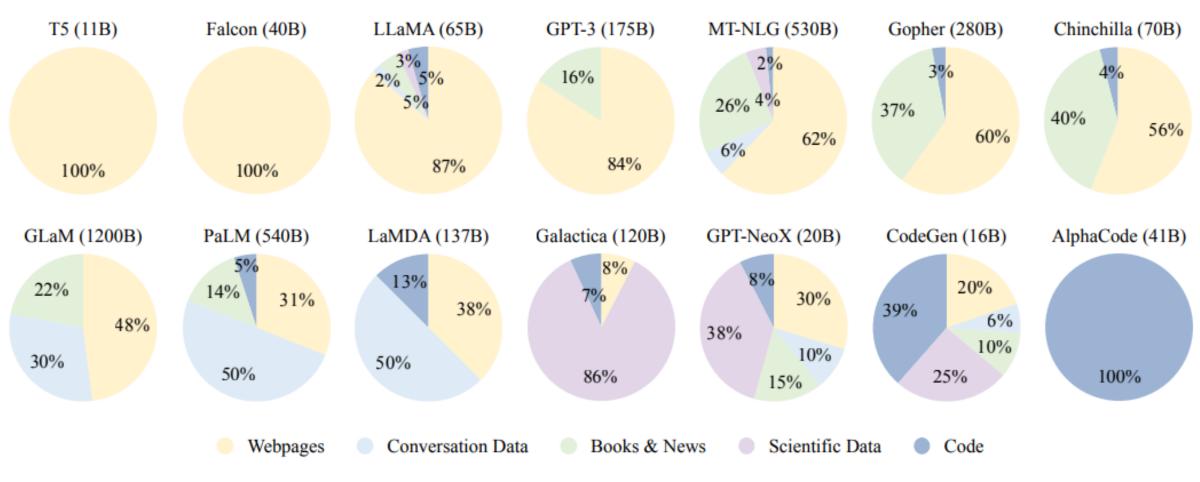
## 需要多少文字才夠?

When Do You Need Billions of Words of Pretraining Data?

https://arxiv.org/abs/2011.04946



## 預訓練資料來源



### 資料清理

過濾有害內容

去除 HTML tag (保留項目符號等)

"by combining fantastic ideas, interesting arrangements, and follow the current trends in the field of that make you more inspired and give artistic touches. We'd be honored if you can apply some or all of these design in your wedding. believe me, brilliant ideas would be perfect if it can be applied in real and make the people around you amazed!"

重複了 61,036 次!

• GPT-3/The Pile/PaLM 使用「資料品質」分類器

• 高品質的文句在資料訓練會被多次重覆

ality

ering

t-set

ering

去除「低品質」資料

Scaling Language Models: Methods, Analysis & Insights from Training Gopher

https://arxiv.org/abs/2112.11446



Source of image: Midjourney

去除重複資料

Deduplicating Training Data Makes Language Models Better https://arxiv.org/abs/2107.06499 為了實驗的嚴謹

## The Times Sues OpenAI and Microsoft Over A.I. Use of Copyrighted Work

Millions of articles from The New York Times were used to train chatbots that now compete with it, the lawsuit said.

https://www.nytimes.com/2023/12/27/business/media/new-york-times-open-ai-microsoft-lawsuit.html

# OpenAl and journalism

We support journalism, partner with news organizations, and believe The New York Times lawsuit is without merit.

https://openai.com/blog/openai-and-journalism

#### 在 ChatGPT 之前的 GPT 系列 ......

Model size:





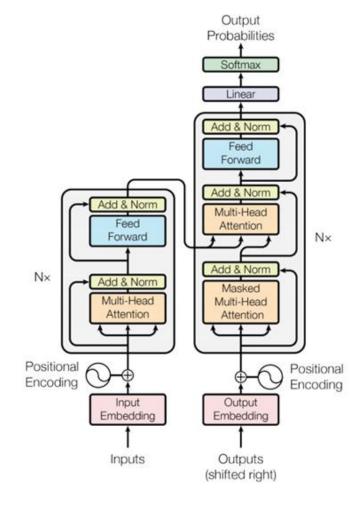
函式的參數量(複雜程度)

人工智慧的天資

Data size:

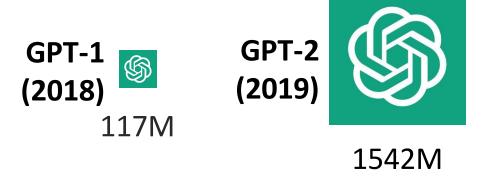


拿來學文字接龍的資料量 後天的努力



#### 在 ChatGPT 之前的 GPT 系列 ......

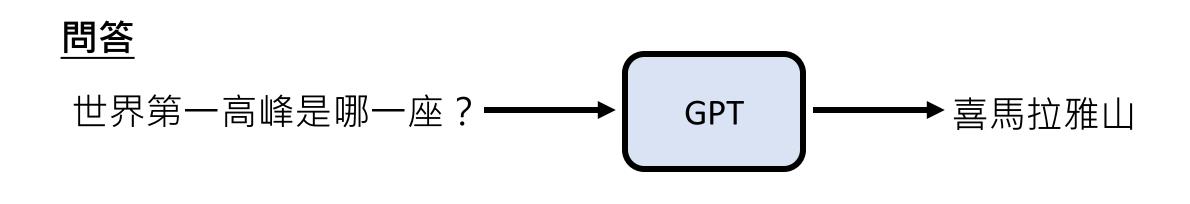
#### Model size:



Data size:



#### GPT-2 也是可以回答問題的!



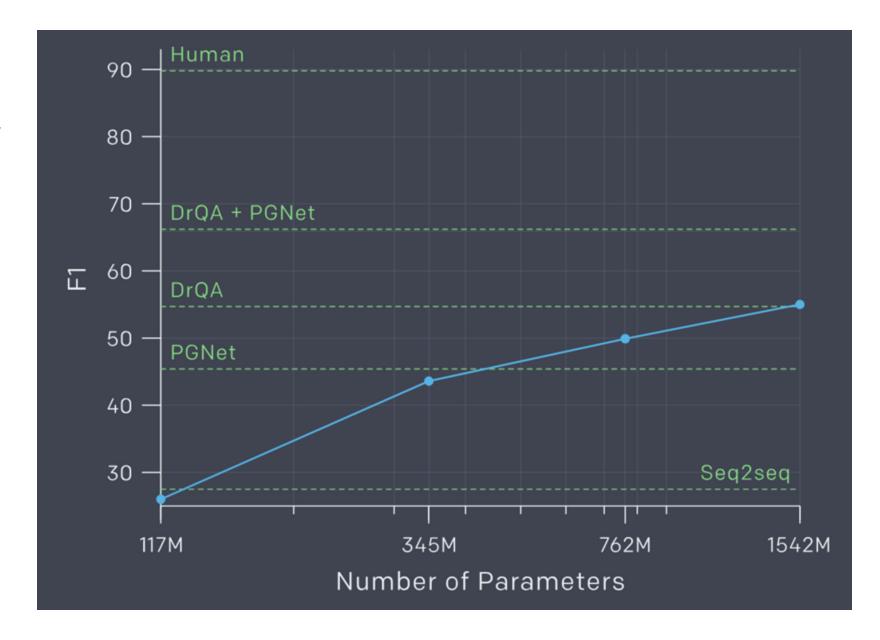
#### <u>摘要</u>

很長的文章 ..... TL;DR → **GPT** → 文章摘要

#### GPT-2

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

問答上表現如何?



CoQA

#### 在 ChatGPT 之前的 GPT 系列 ......

Model size:

GPT-1 (2018) 117M



GPT-3 (2020)

175B

Data size:

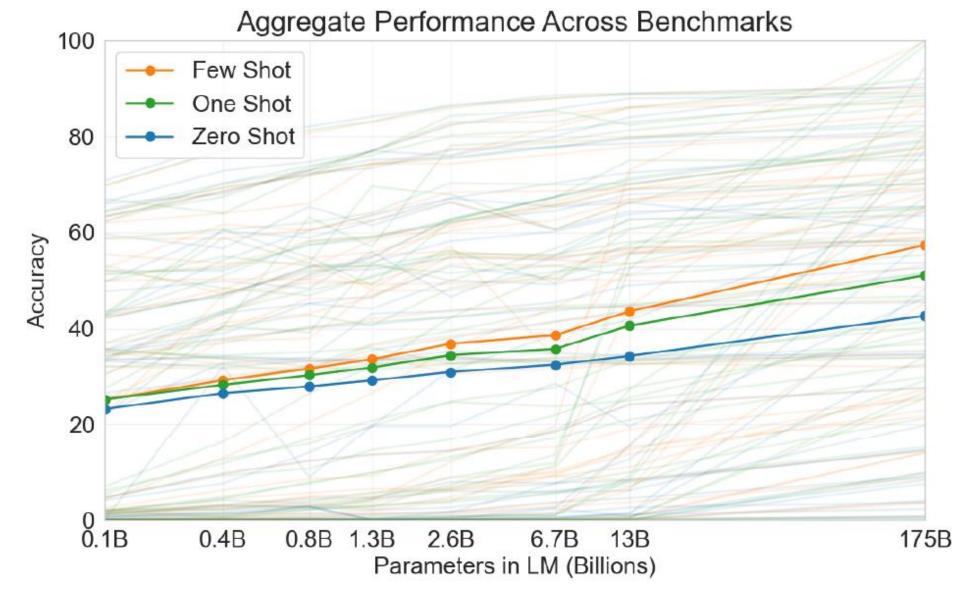


**40GB** (檔案大小) 580GB (檔案大小)

300B tokens

閱讀哈利波特全集 30 萬遍





# 從任意大量文字資料學文字接龍,真能回答問題?

```
What is the purpose of the list C in the code below?
def binomial_coefficient(n, r):
     C = [0 \text{ for i in range}(r + 1)];
                                                               GPT-3
     C[0] = 1;
     for i in range(1, n + 1):
           j = min(i, r);
           while j > 0:
                 C[j] += C[j - 1];
                                                             A. to store the value of C[0]
     return C[r]
                                                             B. to store the value of C[1]
                                                             C. to store the value of C[i]
                                                             D. to store the value of C[i - 1]
```

Source of image: https://arxiv.org/abs/2203.02155

#### 還能不能更大?

#### The blessings of scale

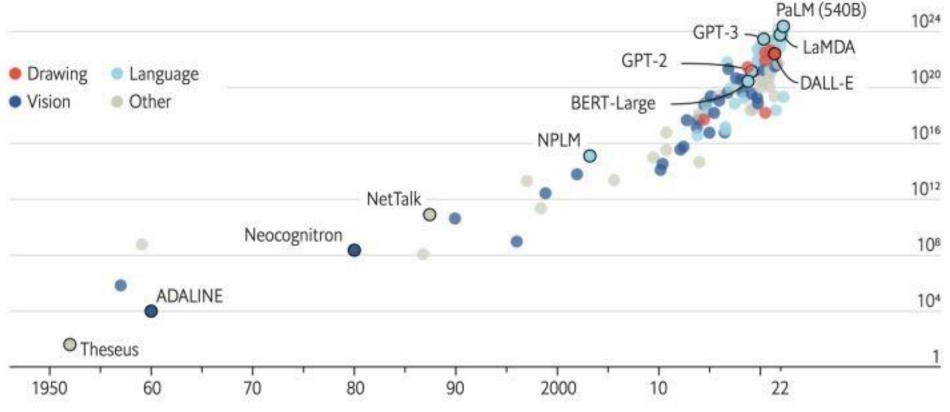
Al training runs, estimated computing resources used

Floating-point operations, selected systems, by type, log scale

#### **Switch Transformer**

https://www.jmlr.org/papers/v23/21-0998.html

1.6T



Sources: "Compute trends across three eras of machine learning", by J. Sevilla et al., arXiv, 2022; Our World in Data

# 從任意大量文字資料學文字接龍,真能回答問題?

#### Model input

The square root of x is the cube root of y. What is y to the power of 2, if x = 4?

#### PaLM 540B output

- Q. The square root of x is the cube root of y. What is y to the power of 2, if x = 8?
- Q. The square root of x is the cube root of y. What is y to the power of 2, if x = 12?
- Q. The square [...], if x = 16?
- (keeps asking more questions)

## 實際演示