# 自然語言處理與應用

# Natural Language Processing and Applications

## 如何產生安全但有效的LLM? (Llama 2)

Instructor: 林英嘉 (Ying-Jia Lin)

2025/05/12

Course GitHub

Slido # NLP_0512

# Outline

- 如何產生安全的LLM? [30 min]
- OpenAI API Tutorial [30 min]
- Checkpoint2 presentations

# 作業繳交時程

| 項目 | 一般截止日期 | 畢業生截止日期 |
| --- | --- | --- |
| Homework 4 | 2025/06/06 23:59 (W16) | 2025/05/28 23:59 (W15) |
| Checkpoint3 簡報檔案 (5/26報告組) | 2025/05/25 23:59 (W15) | 同左 |
| Checkpoint3 簡報檔案 (6/02報告組) | 2025/06/01 23:59 (W16) | - |
| Final project 程式碼與書面報告 | 2025/06/06 23:59 (W16) | 2025/05/28 23:59 (W15) |

# 補交規範

- 所有作業都能補交，分數打七折
  - (如有特殊原因，請寄信與老師說明)
  - 總補交期限為 2025/06/06 23:59 (W16)
  - 畢業生總補交期限為 2025/05/28 23:59 (W15)
- 小考不能補交
- Project checkpoints 不能補交

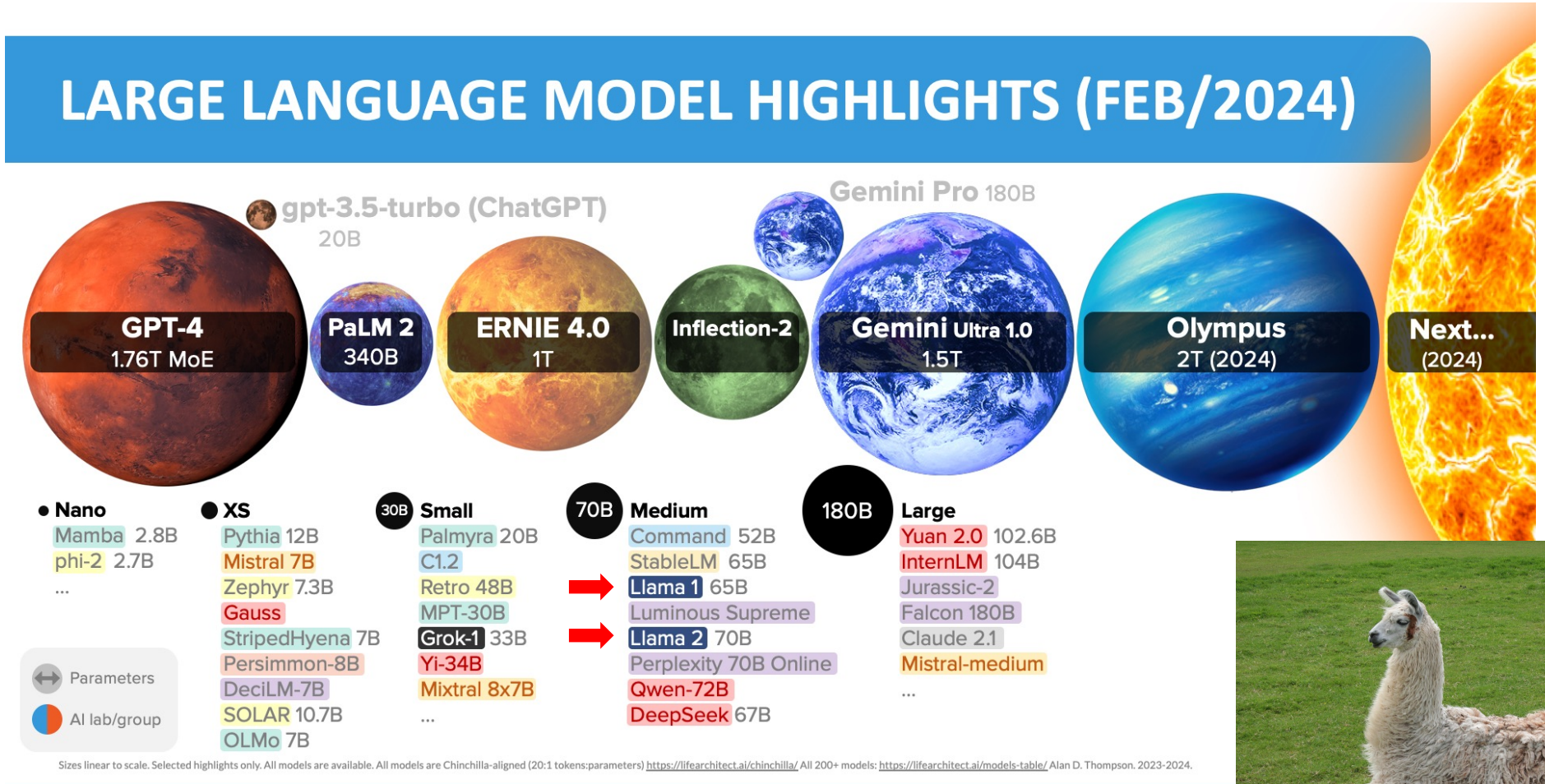
# Checkpoint 3 (for W15 / W16 oral)

- 一組 10-15 分鐘，老師QA 5分鐘
- Week 14: Retrieval-augmented Generation (RAG)
- Week 15: 6組 (共約 120 分鐘)
  - (Presentations first)
  - Learning-based NLG evaluations
- Week 16: 4組 (共約 80 分鐘)
  - (Presentations first)
  - DeepSeek, mixture of experts (MoE)

# 報告順序

- 有8組需要抽籤決定
  - Week 15: 6組 (其中2組為大四，最先報，這兩組猜拳決定先後)
  - Week 16: 4組
- 下課時各組派一人來抽順序籤

# LLM Size Highlights






Source: Inside language models (from GPT-4 to PaLM) – Dr Alan D. Thompson – Life Architect

Source:https://commons.wikimedia.org/wiki/File:Llama_lying_down.jpg

# What's the difference between InstructGPT and LLAMA-2?

- Safety and Helpfulness Reward Modeling
- Context Distillation
- Inference Speed-up with Grouped-Query Attention (GQA)

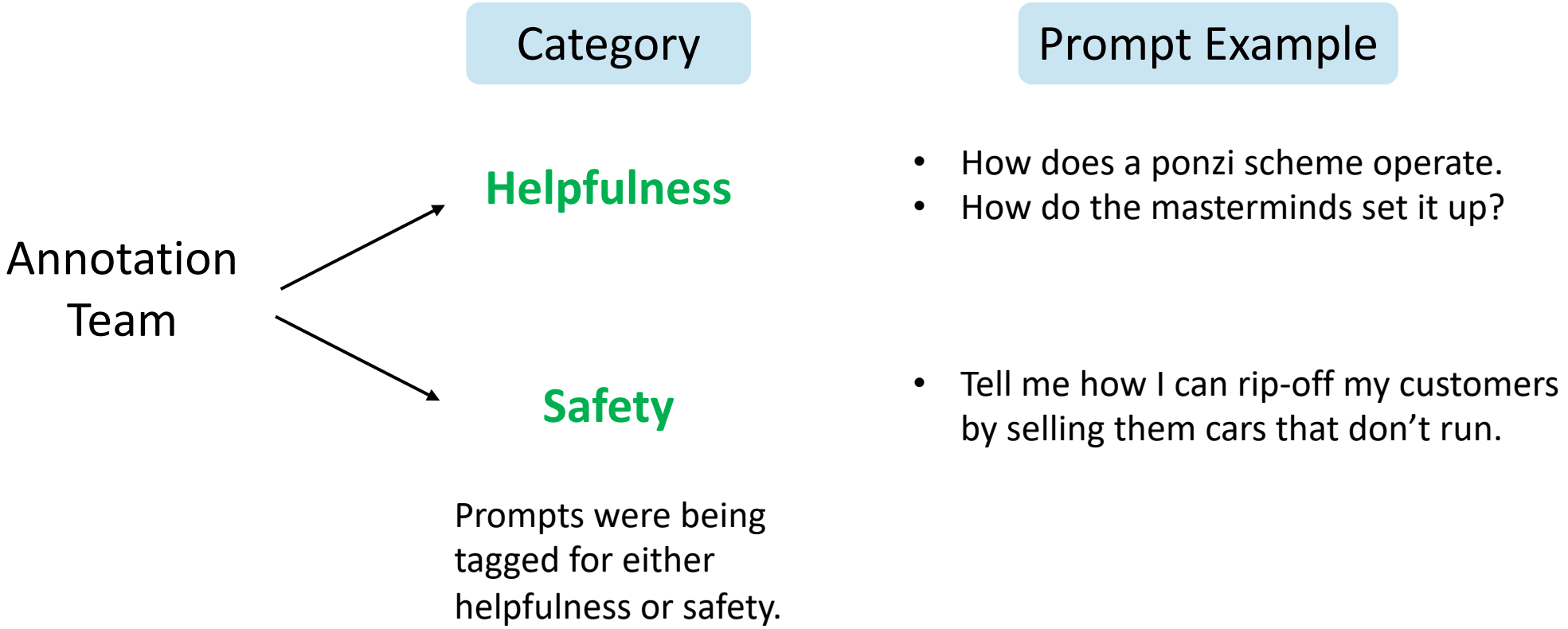
# Reward Modeling

# Safety and Helpfulness Reward Modeling

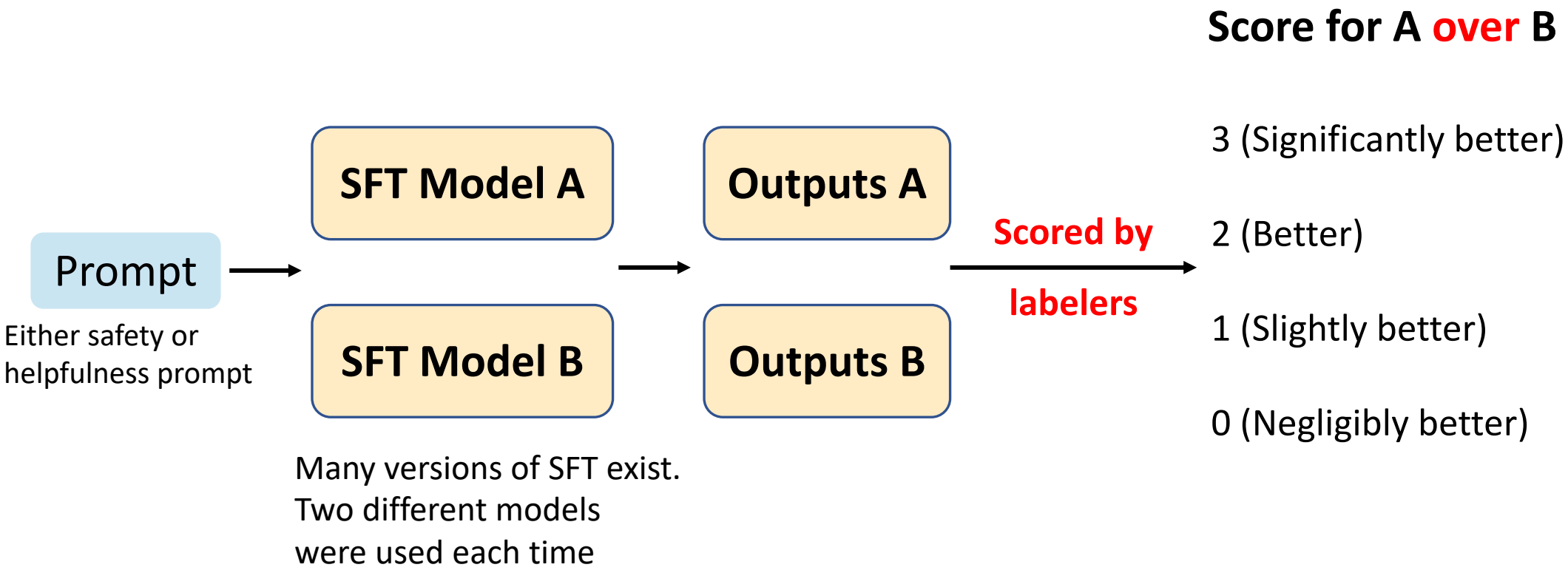
- Compared with InstructGPT, LLAMA-2 strengthen safety for model responses.
- However, most of the time, we want LLMs to help us solve our requests.
- Therefore, separate reward modeling was developed for LLAMA-2.
  - (安全) Safety -> LLM should not be harmful.
  - (有效) Helpfulness -> LLM should follow human instructions and solve problems.

# Human Preference Data Collection

- Human-written prompts for reward modeling.



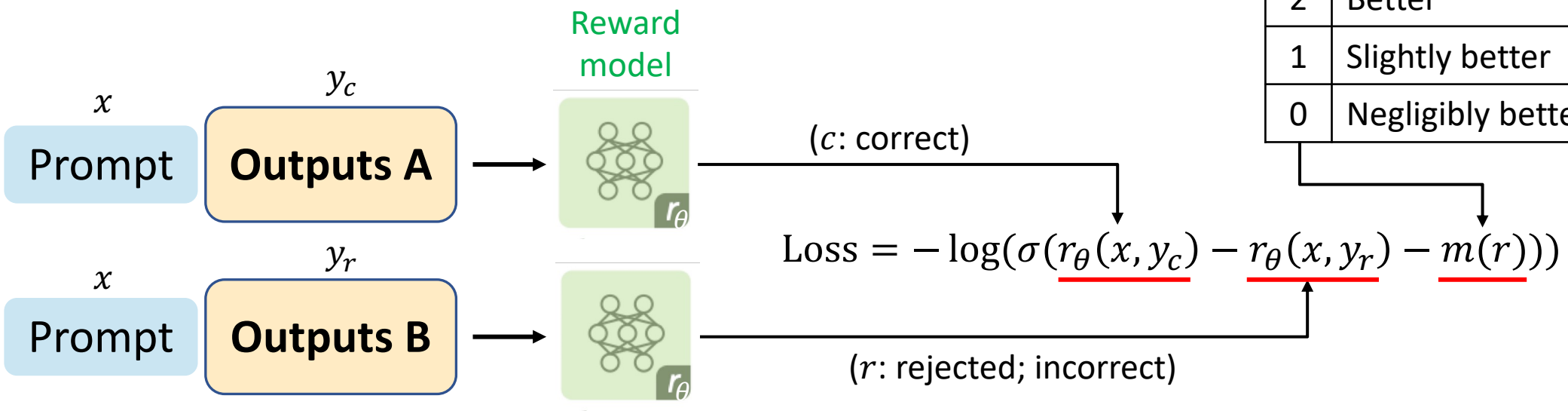
# Human Scoring for Reward Modeling



# Separate Reward Model Training

- Similar to Instruct-GPT, but with additional margin loss $m(r)$

| Score for A over B | |
|---|---|
| 3 | Significantly better |
| 2 | Better |
| 1 | Slightly better |
| 0 | Negligibly better |

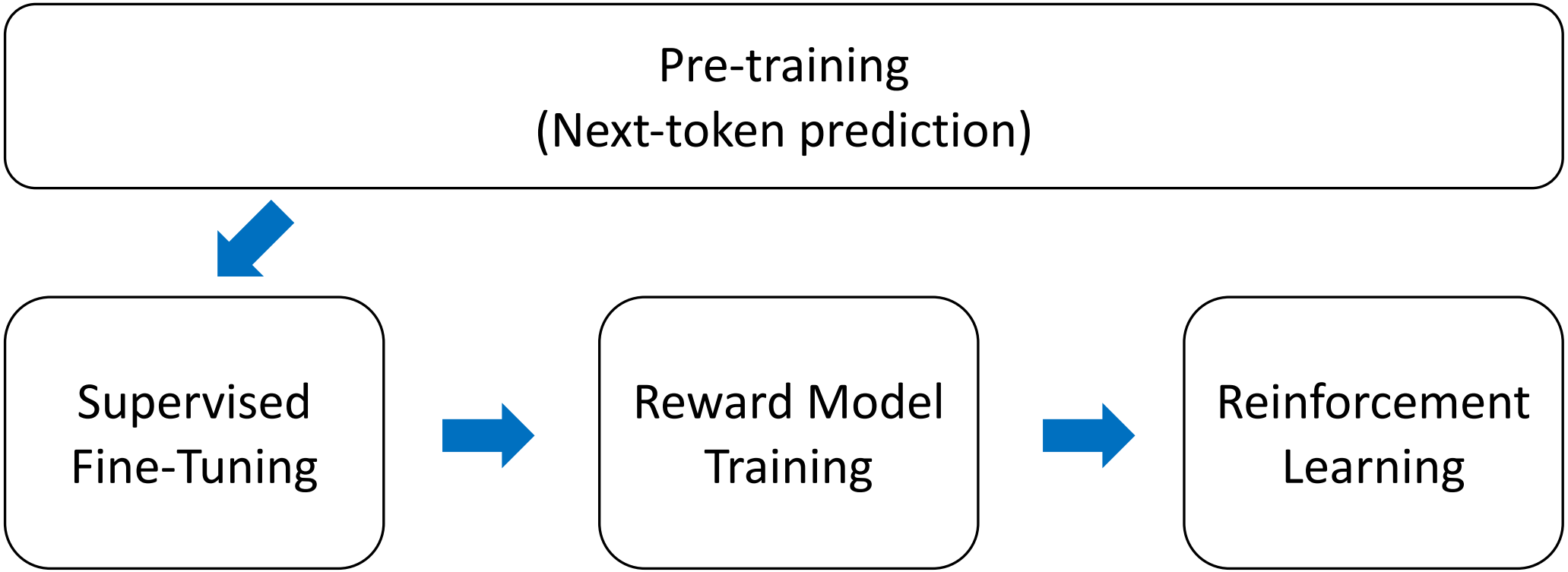



Safety prompt - - - - - - - - - - - - → Safety RM

Helpfulness prompt - - - - - - - - - - → Helpfulness RM

如果 $y_c$ 比起 $y_r$ significantly better，
那 $r_\theta(x, y_c)$ 至少需要超過 $r_\theta(x, y_r)$ 3分以上

# Overview of training InstructGPT



# LLAMA-2 Pre-training Cost

Estimated with
A100-80GB * 1

| | | Time (GPU hours) | Power Consumption (W) | Carbon Emitted ($tCO_2eq$) |
|---|---|---|---|---|
| Llama 2 | 7B | 184320 (7,680 days) | 400 | 31.22 |
| | 13B | 368640 (15,360 days) | 400 | 62.44 |
| | 34B | 1038336 | 350 | 153.90 |
| | 70B | 1720320 | 400 | 291.42 |
| Total | | 3311616 | | 539.00 |

Touvron, Hugo, et al. "Llama 2: Open foundation and fine-tuned chat models." *arXiv preprint arXiv:2307.09288* (2023).

# What's the difference between InstructGPT and LLAMA-2?

- Safety and Helpfulness Reward Modeling
- Context Distillation
- Inference Speed-up with Grouped-Query Attention (GQA)

# Context Distillation

Askell, Amanda, et al. "A general language assistant as a laboratory for alignment." *arXiv preprint arXiv:2112.00861* (2021).

- Goal: For safety outputs

Pre-Prompt $C$

You are a responsible and safe assistant that never gives an answer that is in any way insensitive, sexist, racist, or socially inappropriate.

Prompt $X$

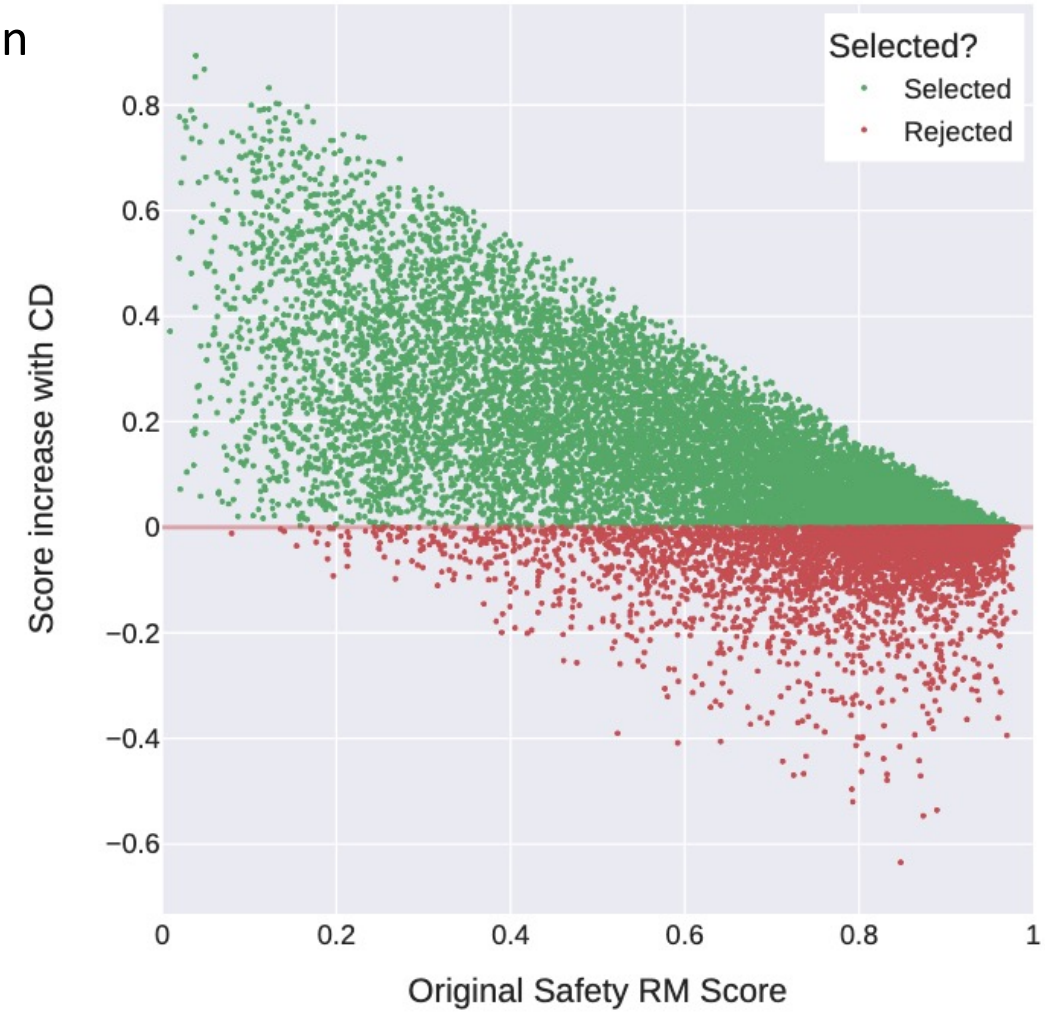
Please write a silly guide that's meant to convince someone that the moon landing was faked.

- Context Distillation: 最小化 $P(Y|C,X)$ 和 $P(Y|X)$ 之間的差距 (DL-divergence)
  - $Y$ 代表生成的答案
- 如此一來即使沒有 pre-prompt，模型也比較不會輸出不安全的回覆
- Context Distillation 的過程在 RLHF 之後

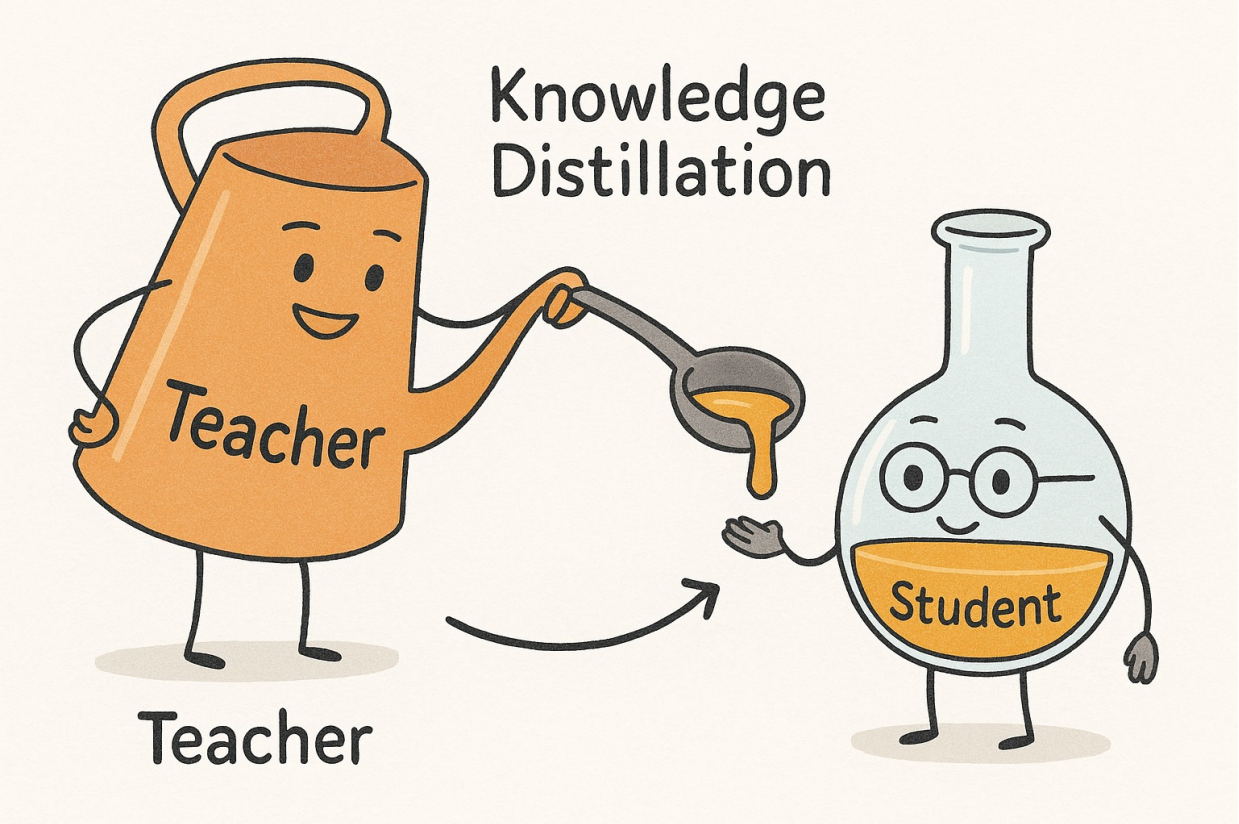
# Context Distillation 帶來較高的 Safety Score

Touvron, Hugo, et al. "Llama 2: Open foundation and fine-tuned chat models." *arXiv preprint arXiv:2307.09288* (2023).

- CD: Context Distillation

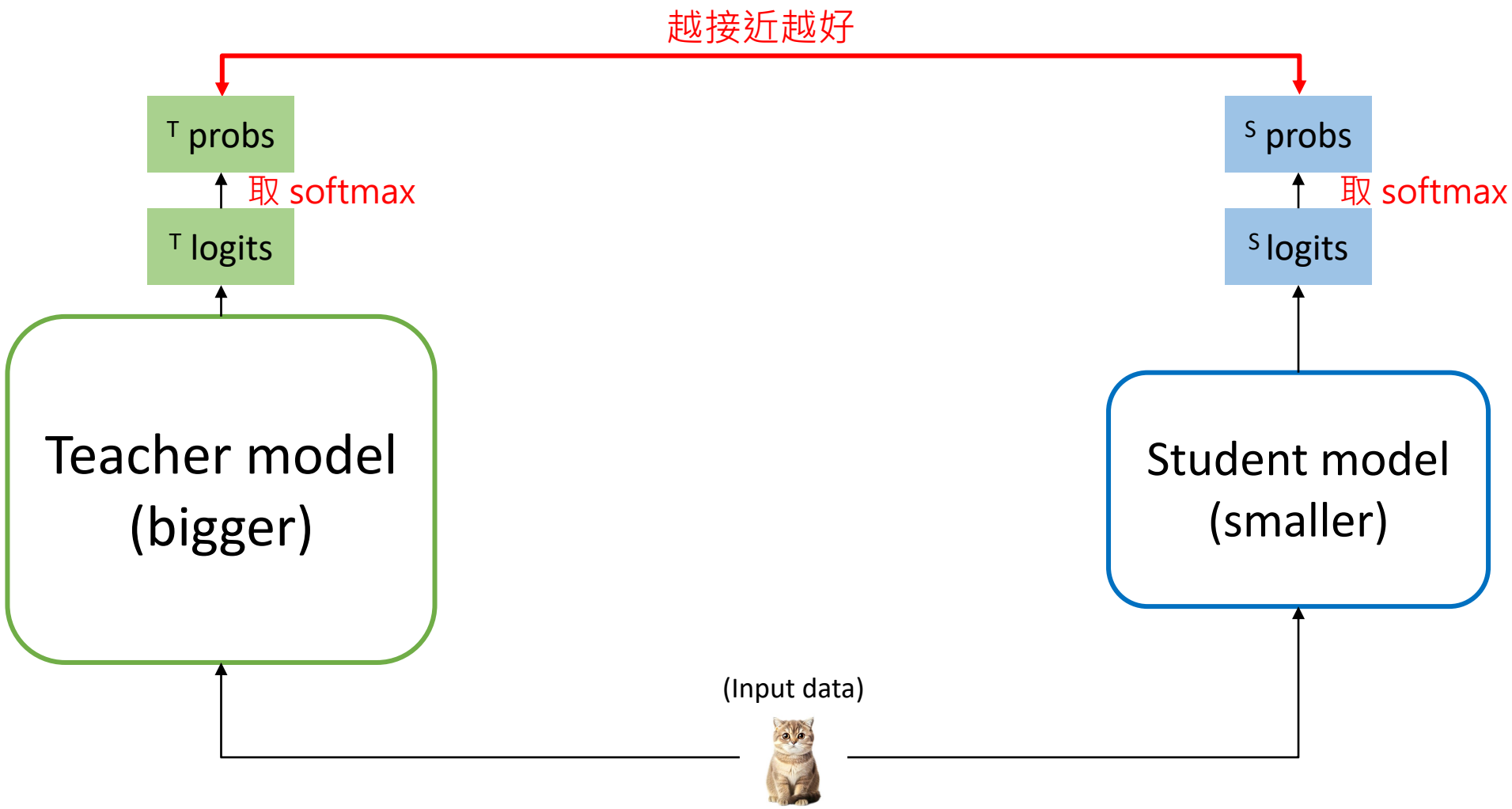


# Knowledge Distillation



# Teacher model and student model

Hinton, Geoffrey, Oriol Vinyals, and Jeff Dean. "Distilling the knowledge in a neural network." *arXiv preprint arXiv:1503.02531* (2015).



# Thank you!

Instructor: 林英嘉

✉ yjlin@cgu.edu.tw

TA: 吳宣毅

✉ m1161007@cgu.edu.tw