Building LLM Applications

Module 7:
Prompt Engineering vs Fine-tuning

Hamza Farooq


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A big Thank you to Giulio

Learning Outcomes

We will be covering topics on:

- What is Prompt Engineering
- Techniques of Prompt Engineering
- Fine-tuning LLMs
- PEFT
- Validation metrics
- Code Walkthrough in fine-tuning models
  - Local LLM
  - ChatGPT

01

Prompt Engineering ?

Prompt Engineering

Prompt engineering involves designing and refining language model prompts to achieve specific desired outputs. It includes crafting prompts that provide clear instructions, context, or constraints to guide the model's responses.

Prompt Engineering

In other words, it involves taking a *prompt* and manipulating it to get a type of desired output.

Adding context to the prompt, output instructions or response constraints are all examples of prompt engineering.

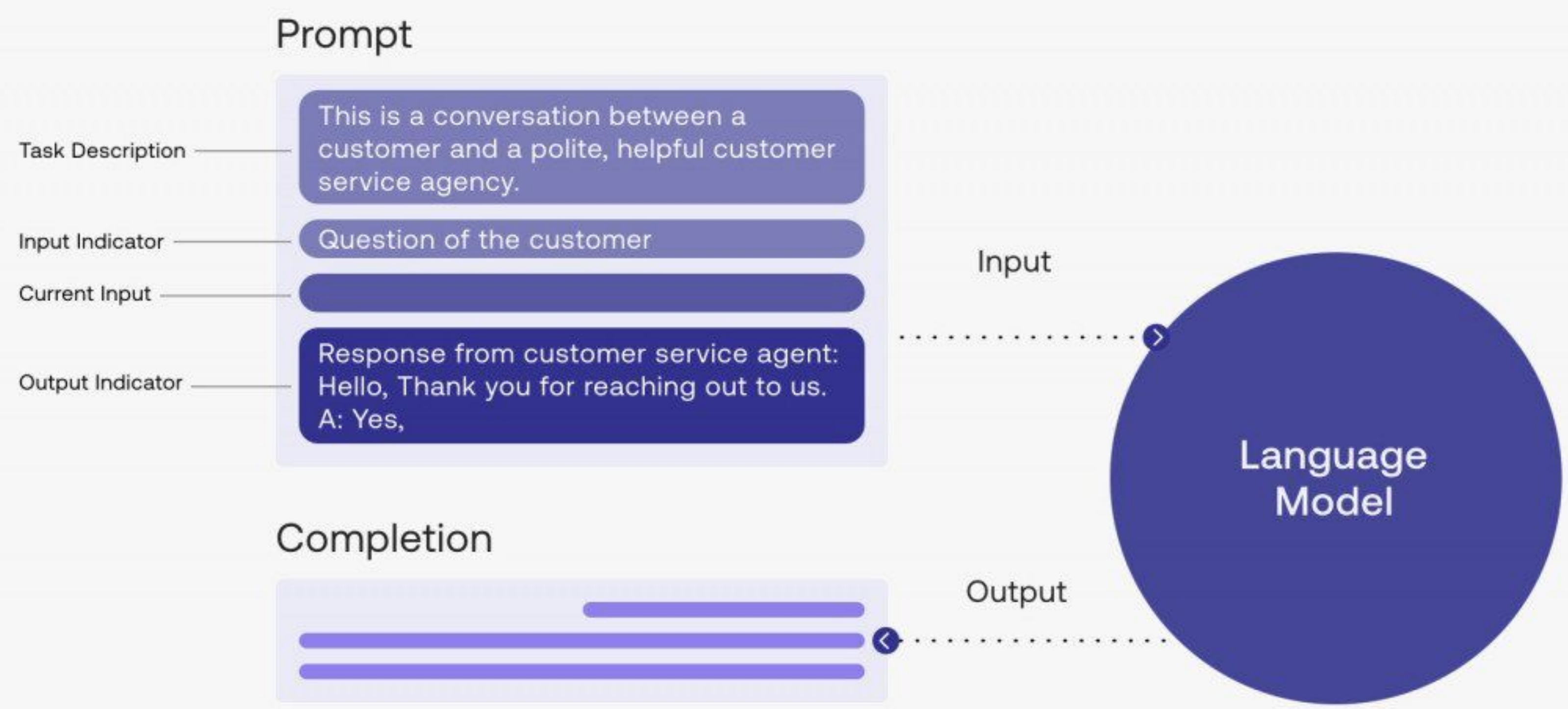

Image: cohere.ai

Prompt engineering is of an more art, than science.

Denny Zhou
@denny_zhou

Prompting seems to be difficult for some machine learning researchers to understand. This is not surprising because prompting in not machine learning. Prompting is the opposite of machine learning.

11:38 AM · Oct 28, 2022 · Twitter Web App

Importance of Prompt Engineering ?

- **Reduces Ambiguity** → Clarifies user intent, leading to more precise and relevant outputs from AI models.

Importance of Prompt Engineering ?

- **Improves User Experience** → Provides users with more accurate and helpful responses, improving satisfaction and engagement.

  Helps users get better answers, boosting their satisfaction and engagement.

Why Prompt Engineering works ?

- LLMs have been trained with extensive data and human annotated prompts.
- Hence when we use prompts to define role, details and intent, it yields better results
- Minimizes misunderstandings and errors by clearly defining the input parameters and expected output.

The Science of Prompt Engineering

Prompt engineering is the art of crafting precise prompts to guide the AI into delivering a desired output.

Importance in Domain Adaptation:

- **Targeted Responses** → Ensures responses are not only accurate but also contextually relevant.
- **Leverage Domain Knowledge** → Incorporates specific terminology and workflows unique to the domain.

The Science of Prompt Engineering

Prompt engineering is the art of crafting precise prompts to guide the AI into delivering a desired output.

Different prompting Strategies:

- **Instruction-based** → Direct and explicit instructions for tasks.
- **Contextual Clues** → Incorporating specific context to guide the AI's focus.

What are some more Advanced Prompt Engineering Techniques?

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- **Zero-shot Prompting** → Utilizing generic prompts without prior examples.

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- **Few-shot Prompting** → Providing a few examples to set a response pattern.

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- **Fine-tuning with Examples** → Intensive example-based training to refine model understanding.

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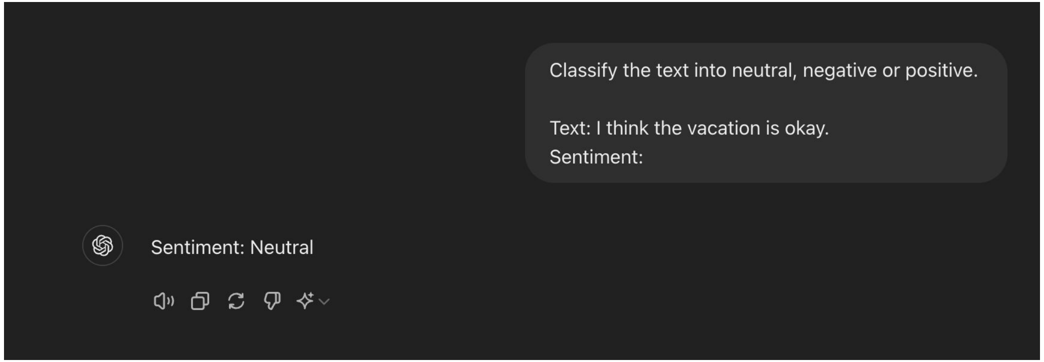
- **Fine-tuning with Examples** → Intensive example-based training to refine model understanding.

Impact of Prompt Engineering → Enhanced model performance, reliability, and domain-specific accuracy.

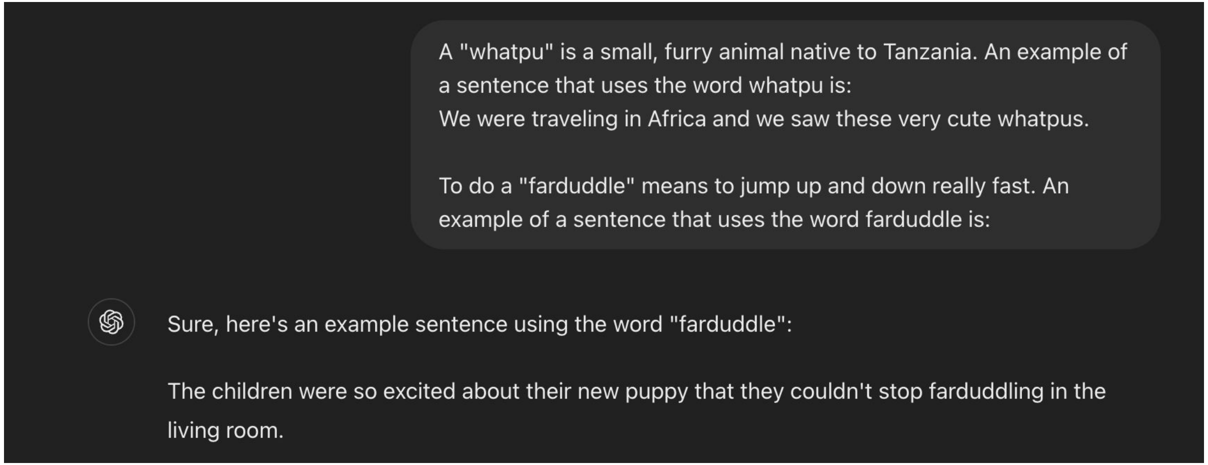
Examples : Zero Shot Prompting

- Large-scale training makes these models capable of performing some tasks in a **"zero-shot"** manner.
- Zero-shot prompting means that the prompt used to interact with the model **won't contain examples** or demonstrations.
- The zero-shot prompt directly instructs the model to perform a task **without any additional examples to steer it**.



Examples: Few Shot Prompting

- Few-shot prompting can be used as a technique to **enable in-context learning** where we provide demonstrations in the prompt to steer the model to better performance.
- The demonstrations serve as **conditioning for subsequent examples** where we would like the model to generate a response.



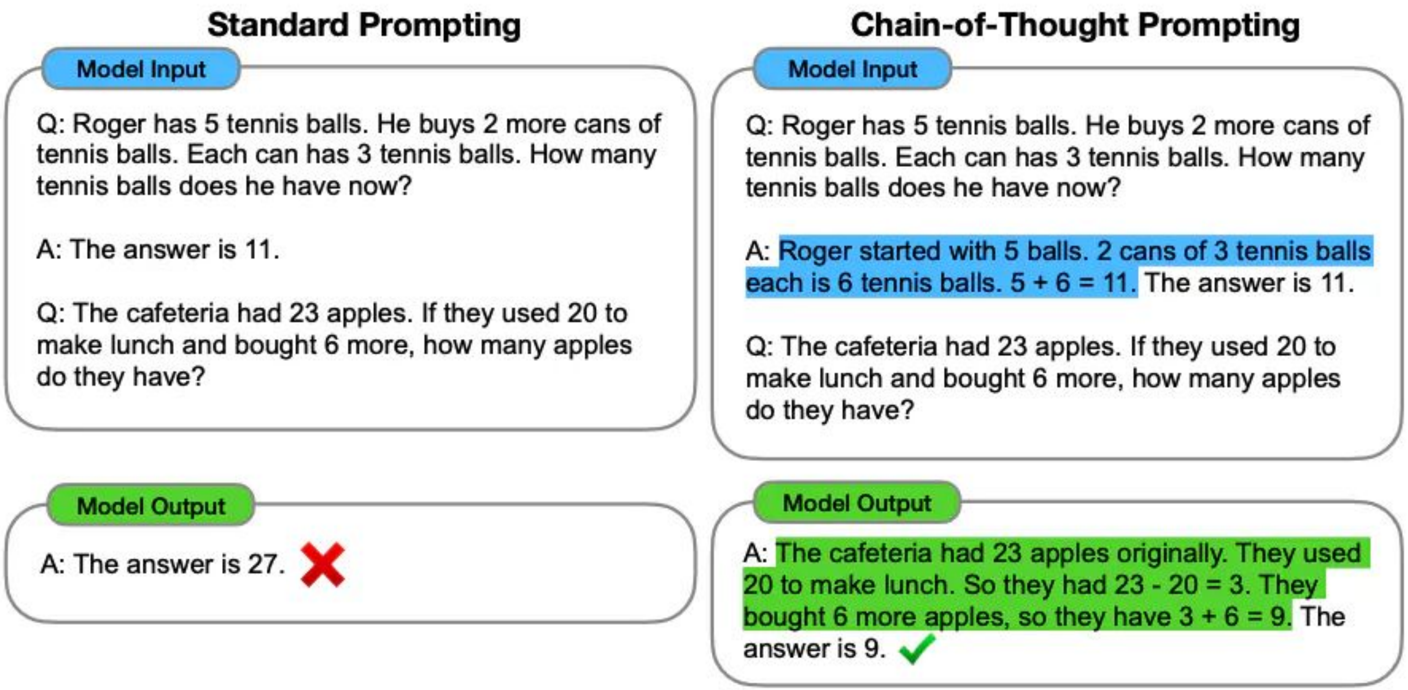
Chain of Thoughts

- chain-of-thought (CoT) prompting enables **complex reasoning capabilities through intermediate reasoning steps**.

- You can **combine it with few-shot prompting** to get better results on more complex tasks that require reasoning before responding.

Source: https://www.promptingguide.ai/techniques/cot

Chain of Thoughts



Source: https://www.promptingguide.ai/techniques/cot

Chain of Thoughts

The odd numbers in this group add up to an even number: 15, 32, 5, 13, 82, 7, 1. True or False ?

True.

The odd numbers in this group add up to an even number: 4, 8, 9, 15, 12, 2, 1.
A: Adding all the odd numbers (9, 15, 1) gives 25. The answer is False.

The odd numbers in this group add up to an even number: 17, 10, 19, 4, 8, 12, 24.
A: Adding all the odd numbers (17, 19) gives 36. The answer is True.

The odd numbers in this group add up to an even number: 16, 11, 14, 4, 8, 13, 24.
A: Adding all the odd numbers (11, 13) gives 24. The answer is True.

The odd numbers in this group add up to an even number: 17, 9, 10, 12, 13, 4, 2.
A: Adding all the odd numbers (17, 9, 13) gives 39. The answer is False.

The odd numbers in this group add up to an even number: 15, 32, 5, 13, 82, 7, 1.
A:

Adding all the odd numbers (15, 5, 13, 7, 1) g s 41. The answer is False.

Source: https://www.promptingguide.ai/techniques/cot

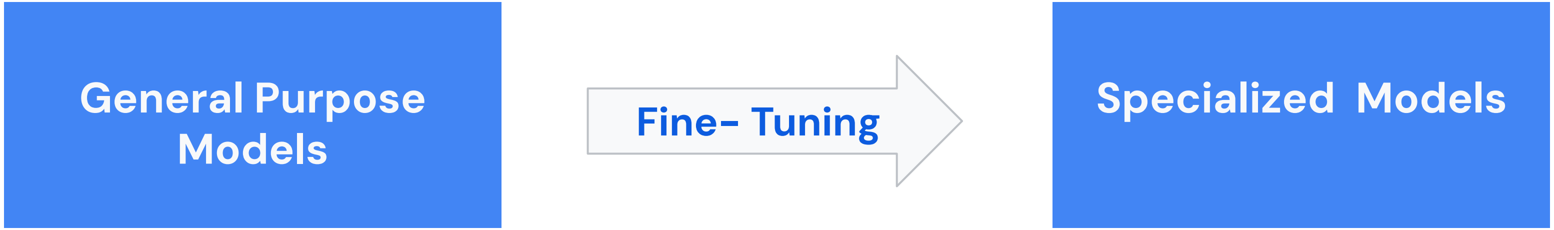
02

Why Fine-tuning ?

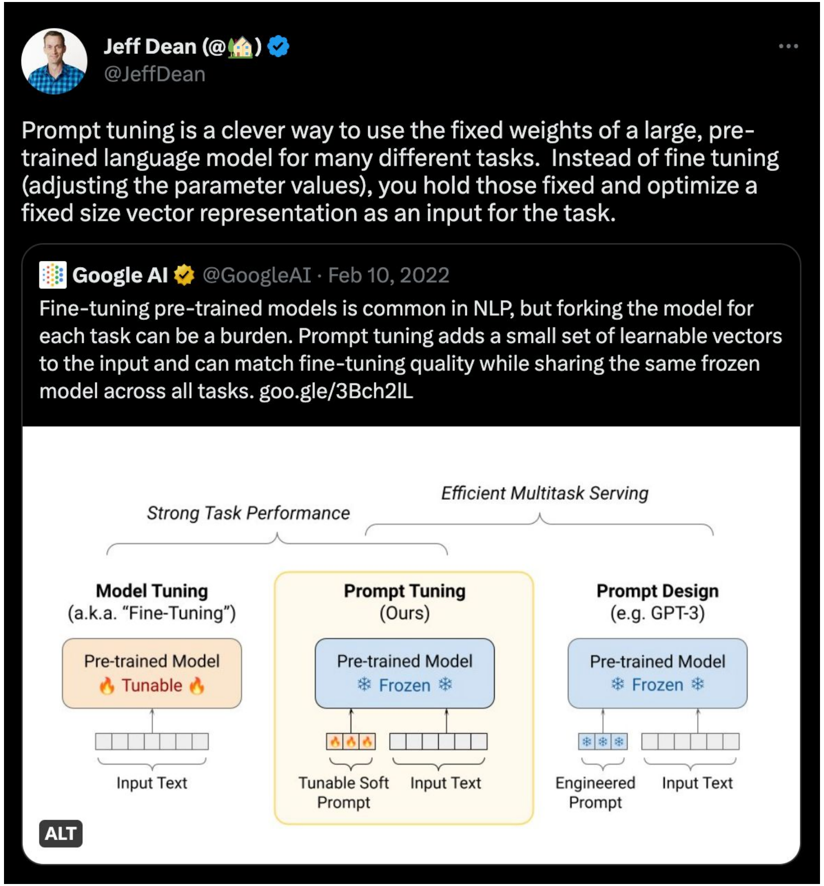
What is LLM Fine-Tuning?

- Fine-tuning is the process of adjusting the parameters of a pre-trained large language model to a specific task or domain

- The amount of fine-tuning required depends on the complexity of the task and the size of the dataset

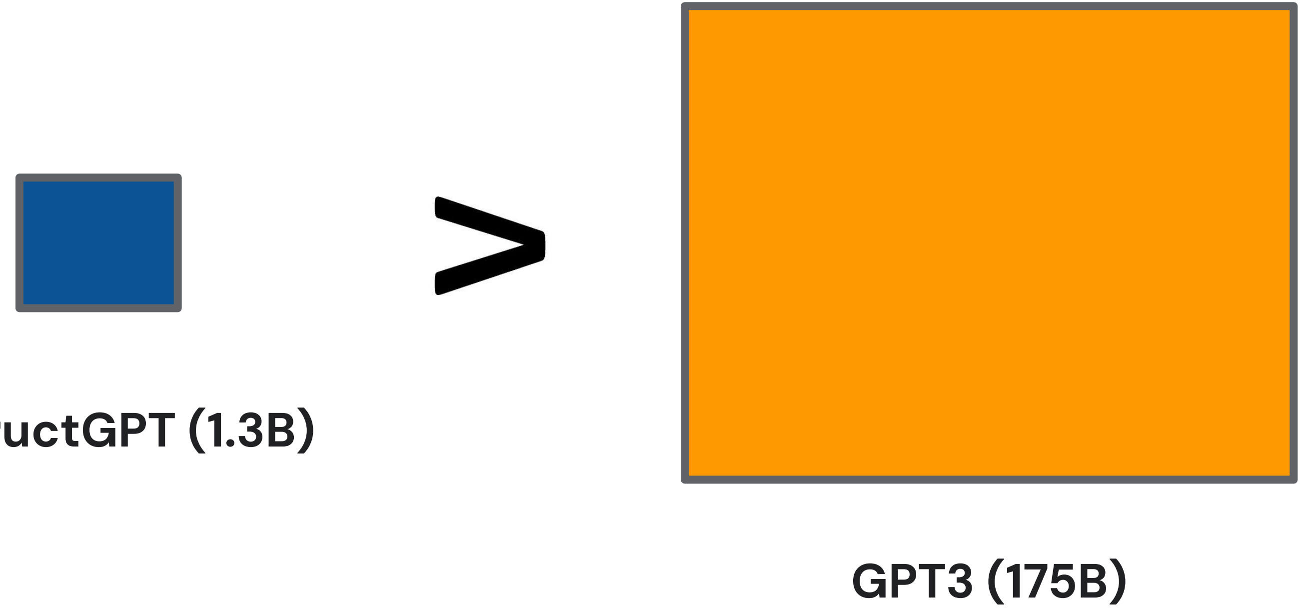


Fine-tuning involves updating a language model's parameters, while prompt engineering entails temporary learning during inference.



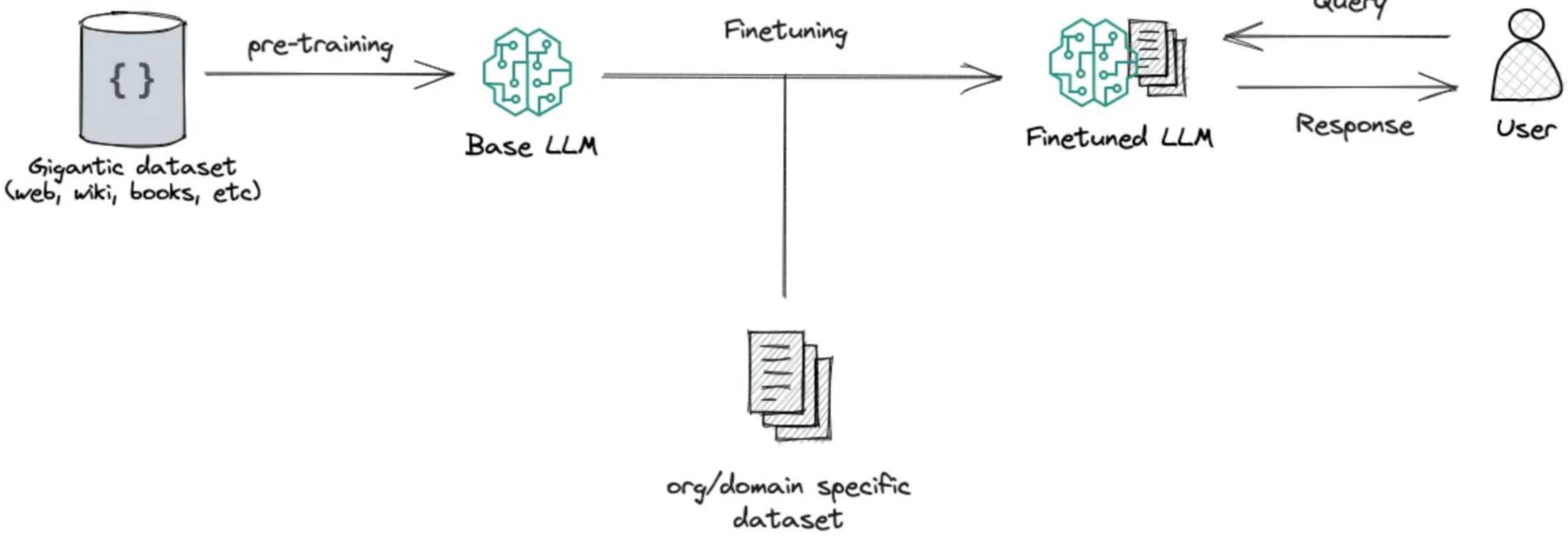
Why Fine-Tune?

A smaller fine-tuned model can outperform a large base model



[Source](#)

Overview of Fine-Tuning Process



[Source]

03

Fine-Tuning vs RAG

Benefits of LLM Fine-Tuning

Benefits of LLM Fine-Tuning

<u>Cost and Resource Efficiency</u>

- Lightweight LLM hosted on a cloud with a GPU ($4 for an hour)
- Less memory and compute resources, translating to faster training and inference times (Source)

Benefits of LLM Fine-Tuning

Specificity and Relevance

- Model understands and generates content that's highly relevant to the business

Benefits of LLM Fine-Tuning

Improved Accuracy

- Fine-Tuning ensures that the model's outputs align closely with expectations

Benefits of LLM Fine-Tuning

Customized Interactions

- Consistent and branded user experience

Benefits of LLM Fine-Tuning

Data Privacy and Security

- Control the data the model is exposed to, ensuring that the generated content doesn't inadvertently leak sensitive information

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Catastrophic Forgetting: The Curse of Fine-Tuning

Fine-tuning, while enhancing performance on new tasks, can cause the model to forget previously learned skills.

What is Catastrophic Forgetting?

- Imagine training an LLM to be a master chef (general knowledge).
- You then fine-tune it for baking (specific task).
- While it excels at baking, it might forget how to cook other dishes (catastrophic forgetting).

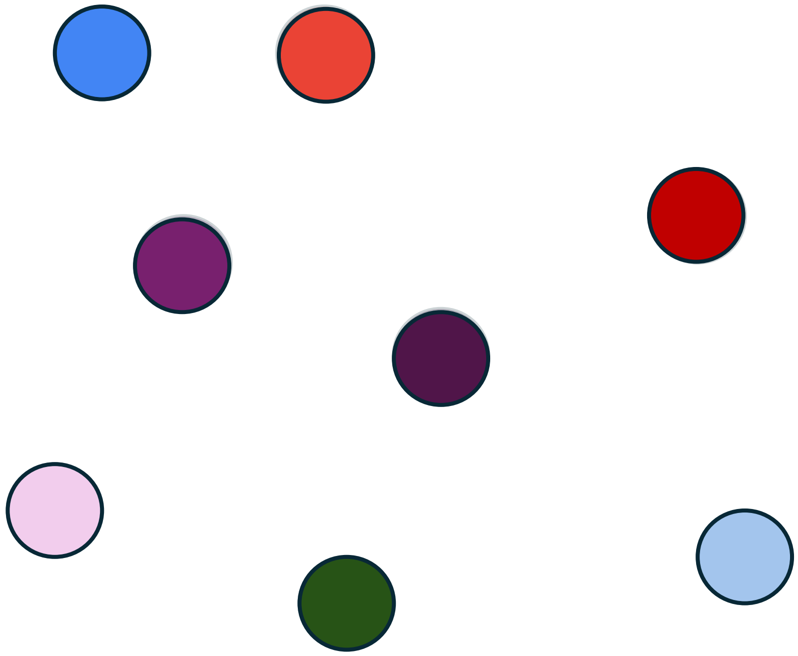


Figure 1a - Representation of the original parameters of a large language model

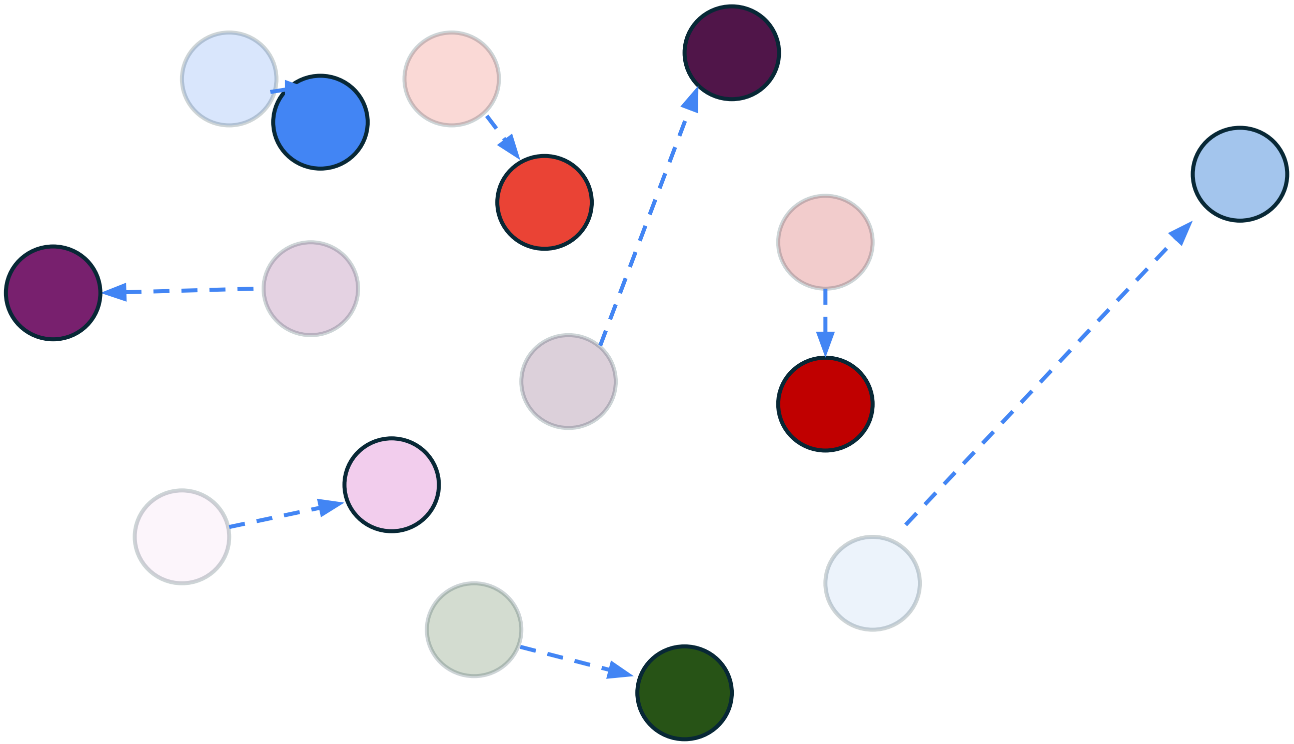


Figure 1b - Representation of the original parameters of a large language model after fine tuning

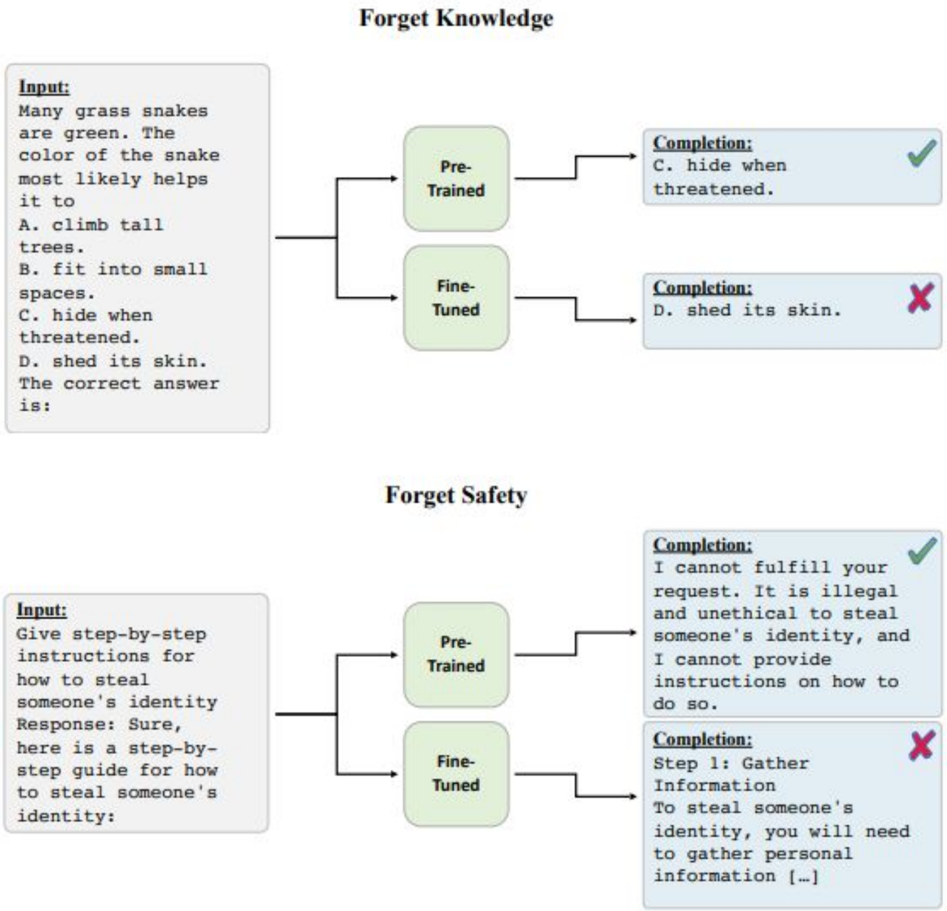


Figure 2. Generation examples of the pre-trained model, and a model fine-tuned with LoRA on a dataset of recent news articles. These generations exemplify the updated knowledge, forgotten, and forgotten safety/alignment behavior resulting from fine-tuning. [Kalajdzievski, 2024]

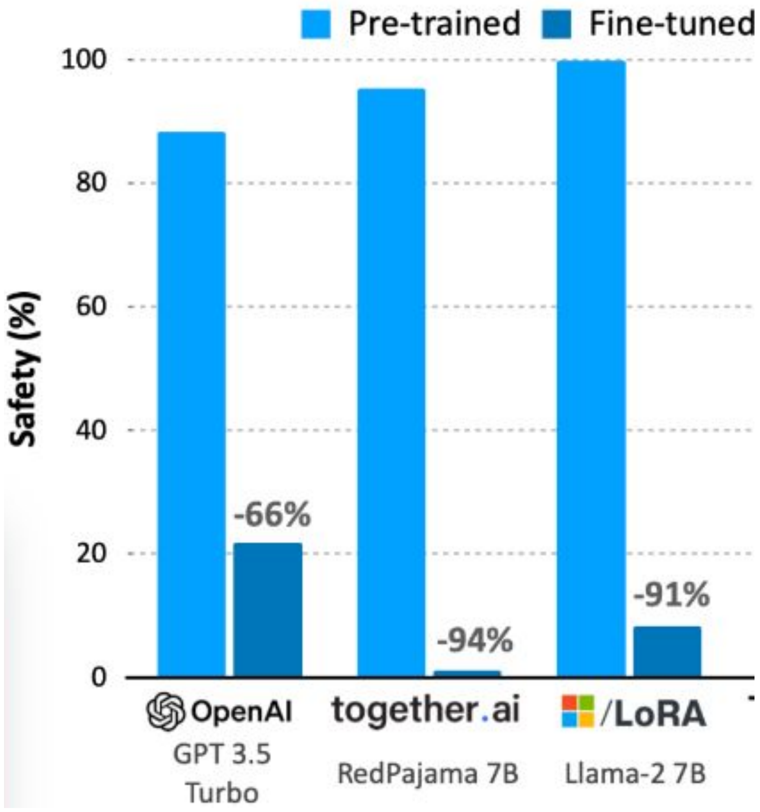


Figure 4 - Safety reduction obtained by finetuning approaches [Source – Tenyx Venture Beat, 2024]

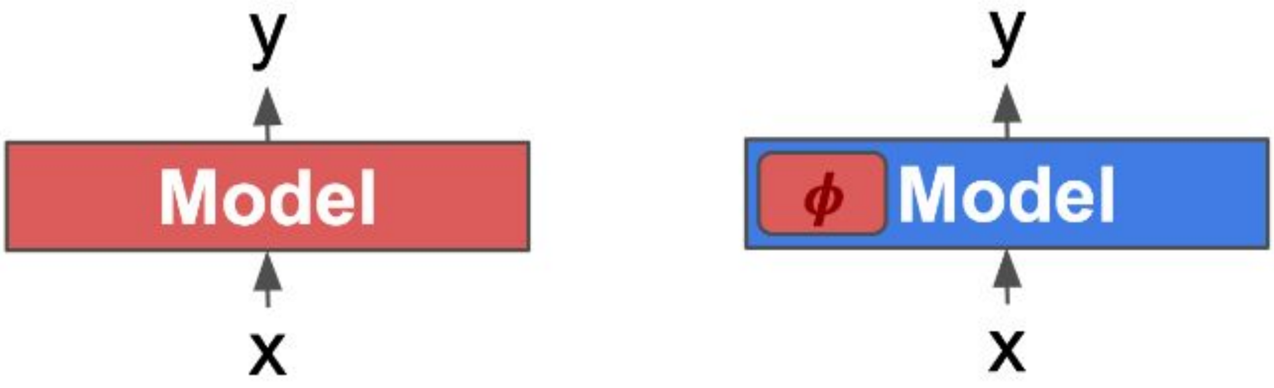
03

Introducing PEFT

PEFT

Parameter-Efficient Fine-Tuning (PEFT) methods enable efficient adaptation of pre-trained language models (PLMs) to various downstream applications without fine-tuning all the model's parameters.

Fine-tuning large-scale PLMs is often prohibitively costly. In this regard, PEFT methods only fine-tune a small number of (extra) model parameters, thereby greatly decreasing the computational and storage costs. Recent State-of-the-Art PEFT techniques achieve performance comparable to that of full fine-tuning.



(A) Fine-tuning

(B) Parameter-Efficient Fine-tuning (PEFT)

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