

## Dataset Overview

One of the most critical components of **fine-tuning Large Language Models (LLMs)** is the **quality of the dataset** used. The dataset directly determines how well the model learns and generalizes.

- **High-quality, well-structured data**
  - ❖ Leads to better generalization
  - ❖ Reduces hallucinations
  - ❖ Produces more reliable and accurate outputs
- **Poor-quality or noisy data**
  - ❖ Causes the model to learn incorrect patterns
  - ❖ Introduces bias and factual errors
  - ❖ Increases hallucinations and inconsistency

**Task :-** This is a group task. Work with your existing groups to find some diverse legal datasets (preferably one that is already in question–answer format), which can be used for our case.

```
{
  "question": "How is India, that is Bharat, defined in terms of its political structure?",
  "answer": "India, that is Bharat, is defined as a Union of States according to the Union and its Territory."
},
{
  "question": "What does the territory of India comprise of?",
  "answer": "The territory of India shall comprise the territories of the States, the Union territories specified in the First Schedule, and such other territories as may be acquired by law." 
},
{
  "question": "What does the territory of a country, such as India, comprise of, according to their constitutional provisions?",
  "answer": "The territory of a country like India comprises the territories of the States, the Union territories specified in the First Schedule, and such other territories as may be acquired by law." 
},
{
  "question": "Who has the authority to admit or establish new states into the union?",
  "answer": "Parliament may by law admit into the Union, or establish, new States."
},
{
  "question": "Who can, by law, admit or establish new States into the Union?",
  "answer": "Parliament"
},
```

## Fine-Tuning Techniques

Fine-tuning methods vary in cost, efficiency, and performance. A detailed overview of different fine-tuning techniques can be found here:

<https://harvard-iacs.github.io/2024-AC215/assets/lectures/lecture9/L09-FineTuning.pdf> (This PDF provides a detailed and highly informative explanation of fine-tuning topics.)

### LLM Fine-Tuning Techniques

<https://medium.com/@jpraveenkanna/llm-fine-tuning-techniques-991b3d7b3b81>

### LoRA (Low-Rank Adaptation)

LoRA is a **parameter-efficient fine-tuning technique** that updates only a small number of trainable parameters instead of the entire model.

- Reduces GPU memory usage

- Faster training
- Preserves the base model weights

### **Learn More About LoRA**

IBM Explanation of LoRA

<https://www.ibm.com/think/topics/lora>

### **QLoRA (Quantized LoRA)**

QLoRA is an extension of LoRA that combines **4-bit quantization** with parameter-efficient fine-tuning.

### **Key Advantages**

- Enables fine-tuning very large LLMs on limited hardware
- Maintains performance close to full fine-tuning
- Highly memory-efficient

### **In-Depth Explanation**

QLoRA Deep Dive

<https://medium.com/@dillipprasad60/qlora-explained-a-deep-dive-into-parametric-efficient-fine-tuning-in-large-language-models-llms-c1a4794b1766>

### **Implementing QLoRA**

GeeksforGeeks Tutorial

<https://www.geeksforgeeks.org/nlp/fine-tuning-large-language-models-llms-using-qlora/>

### **(Optional) Research Papers**

- LoRA Paper: <https://arxiv.org/abs/2106.09685>
- QLoRA Paper: <https://arxiv.org/abs/2305.14314>

## **Summary of Fine-Tuning Approaches**

- **Full Fine-Tuning**
  - ❖ Updates all model parameters
  - ❖ Best performance
  - ❖ Very expensive and memory-intensive
- **Parameter-Efficient Fine-Tuning (PEFT)**  
(Adapters, LoRA, QLoRA, Prompt Tuning)
  - ❖ Updates only a small subset of parameters
  - ❖ Much cheaper and faster
  - ❖ Practical for very large LLMs

Modern LLM fine-tuning mostly relies on **PEFT methods** due to their efficiency.

### **Unsloth Library**

Unsloth is a popular Python library designed to make fine-tuning **2–4x faster** than traditional methods.

#### Unsloth Overview

<https://medium.com/data-science-in-your-pocket/unsloth-the-fastest-way-to-fine-tune-langs-041bb6a785ac>