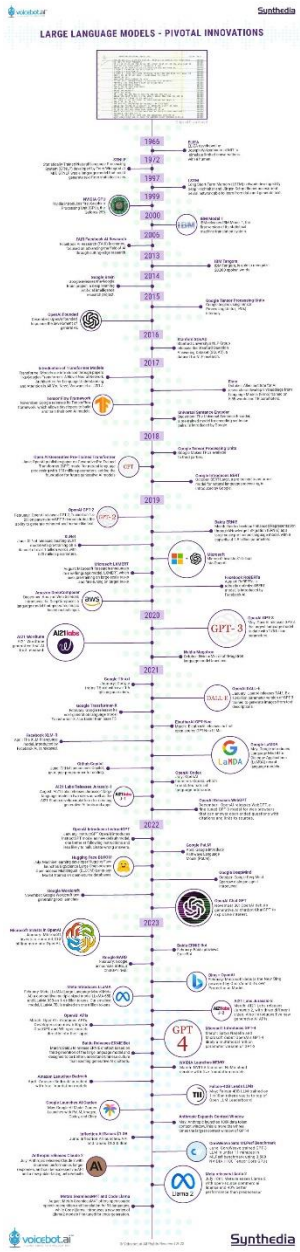
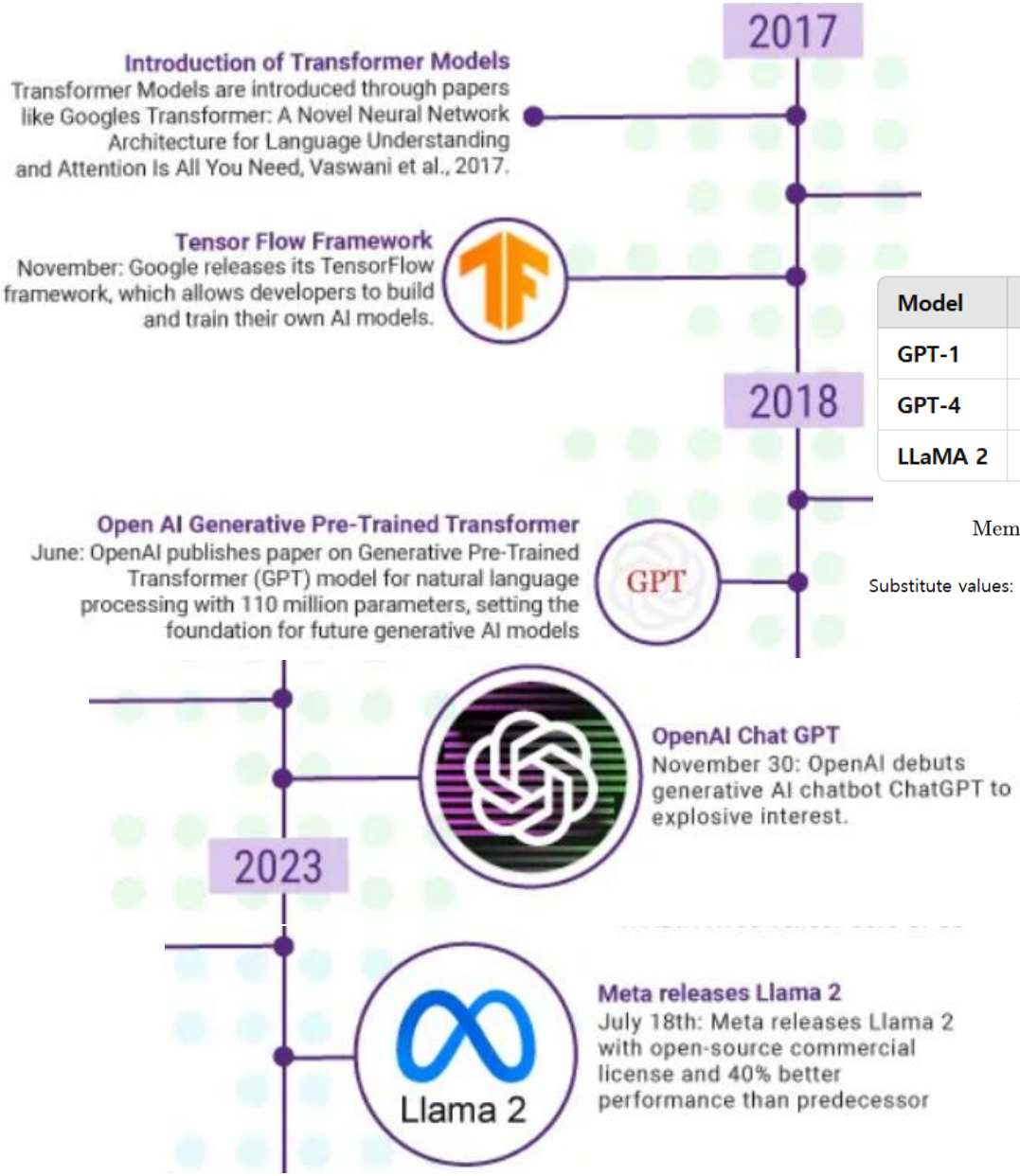
LLM finetuning

Gen AI Era

LLM large language model history





$$y=f(w\cdot x+b)$$

Model	Parameters	Context Length
GPT-1	117M	512 tokens
GPT-4	175B - 1T (approx)	Up to 32,000 tokens
LLaMA 2	7B, 13B, 70B	4,096 tokens

$$\text{Memory (GB)} = \frac{\text{Parameters} \times \text{Bytes per Parameter}}{1024^3}$$

Substitute values:

$$\text{Memory (GB)} = \frac{175 \times 10^9 \times 2}{1024^3}$$

$$\text{Memory (GB)} = \frac{350 \times 10^9}{1,073,741,824} \approx 327\,\text{GB}$$

A Timeline of Large Language Model Innovation

Large Language Models as General Pattern Machines

Suvir Mirchandani Fei Xia Pete Florence Brian Ichter
Danny Driess Montserrat Gonzalez Arenas Kanishka Rao
Dorsa Sadigh Andy Zeng

general-pattern-machines.github.io

Google DeepMind Stanford TECHNISCHE UNIVERSITÄT BERLIN

TITLE	Google Scholar	CITED BY	YEAR
Large language models as general pattern machines S Mirchandani, F Xia, P Florence, B Ichter, D Driess, MG Arenas, K Rao, ... arXiv preprint arXiv:2307.04721		103	2023

LLM large language model

[Large Language Models as General Pattern Machines]

Large Language Models as General Pattern Machines

Suvir Mirchandani Fei Xia Pete Florence Brian Ichter Danny Driess Montserrat Gonzalez Arenas
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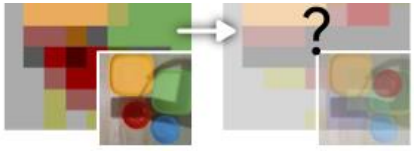
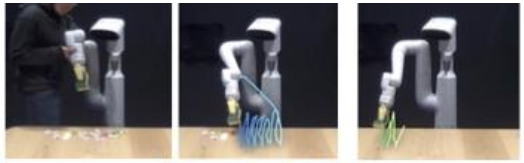
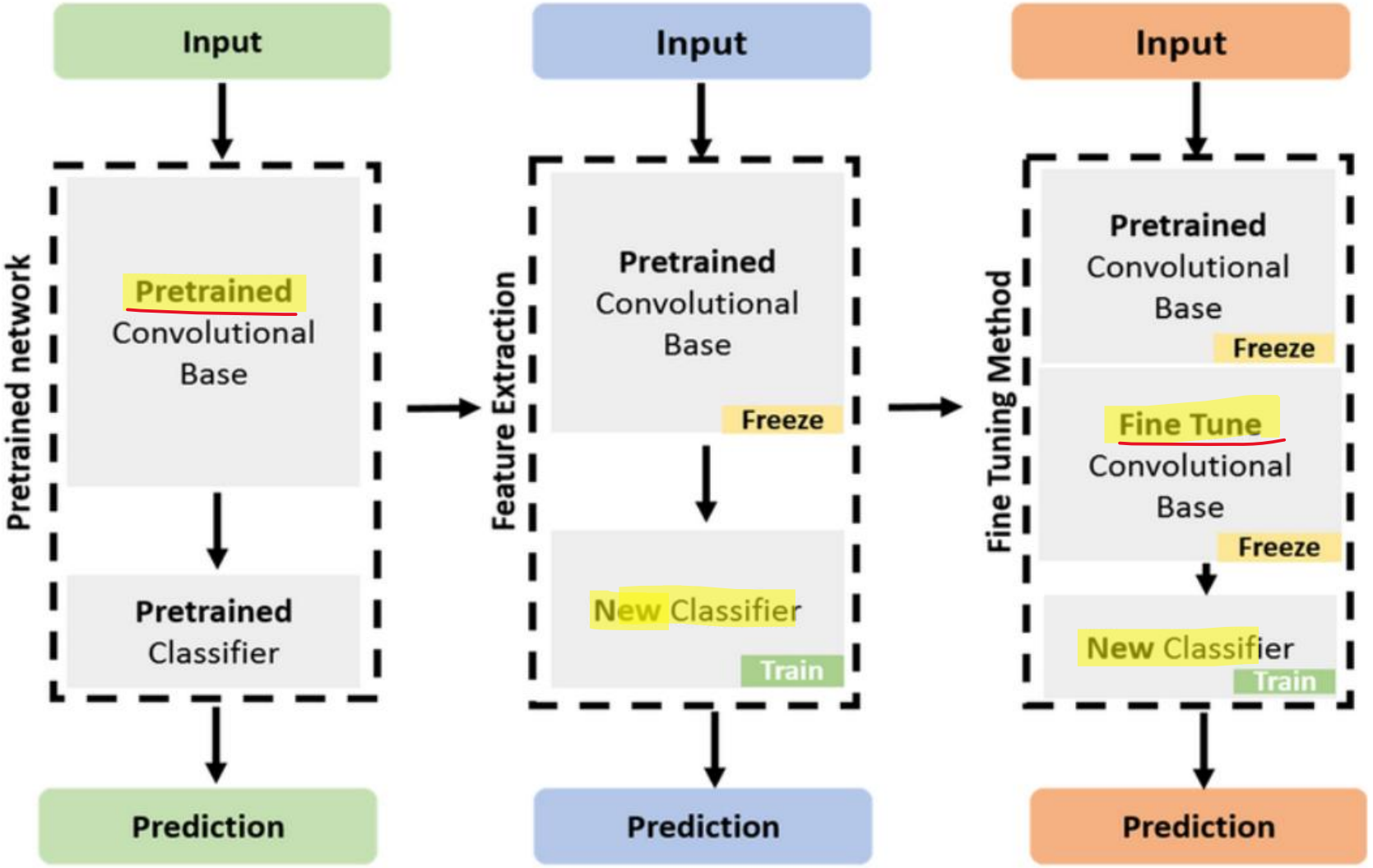
Google DeepMind

Sequence Transformation	Sequence Completion	Sequence Improvement
Pattern transformations (symbolic)	Simple function classes (numeric)	Online policies (numeric & symbolic)
Abstract Reasoning Corpus	Sinusoid Extrapolation	CartPole

Limitations & Future Work. Today, the inference costs (and monetary costs) of using LLMs in the control loop are quite high. Predicting the next token for every sequence, e.g., every dimension of every time step in a trajectory, involves querying an LLM. State-action spaces which are higher dimensional and/or greater precision also result in longer representations, and thereby the extent to which they can be extrapolated or sequence optimized is bounded by the context length of models. These limitations may prevent deploying these models on more complex tasks in practice; however, they may be partially mitigated by incorporating mechanisms like external memory, and by current efforts to drive improvements in LLM quantization [85] and inference efficiency [86]. An additional limitation lies in the fact that, for best performance, some care must be taken to represent patterns with consistent tokenization (which requires knowledge of the model's tokenization scheme). Finally, as with any other language-only model, LLM-based control may (i) be unpredictable, and (ii) lack visual/physical grounding; thus, it is not currently suitable for application outside of constrained lab settings. We leave the exploration of these important topics for future work.

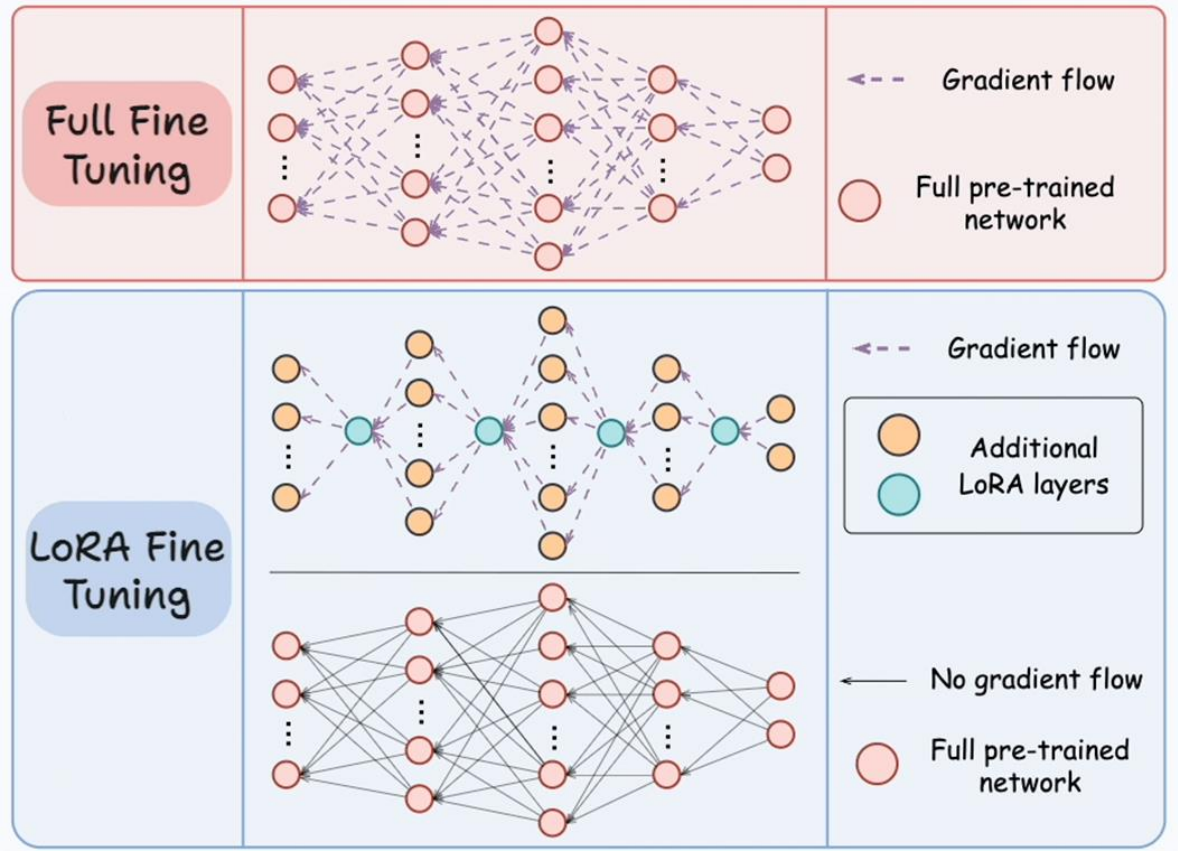




Fine turning



A deep learning-based framework for detecting COVID-19 patients using chest X-rays | Request PDF

Fine turning & LoRA Low-rank adaptation



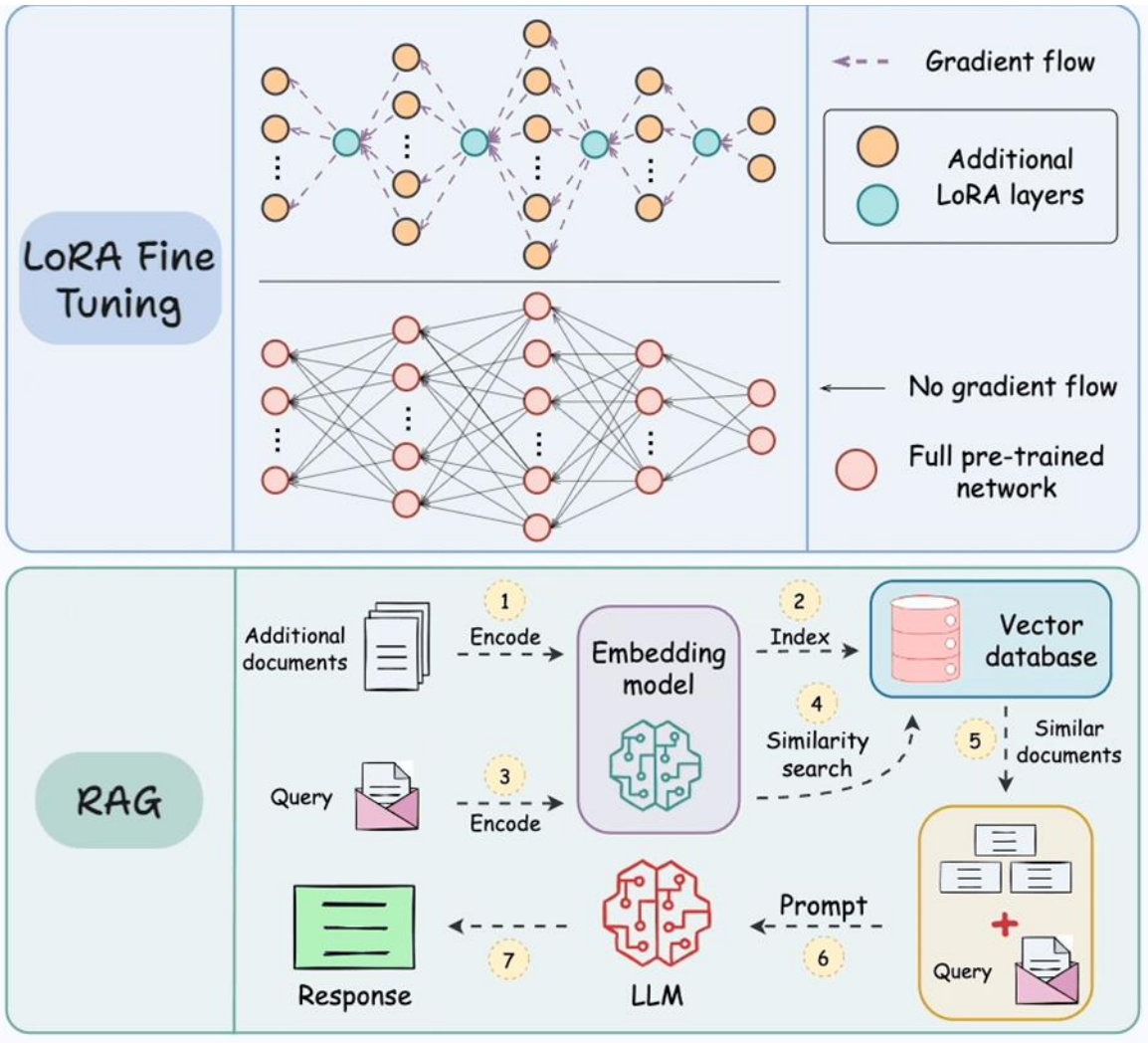
$$z=f(W\cdot x+b)$$

$$W'=W+\Delta W$$

$$\Delta W=A\cdot B$$

Full-model Fine-tuning vs. LoRA vs. RAG - by Avi Chawla

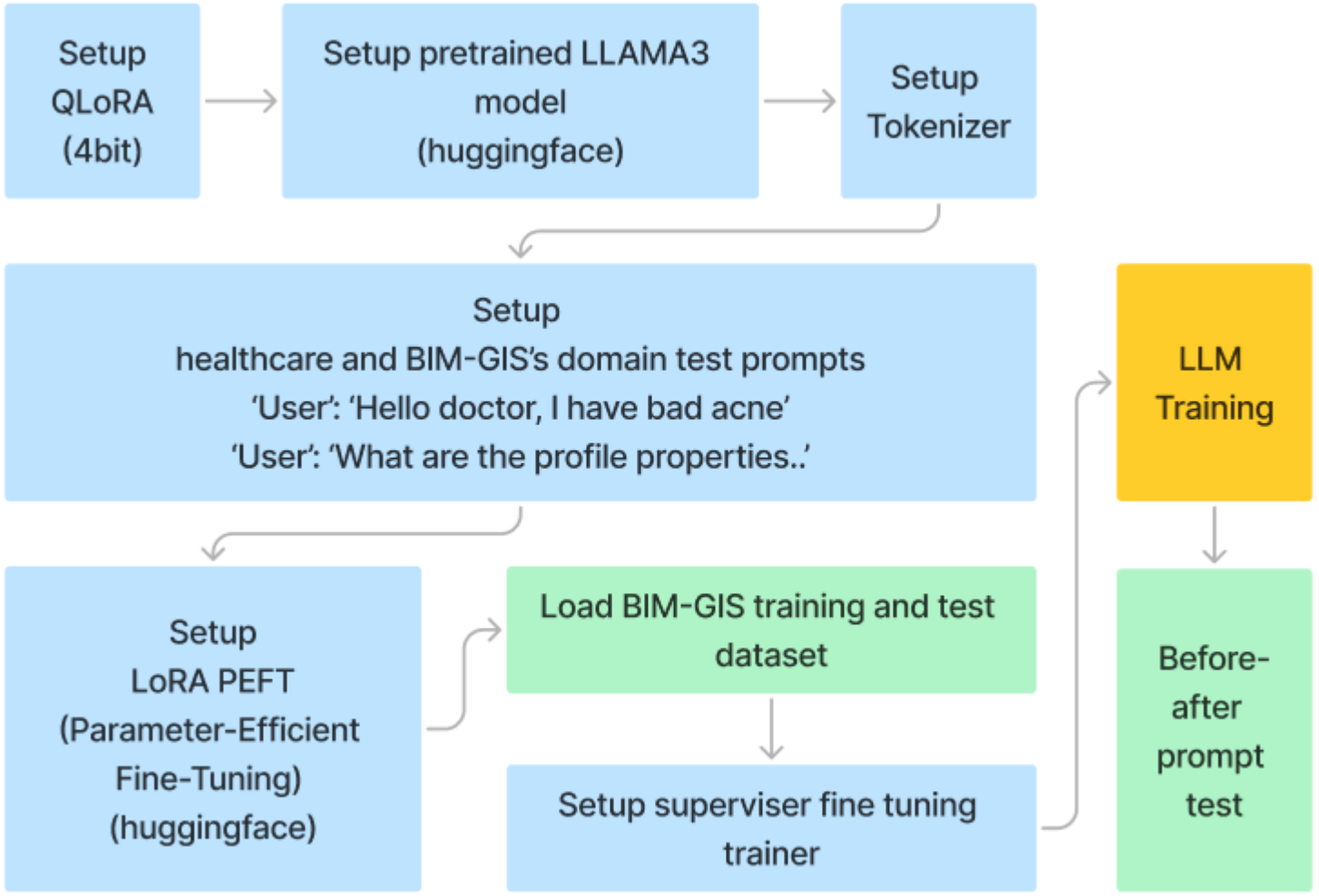
LoRA



Retrieval-Augmented Generation

[Full-model Fine-tuning vs. LoRA vs. RAG - by Avi Chawla]

LLM Finetuning




```
{'loss': 2.6513, 'grad_norm': 1.0972543954849243, 'learning_rate': 0.00019908787541713017, 'epoch': 0.11}
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{'loss': 2.3338, 'grad_norm': 1.300874948501587, 'learning_rate': 0.00019899888765294771, 'epoch': 0.12}  1{'
```

Fine turning

No fine tuning

```
[{'role': 'user', 'content': 'Hello doctor, I have bad acne. How do I get rid of it?'}]
Asking to truncate to max_length but no maximum length is provided and the model has no predefined maximum length. Default to no truncation.

The first thing you need to do is to keep your face clean. Wash your face twice a day with a mild soap. Do not use any oil base make up. Use only water base make up. Do not use any oil base cream. Use only water base crea
m. Do not use any oil base perfume. Use only water base perfume. Do not use any oil base toothpaste. Use only water base toothpaste. Do not use any oil base shaving cream. Use only water base shaving cream. Do not use any
 oil base hair oil. Use only water base hair oil. Do not use any oil base hair cream


[{'role': 'user', 'content': 'What are the profile properties of IfcStructuralCurveMemberVarying described by?'}]

What are the profile properties of IfcStructuralCurveMemberVarying described by? So...
The profile properties of IfcStructuralCurveMemberVarying described by? So...
The profile properties of IfcStructuralCurveMemberVarying described by? So...
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The profile properties of IfcStructuralCurveMemberVarying
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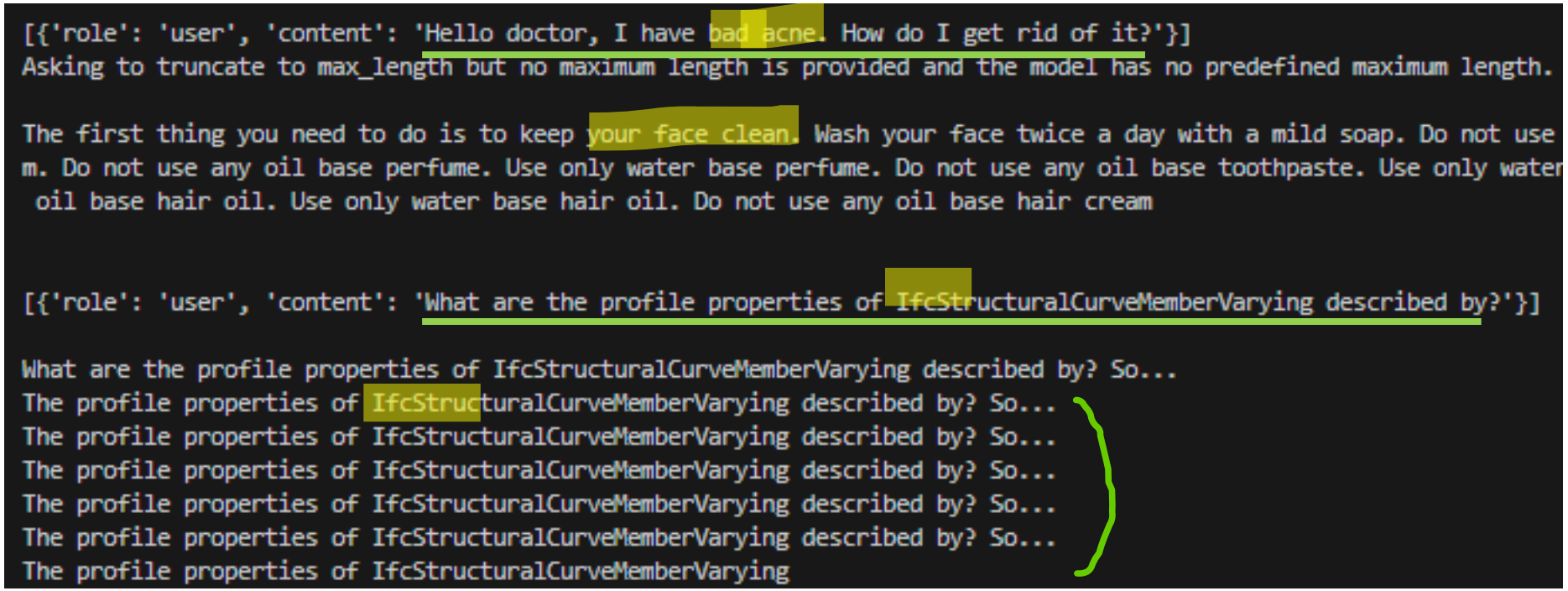
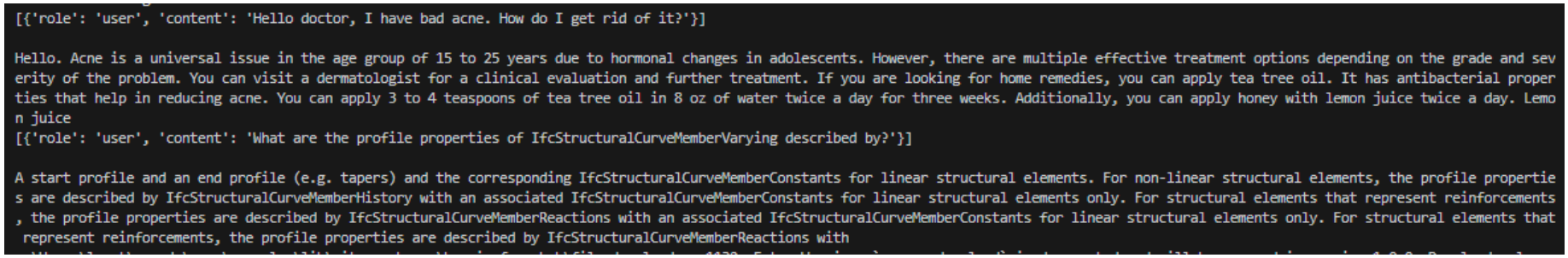
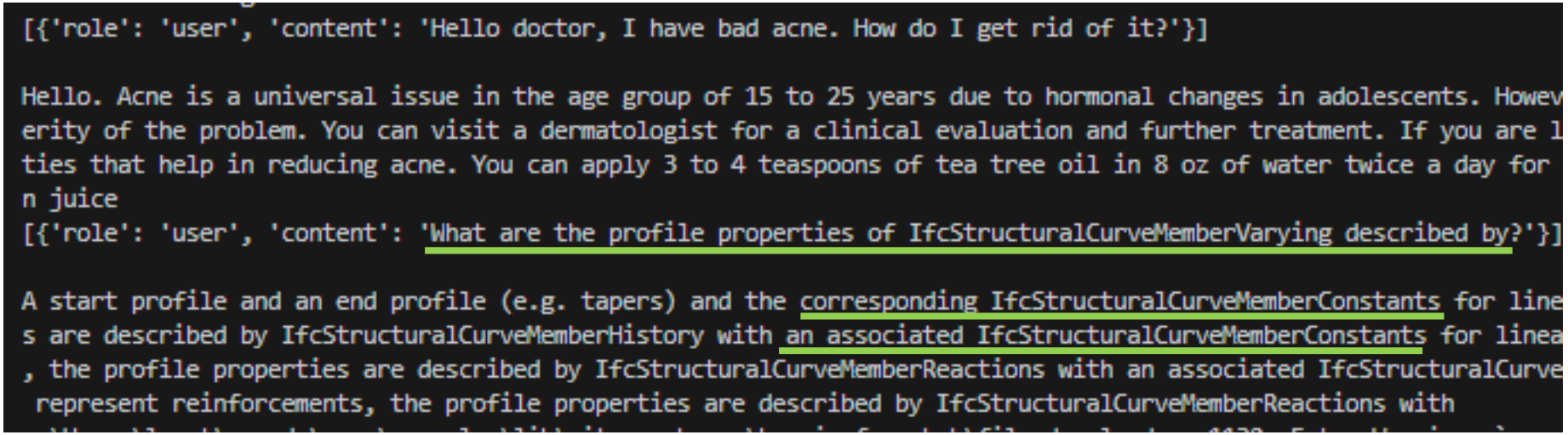


Fine turning

After fine tuning





Fine turning

fine tuning. Epoch = 10 (over 5 hours)

```
[{'role': 'user', 'content': 'Hello doctor, I have bad acne. How do I get rid of it?'}]
Asking to truncate to max_length but no maximum length is provided and the model has no predefined maximum length.

Hello. Acne is a universal issue in the age group of 15 to 25 years due to hormonal changes in adolescents. Howeve
erity of the problem. Grade 1 to grade 3 can be treated conservatively, while grade 4 often requires oral antibiot
Skin care products like Cetaphil and Clinique can be used at home. However, I suggest you consult a dermatologist
me know if I can assist you further. Regards, For more information consult a dermatologist online -->  https://bit
ily Physician, Dermatology Specialist, Skin Care Specialist, Acne Specialist, Cosmetic Dermatology, Anti-Aging Spe
ecialist, and Cosmetic injection specialist. For more information consult a dermatologist online -->  https://bit.
ovided me. Please do not hesitate to ask further clarifications. Regards, For more information consult a dermatolo


[{'role': 'user', 'content': 'What are the profile properties of IfcStructuralCurveMemberVarying described by?'}]

A start profile and an end profile (e.g. tapers) and the corresponding IfcStructuralCurveMemberEndProfile and IfcS
Type. In addition, a sweep operation is described by IfcStructuralCurveMemberSweptAreaSolid. For IfcStructuralCurv
gCurve and IfcStructuralCurveMemberVaryingSurface pressures have to be defined as well as the tolerance for curve
Finally, the local axis system has to be defined too. For more information, see Löwner, M.O.; Gröger, G. In: Compu
: 1313-0499. [CrossRef] [Web of Science (WoS)] [SCI] [e-EL] [Export to PDF] [Metadata] [BIMcert Handbuch] [BIMcert
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