

LLM Fine-Tuning

SIH Seminar

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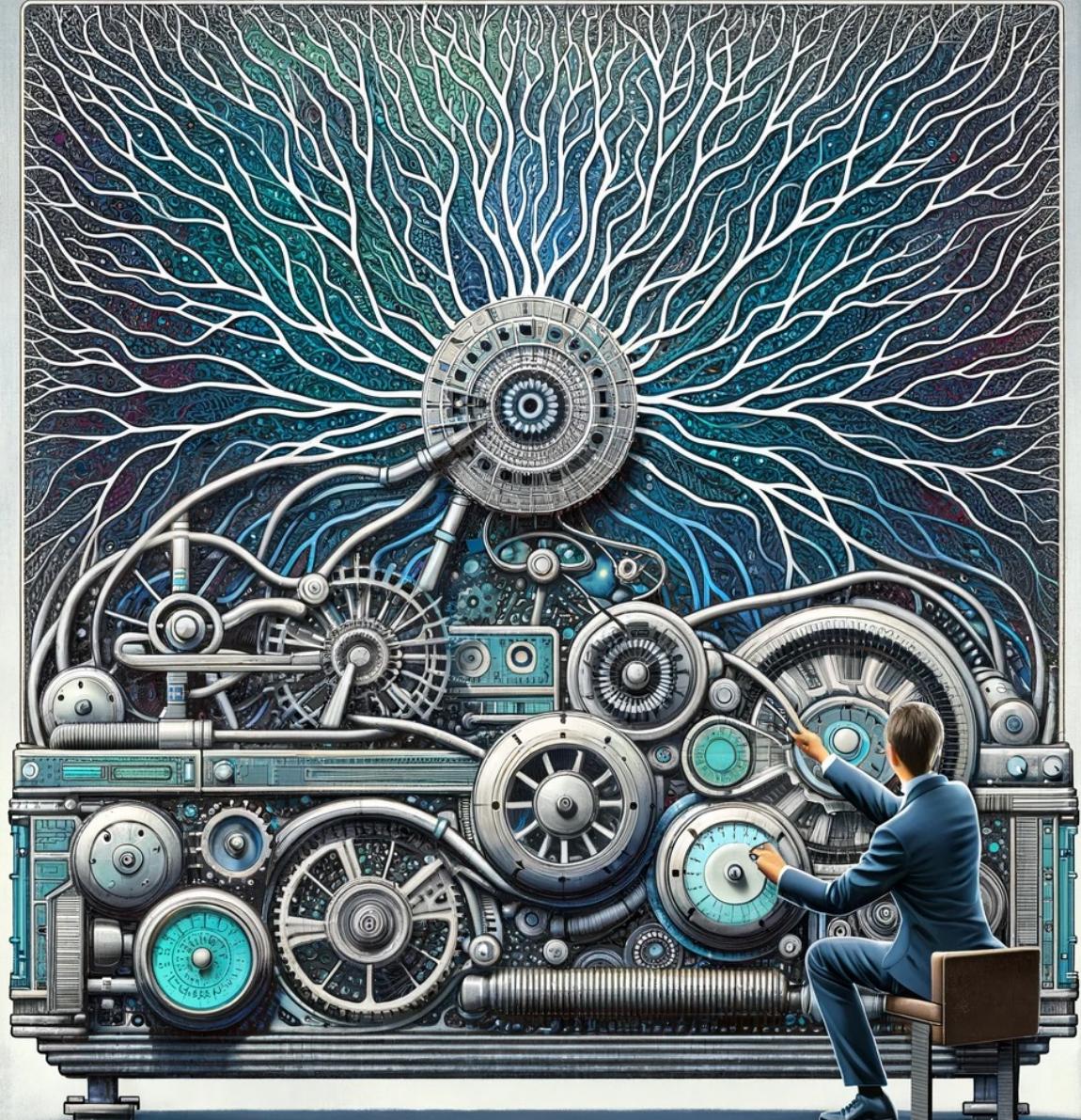
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Outline

1. When do I need finetuning and when not
 - What is LLM finetuning
 - Finetuning vs vector databases
 - Why fine-tuning and other options
2. How To (with notebook)
 - Example use-case
 - Data preparation
 - Model training
 - Evaluation
3. Summary and Outlook
 - Frameworks and tools
 - LLM Guardrails
 - Take away

Part I - Why

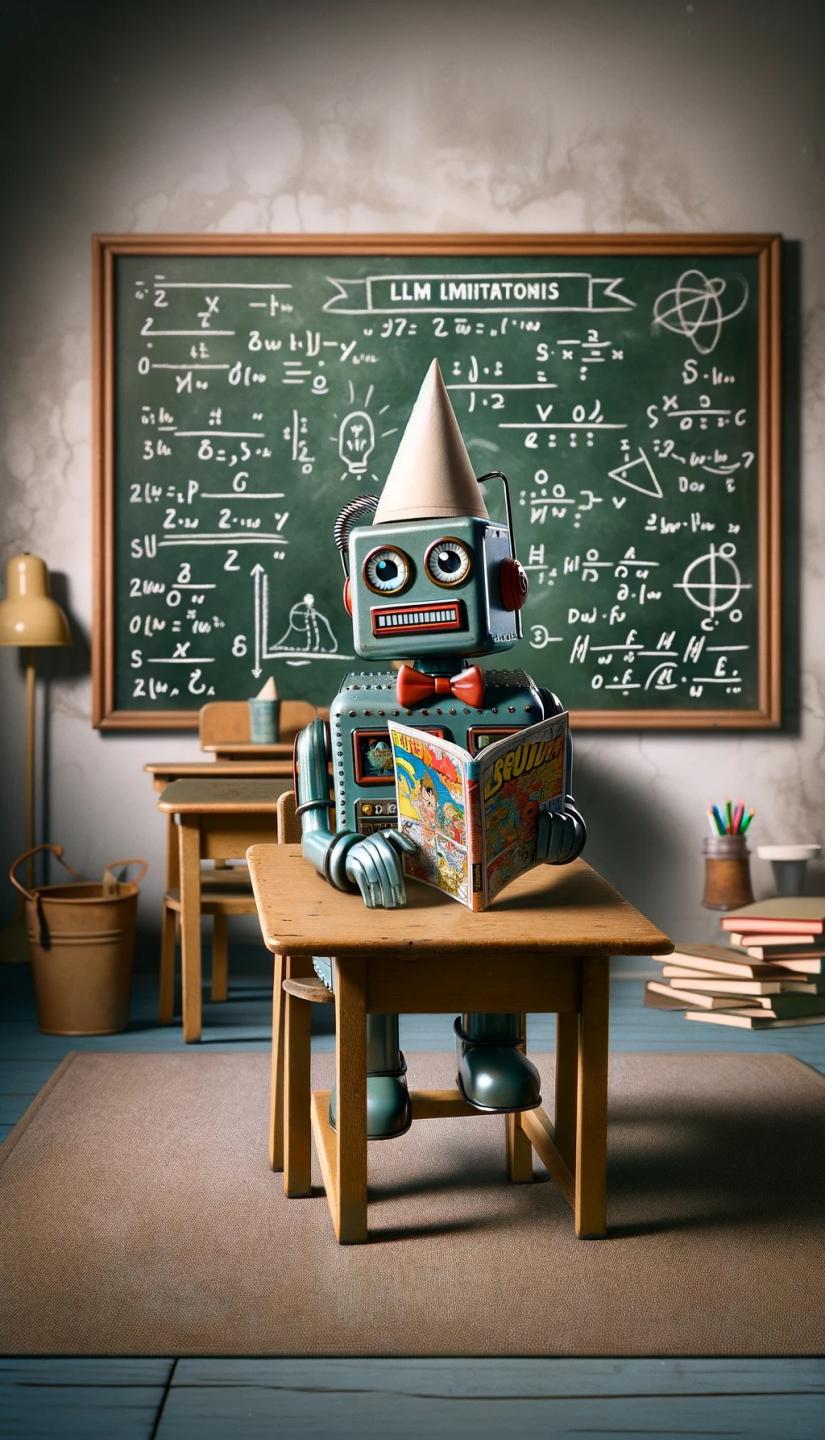
What are LLMs?

Characteristics:

- **Advanced AI:** LLMs are state-of-the-art Transformer Models capable of processing and generating human-like text.
- **Vast Knowledge:** They draw on extensive data to answer queries, create content, and understand language.

Limitations:

1. **Information Limitation:** lack specific or up-to-date information that was not part of their training data, leading to a phenomenon known as "hallucination".
1. **Behavioral Limitation:** May misalign with user expectations of context or intended format.





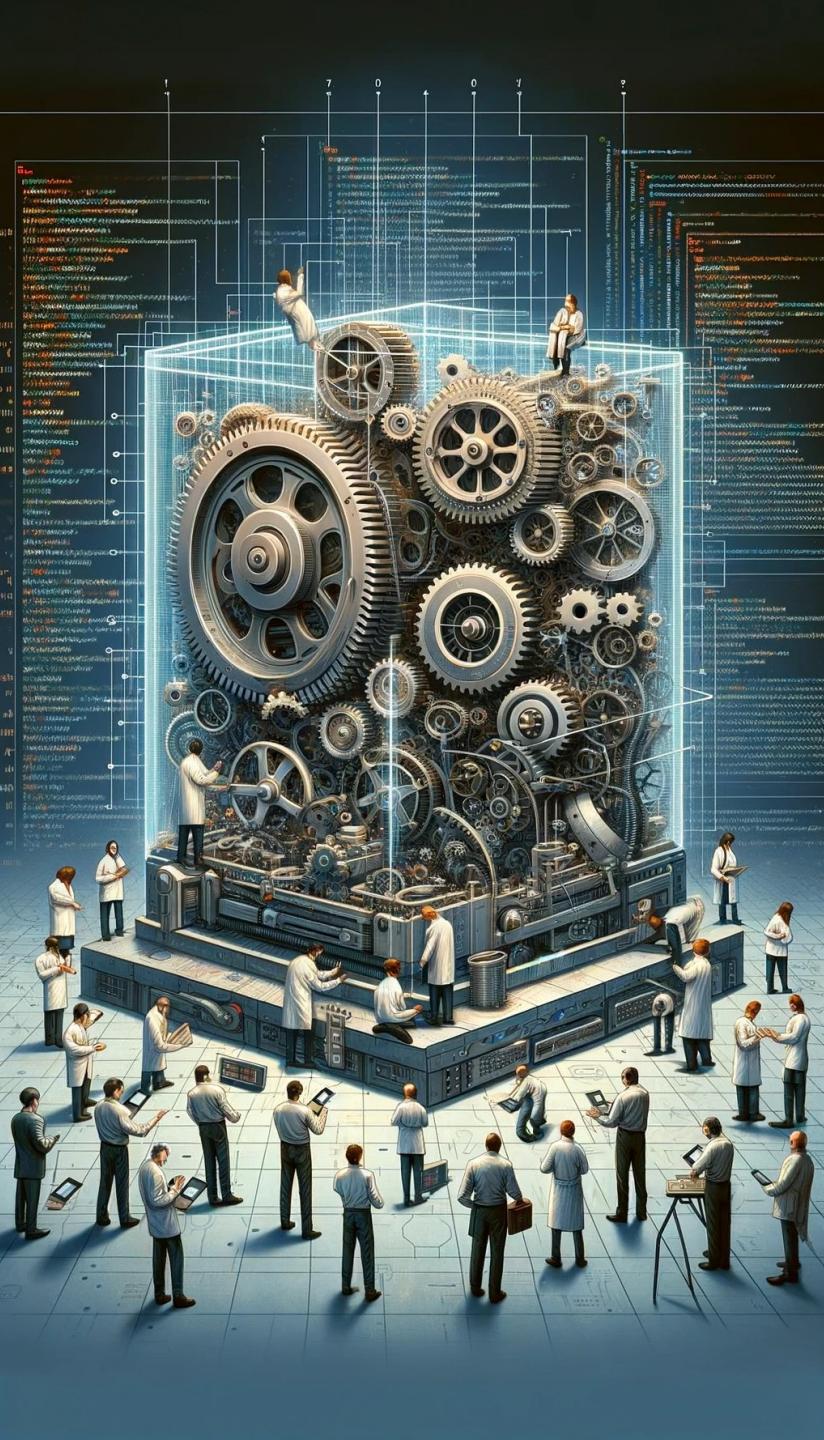
Finetuning vs Vector Databases

- **Finetuning:**

- Collect a set of examples (paired input/output data) that represent the custom knowledge or desired behavior.
- Use these examples to train the LLM; typically start with general pretrained model (e.g. GPT, Llama, Falcon).
- LLM network weights are changed.

- **Vector Databases/Embedding:**

- Collect a set of documents or data that represent the desired knowledge.
- Chunk and encode these documents into vectors and store them in a vector database. (FAISS, Pinecone, etc)
- When a query is made, use the vector database to retrieve the relevant vectors based on similarity (typically dot product of query vector and vector database chunks).
- Decode vectors to text and add this information to the prompt for the LLM
- LLM network weights not changed.



Why Fine-Tuning?

- **Behavior Optimisation:** Fine-tuning adjusts LLMs to better meet specific requirements or expectations. Examples:
 - CustomCare Chatbot
 - MarketMentor AI
- **Targeted Training:** Involves supplementing the model with additional data for improved accuracy and relevance, such as for specific domain or industry. Examples:
 - Legal Interpreter
 - TechSupport Genius
- **Specialization Process:** teaching a general LLM to master a specific task such as classification and filtering. Examples:
 - GourmetSuggest
 - MedicoConsultant

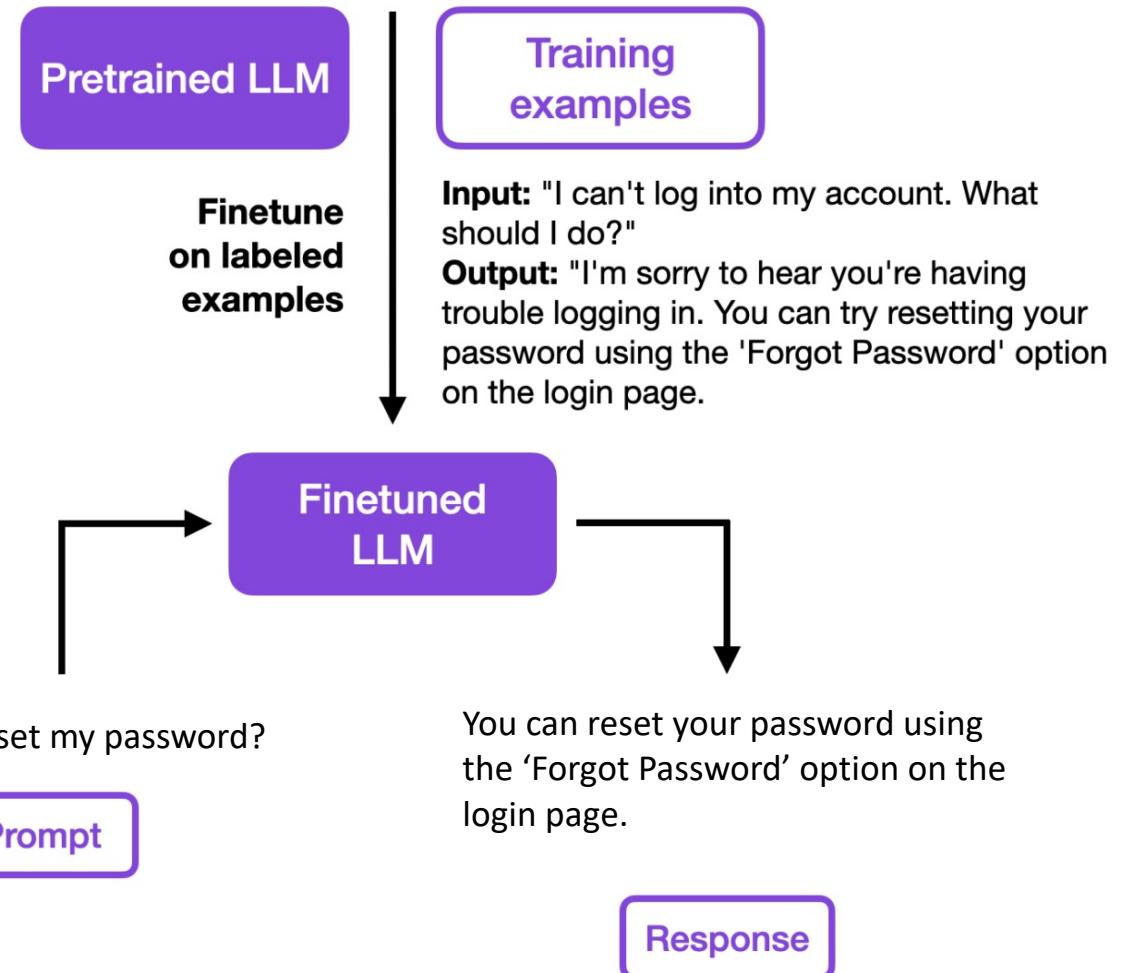
LLM Optimisation Methods

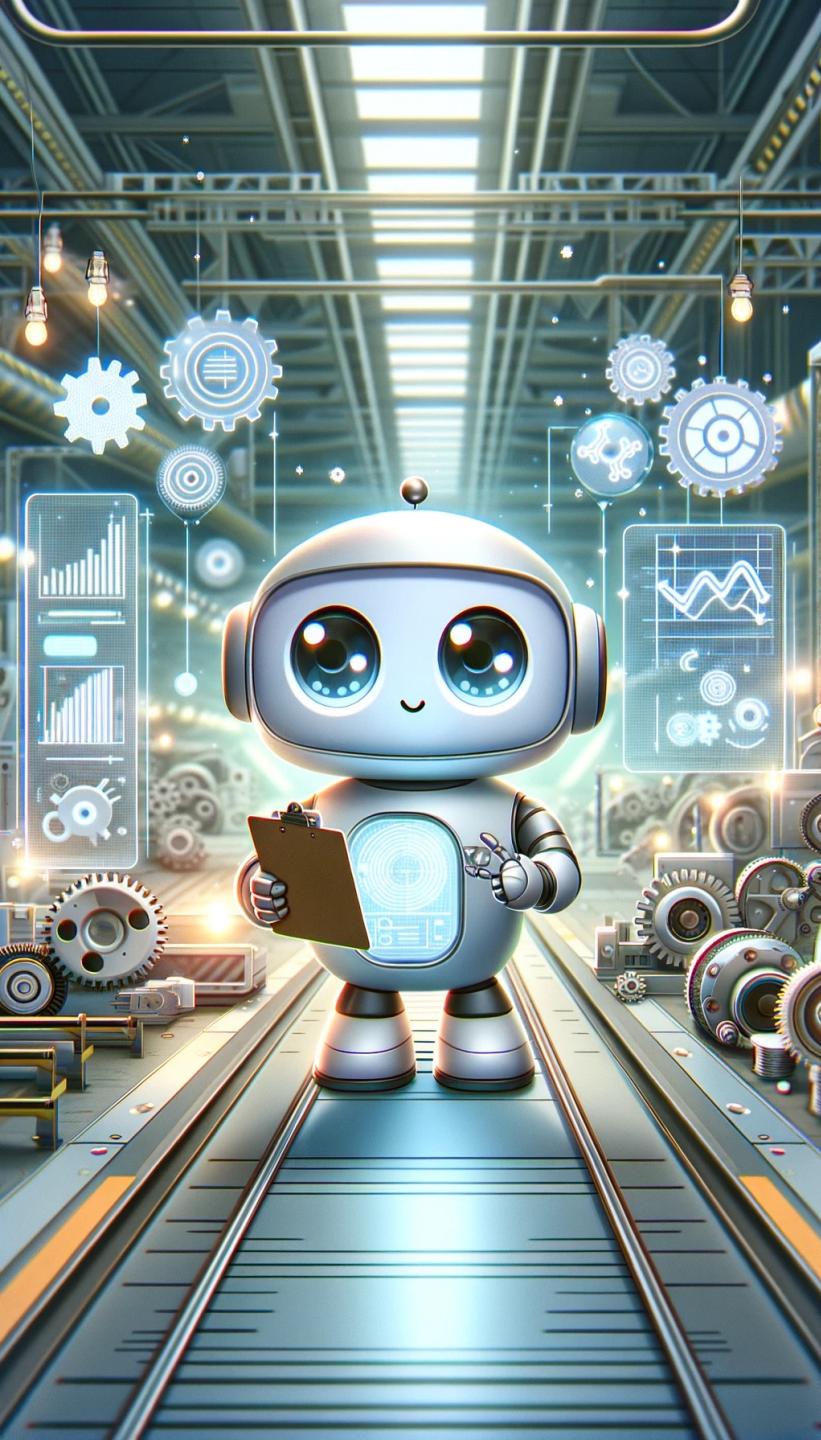
Task	Zero-Shot Prompt	Functions/Tools (Programmatic Interactions)	Vector Embeddings	Fine-Tuning
Prototyping	✓			
Automated Workflow Integration		✓		
Consistent Task Execution		✓		✓
Semantic Search			✓	
Content Clustering			✓	
Specialized Domain Adaptation				✓
Personalized Interaction	✓			✓
Classification	✓	✓	✓	✓

Part III - How



Fine-tuning process





Key: Data Prep

Collect data (e.g., from files or web sources)

Process training material to LLM-readable topics

Use question generator (e.g., GPT-4 or Llama-2) to create a list of questions about each topic

Format dataset (LLM specific): typically consists of a set of text prompts + corresponding target outputs

Split in train and test set



Fine-Tuning Example

APIcoder – a custom LLM code assistant for API calls.

In this example, fine-tuning solves the problem of:

- a) Retrieving external tools and information
- b) Workflow integration via custom code generation
- c) Can learn new API queries that are not known to foundation models

FOLLOW WORKFLOW IN NOTEBOOK:

[LLM_finetuning_seminar.ipynb](#)

GitHub:

<https://github.com/Sydney-Informatics-Hub/LLM-finetuning-seminar>

Part III - Sum



Popular Fine-tuning Tools

Pre-trained base-models:

GPT-3.5, Llama-2, Falcon, code-llama, phi, Pythia, mpt, cerebras, Lit-GPT, mistral, GPT-j ...

[LoRA](#) (Low-Rank Adaptation Hu et al 2021): widely used framework for LLM hyperparameter tuning

[QLoRA](#) (popular quantized LoRA technique by Dettmers et al) for memory savings

[Axolotl](#): streamline fine-tuning of various LLM base model



LLM Guardrails





Take-Away

Fine-tuning advantages:

- Enhanced Accuracy
- Improved Robustness
- Increased Interpretability

Potential Risks:

- Can amplify data sensitivity and bias
- Can be costly and time-consuming

Key Strategies:

- High-quality, relevant training data
- Combine with other LLM optimisation techniques

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