

Comprehensive Generative AI Learning Path

Curated by Anish Roychowdhury

April 4, 2025

Contents

1	Foundations of Generative AI	3
1.1	Introduction to Generative AI	3
1.2	Large Language Models (LLMs) Basics	3
2	Prompt Engineering	3
2.1	Basics of Prompt Engineering	3
2.2	Advanced Prompt Engineering	3
3	Generative Models	3
3.1	Diffusion Models	3
3.2	GANs (Generative Adversarial Networks)	4
4	Building AI Agents	4
4.1	AI Agent Frameworks	4
4.2	Multi-Agent Systems	4
5	Retrieval-Augmented Generation (RAG)	4
5.1	Basics of RAG	4
5.2	Vector Databases	4
6	Fine-Tuning LLMs	5
6.1	Parameter-Efficient Fine-Tuning (PEFT)	5
6.2	Instruction Fine-Tuning	5
7	Reinforcement Learning from Human Feedback (RLHF)	5
7.1	Introduction to RLHF	5
8	Model Context Protocol (MCP)	5
8.1	Fundamentals of MCP	5
8.2	Implementing MCP in Applications	5
8.3	Advanced MCP Patterns	6
9	Deployment of Generative AI Models	6
9.1	Local Deployment	6
9.2	Serverless Deployment	6
9.3	Edge Deployment	6
10	Evaluation Metrics for Generative AI Models	6
10.1	Error Metrics and Loss Computation	6
10.2	Advanced Evaluation Frameworks	6

11 Practical Projects and Applications	7
11.1 End-to-End Gen AI Projects	7
11.2 Industry-Specific Applications	7
12 Ethical Considerations and Responsible AI	7
12.1 Ethical Frameworks	7
12.2 Bias Mitigation	7
13 Future Directions in Generative AI	7
13.1 Multimodal Models	7
13.2 AI Research Frontiers	8
14 Community Resources and Continuous Learning	8
14.1 Open Source Communities	8
14.2 Conferences and Workshops	8

1 Foundations of Generative AI

1.1 Introduction to Generative AI

- Overview of generative models and applications.
 - [DeepLearning.AI Generative AI for Beginners](https://github.com/microsoft/generative-ai-for-beginners)
<https://github.com/microsoft/generative-ai-for-beginners>
 - [Big Book of Generative AI by Databricks](https://www.databricks.com/resources/ebook/big-book-generative-ai)
<https://www.databricks.com/resources/ebook/big-book-generative-ai>

1.2 Large Language Models (LLMs) Basics

- Learn about LLMs, tokenization, embeddings, and transformers.
 - [Building LLMs from Scratch \(15 Lectures\)](https://lnkd.in/gifp9PkM)
<https://lnkd.in/gifp9PkM>
 - [Transformer Architecture Explained](https://jalammar.github.io/illustrated-transformer/)
<https://jalammar.github.io/illustrated-transformer/>
 - [Transformers from Scratch in Python](https://towardsdatascience.com/build-your-own-transformer-from-scratch-using-pytorch-84c850470dcb)
<https://towardsdatascience.com/build-your-own-transformer-from-scratch-using-pytorch-84c850470dcb>

2 Prompt Engineering

2.1 Basics of Prompt Engineering

- Techniques like zero-shot, one-shot, few-shot learning, and chain-of-thought prompting.
 - [Prompt Engineering Guide](https://aman.ai/primers/ai/prompt-engineering/)
<https://aman.ai/primers/ai/prompt-engineering/>
 - [LangChain Prompt Templates](https://lnkd.in/dVkuizQ)
<https://lnkd.in/dVkuizQ>

2.2 Advanced Prompt Engineering

- Generated knowledge, prompt chaining, and ReAct.
 - [Prompt Tuning with Hugging Face](https://huggingface.co/docs/peft/task_guides/clm-prompt-tuning)
https://huggingface.co/docs/peft/task_guides/clm-prompt-tuning
 - [NVIDIA Blog on Prompt Engineering](https://developer.nvidia.com/blog/an-introduction-to-large-language-models-prompt-engineering-and)
<https://developer.nvidia.com/blog/an-introduction-to-large-language-models-prompt-engineering-and>

3 Generative Models

3.1 Diffusion Models

- Learn how diffusion models generate images and other content.
 - [Diffusion Models Explained](https://towardsdatascience.com/diffusion-models-made-easy-8414298ce4da)
<https://towardsdatascience.com/diffusion-models-made-easy-8414298ce4da>
 - [Illustrated Stable Diffusion](https://jalammar.github.io/illustrated-stable-diffusion/)
<https://jalammar.github.io/illustrated-stable-diffusion/>

3.2 GANs (Generative Adversarial Networks)

- Explore GAN architectures and applications.
 - [Understanding GANs](https://towardsdatascience.com/understanding-generative-adversarial-networks-gans-cd6e4651a29)
<https://towardsdatascience.com/understanding-generative-adversarial-networks-gans-cd6e4651a29>
 - [GAN Lecture Series](https://lnkd.in/eSf66zT)
<https://lnkd.in/eSf66zT>

4 Building AI Agents

4.1 AI Agent Frameworks

- Learn frameworks like LangChain, CrewAI, and AutoGen.
 - [LangChain Crash Course](https://medium.com/databutton/getting-started-with-langchain-a-powerful-tool-for-working-with-lar)
<https://medium.com/databutton/getting-started-with-langchain-a-powerful-tool-for-working-with-lar>
 - [CrewAI GitHub Repository](https://github.com/joaomdmoura/crewAI)
<https://github.com/joaomdmoura/crewAI>

4.2 Multi-Agent Systems

- Practical workflows for multi-agent environments.
 - [Multi AI Agent Systems with CrewAI](https://lnkd.in/dTudrD55)
<https://lnkd.in/dTudrD55>
 - [OpenAI Agents SDK in Python](https://github.com/openai/openai-agents-python)
<https://github.com/openai/openai-agents-python>

5 Retrieval-Augmented Generation (RAG)

5.1 Basics of RAG

- Combine LLMs with external knowledge bases using vector databases.
 - [Guide to RAG Frameworks](https://deepchecks.com/practical-guide-to-crafting-your-first-llm-powered-app-using-rag-framework)
<https://deepchecks.com/practical-guide-to-crafting-your-first-llm-powered-app-using-rag-framework>
 - [LangChain for RAG Applications](https://medium.com/mlearning-ai/create-a-chatbot-in-python-with-langchain-and-rag-85bfba8c62d2)
<https://medium.com/mlearning-ai/create-a-chatbot-in-python-with-langchain-and-rag-85bfba8c62d2>

5.2 Vector Databases

- Learn about vector search and embedding storage solutions.
 - [Introduction to Vector Databases](https://weaviate.io/blog/what-is-a-vector-database)
<https://weaviate.io/blog/what-is-a-vector-database>
 - [FAISS Tutorial](https://medium.com/mlearning-ai/mastering-similarity-searches-building-a-faiss-index-with-cosine-)
<https://medium.com/mlearning-ai/mastering-similarity-searches-building-a-faiss-index-with-cosine->

6 Fine-Tuning LLMs

6.1 Parameter-Efficient Fine-Tuning (PEFT)

- Techniques like LoRA and QLoRA for efficient tuning.
 - [Fine-Tuning with LoRA](https://abvijaykumar.medium.com/fine-tuning-llm-parameter-efficient-fine-tuning-peft-lora-qlora-p)
<https://abvijaykumar.medium.com/fine-tuning-llm-parameter-efficient-fine-tuning-peft-lora-qlora-p>
 - [Hugging Face Blog on PEFT](https://huggingface.co/blog/trl-peft)
<https://huggingface.co/blog/trl-peft>

6.2 Instruction Fine-Tuning

- Customize LLMs for specific tasks using instruction tuning.
 - [Instruction Fine-Tuning Guide](https://medium.com/@ud.chandra/instruction-fine-tuning-llama-2-with-pefts-qlora-method-d6a801ebb1)
<https://medium.com/@ud.chandra/instruction-fine-tuning-llama-2-with-pefts-qlora-method-d6a801ebb1>
 - [Fine-Tune Your Own Llama Model in Colab](https://towardsdatascience.com/fine-tune-your-own-llama-2-model-in-a-colab-notebook-df9823a04a32)
<https://towardsdatascience.com/fine-tune-your-own-llama-2-model-in-a-colab-notebook-df9823a04a32>

7 Reinforcement Learning from Human Feedback (RLHF)

7.1 Introduction to RLHF

- Understand how RLHF improves model alignment with human preferences.
 - [Hugging Face RLHF Blog](https://huggingface.co/blog/rlhf)
<https://huggingface.co/blog/rlhf>
 - [Short Course on RLHF by DeepLearning.AI](https://www.deeplearning.ai/short-courses/reinforcement-learning-from-human-feedback/)
<https://www.deeplearning.ai/short-courses/reinforcement-learning-from-human-feedback/>

8 Model Context Protocol (MCP)

8.1 Fundamentals of MCP

- Understanding the Model Context Protocol for LLM interactions.
 - [Anthropic's MCP Guide](https://github.com/anthropics/anthropic-cookbook/blob/main/model_context_protocol/model_context_protocol.md)
https://github.com/anthropics/anthropic-cookbook/blob/main/model_context_protocol/model_context_protocol.md
 - [Claude MCP Documentation](https://docs.anthropic.com/claude/docs/model-context-protocol)
<https://docs.anthropic.com/claude/docs/model-context-protocol>

8.2 Implementing MCP in Applications

- Practical implementations and best practices.
 - [Structured Outputs with Claude 3 MCP](https://medium.com/@saitejasagi/structured-outputs-with-anthropics-claude-3-model-context-protocol)
<https://medium.com/@saitejasagi/structured-outputs-with-anthropics-claude-3-model-context-protocol>
 - [OpenAI's Approach to Structured Outputs](https://github.com/openai/openai-cookbook/blob/main/examples/How_to_format_inputs_to_GPT_3_5_turbo_models.md)
https://github.com/openai/openai-cookbook/blob/main/examples/How_to_format_inputs_to_GPT_3_5_turbo_models.md

8.3 Advanced MCP Patterns

- Complex data extraction and validation patterns.
 - [Anthropic Research on MCP](https://www.anthropic.com/research/claude-3-model-context-protocol)
<https://www.anthropic.com/research/claude-3-model-context-protocol>
 - [MCP Implementation Examples](https://github.com/ArnaudBuchholz/reserve-mcp)
<https://github.com/ArnaudBuchholz/reserve-mcp>

9 Deployment of Generative AI Models

9.1 Local Deployment

- Run models locally on your machine.
 - [5 Free Tools for Local Deployment of LLMs](https://lnkd.in/dJsRrn2c)
<https://lnkd.in/dJsRrn2c>

9.2 Serverless Deployment

- Deploy serverless applications using platforms like AWS Bedrock.
 - [Serverless Workflows with Amazon Bedrock](https://lnkd.in/dENCd795)
<https://lnkd.in/dENCd795>

9.3 Edge Deployment

- Bring generative AI capabilities to edge devices.
 - [Deploying LLMs at the Edge with NVIDIA IGX Orin Developer Kit](https://lnkd.in/d94BxVjw)
<https://lnkd.in/d94BxVjw>

10 Evaluation Metrics for Generative AI Models

10.1 Error Metrics and Loss Computation

- Evaluate model performance using metrics like BLEU score and perplexity.
 - [Foundations of NLP Metrics: BLEU Score and WER Metrics](https://towardsdatascience.com/foundations-of-nlp-explained-bleu-score-and-wer-metrics-1a5ba06d81)
<https://towardsdatascience.com/foundations-of-nlp-explained-bleu-score-and-wer-metrics-1a5ba06d81>
 - [Perplexity in Language Models Explained](https://medium.com/@priyankads/perplexity-of-language-models-41160427ed72)
<https://medium.com/@priyankads/perplexity-of-language-models-41160427ed72>

10.2 Advanced Evaluation Frameworks

- Comprehensive evaluation strategies for generative models.
 - [OpenAI Evals Framework](https://github.com/openai/evals)
<https://github.com/openai/evals>
 - [Hugging Face Evaluation Leaderboard](https://huggingface.co/spaces/evaluate-measurement/leaderboard)
<https://huggingface.co/spaces/evaluate-measurement/leaderboard>

11 Practical Projects and Applications

11.1 End-to-End Gen AI Projects

- Build complete applications leveraging generative AI.
 - [LangChain Practical Projects](https://github.com/gkamradt/langchain-tutorials)
<https://github.com/gkamradt/langchain-tutorials>
 - [Microsoft TaskWeaver Framework](https://github.com/microsoft/TaskWeaver)
<https://github.com/microsoft/TaskWeaver>

11.2 Industry-Specific Applications

- Learn how generative AI is transforming specific industries.
 - [McKinsey: Generative AI in Healthcare](https://www.mckinsey.com/capabilities/quantumblack/our-insights/generative-ai-in-healthcare)
<https://www.mckinsey.com/capabilities/quantumblack/our-insights/generative-ai-in-healthcare>
 - [AWS Gen AI Case Studies](https://aws.amazon.com/solutions/case-studies/generative-ai/)
<https://aws.amazon.com/solutions/case-studies/generative-ai/>

12 Ethical Considerations and Responsible AI

12.1 Ethical Frameworks

- Understanding ethical considerations in generative AI development.
 - [Stanford HAI Ethics Framework](https://hai.stanford.edu/sites/default/files/2020-09/AI-Ethics-Framework_HDSI.pdf)
https://hai.stanford.edu/sites/default/files/2020-09/AI-Ethics-Framework_HDSI.pdf
 - [UNESCO AI Ethics Guidelines](https://www.unesco.org/en/artificial-intelligence/recommendation-ethics)
<https://www.unesco.org/en/artificial-intelligence/recommendation-ethics>

12.2 Bias Mitigation

- Techniques to identify and reduce bias in generative models.
 - [Ethical Considerations in NLP Research](https://huggingface.co/blog/ethics-soc-2)
<https://huggingface.co/blog/ethics-soc-2>
 - [Anthropic's Red Teaming Approach](https://www.anthropic.com/research/red-teaming-language-models-to-reduce-harms)
<https://www.anthropic.com/research/red-teaming-language-models-to-reduce-harms>

13 Future Directions in Generative AI

13.1 Multimodal Models

- Explore models that handle multiple modalities (text, image, audio).
 - [GPT-4V System Card](https://openai.com/research/gpt-4v-system-card)
<https://openai.com/research/gpt-4v-system-card>
 - [Multimodal Reasoning in LLMs](https://huggingface.co/blog/multimodal-reasoning)
<https://huggingface.co/blog/multimodal-reasoning>

13.2 AI Research Frontiers

- Cutting-edge research directions in generative AI.
 - [Mamba: State-Space Models](https://arxiv.org/abs/2312.11805)
<https://arxiv.org/abs/2312.11805>
 - [Practical Guide to LLMs in Production](https://github.com/Mooler0410/LLMsPracticalGuide)
<https://github.com/Mooler0410/LLMsPracticalGuide>

14 Community Resources and Continuous Learning

14.1 Open Source Communities

- Join communities to collaborate and learn from peers.
 - [Hugging Face Community](https://huggingface.co/)
<https://huggingface.co/>
 - [LAION AI Organization](https://github.com/LAION-AI)
<https://github.com/LAION-AI>

14.2 Conferences and Workshops

- Stay updated with the latest research through conferences.
 - [NeurIPS Conference](https://neurips.cc/)
<https://neurips.cc/>
 - [ACL Conference Proceedings](https://aclanthology.org/venues/acl/)
<https://aclanthology.org/venues/acl/>