

Building Text-Based Applications with the ChatGPT API & LangChain

Lucas Soares

04-03-2024

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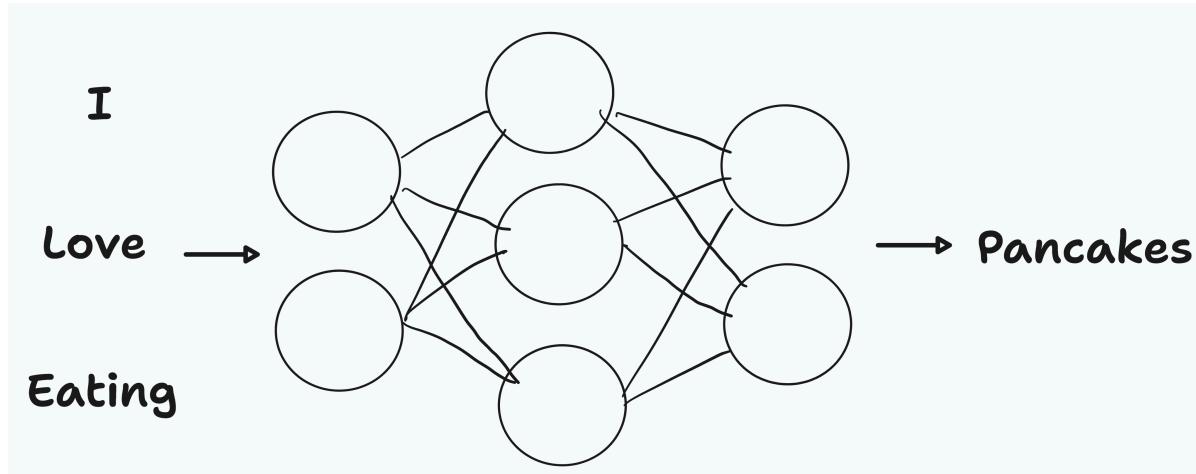
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- Repeat

Large Language Models

Large Language Models

Large Language Models Predict the Next Word



Applications of Large Language Models

- Conversational ChatBots



How can I help you today?

Explain nostalgia
to a kindergartener

Write a course overview
on the psychology behind decision-making

Brainstorm content ideas
for my new podcast on urban design

Compare business strategies
for transitioning from budget to luxury

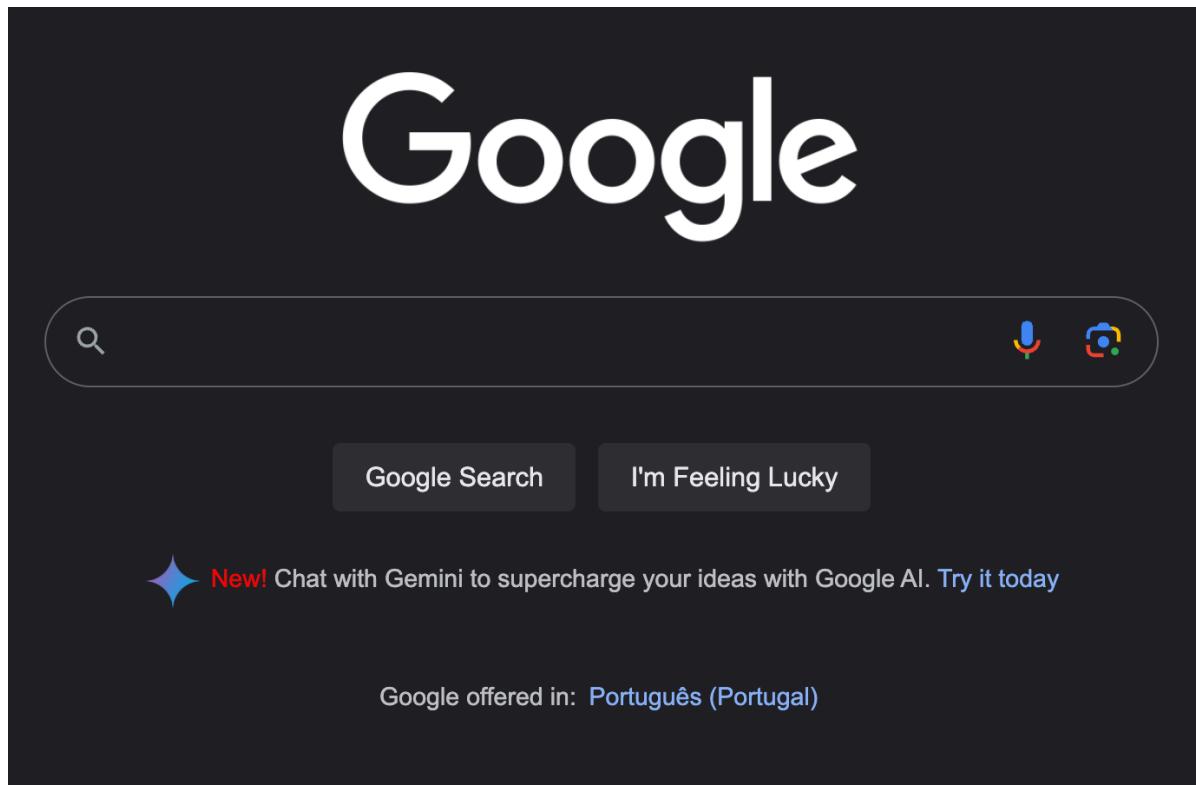
 Message ChatGPT... 

ChatGPT can make mistakes. Consider checking important information.

10 / 161

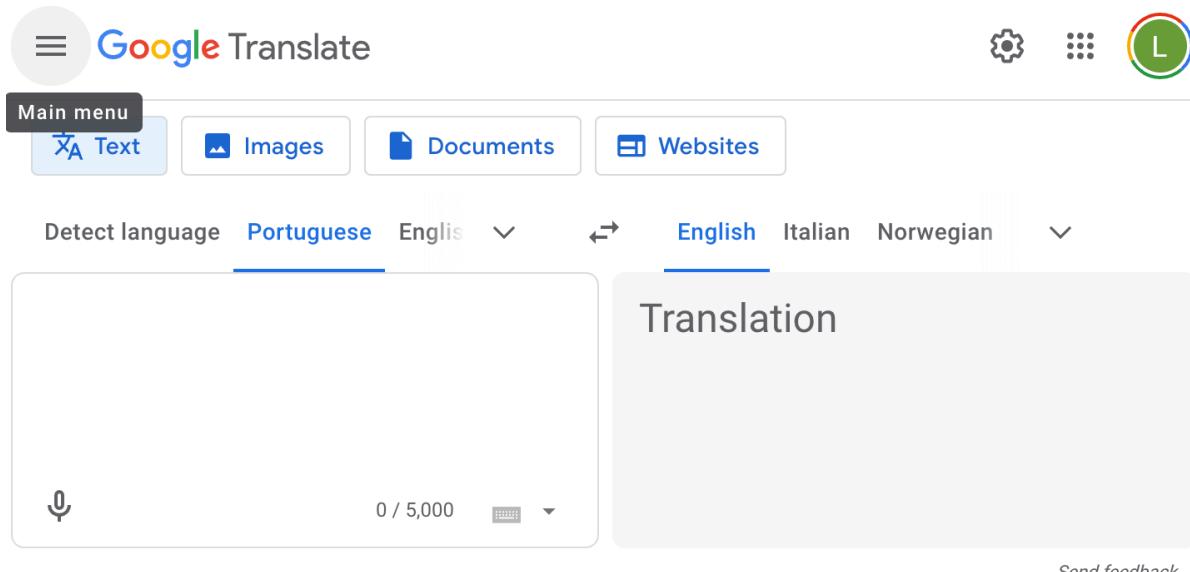
Applications of Large Language Models

- Search Engines



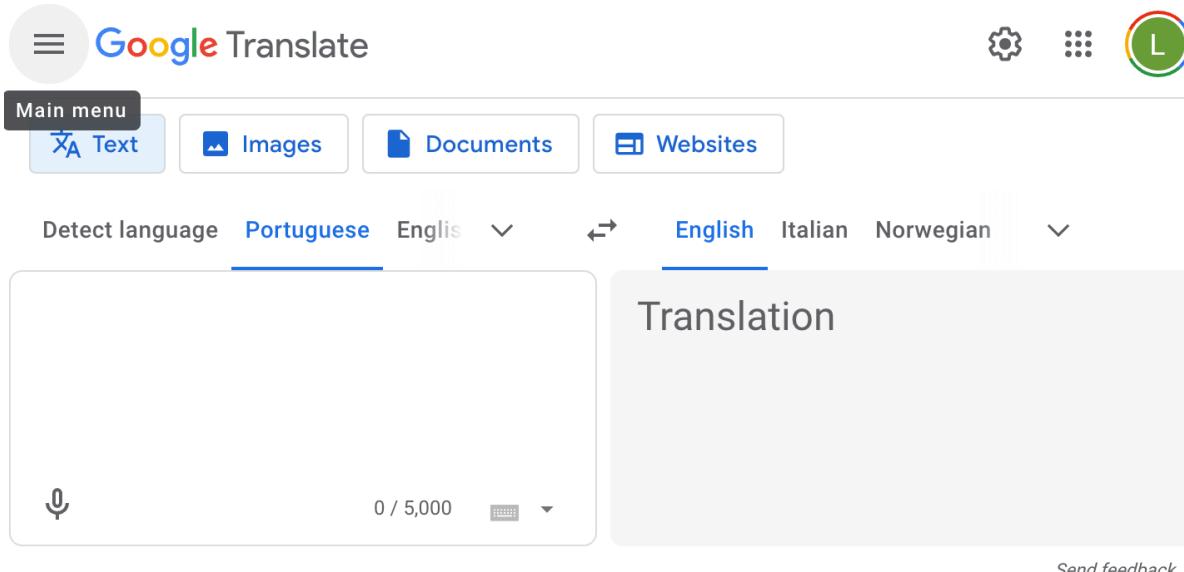
Applications of Large Language Models

- Translation



Applications of Large Language Models

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- And so much more from Q&A over PDFs to personalized tutoring.

Transformers

(Super quickly)

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They generate text one word at a time. For example:

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→ "PANCAKES!!!!"

Transformers

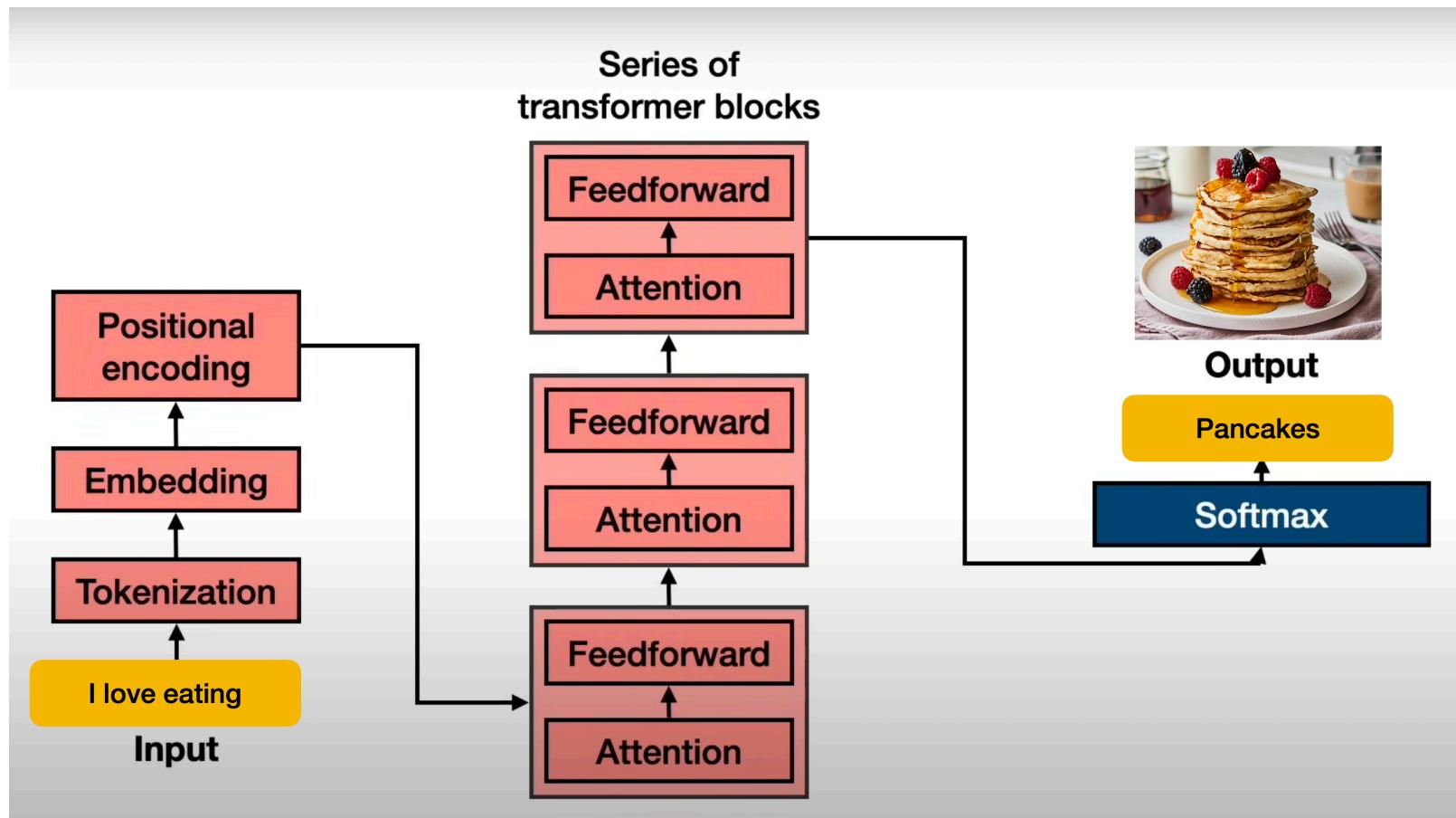
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Transformers



[1] [What are Transformers and How do They Work? By Serrano Academy](#)

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- Scalability
 - LLMs demonstrate excellent scalability to very large capacity networks and huge datasets.

Limitations and Ethical Considerations

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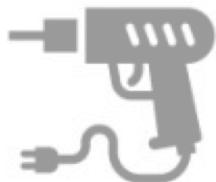
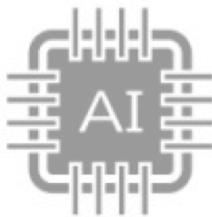
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- **Misuse:** LLMs can hallucinate and produce false or harmful content
- **Reproducibility:** Unpredictability of LLM behavior. Watkins 2023
- **Data Privacy and Bias:** Ethical considerations should extend to the acquisition of data for training additional models. Models may have biases; their use should be transparent and biases mitigated. Watkins 2023



Applications of LLMs
**Content
generation
Example - DEMO**

Demo App - Panda Letters

Q&A & Summary

- **LLMs predict the next word** and generate human-like text.
- **LLMs power diverse applications** including conversational chatbots, search engines, and translation services, demonstrating their versatility in handling various language tasks.
- **Transformer architecture** processes text sequentially, utilizing mechanisms like tokenization, embedding, positional encoding, and attention to understand context and generate relevant outputs.
- **Advantages of LLMs:** LLMs are multi-taskers capable of content generation, question answering, and more, with the ability to be fine-tuned for specific tasks and scale effectively to handle large datasets and complex models.
- **Benefits and Limitations:** Despite their benefits (multi-tasking, fine-tuning etc..), LLMs have limitations, including a fixed knowledge base, lack of true understanding, potential for misuse, and ethical concerns around data privacy and inherent biases.
- Optional Exercise
 - Set up your OpenAI API key and prepare for the practical demos

Break

Introduction to the ChatGPT API

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- Basic structure of calling the API:

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from openai import OpenAI
client = OpenAI()

def get_response(prompt_question):
    response = client.chat.completions.create(
        model="gpt-3.5-turbo-0125",
        messages=[{"role": "system", "content": "You are a helpful research and
                    {"role": "user", "content": prompt_question}]
    )

    return response.choices[0].message.content
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```

- Required parameters: `model`, `messages`

[2][OpenAI Docs](#)

Notebook Demo 1.0 - Intro to ChatGPT API & Prompt Basics

Prompt Basics



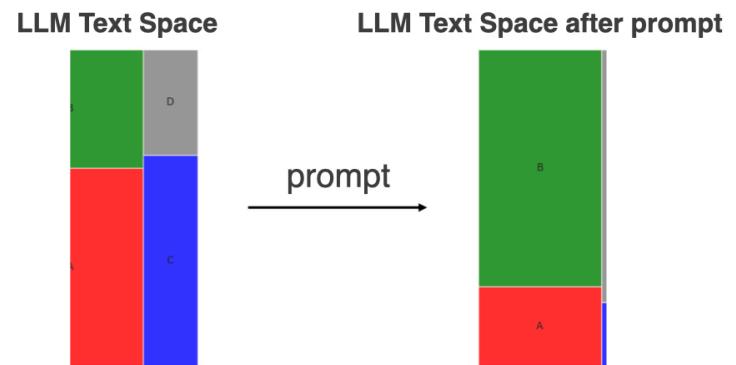
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- Question → Instruction → Behavior
- It **constrains the space of possibilities** in the LLM's text space



Prompt Basics

Components of the prompt

You are a text annotation engine.

Classify this sentence into positive or negative:

Text: *I like eating pancakes*

Output:

Prompt Basics

Components of the prompt: instruction



Instruction: where you describe what you want

You are a text annotation engine.
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Prompt Basics

Components of the prompt: **instruction**, **context**

- **Instruction:** where you describe what you want
- **Context:** additional information to help with performance.

→ You are a text annotation engine.
Classify this sentence into positive or negative:
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Prompt Basics

Components of the prompt: **instruction**, **context** **input data**



Instruction: where you describe what you want



Input data: example of data you wish the model to process



Context: additional information to help with performance.

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Classify this sentence into positive or negative:

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Prompt Basics

Components of the prompt: **instruction**, context **input data**, **output indicator**

- **Instruction:** where you describe what you want
- **Context:** additional information to help with performance.
- **Input data:** example of data you wish the model to process
- **Output indicator:** Priming model to output what you want (e.g. structure, length, etc..)

You are a text annotation engine.

Classify this sentence into positive or negative:

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Q&A & Summary

- **Prompts** are the inputs to LLMs
- **Prompts** allow users to **guide the model's responses** and generate specific outputs.
- **Components of a prompt:** instruction, context, input data, and output indicator.
- **ChatGPT API:** programmatic access to GPT models by OpenAI
- **ChatGPT API:** required parameters: `model`, `messages`
- **Optional Exercise During Q&A**

Create a prompt that summarizes a piece of text in a format/structure of your choice.

Break

Prompt Engineering Guide

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What is Prompt Engineering?

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- Prompt engineering: Discipline for engineering prompts

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- The goal is to **design good prompts**

Prompt Engineering Guide

What is Prompt Engineering?

- Prompt engineering: Discipline for engineering prompts
- The goal is to **design good prompts**
- Process for developing prompts that yield high performance in a task.

Prompt Engineering Guide

OpenAI's Guide for Building Good Prompts

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- **Strategy 1: Write clear instructions**

Prompt Engineering Guide

OpenAI's Guide for Building Good Prompts

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- **Bad:** Who's president?

Prompt Engineering Guide

OpenAI's Guide for Building Good Prompts

- **Strategy 1: Write clear instructions**
- **Bad:** Who's president?
- **Better:** Who was the president of Mexico in 2021?

[3][OpenAI's Prompt Engineering Guide](#)

Prompt Engineering Guide

OpenAI's Guide for Building Good Prompts

- **Strategy 2: Provide reference text**

Prompt Engineering Guide

OpenAI's Guide for Building Good Prompts

- Strategy 2: Provide reference text

SYSTEM

Use the provided articles delimited by triple quotes to answer questions. If the answer cannot be found in the articles, write "I could not find an answer."

USER

<insert articles, each delimited by triple quotes>

Question: <insert question here>

[3] [OpenAI's Prompt Engineering Guide](#)

Prompt Engineering Guide

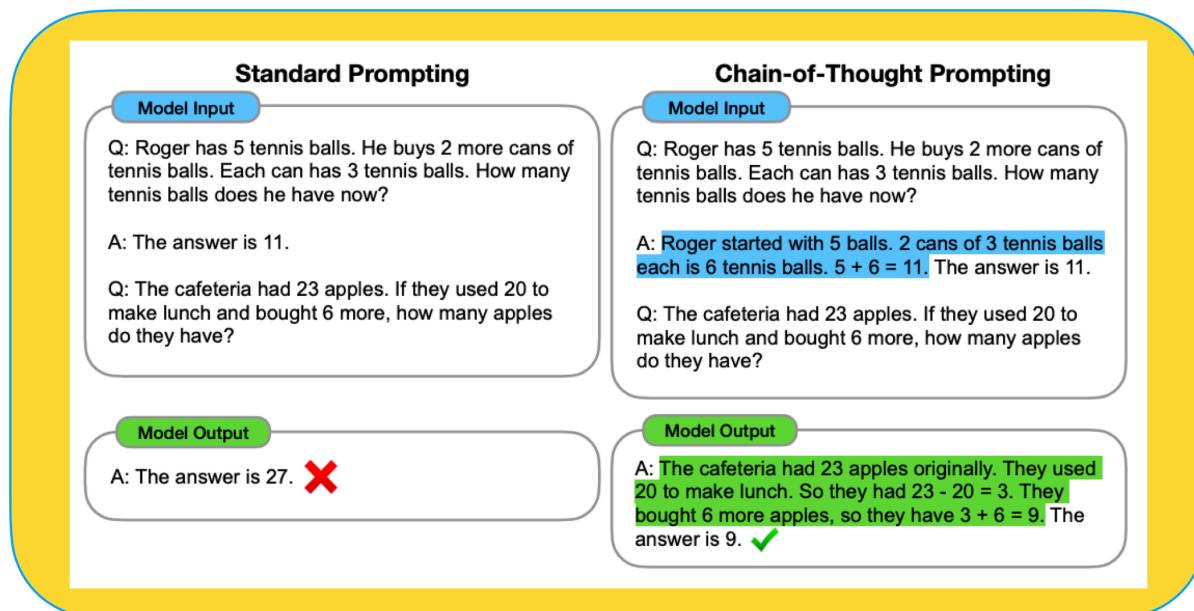
OpenAI's Guide for Building Good Prompts

- **Strategy 3: Break tasks into subtasks**

Prompt Engineering Guide

OpenAI's Guide for Building Good Prompts

- Strategy 3: Break tasks into subtasks



[3] [OpenAI's Prompt Engineering Guide](#)

Prompt Engineering Guide

OpenAI's Guide for Building Good Prompts

- **Strategy 4: Give the model time to think**

Prompt Engineering Guide

OpenAI's Guide for Building Good Prompts

- **Strategy 4: Give the model time to think**

SYSTEM

Follow these steps to answer the user queries.

Step 1 - First work out your own solution to the problem. Don't rely on the student's solution since it may be incorrect. Enclose all your work for this step within triple quotes (""""").

Step 2 - Compare your solution to the student's solution and evaluate if the student's solution is correct or not. Enclose all your work for this step within triple quotes (""""").

Step 3 - If the student made a mistake, determine what hint you could give the student without giving away the answer. Enclose all your work for this step within triple quotes (""""").

Step 4 - If the student made a mistake, provide the hint from the previous step to the student (outside of triple quotes). Instead of writing "Step 4 - ..." write "Hint:".

USER

Problem Statement: <insert problem statement>

Student Solution: <insert student solution>

Prompt Engineering Guide

OpenAI's Guide for Building Good Prompts

- **Strategy 5: Use external tools**

Prompt Engineering Guide

OpenAI's Guide for Building Good Prompts

- **Strategy 5: Use external tools**

SYSTEM

You can write and execute Python code by enclosing it in triple backticks, e.g. ``code goes here``. Use this to perform calculations.

USER

Find all real-valued roots of the following polynomial: $3*x^{**5} - 5*x^{**4} - 3*x^{**3} - 7*x - 10$.

[3] [OpenAI's Prompt Engineering Guide](#)

Prompt Engineering Guide

OpenAI's Guide for Building Good Prompts

- **Strategy 6: Test changes systematically**

Prompt Engineering Guide

OpenAI's Guide for Building Good Prompts

- **Strategy 6: Test changes systematically**

Evaluation procedures are useful for optimizing system designs. **Good evals are:**

- **Representative** of real-world usage (or at least diverse)
- **Contain many test cases** for greater statistical power (see table below for guidelines)
- **Easy to automate** or repeat

[3] [OpenAI's Prompt Engineering Guide](#)

Notebook Demo 2.0 - Applying Prompt Engineering Strategies

Notebook Demo 2.1 - Prompt Engineering Guide

Q&A & Summary

- **Prompt Engineering** is the discipline for engineering prompts
- **Prompt Engineering** aims to design prompts that yield high performance across tasks.
- **OpenAI's Guide for Building Good Prompts** includes strategies like writing clear instructions, providing reference text, breaking tasks into subtasks, giving the model time to think, using external tools, and testing changes systematically.
- **Optional Exercise During Q&A**

Craft a prompt that can answer questions about a specific topic.
Remember to incorporate the strategies discussed.

Break

Fine Tuning ChatGPT Applications

A primer on how to fine tune ChatGPT on your data



Fine Tuning:

Fine Tuning ChatGPT Applications

A primer on how to fine tune ChatGPT on your data



Fine Tuning: process of “specialising an LLM on your specific dataset”

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Why?

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Why? Better results on specific tasks, lower latency... [See OpenAI docs](#)

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How?

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How? By preparing a custom `.jsonl` dataset on your specific use case

The goal of fine tuning is to adapt the model to your specific use case by providing it with a few examples of successful interactions

[4] [OpenAI's Fine Tuning Docs](#)

Fine Tuning ChatGPT Applications

Common Use Cases

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Setting style, tone,
format

[OpenAI docs](#)

Fine Tuning ChatGPT Applications

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[OpenAI docs](#)

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[OpenAI docs](#)

Fine Tuning ChatGPT Applications

Common Use Cases

-  | Setting style, tone, format
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[OpenAI docs](#)

Fine Tuning ChatGPT Applications

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-  | Extracting structured output

[OpenAI docs](#)

Fine Tuning ChatGPT Applications

Common Use Cases

- | | |
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|  Setting style, tone, format |  Handling edge cases |
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|  Improving reliability |  Function Calling |

[OpenAI docs](#)

Fine Tuning ChatGPT Applications

Basic Steps

[OpenAI docs](#)

Fine Tuning ChatGPT Applications

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Prepare and upload training data

[OpenAI docs](#)

Fine Tuning ChatGPT Applications

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Fine Tuning ChatGPT Applications

Basic Steps

- | Prepare and upload training data
- | Train a new fine-tuned model

[OpenAI docs](#)

Fine Tuning ChatGPT Applications

Fine Tuning Jobs

```
from openai import OpenAI
# OpenAI API key should be set as
# environment variable - OPENAI_API_KEY
client = OpenAI()
client.files.create(
    file=open("dataset.jsonl", "rb"),
    purpose="fine-tune"
)
client.fine_tuning.jobs.create(
    training_file="file-id",
    model="gpt-3.5-turbo-1106"
)
```

Fine Tuning ChatGPT Applications

Basic Steps

- | Prepare and upload training data
- | Train a new fine-tuned model
- | Use your fine-tuned model

[OpenAI docs](#)

Fine Tuning ChatGPT Applications

Fine Tuning Jobs

```
def get_response(prompt, fine_tuned_model_id="ft:gpt-3.5-turbo-1106:personal::80q91T4e"): ←
    client = OpenAI()
    response = client.chat.completions.create(model=fine_tuned_model_id,
                                                messages=
                                                [
                                                    {"role": "system", "content": "You are a helpful assistant."},
                                                    {"role": "user", "content": prompt}
                                                ],
                                                temperature=0.0,
                                                n = 1
                                            )
    return response.choices[0].message.content
```

Disclaimer: Example code is provided in the repository notebooks

Notebook Demo 3.0 - Fine Tuning ChatGPT API

What is Langchain?



What is Langchain?



- **LangChain is a framework that facilitates creation of LLM-based applications**

What is Langchain?



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- **Main features:**

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 - components
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- **LangChain is a framework that facilitates creation of LLM-based applications**
- **Main features:**
 - components
 - off-the-shelf-chains
- LangChain gives you building blocks for creating powerful LLM applications

^[5][LangChain Docs](#)

LangChain Components

LangChain Components

Models

LangChain Components

Models

- Abstractions over the LLM APIs like the ChatGPT API

LangChain Components

Models

- Abstractions over the LLM APIs like the ChatGPT API

```
from langchain_openai import ChatOpenAI

chat_model = ChatOpenAI(model="gpt-3.5-turbo-0125")

output = chat_model.invoke("I am teaching a live-training\
    about LLMs!")

print(output.content)
```

[5] [LangChain Docs](#)

LangChain Components

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Prompt Templates

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- Abstractions over standard prompts to LLMs

LangChain Components

Prompt Templates

- Abstractions over standard prompts to LLMs

```
from langchain_core.prompts import ChatPromptTemplate

prompt = ChatPromptTemplate.from_template(
    """Show me 5 examples of this concept: {concept}"""
)

prompt.format(concept="animal")

# Output
# 'Human: Show me 5 examples of this concept: animal'
```

[5] [LangChain Docs](#)

LangChain Components

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Output Parsers

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Output Parsers

- Translates raw output from LLM to a workable format

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- Translates raw output from LLM to a workable format

```
from langchain_core.output_parsers import StrOutputParser
output_parser = StrOutputParser()
```

^[5][LangChain Docs](#)

Chains in LangChain

Chains in LangChain

Chain = Model + Prompt + Output Parser

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- They are used to compose abstractions that go from simple to complex components

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- Chains are the building blocks in LangChain
- They are used to compose abstractions that go from simple to complex components

```
llm = ChatOpenAI(model="gpt-3.5-turbo-0125")
prompt = ChatPromptTemplate.from_template("""
    output_parser = StrOutputParser()
    Write 5 concepts that are fundamental to learn about {topic}.
    """)
chain = prompt | llm | output_parser
chain.invoke({"topic": "Artificial Neural Networks"})
```

[5] [LangChain Docs](#)

LCEL - LangChain Expression Language

Composing Chains with LCEL

LCEL - LangChain Expression Language

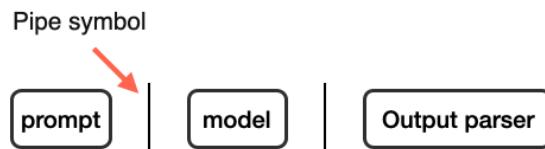
Composing Chains with LCEL

- LCEL is a powerful, declarative language designed to streamline the composition of complex chains in the LangChain framework.

LCEL - LangChain Expression Language

Composing Chains with LCEL

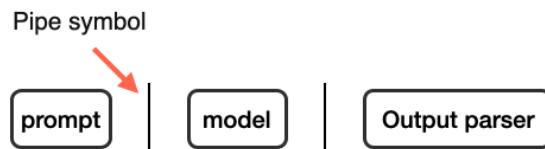
- LCEL is a powerful, declarative language designed to streamline the composition of complex chains in the LangChain framework.
- Pipe syntax



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LCEL - LangChain Expression Language

Composing Chains with LCEL

- LCEL is a powerful, declarative language designed to streamline the composition of complex chains in the LangChain framework.
- Pipe syntax



```
chain = prompt | llm | output_parser
```

- Allows you to build complex chain pipelines with a simple standard interface

^[5][LangChain Docs](#)

LCEL - Runnables

- To facilitate creation of custom chains, LangChain has implemented a **"Runnable" protocol.**

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LCEL - Runnables

- To facilitate creation of custom chains, LangChain has implemented a **"Runnable" protocol.**
- The standard interface includes `stream`, `invoke`, and `batch` methods. Async methods are also available
- The input type and output type vary by component:

Component	Input Type	Output Type
Prompt	Dictionary	PromptValue
ChatModel	Single string, list of chat messages or a PromptValue	ChatMessage
LLM	Single string, list of chat messages or a PromptValue	String
OutputParser	The output of an LLM or ChatModel	Depends on the parser
Retriever	Single string	List of Documents
Tool	Single string or dictionary, depending on the tool	Depends on the tool

Notebook Demo 4.0 - Intro to LangChain

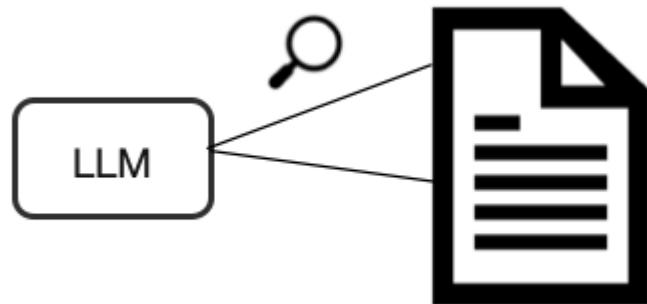
Q&A & Summary

- Fine tuning ChatGPT API: process of training a pre-trained model on a specific task or dataset.
- Fine tuning steps for the ChatGPT API: prepare the data, train the model, use the model.
- **LLMs can predict the next word in a sequence.** ("I Like eating...? ;P ")
- **Chains** are the building blocks in LangChain, composed of Models, Prompt Templates, and Output Parsers.
- **LCEL** is a declarative language that users the Unix pipe symbol to build complex chain pipelines with a simple standard interface.
- Optional Exercise During Q&A

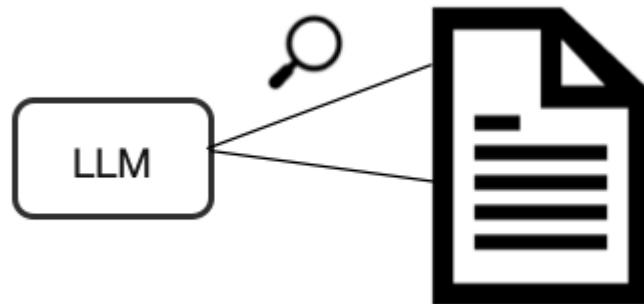
Create a simple chain that can answer questions about a specific topic.

Break 5 minutes

LangChain for Chat Over Documents

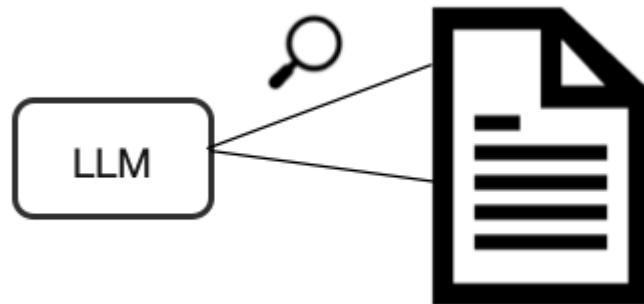


LangChain for Chat Over Documents



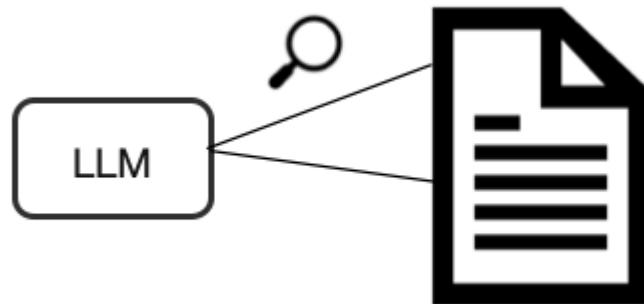
- RAG = Retrieval Augmented Generation

LangChain for Chat Over Documents



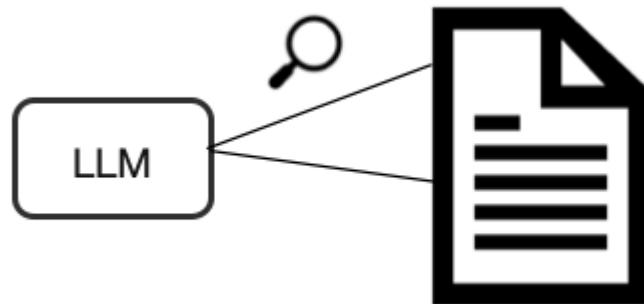
- RAG = **R**etrieval **A**ugmented **G**eneration
- It's about connecting LLMs to documents like PDFs, Text files, HTML, etc.

LangChain for Chat Over Documents



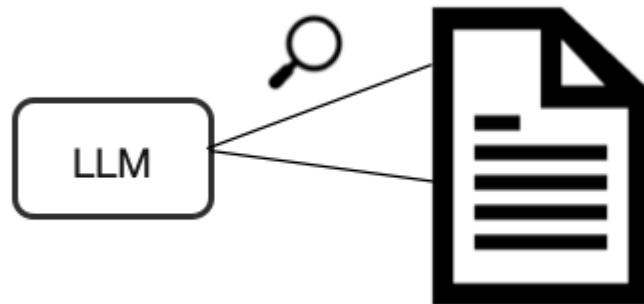
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- How do we get around the context length limitations of LLMs?

LangChain for Chat Over Documents



- RAG = **Retrieval Augmented Generation**
- It's about connecting LLMs to documents like PDFs, Text files, HTML, etc.
- How do we get around the context length limitations of LLMs?
- Quick Answer is **Embeddings!**

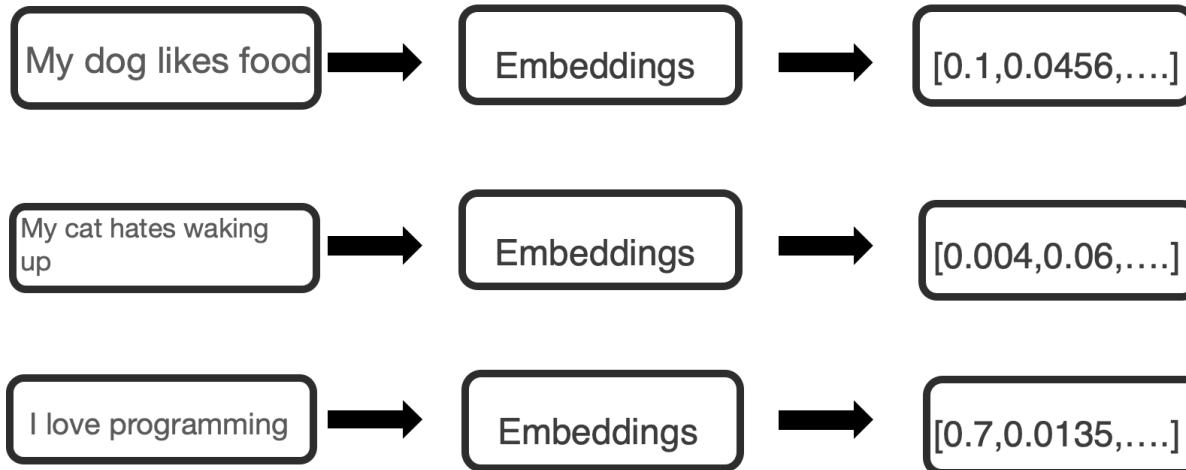
LangChain for Chat Over Documents



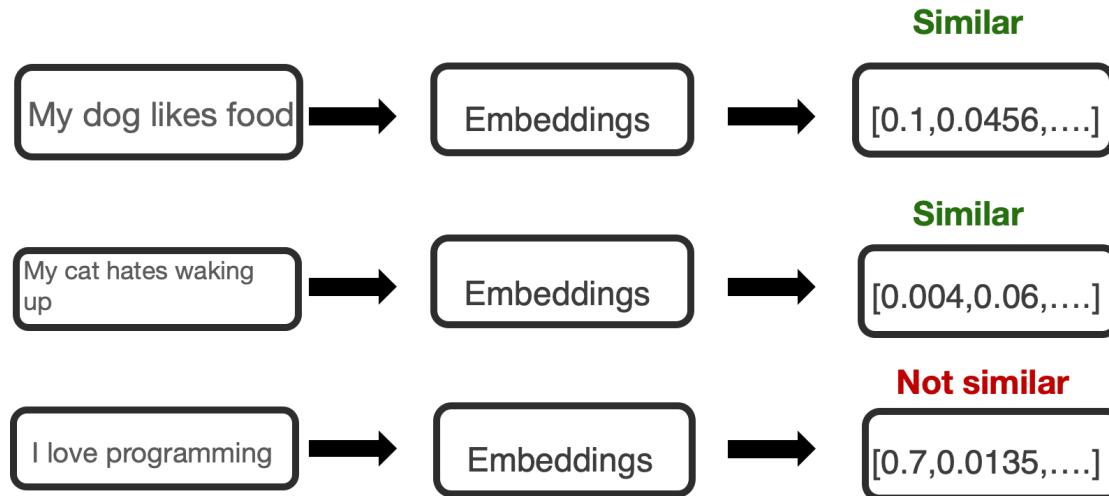
- Embeddings are vectorized representations of text



LangChain for Chat Over Documents

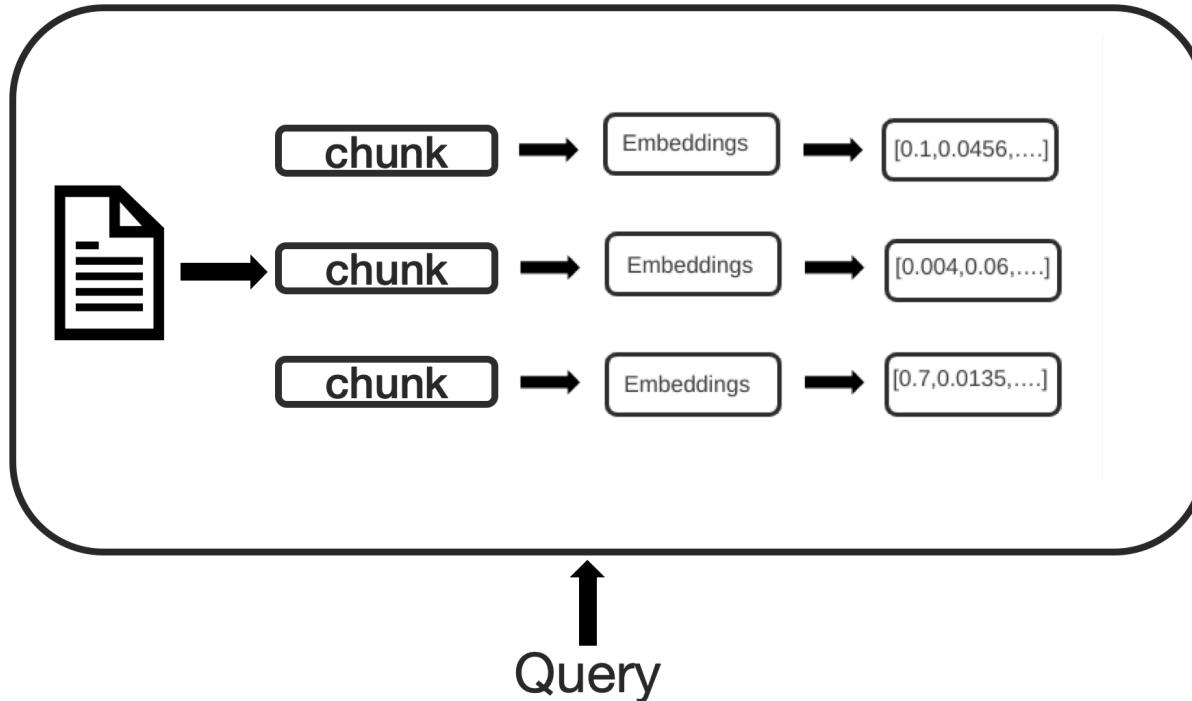


LangChain for Chat Over Documents



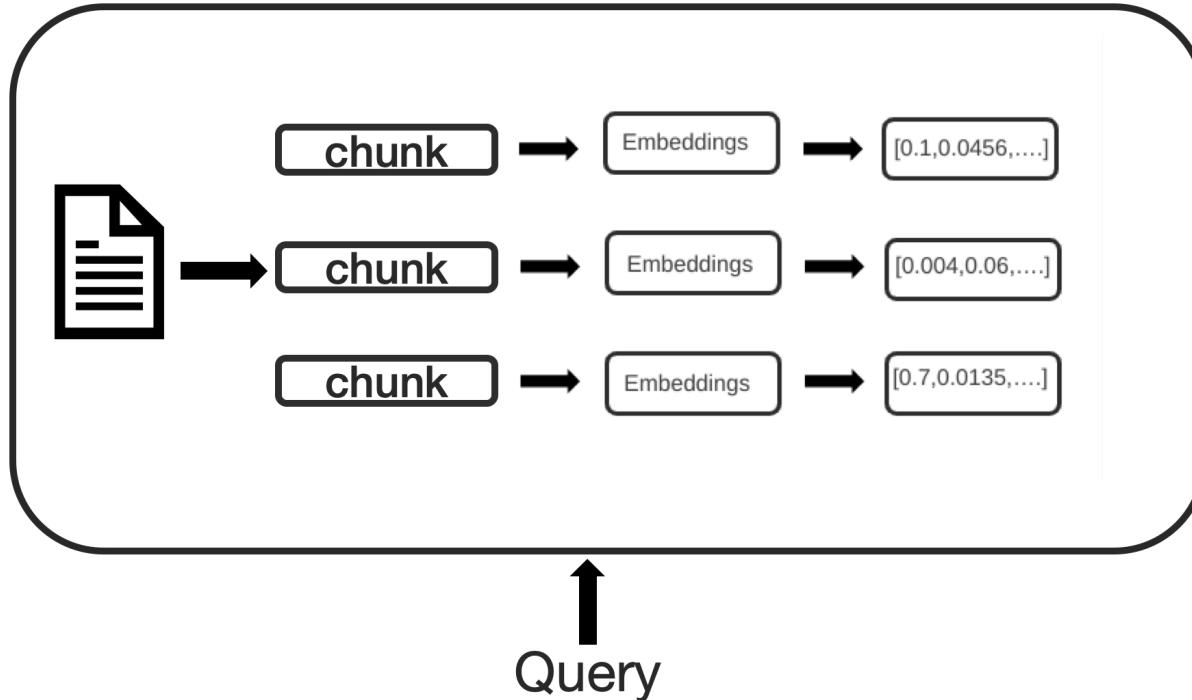
- Embeddings capture content and meaning

LangChain for Chat Over Documents



- Embeddings capture content and meaning
- Vector DBs

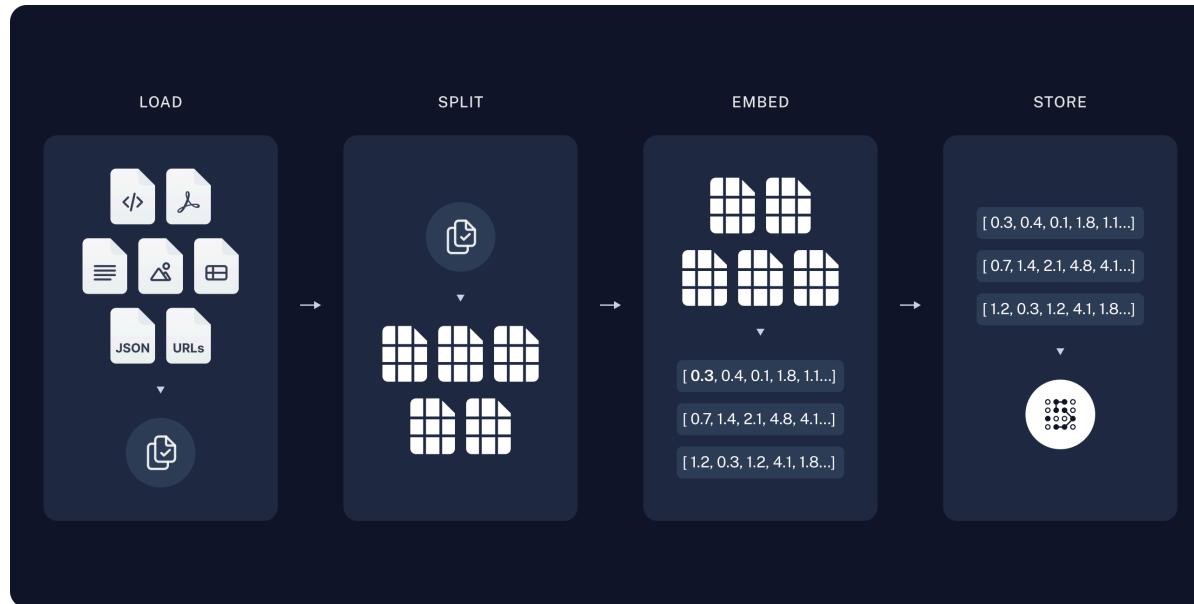
LangChain for Chat Over Documents



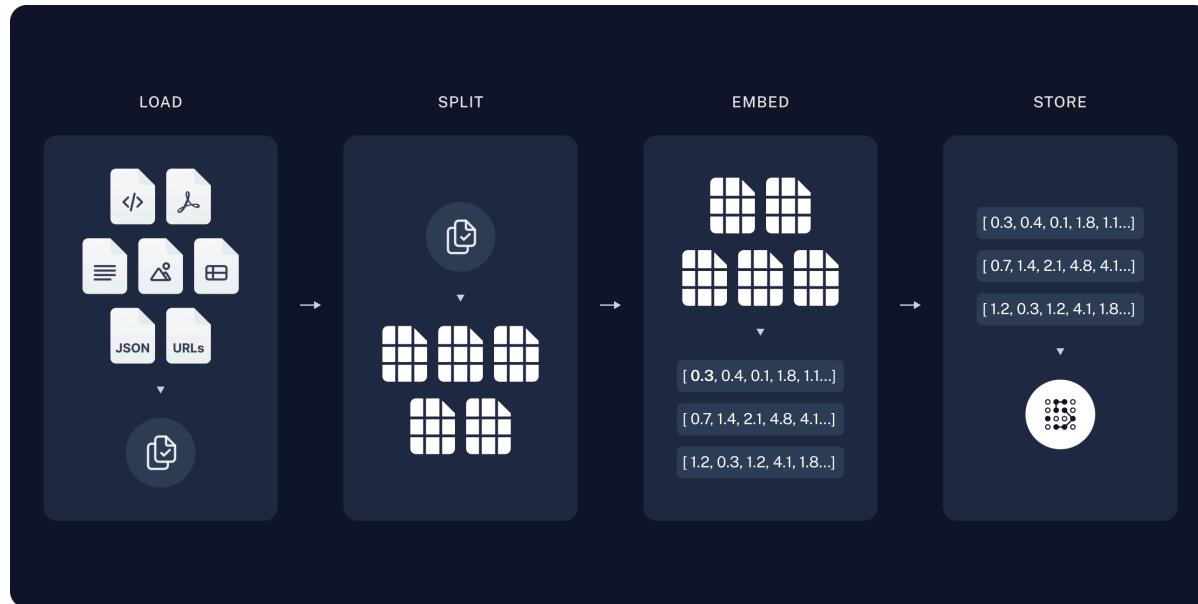
- Embeddings capture content and meaning
- Vector DBs
- How to build RAG systems with LangChain?

LangChain for Chat Over Documents

LangChain for Chat Over Documents

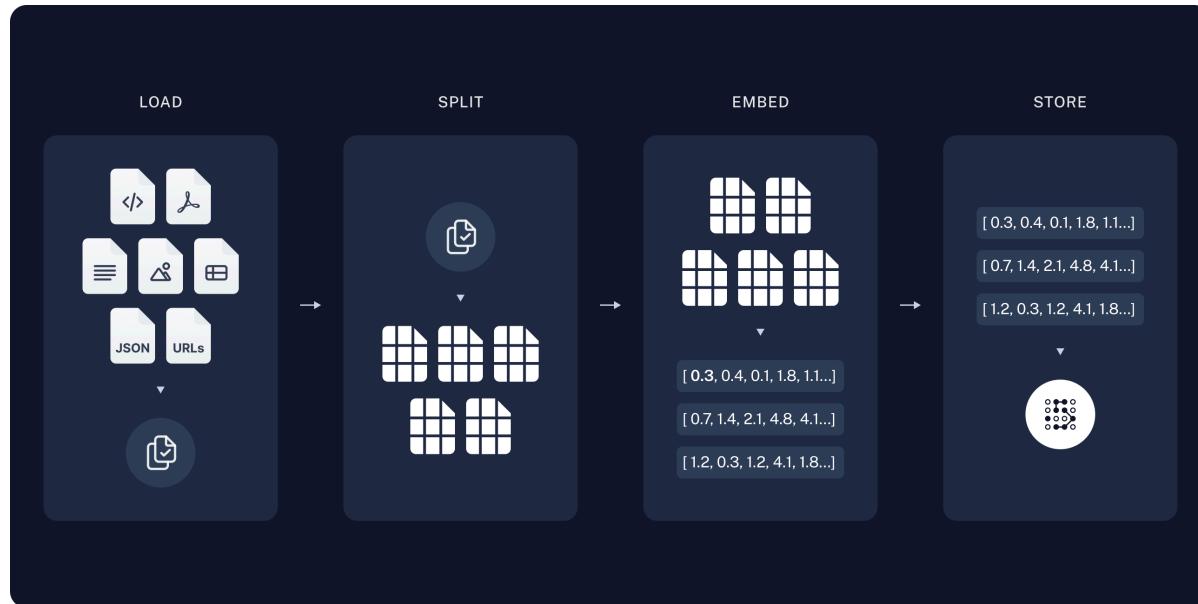


LangChain for Chat Over Documents



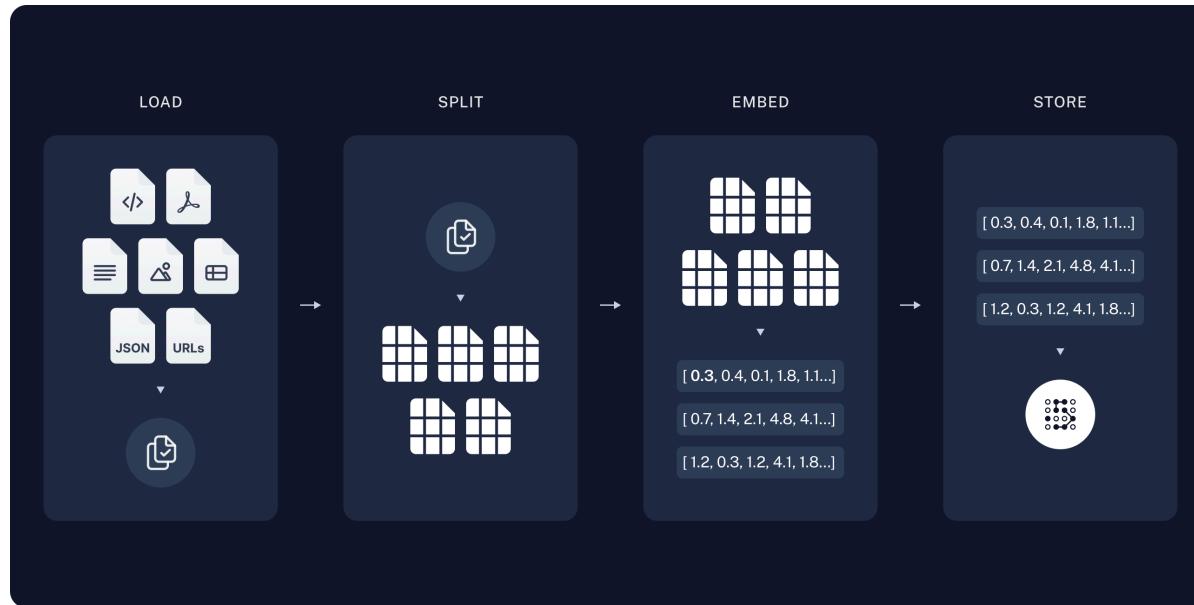
- Load

LangChain for Chat Over Documents



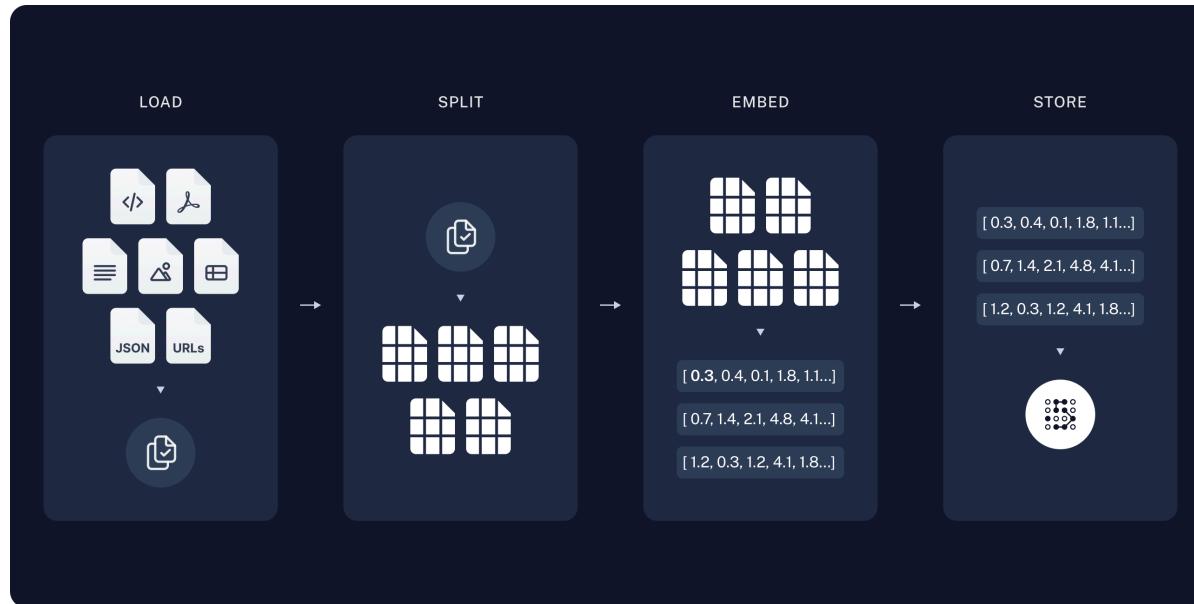
- Load
- Split

LangChain for Chat Over Documents



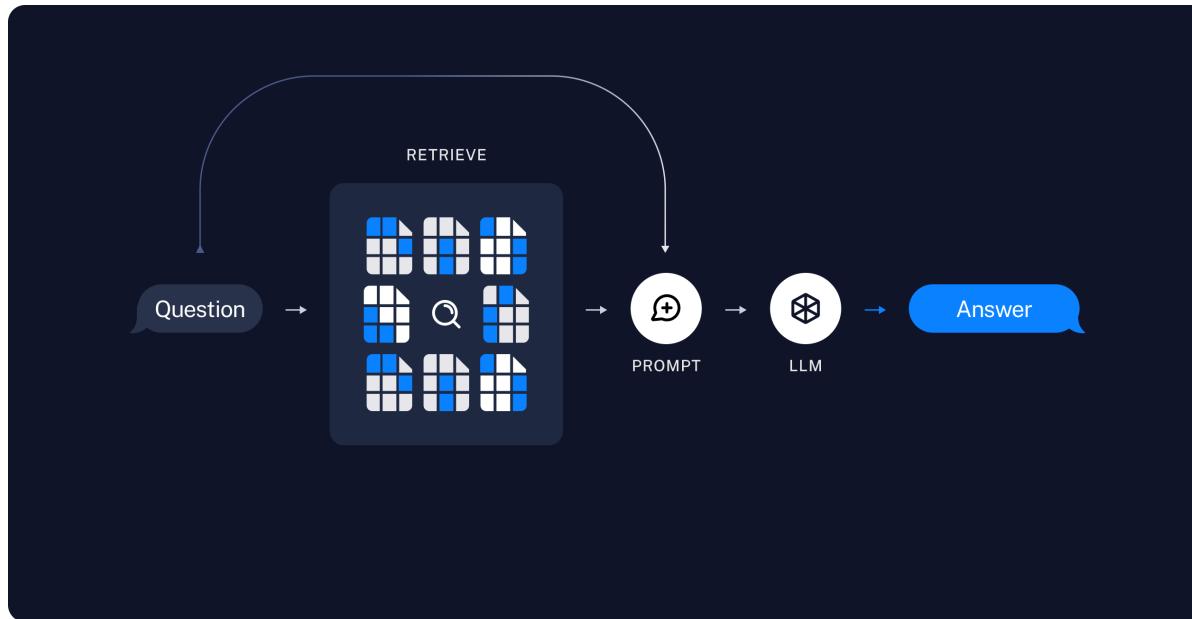
- Load
- Split
- Embed

LangChain for Chat Over Documents

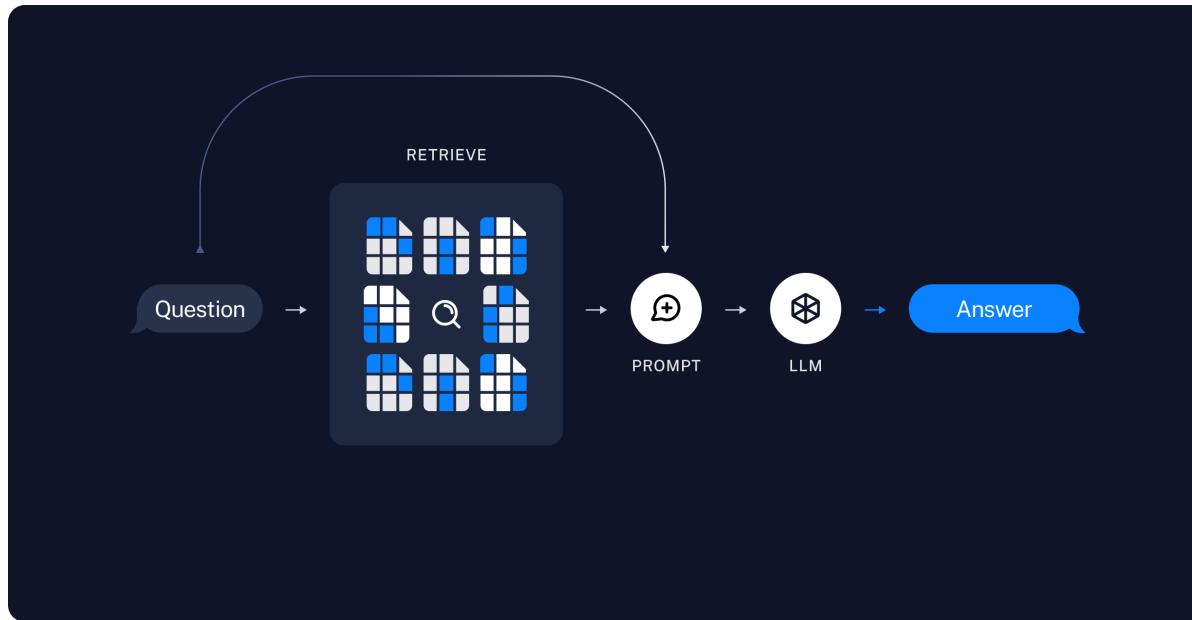


- Load
- Split
- Embed
- Store

LangChain for Chat Over Documents

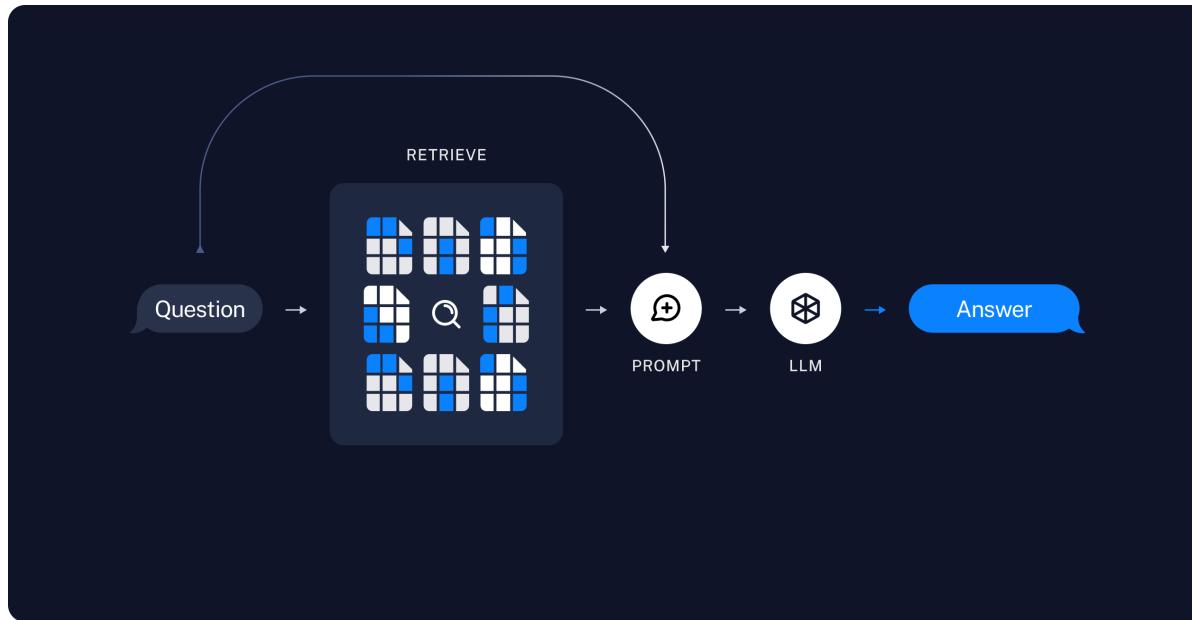


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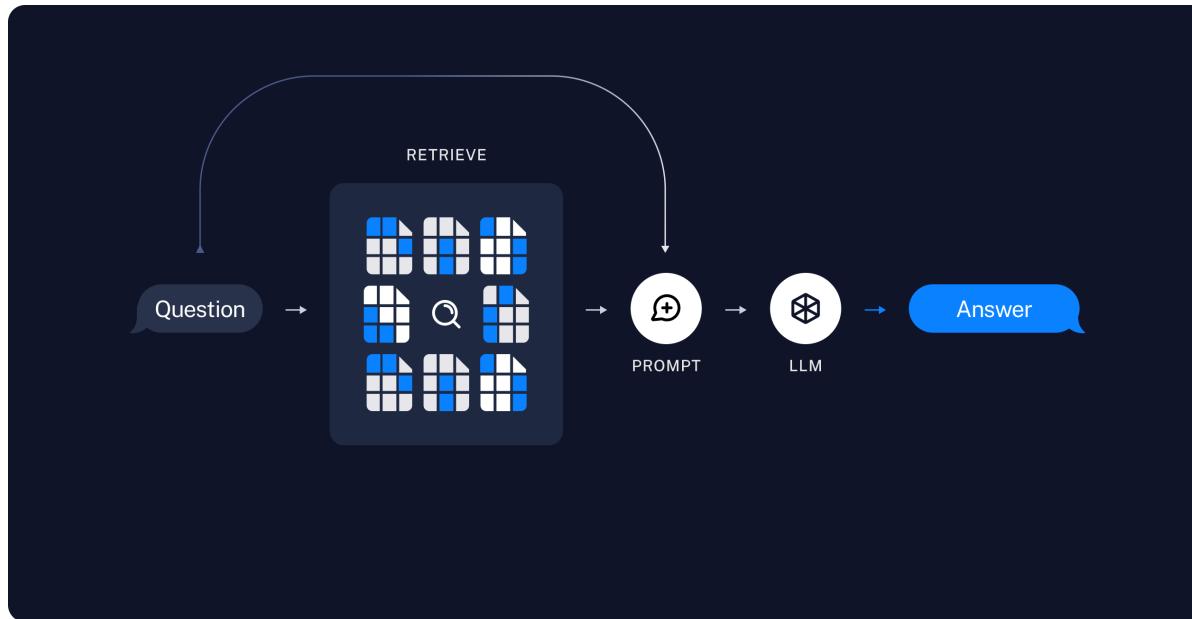
- Retrieval Piepline

LangChain for Chat Over Documents



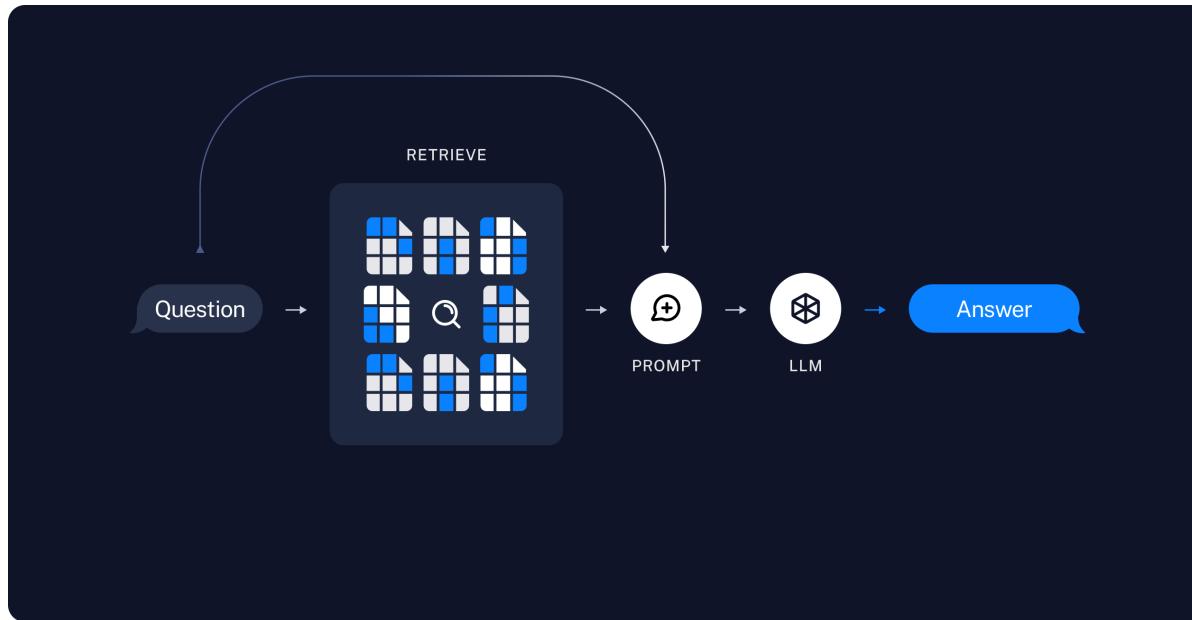
- Retrieval Piepline
 - Input Question

LangChain for Chat Over Documents



- Retrieval Piepline
 - Input Question
 - Retrieve Relevant Documents

LangChain for Chat Over Documents



- Retrieval Piepline
 - Input Question
 - Retrieve Relevant Documents
 - LLM uses the prompt question + retrieved data to produce a final answer

LangChain for Chat Over Documents

- Sample Code

```
from langchain import hub
from langchain_community.vectorstores import Chroma
from langchain_openai import ChatOpenAI, OpenAIEMBEDDINGS
from langchain.document_loaders import PyPDFLoader
from langchain.chains import RetrievalQA

pdf_path = "path-to-pdf.pdf"
loader = PyPDFLoader(pdf_path) # LOAD
pdf_docs = loader.load_and_split() # SPLIT
embeddings = OpenAIEMBEDDINGS() # EMBED
vectordb = Chroma.from_documents(pdf_docs, embedding=embeddings) # STORE
retriever = vectordb.as_retriever()
llm = ChatOpenAI(model="gpt-3.5-turbo-0125")
pdf_qa = RetrievalQA.from_llm(llm=llm, retriever=retriever) # RETRIEVE
pdf_qa.invoke("What is this paper about?") # ANSWER
```

Notebook Demo 4.1 - Q&A with LangChain

Q&A & Summary

- **RAG** = Retrieval Augmented Generation
- **RAG** is about connecting LLMs to documents like PDFs, Text files, HTML, etc.
- **Embeddings** are vectorized representations of text that capture content and meaning.
- **Vector DBs** are used to store and retrieve embeddings.
- **RAG** systems with LangChain are built using a pipeline that includes loading, splitting, embedding, and storing documents.
- **Optional Exercise During Q&A**

Create a simple RAG system with LangChain that can answer questions about pdfs or csvs.

Break

Practical Session

References

1. [What are Transformers and How do They Work? By Serrano Academy.](#)
2. [OpenAI Docs](#)
3. [OpenAI's Prompt Engineering Guide](#)
4. [OpenAI's Fine Tuning Docs](#)
5. [LangChain Docs](#)
6. [ReACT Paper](#)

