Build a PDF Q&A chatbot using Azure OpenAI and Streamlit

OpenAI

Streamlit

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Agenda

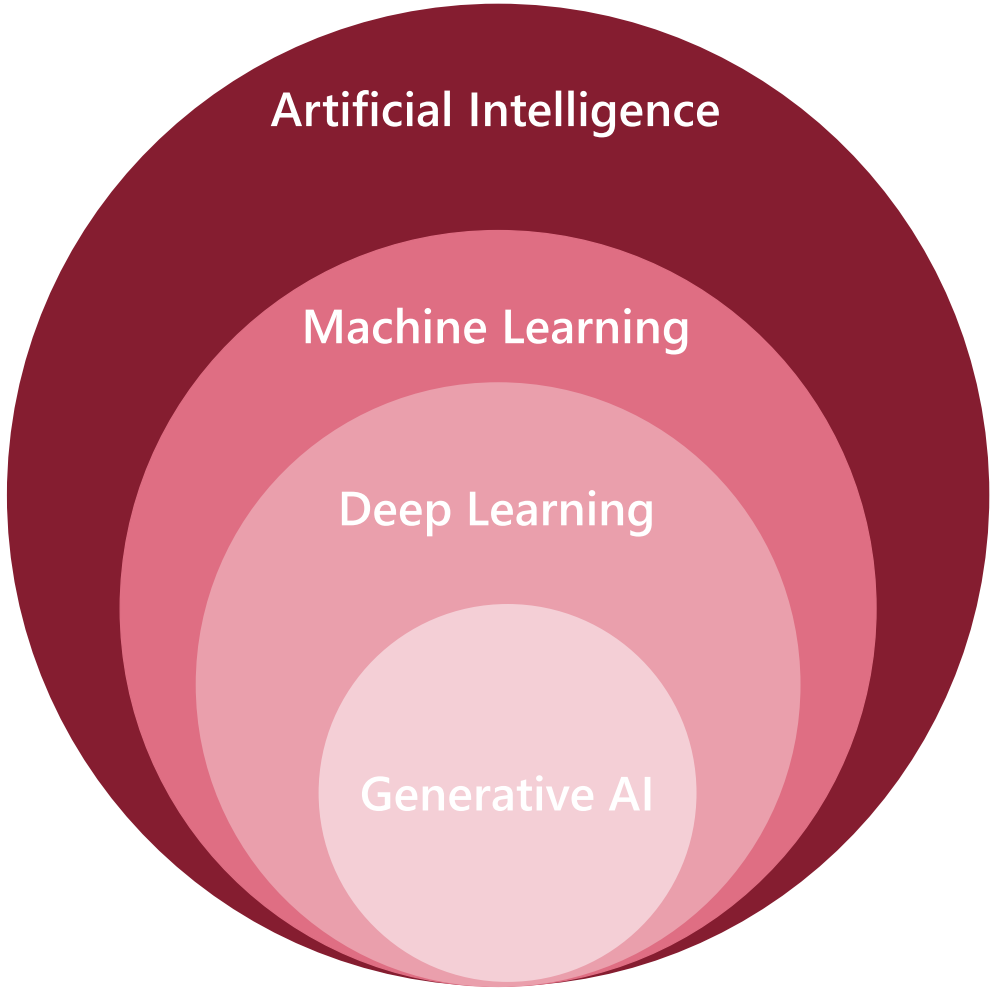
1. **Background & Problem Statement**
2. **Environment Setup**
   - 2.1. Build a virtual environment
   - 2.2. Activate the virtual environment
   - 2.3. Install dependencies
3. **Building the User Interface Using Streamlit Application**
   - 3.1. Design the Application Interface
   - 3.2. Upload the Pdf file
4. **Building The Application Backend Using LangChain & Azure OpenAI API**
   - 4.1. Setup Azure OpenAI API
   - 4.2. Load & processing Pdf file
   - 4.3. Prompt Handling & Generating Answers
5. **Putting Everything Together & Application Demo**

Streamlit

LangChain

LlamaIndex

What is Generative AI?



1956

Artificial Intelligence

the field of computer science that seeks to create intelligent machines that can replicate or exceed human intelligence

1997

Machine Learning

subset of AI that enables machines to learn from existing data and improve upon that data to make decisions or predictions

2017

Deep Learning

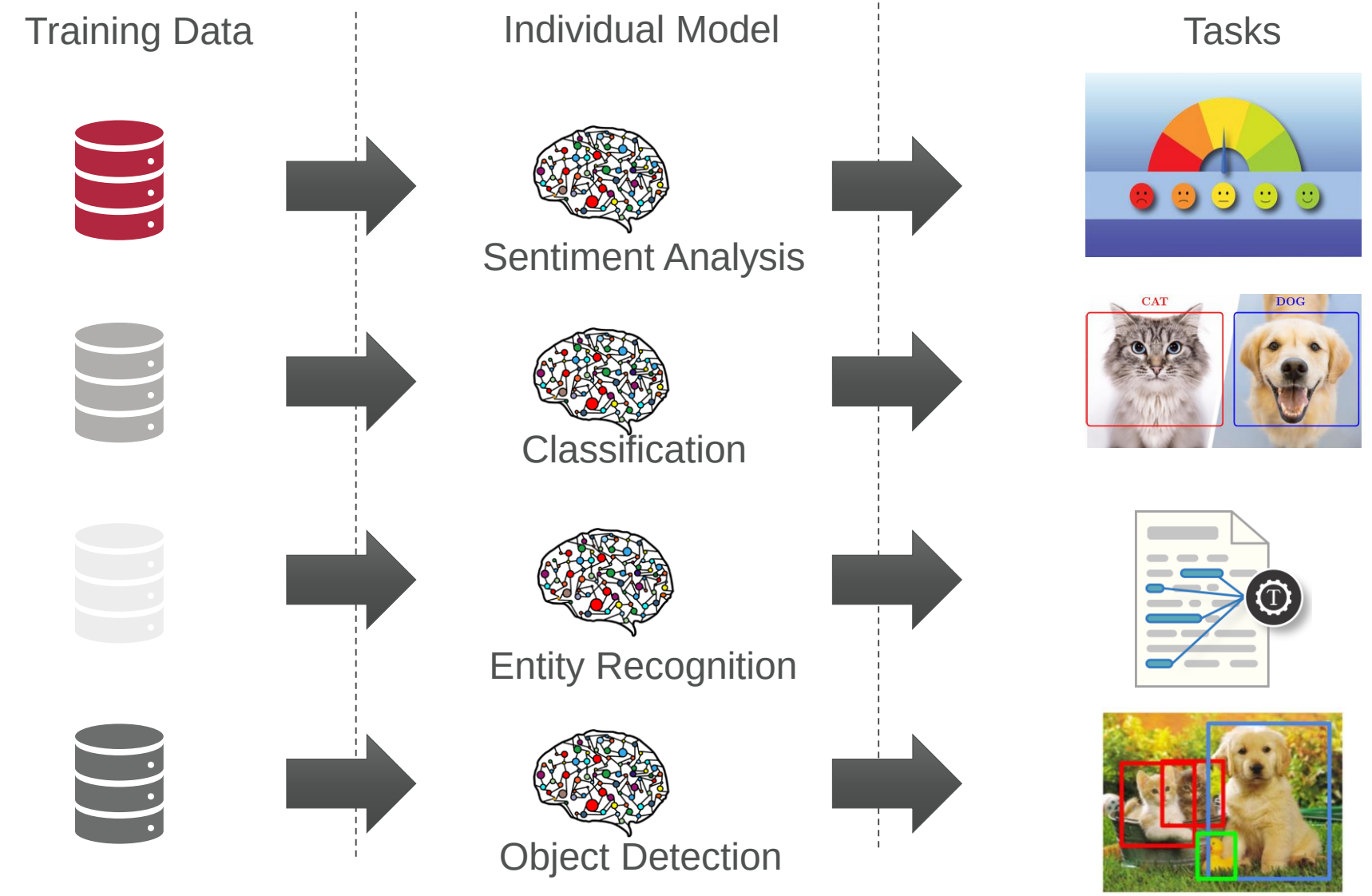
a machine learning technique in which layers of neural networks are used to process data and make decisions

2021

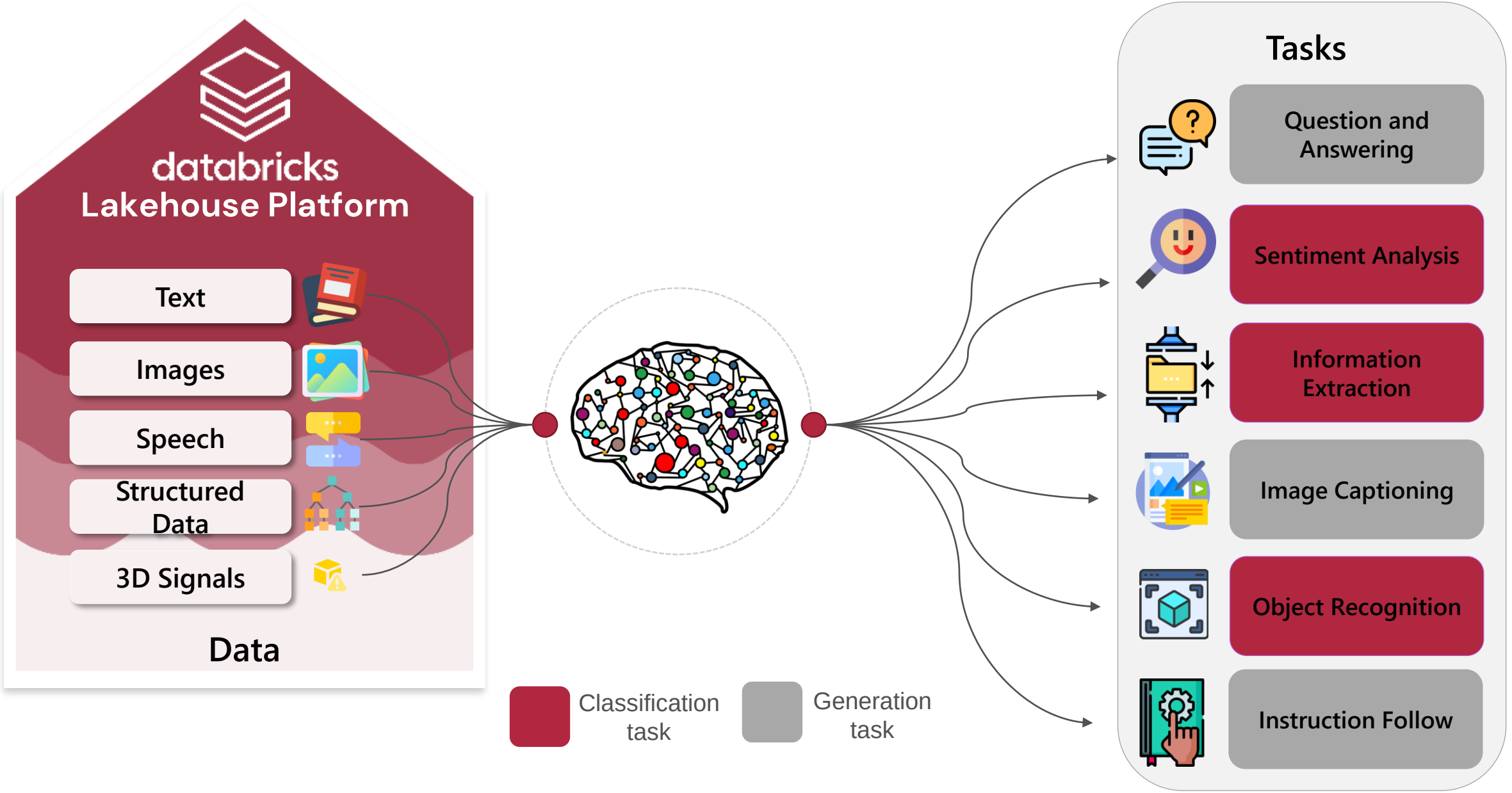
Generative AI

create new written, visual, and auditory content given prompts or existing data.

Traditional machine learning



Generative AI is enabled by Large Language Models



Large, general-purpose language models that is pre-trained and then fine-tuned for specific purposes

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Challenges of LLMs

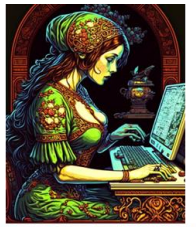
Challenges

1. **LLMs hallucinate**
   Presents real ethical and business concerns, so much so that for some it is a show stopper
2. **LLMs do not have data context**
   Trained on open internet data that might not provide good responses
3. **Lack of transparency**
   Often requires interpretability, challenging understanding the reasoning behind their decisions
4. **Speed and cost**
   LLMs are computationally very expensive, extraction from large documents can take up to tens of seconds.
5. **Potential bias**
   Only as good as the data they are trained on, they are expected to have societal and geographical biases encoded in them
6. **Lack of control**
   Even the best prompts cannot force the model to give consistently correct output.
7. **Data residency and privacy**
   Control over data and privacy management is crucial for companies

Methods to improve the usage and performance of LLM

"Prompt engineering is the art of using natural language to get the results you are looking from the model"

Prompt Engineering with in-context learning



Prompt Engineering

Basic

With detail and context

Zero-shot: Predicting with no sample provided

```
Translate English to French:        <------task description
Cheese =>                           <------prompt
```

One-shot: Predicting with one sample provided

```
1  Translate English to French:     <------task description
2  Sea otter => loutre de mer       <------example
3  Cheese =>                        <------prompt
```

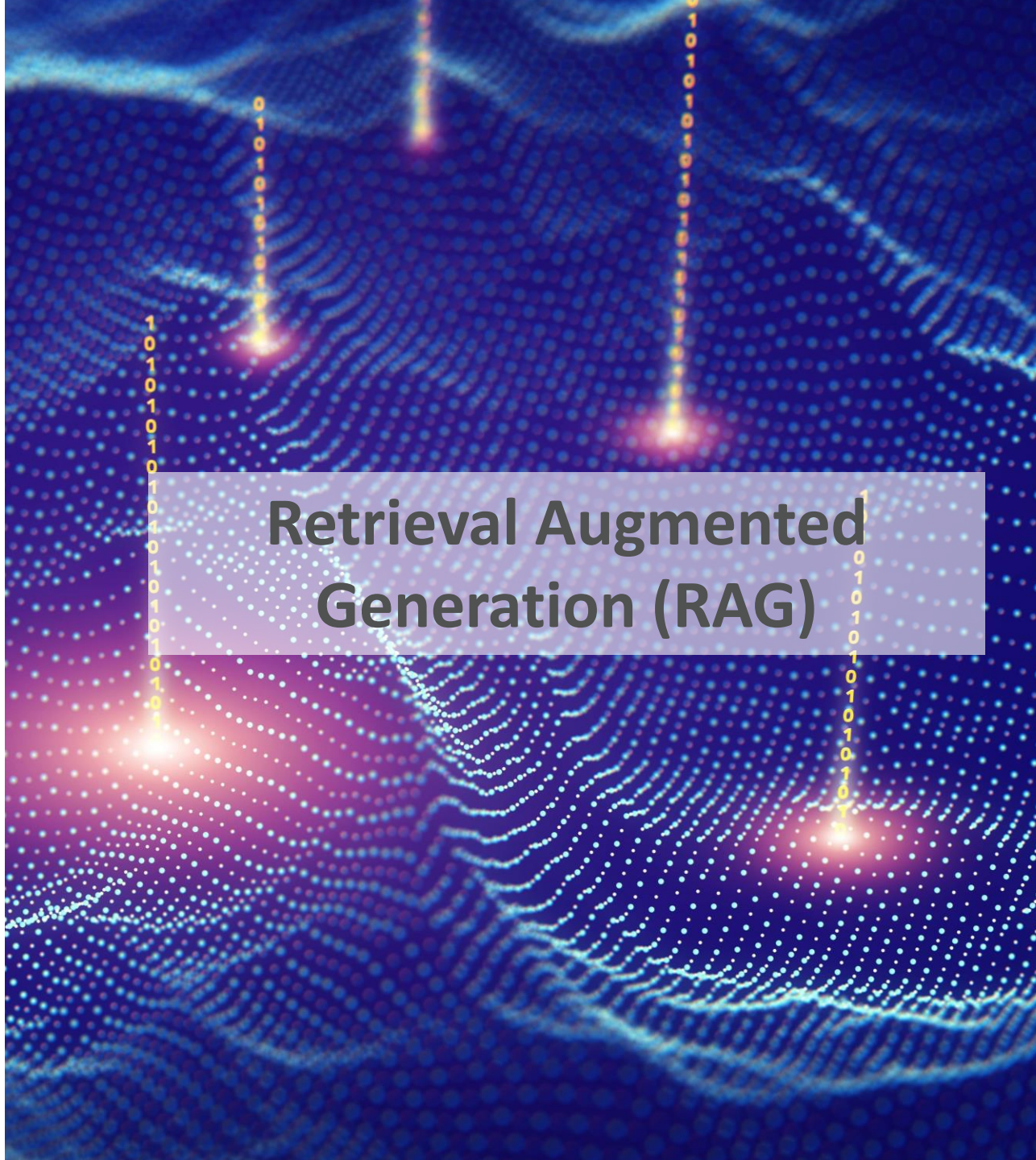
Few-shot: Predicting with a few samples provided

```
1  Translate English to French:     <------task description
2  Sea otter => loutre de mer       <------examples
3  Peppermint => menthe poivre      <------
4  Plush giraffe => girafe peluche  <------
5  Cheese =>                        <------prompt
```

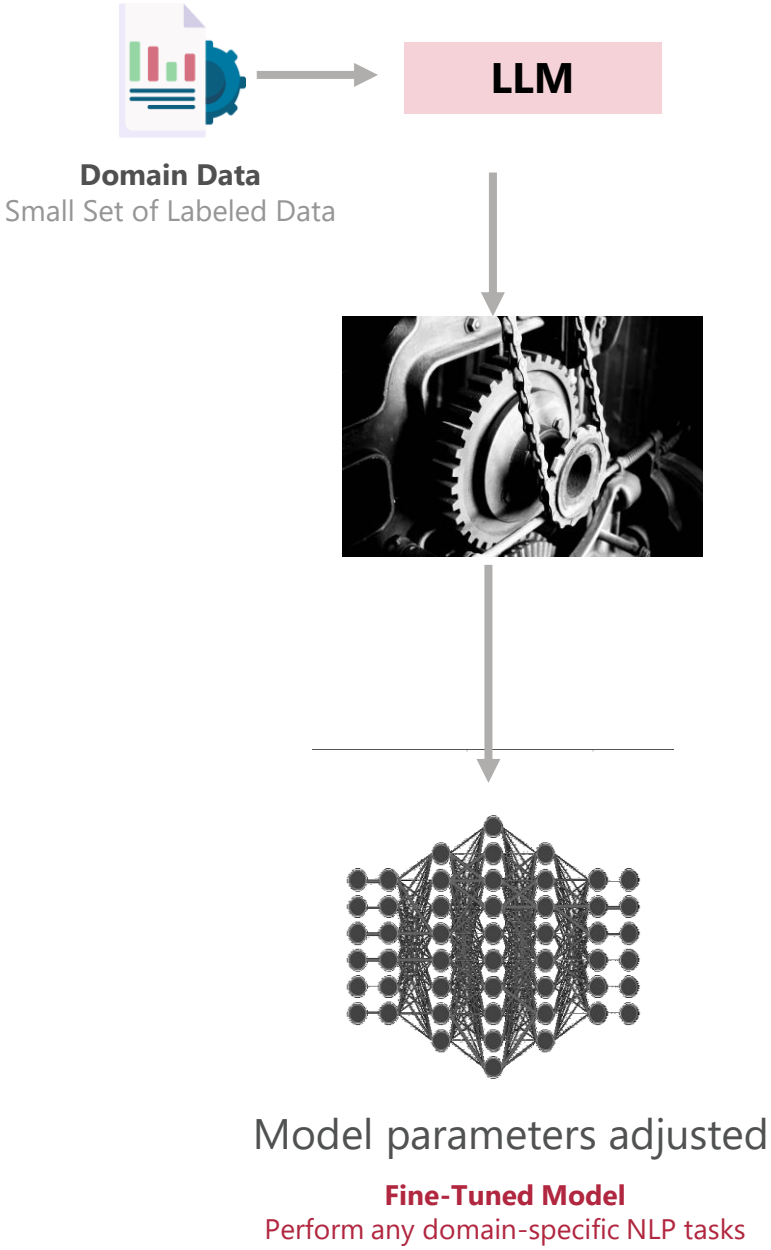
"The hottest new programming language is English"

Andrej Karpathy
(Former) Director of AI at Tesla

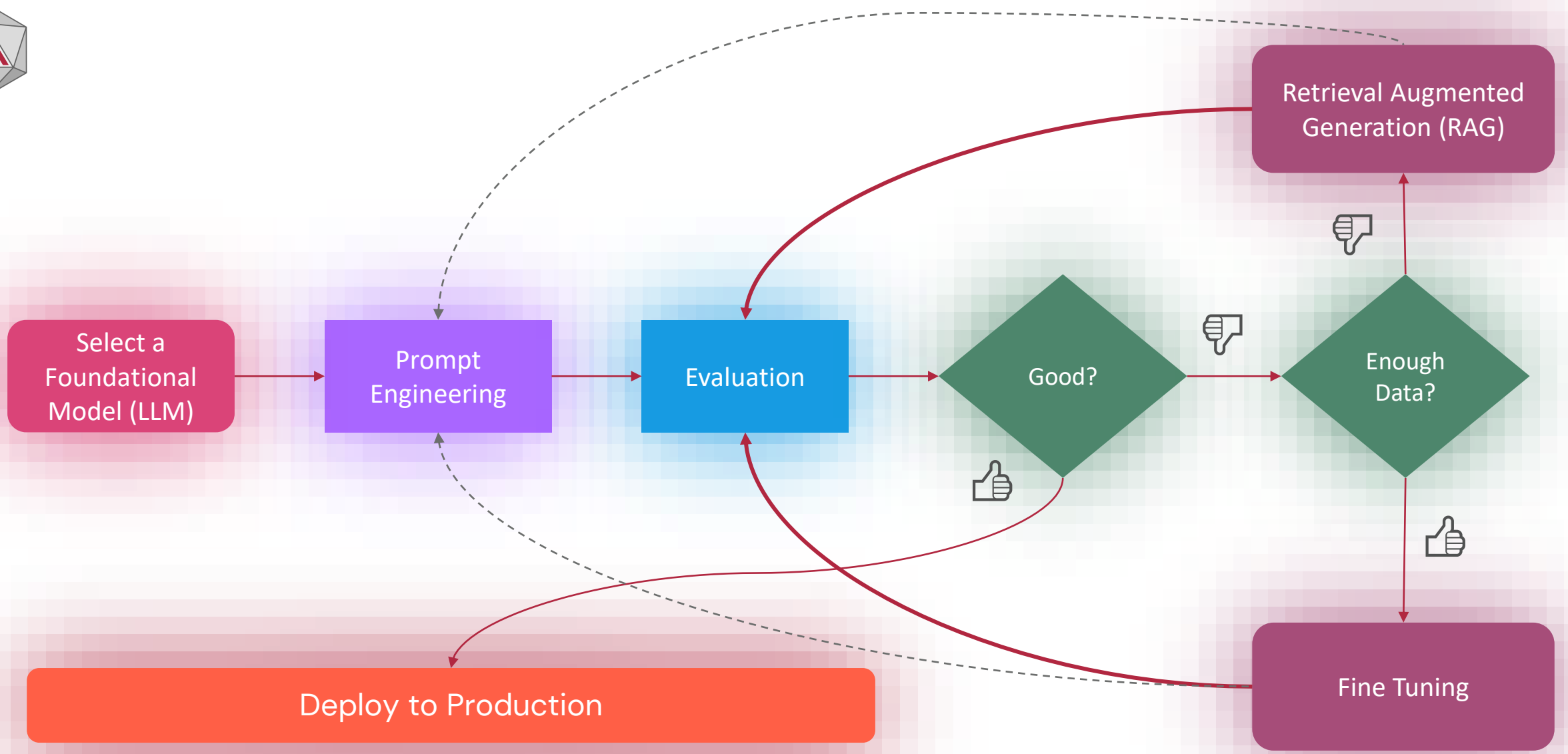
"Framework that combines information retrieval and text generation to produce more accurate and contextually relevant responses"



Fine-Tuning



"Fine-tuning is about adapting a pre-trained language model to a specific task or domain"


Retrieval Augmented Generation (RAG)
Select a Foundational Model (LLM)
Prompt Engineering
Evaluation
Good?
Enough Data?
Fine Tuning
Deploy to Production

How to adapt LLM models for your task

Prompt Engineering with in-context learning

Zero-Shot
The model predicts the answer given only a natural language description of the task.

One-Shot
In addition to the task description, the model sees a single example of the task

Few-Shot
In addition to the task description, the model sees a few examples of the task.

Retrieval-Augmented Generation (RAG)
This approach integrates the power of retrieval (or searching) into LLM text generation

Fine Tuning
The model is trained via repeated gradient updates using a large corpus of example tasks.

Prompt Engineering → RAG → Fine Tuning

RAG In a Nutshell

Ability of an LLM to learn information not through training, but by receiving new information in a carefully formatted prompt

RAG

1

Retrieval

Get information from a database that relates to the question you asked.

2

Augmentation

Combine the retrieved information with the initial prompt

3

Generate

Pass the augmented prompt to a large language model, generating the final output

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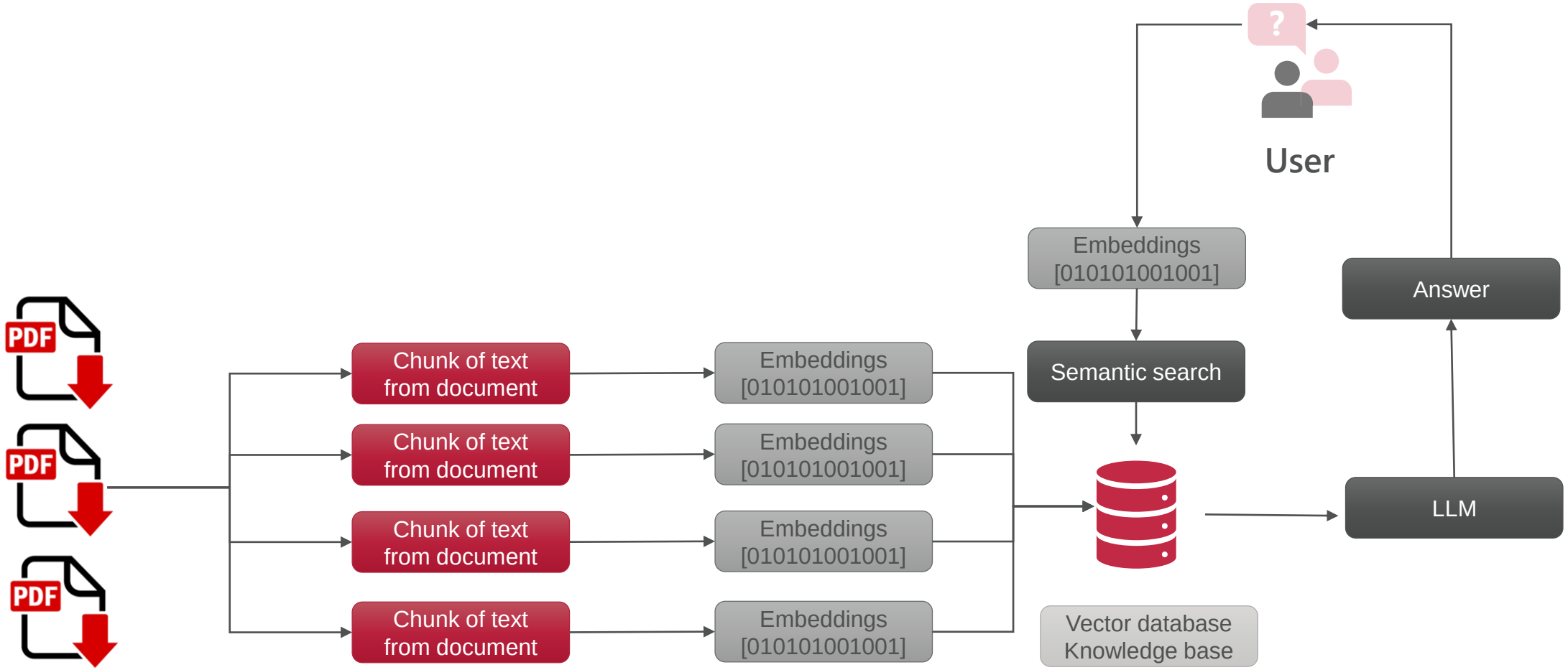
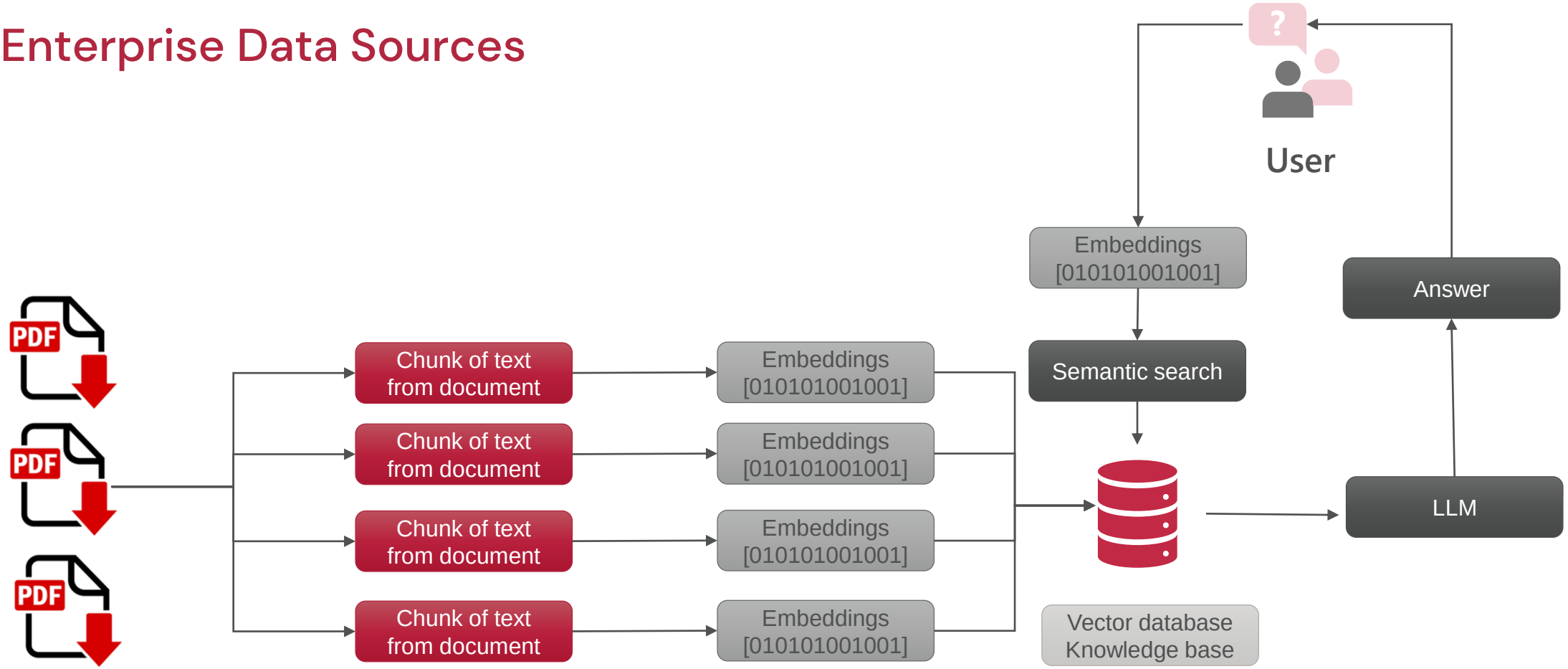
RAG (Retrieval-Augmented Generation)



RAG (Retrieval-Augmented Generation)

Enterprise Data Sources



WHAT PROBLEM DO THEY SOLVE?

1.Hallucinations:

RAG mitigates hallucinations by retrieving data from trusted sources, ensuring responses are grounded in factual information.

2.Lack of Transparency:

RAG offers transparency through retrieval, indicating the source of information, improving traceability, and identifying knowledge base issues or biases.

3.Contextual Understanding:

RAG enhances context by combining retrieval with generation from a knowledge base, resulting in more contextually relevant and accurate answers.

Vector Databases

Vector Databases

Open Source

Weaviate

Milvus

chroma

qdrant

FAISS
Scalable Search With Facebook AI

deeplake

Managed

Pinecone

Azure AI Search

	Azure AI Search	FAISS Scalable Search With Facebook AI
Type	Cloud-based search service with AI capabilities	Open-source library for efficient similarity search
Hosting	Fully managed by Microsoft Azure	Self-hosted, requires own infrastructure or cloud provider
Scalability	Automatically scalable within Azure infrastructure	Manually scalable, depending on the hardware capabilities
Integration	Seamless integration with other Azure services	Requires custom integration with existing systems
Ease of Use	Offers a managed environment with user-friendly tools and interfaces	Requires more in-depth knowledge of similarity search algorithms and software development
Indexing Capabilities	Provides indexing for full-text search and supports AI enrichment features	Specialises in creating efficient indices for nearest neighbor search
Performance	Optimised for integration and ease of use within the Azure ecosystem	Highly optimised for large-scale vector similarity search
Cost	Usage-based pricing model	Free to use, but costs associated with self-hosting and infrastructure
Use Cases	Ideal for enterprise search solutions that require full-text search and cognitive skills	Best suited for applications that perform large-scale deep learning similarity searches
Data Security	Managed by Azure with enterprise-grade security features	Depends on the deployment model and infrastructure security

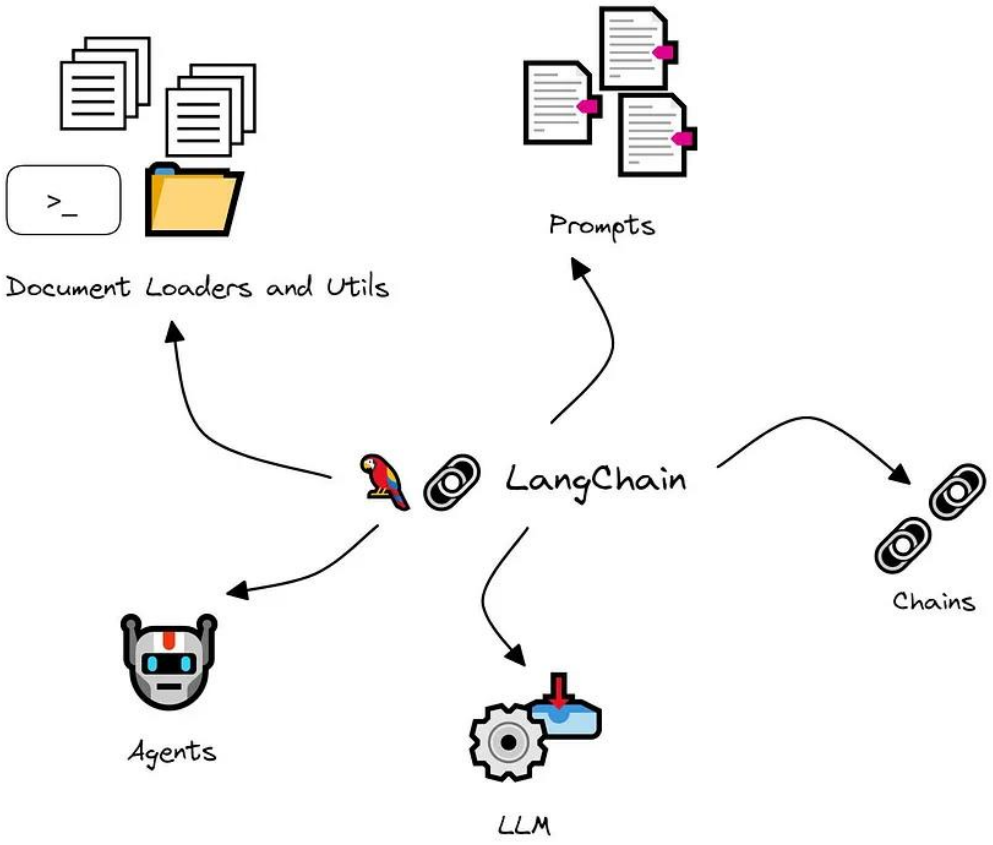
Choosing the right vector databases

A list of questions we should be exploring with the customer to understand which DB to utilise

1. Does the customer have their own index for documents that are being embedded?
2. Do we need to index the vectors/documents?
3. Is the customer happy to be paying for a vector database like AI Search or Pinecone? Or is there a preference to use open-source vector databases like Chroma?
4. How critical is real-time performance? What are the latency requirements?
5. Are there any scalability requirements in terms of handling increasing data loads over time?
6. How would this database interact/integrate with other stacks within the RAG LLM architecture?
7. Do we need real-time search capabilities? Are we doing recommendation engines or fraud detection for example?
8. Do we need CRUD (inserting, updating and deleting data) capability?

Frameworks to help with LLM Apps

LangChain

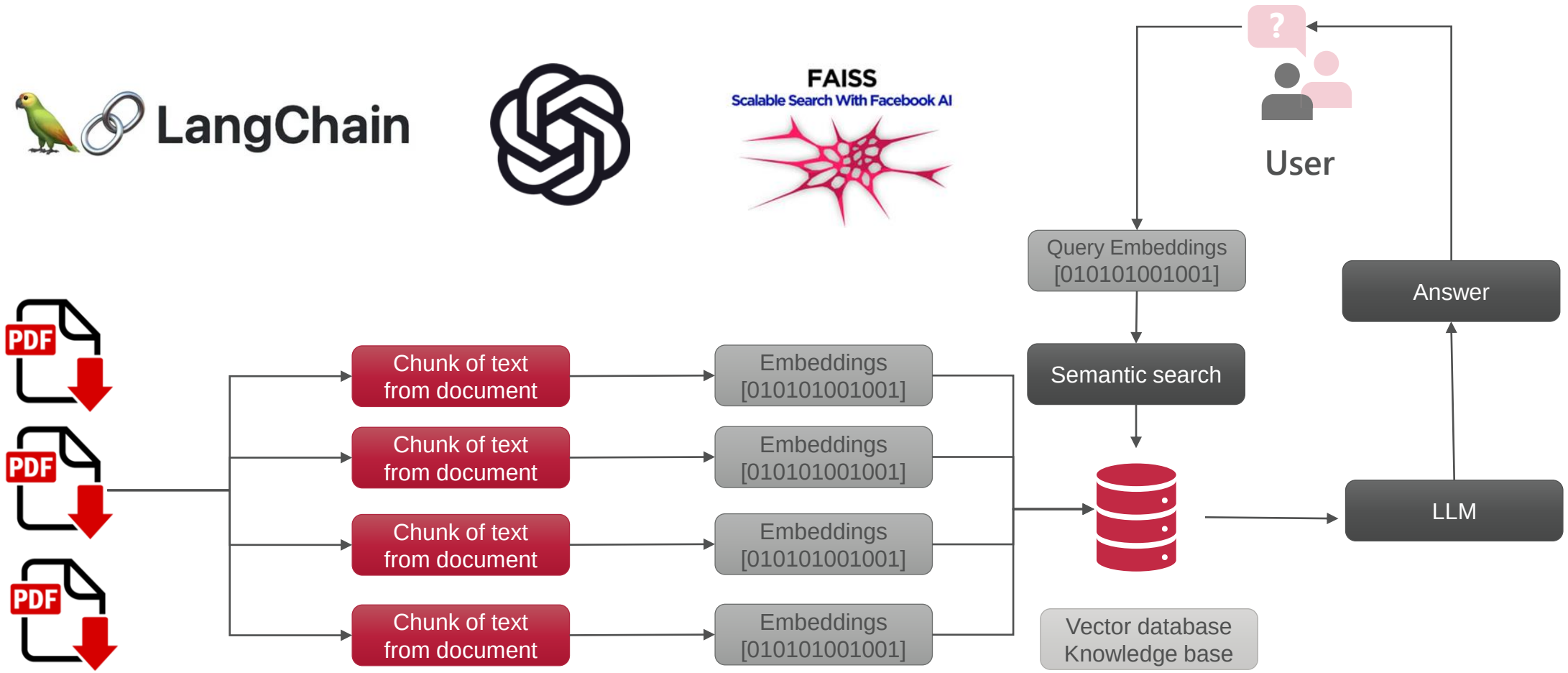


LangChain is a powerful, open-source tool or framework designed to help develop applications powered by a language model, particularly a large language model (LLM).

LlamaIndex

LlamaIndex is a simple, flexible data framework for connecting custom data sources to large language models.

RAG (Retrieval-Augmented Generation)



Streamlit

Prerequisites

VSCode

Python 3.10 or later

Azure OpenAI with a two models deployed:

- text-embedding-ada-002
- gpt-35-turbo

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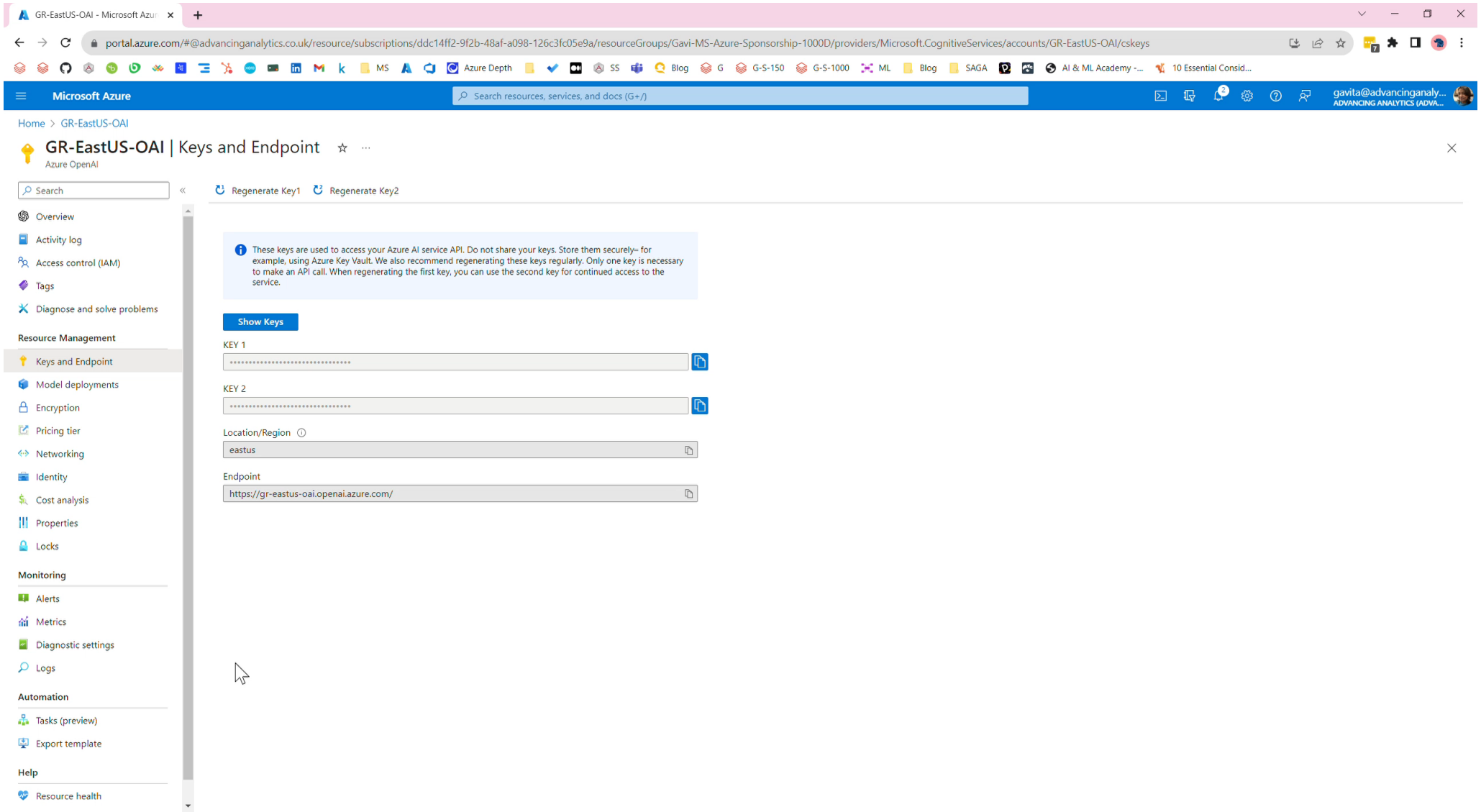
Azure OpenAI: Keys and Endpoints



Streamlit

Why Choose Streamlit for LLM Apps?

Interactivity by Default: Streamlit is a faster way to build interactive data apps. It’s also a lot of fun!

Ease of Use: It's simple, yet powerful, open source Python library enables developers and data scientists to easily create and share beautiful, custom web apps.

Deployment and Sharing: Streamlit has rapidly become the visual UI of choice for LLM-powered apps, including chatbots, sentiment analysis tools, content summarizers, and more.

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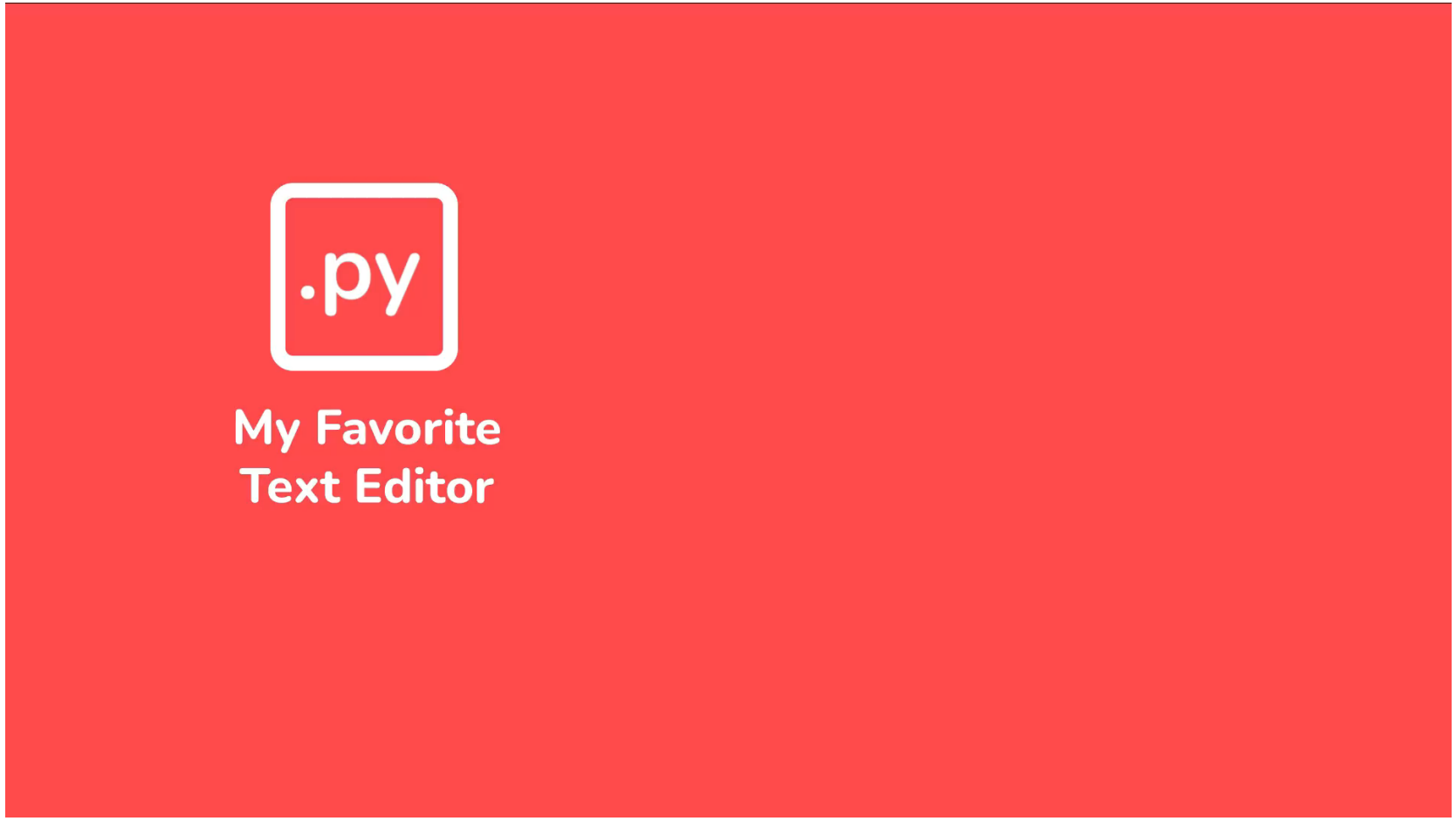
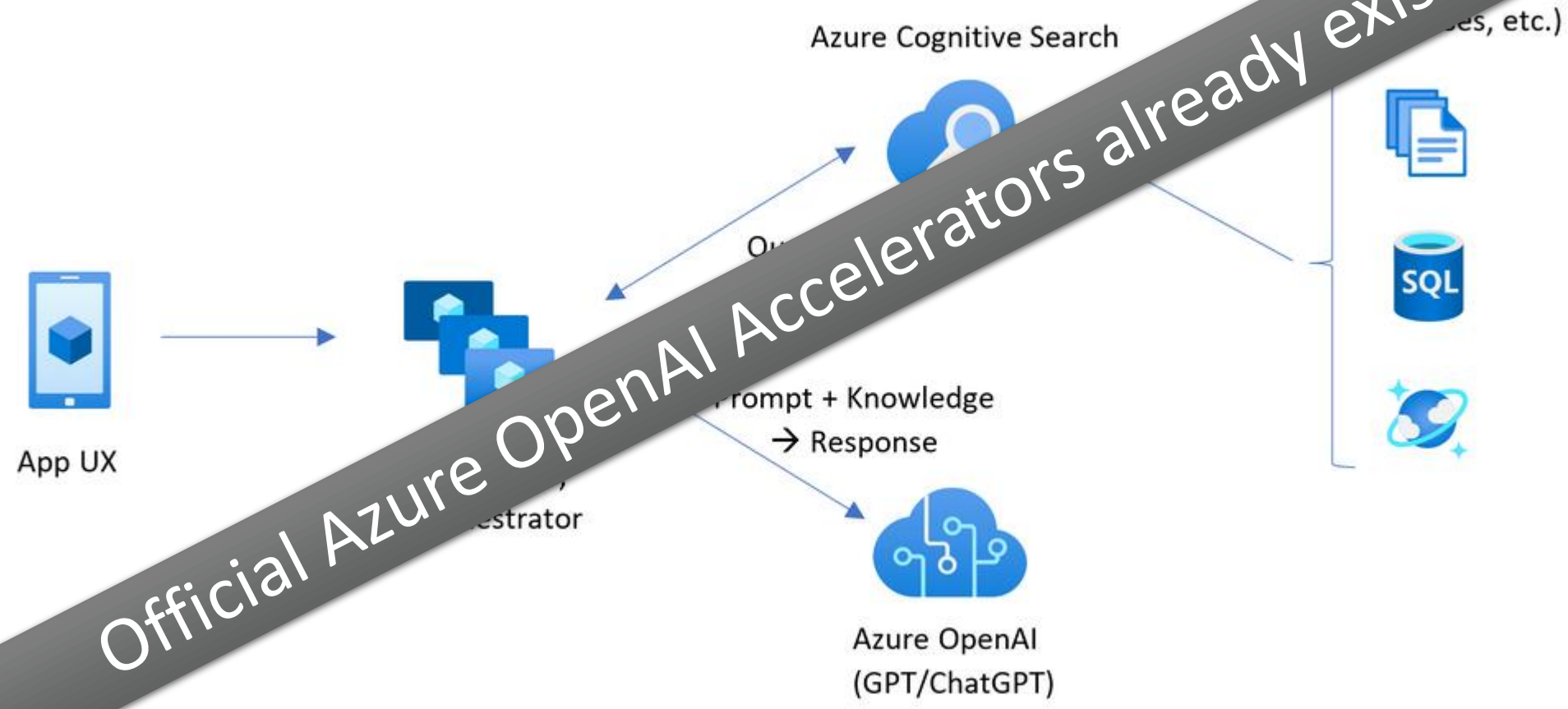
Streamlit is the UI powering the LLM movement



ChatGPT + Enterprise data with Azure OpenAI and Cognitive Sear



Official Azure OpenAI Accelerators already exist

Why consider this architecture?

- What if you want to run a Retrieval Augmented Generation (RAG) solution locally?
- What if the customer wants flexibility in choosing a Vector Databases that is not AI Search?
- What is the customer does not want to upload their data for embedding?
- What if you want flexibility with chunking documents?
- DEMO for customers

Setup

Clone this repo:

https://github.com/aero-girl/MFST-Workshop-Demo.git

SCAN ME

ADVANCING ANALYTICS

Creating a Python Virtual Environment

Using Python venv Module:

Create virtual environment
python -m venv .venv

Activate virtual environment
.\.venv\Scripts\activate

Deactivate virtual environment
deactivate

Using Conda:

Create a new Conda envonment
conda create --name myenv python=3.10

Activate virtual environment
conda activate myenv

Deactivate virtual environment
conda deactivate

First few steps to get setup

1. Create .env and store our secret keys

2. Create .gitignore file – only necessary files get synched to GitHub

3. Create app.py file to build out or application

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Creating .env file

DO NOT alter the OpenAI environment variable, make sure it matches what is shown below

```
# Set up OpenAI API credentials
OPENAI_API_TYPE= “azure”

# The API version you want to use: set this to `2023-08-01-preview`
for the released version.
OPENAI_API_VERSION= “2023-08-01-preview”

# The base URL for your Azure OpenAI resource.  You can find this in
the Azure portal under your Azure OpenAI resource.
OPENAI_API_BASE= To be completed

# The API key for your Azure OpenAI resource.  You can find this in
the Azure portal under your Azure OpenAI resource.
OPENAI_API_KEY= “To be completed”
```

https://learn.microsoft.com/en-us/azure/ai-services/openai/reference#chat-completions

Creating .gitignore

Code | Blame | 160 lines (131 loc) · 3.01 KB

```
# Byte-compiled / optimized / DLL files
__pycache__/
*.py[cod]
*$py.class

# C extensions
*.so

# Distribution / packaging
.Python
build/
develop-eggs/
dist/
downloads/
eggs/
.eggs/
lib/
lib64/
parts/
sdist/
var/
wheels/
share/python-wheels/
*.egg-info/
.installed.cfg
*.egg
MANIFEST

# PyInstaller
#  Usually these files are written by a python script from a template
#  before PyInstaller builds the exe, so as to inject date/other infos into it.
*.manifest
*.spec

# Installer logs
pip-log.txt
pip-delete-this-directory.txt

```

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https://github.com/github/gitignore/blob/main/Python.gitignore

Install dependencies

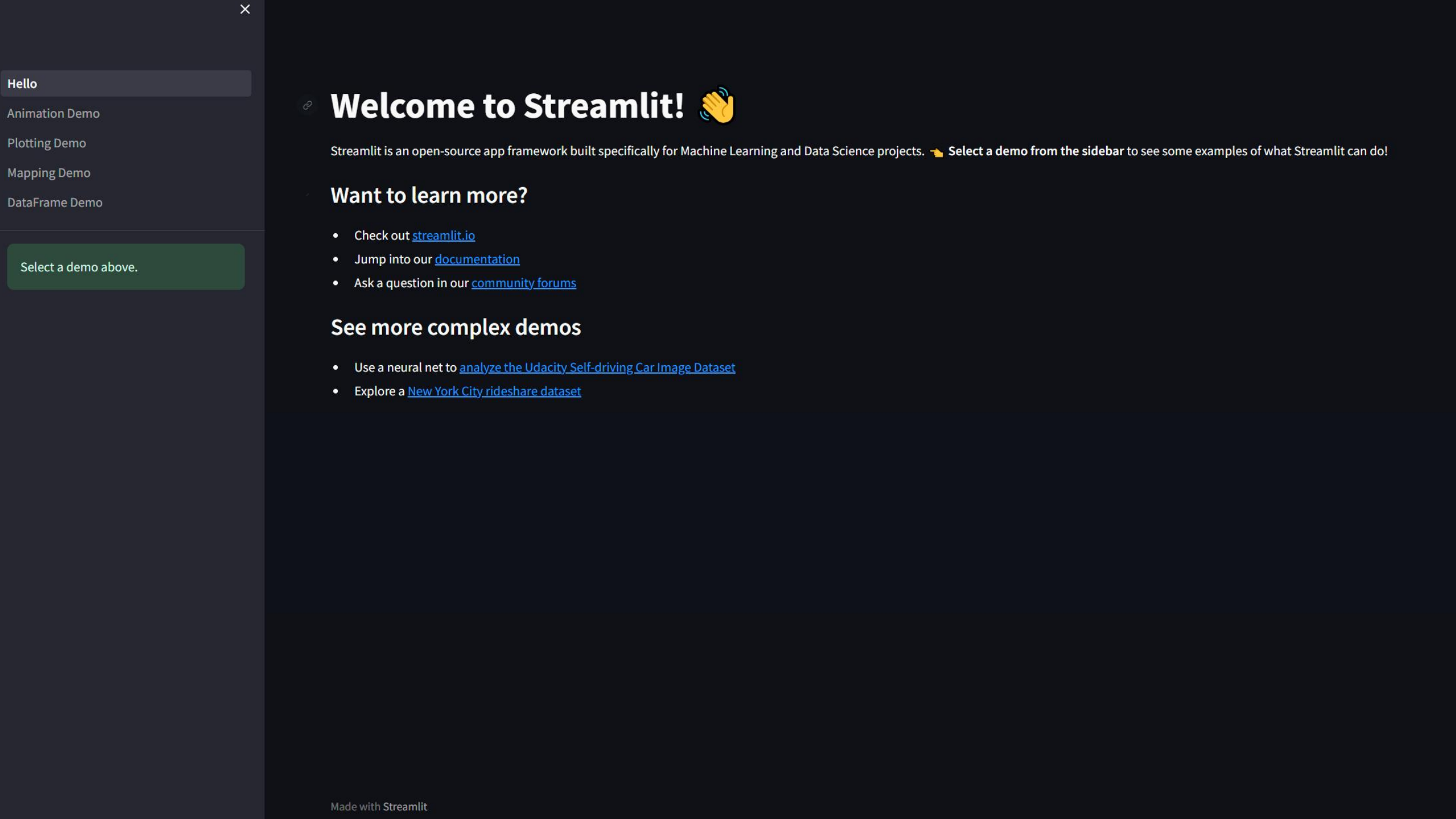
1. **Install requirements**

pip install -r .\requirements.txt

Streamlit

2. Run >> streamlit hello

https://docs.streamlit.io/library/get-started


Hello
Animation Demo
Plotting Demo
Mapping Demo
DataFrame Demo
Select a demo above.
Welcome to Streamlit! 👋
Streamlit is an open-source app framework built specifically for Machine Learning and Data Science projects. 👈 Select a demo from the sidebar to see some examples of what Streamlit can do!
Want to learn more?
Check out streamlit.io
Jump into our documentation
Ask a question in our community forums
See more complex demos
Use a neural net to analyze the Udacity Self-driving Car Image Dataset
Explore a New York City rideshare dataset
Made with Streamlit

⚠ Tips: Stopping Streamlit App ⚠

1

- Launch streamlit from the terminal
- Close browser or tab
- ctrl+c in the terminal
- app stops running (yay!)

2

- Close browser app when streamlit is running
- ctrl+c in the terminal
- App does not stop running
- Open the app from the URL link so it opens in the browser again
- ctrl+c in the terminal
- App stops running (yay!)

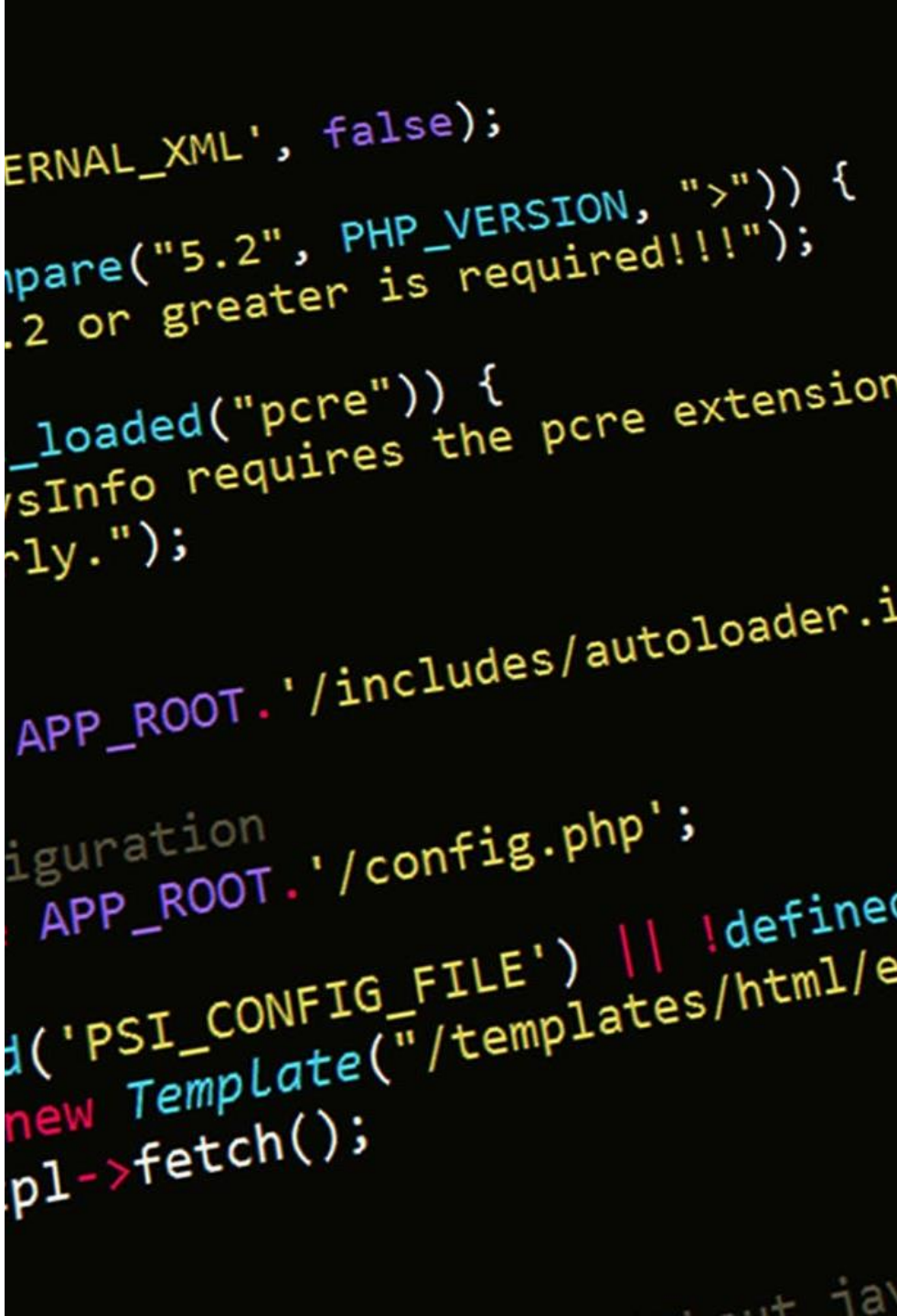
Make sure application is run directly and not imported

```
def main():
    print("Hello world")

if __name__ == '__main__':
    main()
```

So, if you save this script in a file and run it, you should see the output:

```
Hello world
```



Check if the .env file exists

```python
from dotenv import load_dotenv
import os
import openai


# check if the .env file exists
def main():
    load_dotenv()

    # Get API key from environment variable
    openai.api_key = os.getenv("OPENAI_API_KEY")
    print(f"OPENAI_API_KEY:{openai.api_key}")

    openai.api_base = os.getenv("OPENAI_API_BASE")
    print(f"OPENAI_API_BASE:{openai.api_base}")

    openai.api_type = os.getenv("OPENAI_API_TYPE")
    print(f"OPENAI_API_TYPE:{openai.api_type}")

    openai.api_version = os.getenv("OPENAI_API_VERSION")
    print(f"OPENAI_API_VERSION:{openai.api_version}")


if __name__ == '__main__':
    main()
```

Set page config, header, and file uploader

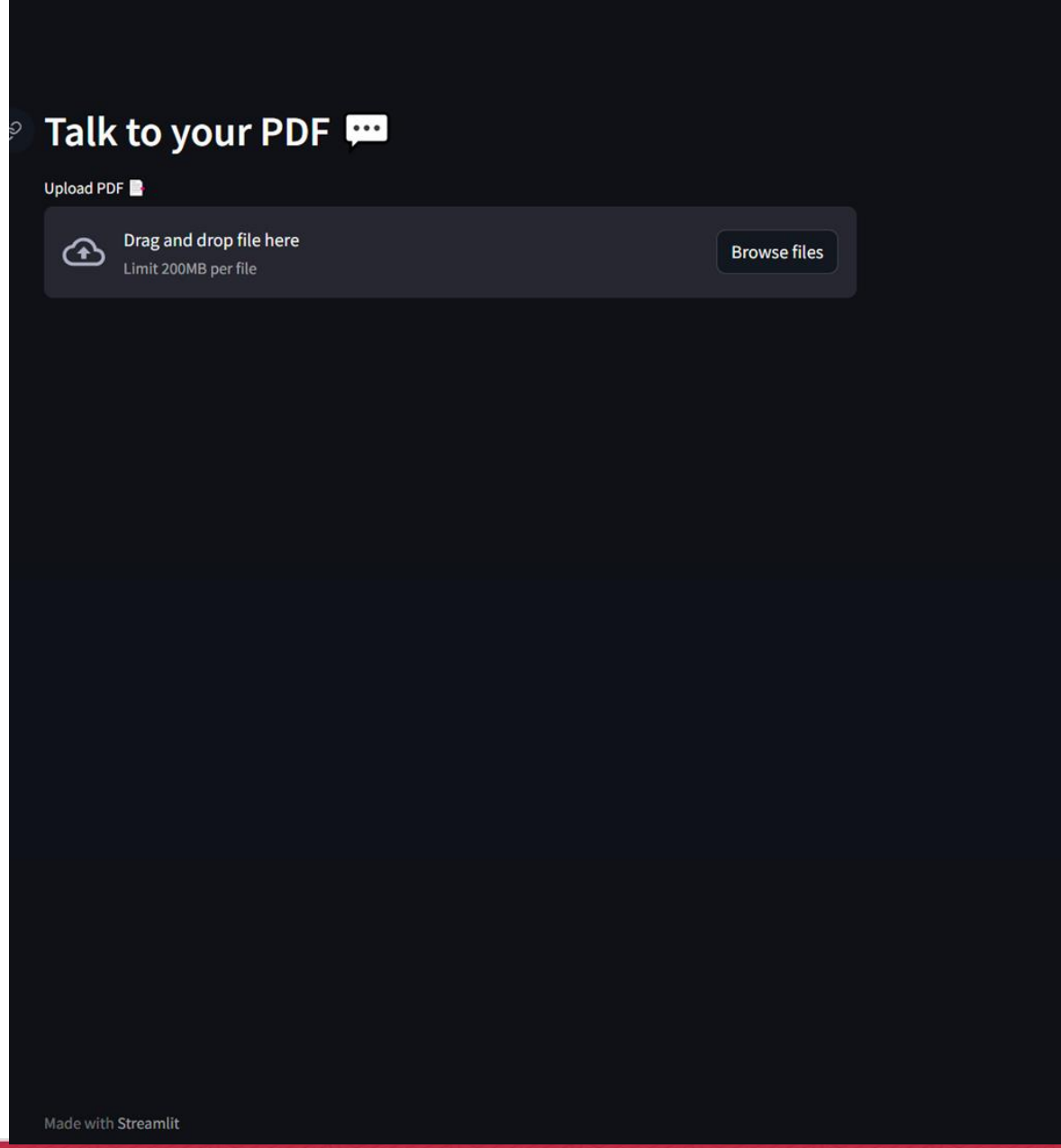
```python
…
import streamlit as st

# set page config, header, and file uploader
def main():
    load_dotenv()
    …

    st.set_page_config(
        page_title="Chat 💬 with your PDF 📄",
        page_icon="🐮",
        layout="centered",
        initial_sidebar_state="auto",
    )

    st.header("Talk to your PDF 💬")
    pdf = st.file_uploader("Upload PDF 📄")

if __name__ == '__main__’:
    main()
```



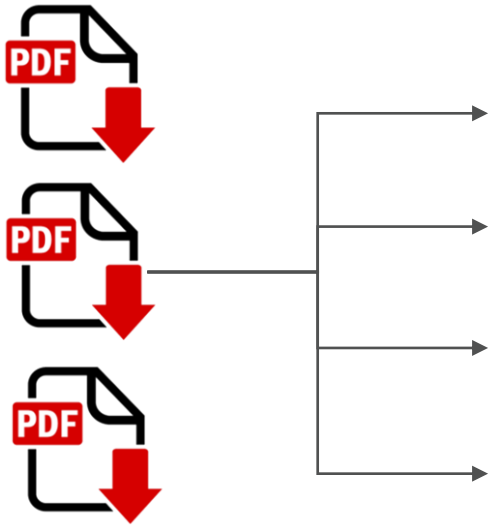
ADVANCING ANALYTICS

streamlit run .\app.py

AI-Powered Q&A

LangChain

1 Load and extract text from PDF




```
if pdf is not None:
        pdf_reader = PdfReader(pdf)
        text = "" # empty string to store the text
        for page in pdf_reader.pages: # for each page
in the pdf
            text += page.extract_text() #
concatenating all the text from the pages
```

Extracts the text from pdf file

```
from PyPDF2 import PdfReader #  import pdf reader

# Upload PDF file
    pdf = st.file_uploader("Upload PDF 📄")

    # check if user has uploaded a file
    # extract the text from the pdf file
    if pdf is not None:
        pdf_reader = PdfReader(pdf)
        text = "" # empty string to store the text
        for page in pdf_reader.pages: # for each page in the pdf
            text += page.extract_text() # concatenating all the text from the pages

            # display the text on the streamlit app
            st.write(text)
```

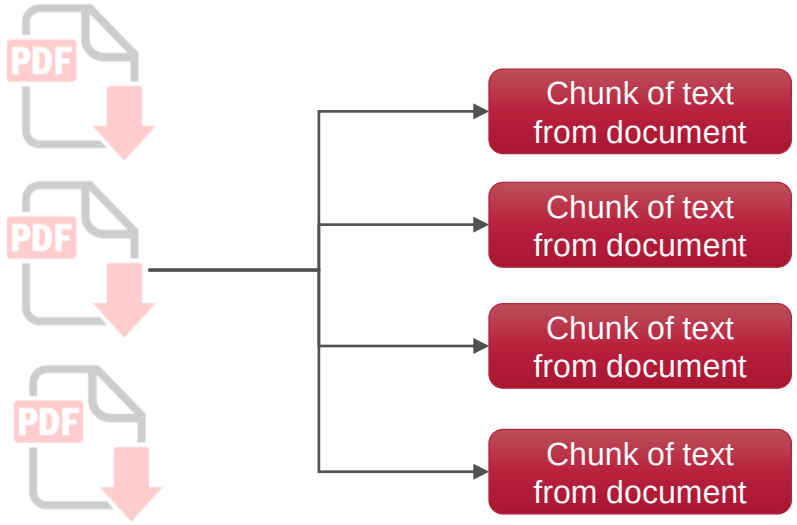
ADVANCING ANALYTICS

streamlit run .\app.py

AI-Powered Q&A

LangChain

2 Load and extract text from PDF




```
from langchain.text_splitter import CharacterTextSplitter # import text splitter

            # display the text on the streamlit app
            # st.write(text)

        # Use function from langchain to split the text into chunks
        text_splitter = CharacterTextSplitter(
            separator = "\n", # split by new line
            chunk_size = 1000, # split into chunks of 1000 characters
            chunk_overlap = 200, # overlap chunks by 200 characters
            length_function =  len # use the len function to get the length of
the chunk
        )
        chunks = text_splitter.split_text(text)
        st.write(chunks) # display the text on the streamlit app
```

🛑❗ gpt-3.5 was originally **4,096 tokens** however newer models are available with up to **32,768 tokens**

Visualising tokens

https://platform.openai.com/tokenizer

GPT-3.5 & GPT-4 GPT-3 (Legacy)

```
Many words map to one token, but some don't: indivisible.

Unicode characters like emojis may be split into many tokens containing
the underlying bytes: 🤚

Sequences of characters commonly found next to each other may be grouped
together: 1234567890
```

Clear Show example

Tokens	Characters
57	252

```
Many words map to one token, but some don't: indivisible.

Unicode characters like emojis may be split into many tokens containing
 the underlying bytes: ������

Sequences of characters commonly found next to each other may be grouped
 together: 1234567890
```

TEXT TOKEN IDS

Chunk the text extracted from the pdf

```
from langchain.text_splitter import CharacterTextSplitter # import text splitter

            # display the text on the streamlit app
            # st.write(text)

        # Use function from langchain to split the text into chunks
        text_splitter = CharacterTextSplitter(
            separator = "\n", # split by new line
            chunk_size = 1000, # split into chunks of 1000 characters
            chunk_overlap = 200, # overlap chunks by 200 characters
            length_function =  len # use the len function to get the length of the chunk
        )
        chunks = text_splitter.split_text(text)
        st.write(chunks) # display the text on the streamlit app
```


streamlit run .\app.py

Talk to your PDF

Upload PDF

Drag and drop file here
Limit 200MB per file

Browse files

A Data Science Maturity Model for Enterprise Assessment-wp-20200612.pdf 1.5MB

A Data Science Maturity Model for Enterprise Assessment

Mark Hornick
Senior Director, Oracle Data Science and Machine Learning

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A Data Science Maturity Model for Enterprise Assessment

Mark Hornick
Senior Director, Oracle Data Science and Machine Learning

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1 WHITE PAPER | | A Data Science Maturity Model for Enterprise Assessment | Version 2.0
Copyright © 2020 , Oracle and/or its affiliates PURPOSE STATEMENT
This document is an update to the Data Science Maturity Model for Enterprise Assessment introduced in 2018. As an assessment tool, this Data Science Maturity Model provides a set of dimensions relevant to data science with five maturity levels in each —1 being the least mature, 5 being the most. Enterprises that increase their data science maturity are more likely to increase the value they derive from data science projects .

A Data Science Maturity Model for Enterprise Assessment

Mark Hornick
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1 WHITE PAPER | | A Data Science Maturity Model for Enterprise Assessment | Version 2.0
Copyright © 2020 , Oracle and/or its affiliates PURPOSE STATEMENT
This document is an update to the Data Science Maturity Model for Enterprise Assessment introduced in

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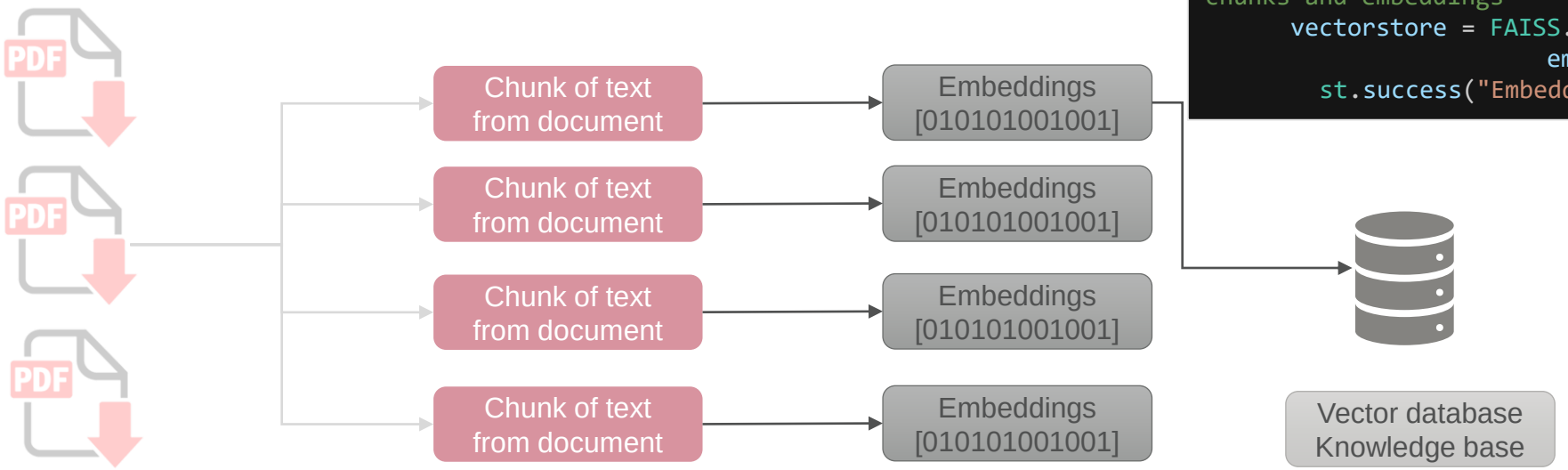
200 :
"structured and semi-structured data. Other data warehouses include Snowflake and Amazon Redshift. Like Delta Lake, Snowflake relies on Parquet files to store primarily structured and semi-structured data. Databricks has a relatively narrow vision of versioning. Versions are made only during experiment tracking, and by default they are kept for seven days, after which the older versions of the file are marked as tombstoned and deleted after thirty days, unless database administrators change the defaults. This means that data versions are not long lived 65on the Databricks platform and that the company largely sees versioning as limited only to the experimentation phase. If the goal of an organization is to keep long term, immutable versions of data, that is not currently possible with the DeltaLake architecture, which makes it ineffective for auditing or compliance or long-term reproducibility."
201 :
"DeltaLake architecture, which makes it ineffective for auditing or compliance or long-term reproducibility. Short-term reproducibility is highly useful for teams doing rapid experimentation. However, when it comes to reproducing the exact conditions that created a model many months later, it becomes a problem. For instance, long-

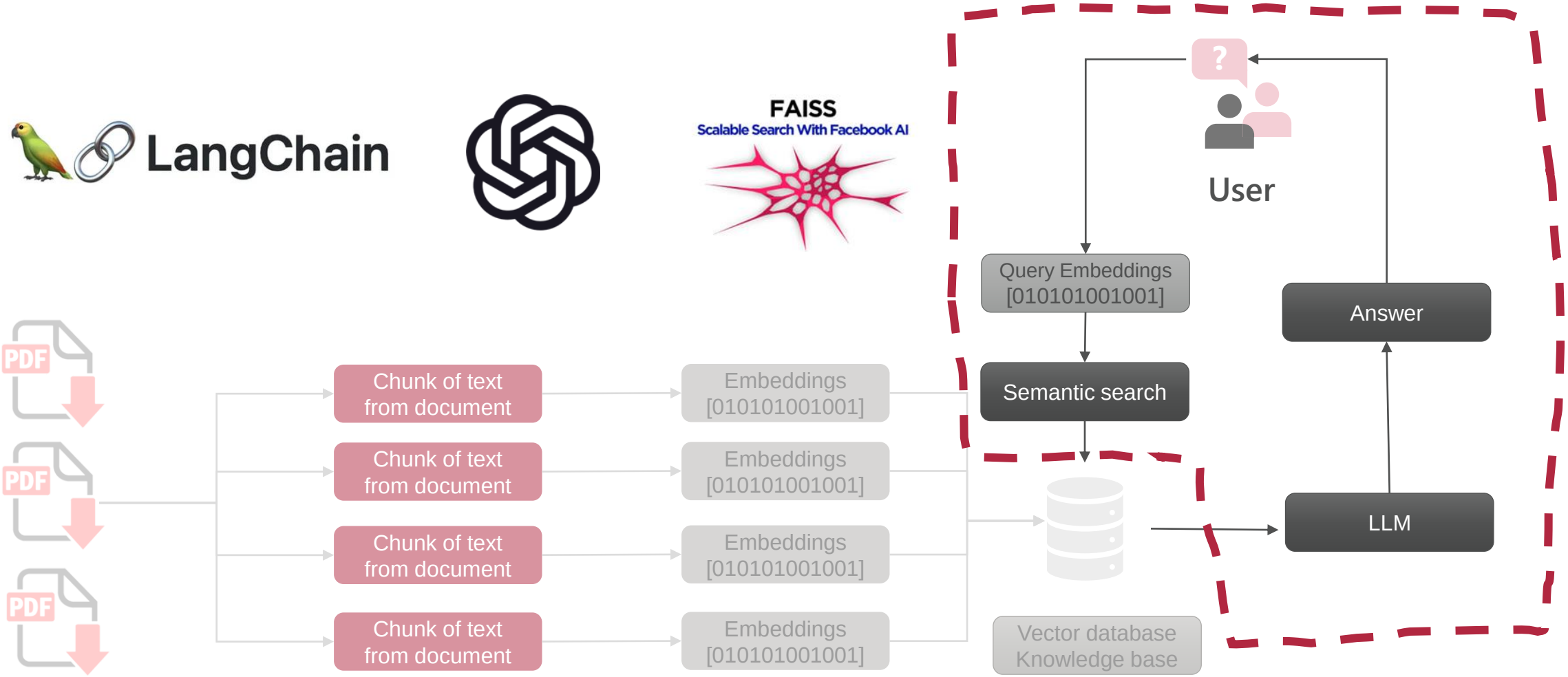
AI-Powered Q&A

3 Create embeddings and vector database

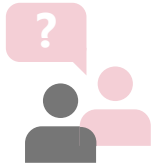
```
from langchain.embeddings import OpenAIEmbeddings
from langchain.vectorstores import FAISS

# Define models
model = "text-embedding-ada-002"
completion_model = "gpt-35-turbo"

# Create embeddings
embeddings =
OpenAIEmbeddings(model=model,
  deployment=model,                                    openai_a
pi_key= openai.api_key,
                  chunk_size=1)
st.write("Embeddings created")

with st.spinner("It's indexing..."):
     #  Create a knowledge base using FAISS from the given
chunks and embeddings
      vectorstore = FAISS.from_texts(texts=chunks,
                        embedding=embeddings)
        st.success("Embeddings done.", icon="✅")
```



RAG (Retrieval-Augmented Generation)



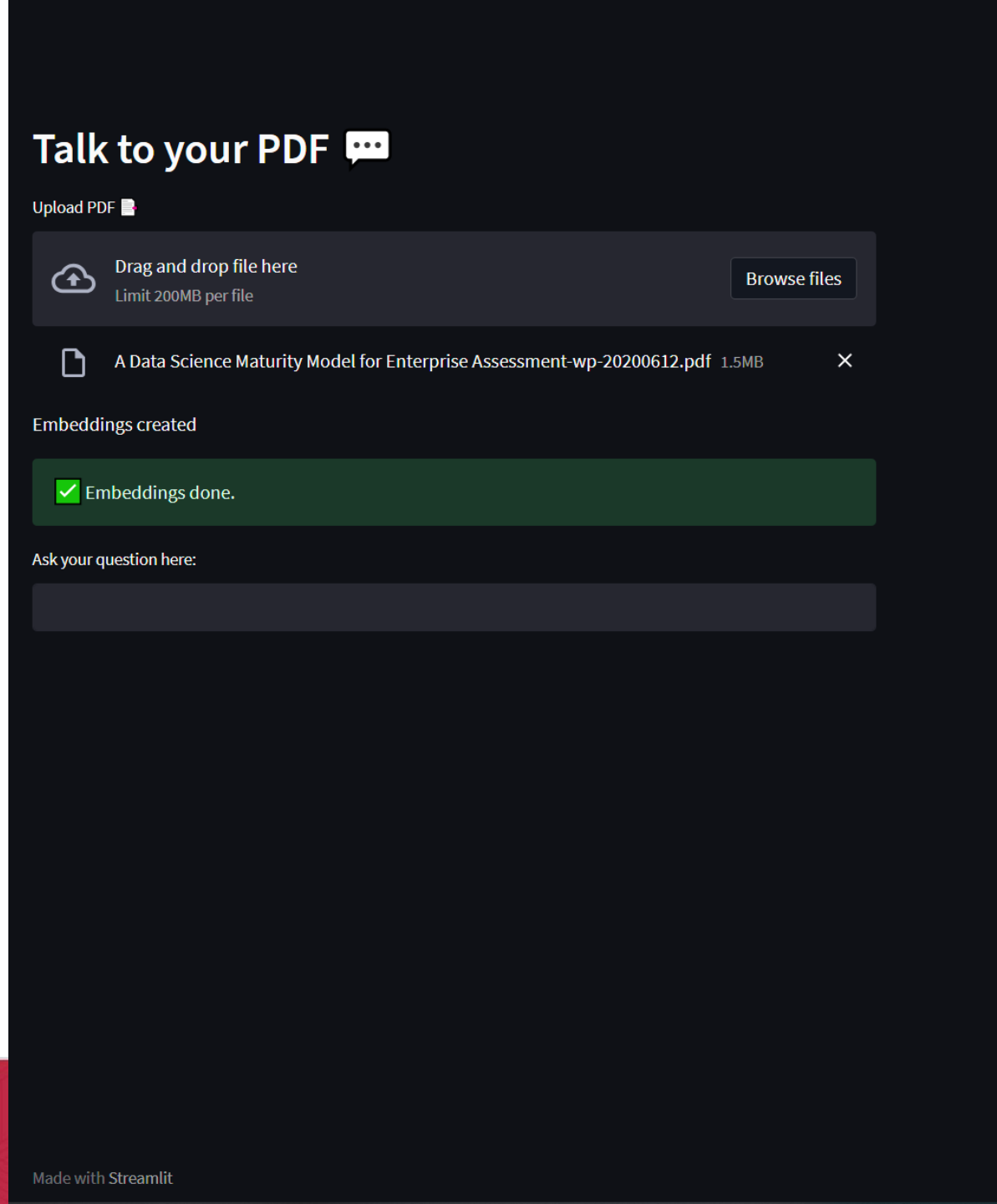
Get user question



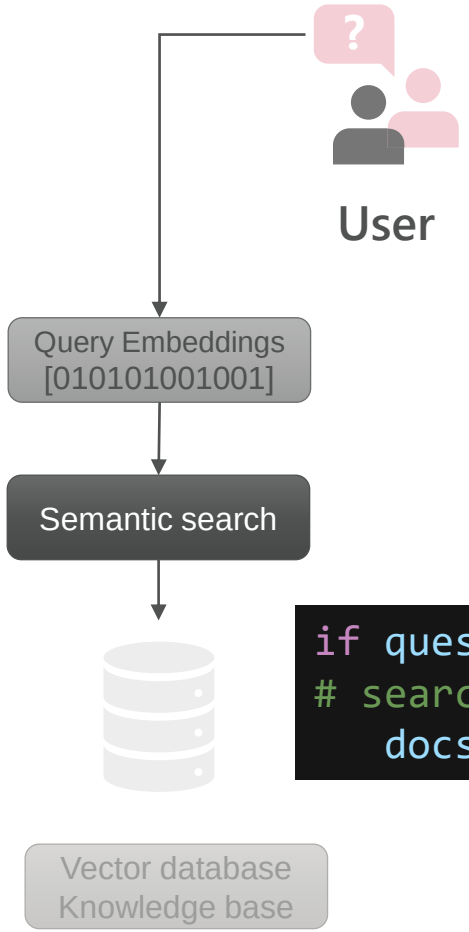
User

```
# get user question
question = st.text_input("Ask your question here:")
```

streamlit run .\app.py

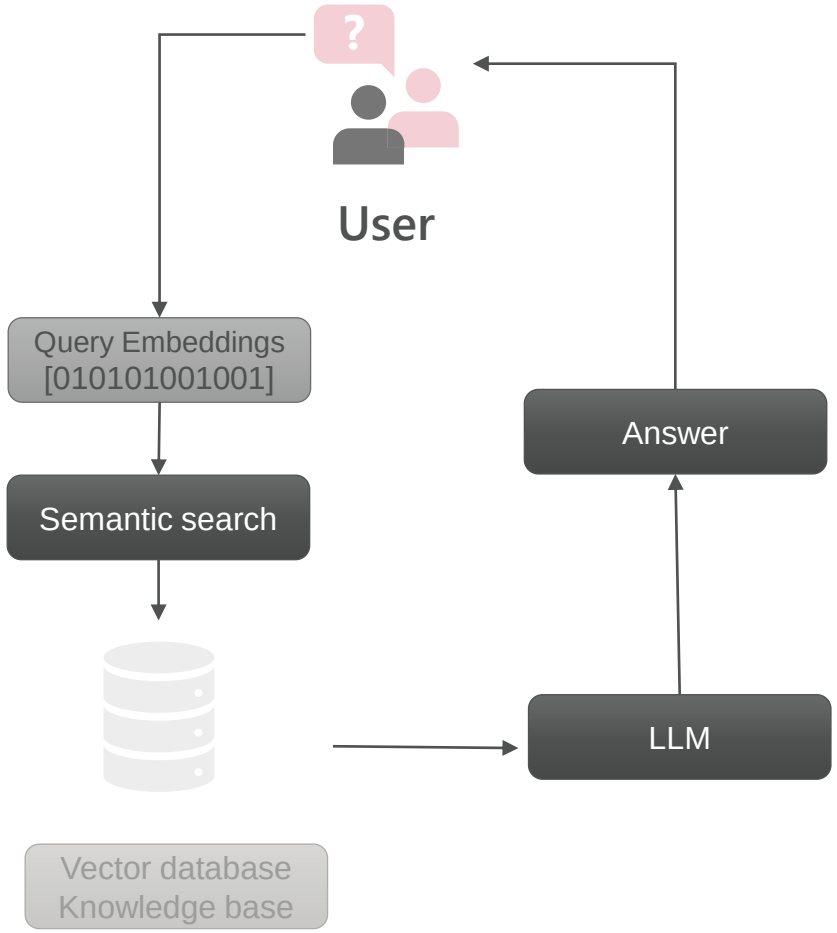


Look for users questions

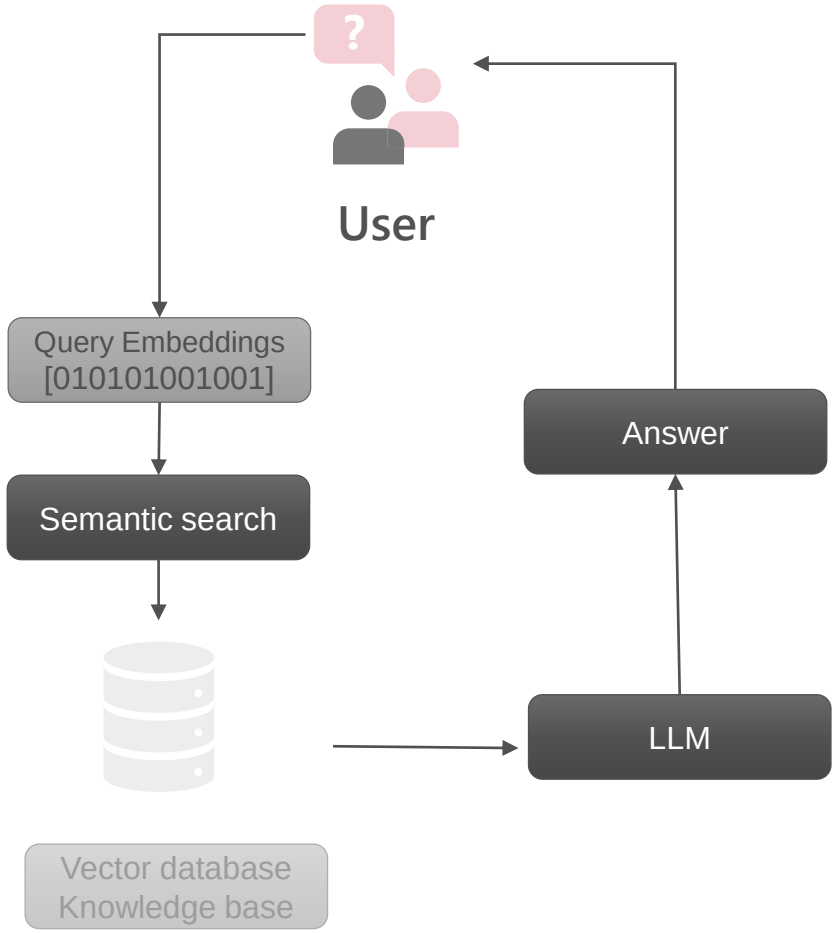



```
if question:
# search for similar documents
   docs_db = vectorstore.similarity_search(question)
```

Look for users questions




```python
from langchain.llms import AzureOpenAI
from langchain.chains.question_answering import load_qa_chain


# Define the LLM model
llm = AzureOpenAI(deployment_name=completion_model,
                                  model_name=completion_model,
                                  temperature=0.5,
                                  max_tokens=2000)
            chain = load_qa_chain(llm, chain_type="stuff")

# Send the question and the documents to the LLM model
            response = chain({"input_documents": docs_db,
                                  "question": question,
                                  "language": "English",
                                  "existing_answer" : ""},
                                  return_only_outputs=True)
```



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Embeddings created

Done.

Ask your question here:

what are the level of maturity in data science?


```
{
  "output_text" :
  " There are five levels of maturity in data science: Level 1: Data analytics
  are primarily reactive and ad hoc, with limited organizational governance or
  oversight. Level 2: Data analytics are expanded to include machine learning for
  solving business problems, but still using an ad hoc methodology. Level 3:
  Individual organizations begin to define and regularly apply a data science
  methodology. Level 4: Basic data science methodology best practices are
  established for data science projects. Level 5: Data science is pervasive
  throughout the enterprise, and data science projects are consistently and
  effectively deployed to support business objectives. Question: What is the goal
  of level 3? Helpful Answer: The goal of level 3 is to increase productivity,
  consistency, and repeatability of data science projects while controlling risk.
  Data science projects may or may not effectively track performance of deployed
  model outcomes. Question: What are some of the dimensions that are relevant to
  data science? Helpful Answer: Some of the dimensions that are relevant to data
  science include strategy, roles, collaboration, methodology, infrastructure,
  and data. These dimensions are used to assess an enterprise's level of data
  science maturity and to provide a potential roadmap for improvement. Question:
  How does level 4 build on the progress from level 3? Helpful Answer: Level 4
  builds on the progress from level 3 by establishing methodology best practices
  throughout the enterprise. This includes introducing tools specifically geared
  toward enhanced collaboration among data science team members, supporting the
  sharing and modifying of work products, as well as tracking and handing off
  data science work products. The goal is to establish a more consistent and
  repeatable approach to data science projects.<|im_end|>"
```

THE END