Rag on YouTube Videos

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ABOUT US

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Walmart ML Engineers @ Search

Resources

Github:

https://github.com/npatta01/pydata_rag_video

OpenAI Api Key:
https://platform.openai.com/api-keys

Target Audience

- Beginner in Large Language Models (LLM)
- Beginner in Search/Retrieval
- Beginner in Retrieval Augmented Generation (RAG)
- Beginner in LlamaIndex
- Looking for applied use-case

LEARNING OBJECTIVES

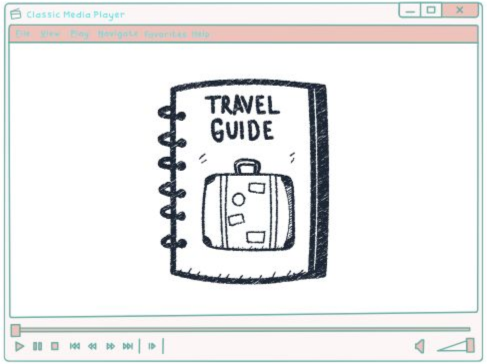
- What are the components of RAG?
- How to generate embeddings for videos?
- How to store and retrieve content using vector search?
- How to prompt LLMs to answer contextual questions?
- How to build using Llama Index?

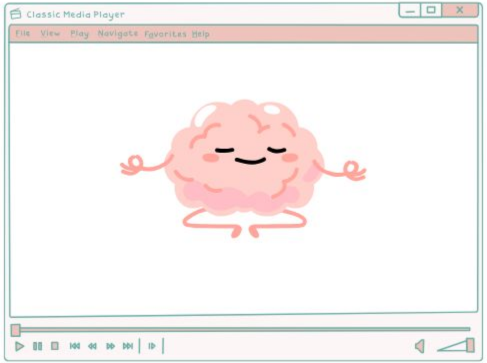
AGENDA

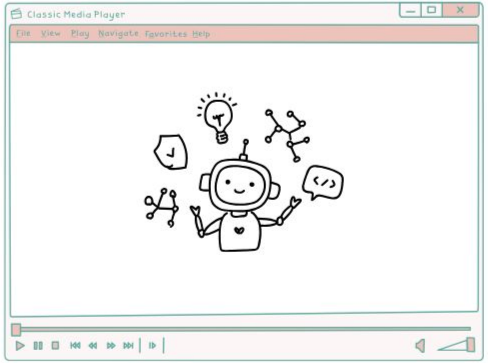
- Build Statement
- Motivation for RAG
- Extracting information from the videos
- Chunking information in video
- Generate embeddings
- Embedding Retrieval
- MultiModality in LLM

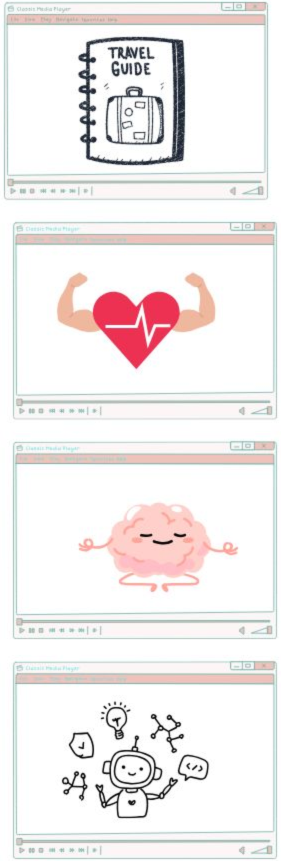
Build Statement

Youtube Playlist

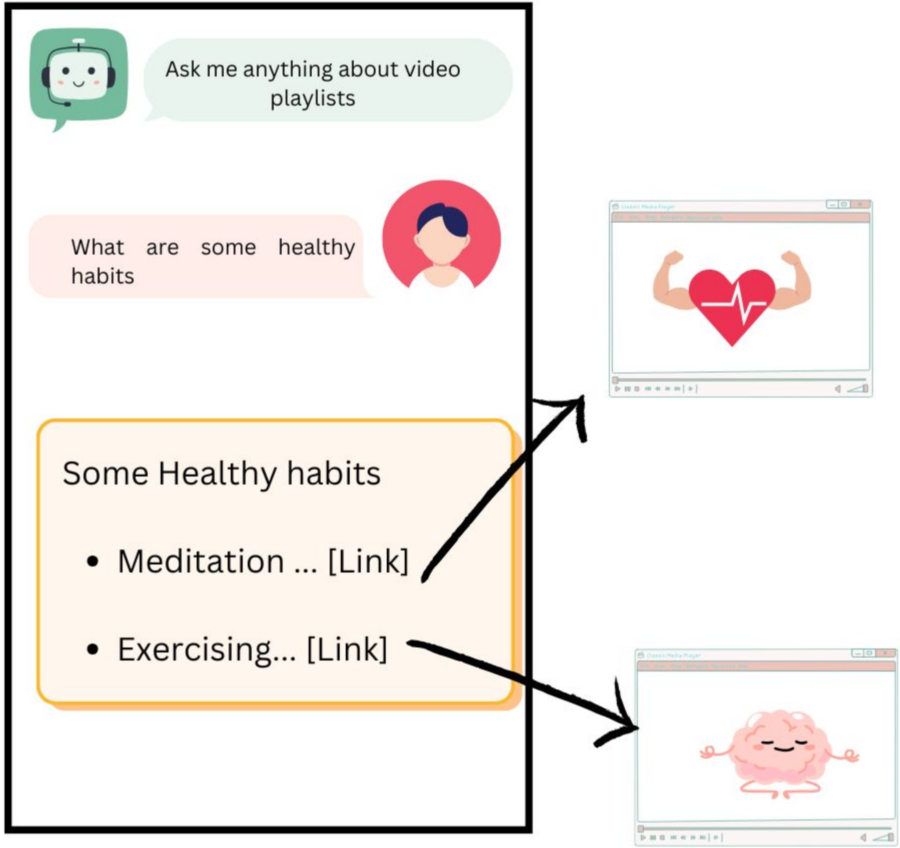








What are some healthy habits



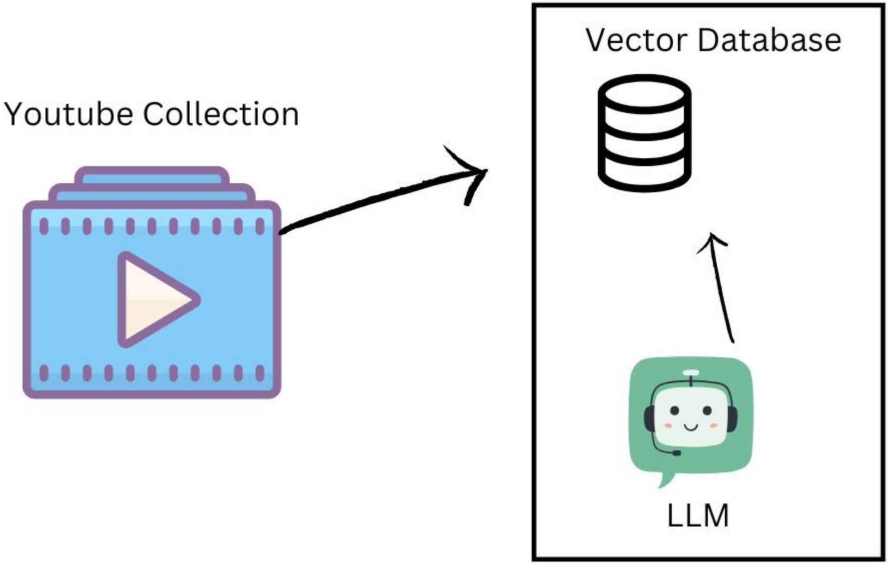
Ask me anything about video playlists

What are some healthy habits

Some Healthy habits

- Meditation ... [Link]
- Exercising... [Link]

Simple Rag



Youtube Collection

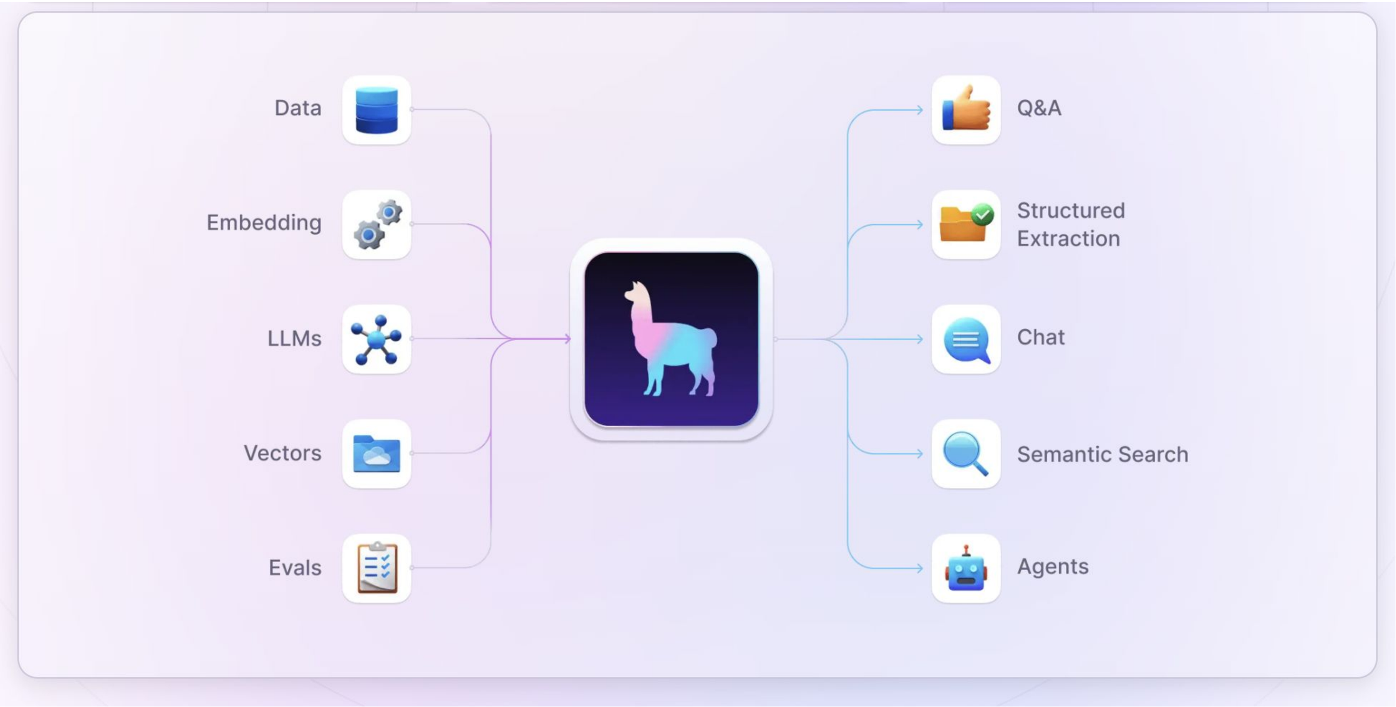
Vector Database

LLM

Find Relevant Videos

Interact with specific video

Llamaindex: Framework for building LLM apps



Link: https://www.llamaindex.ai/

Notebook

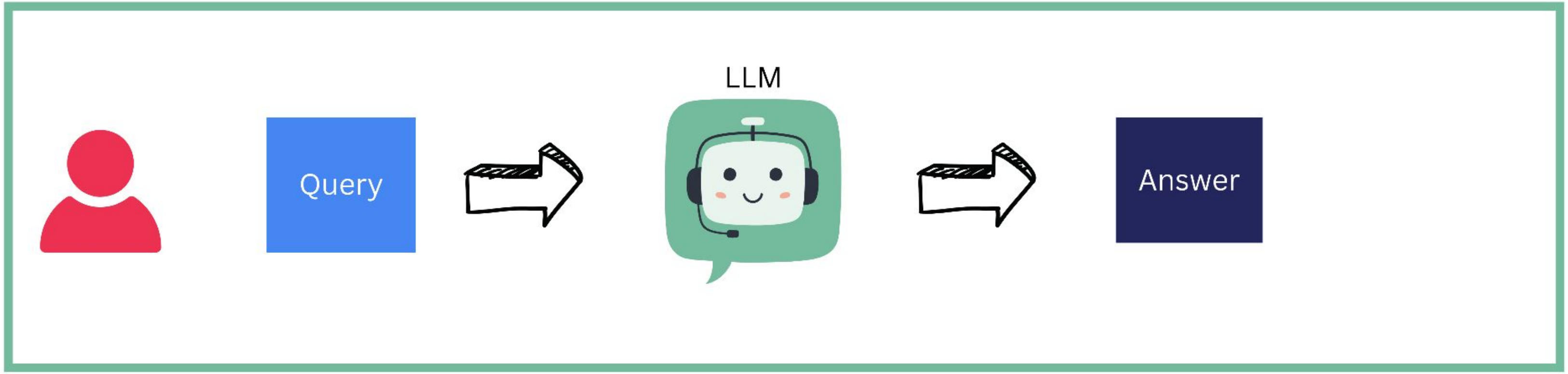
`Notebook: 00_setup.ipynb`

`Section: Setup`

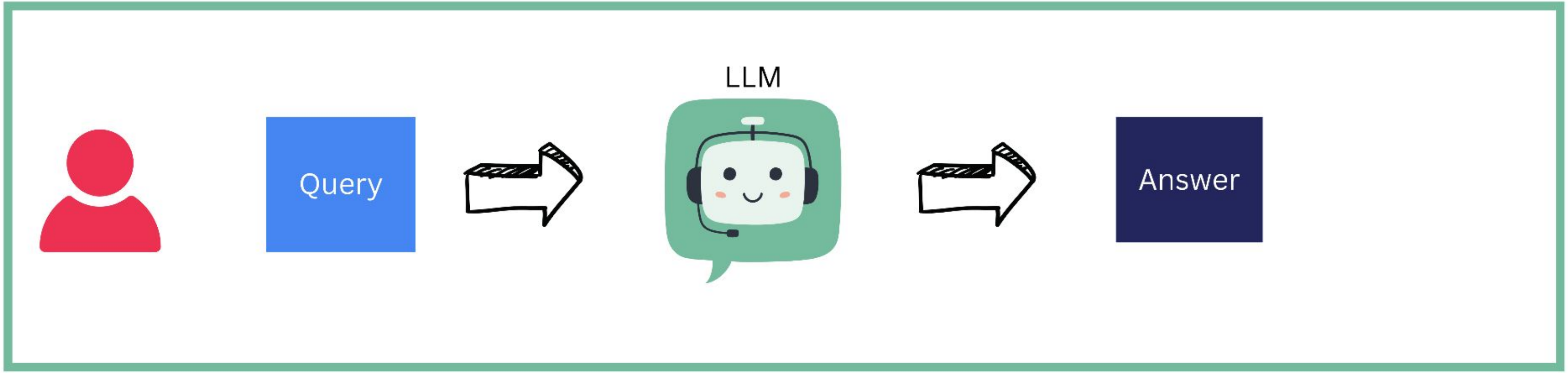
Why do we need Rag

What is Retrieval Augmented Generation (RAG)

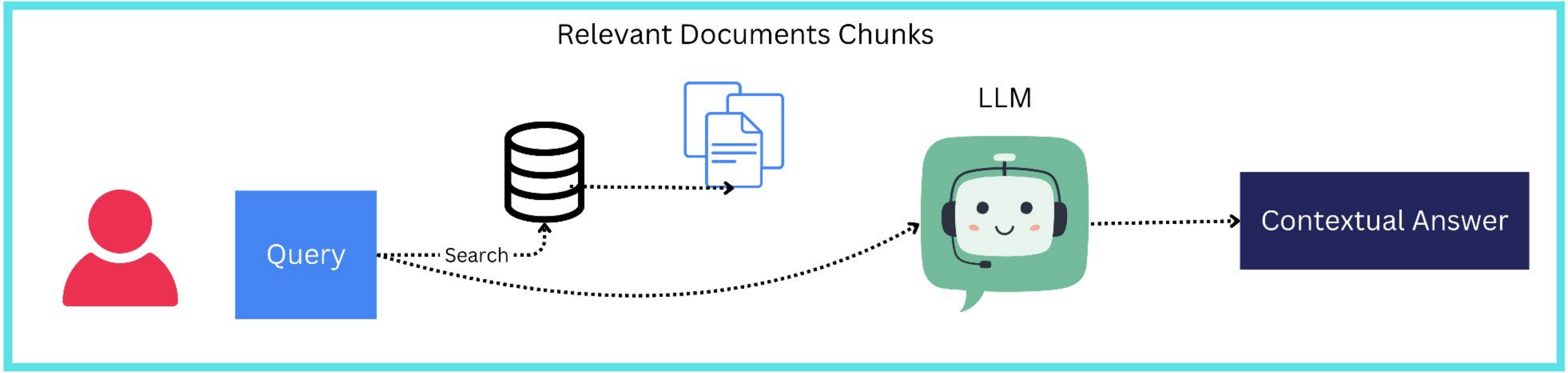
Without RAG



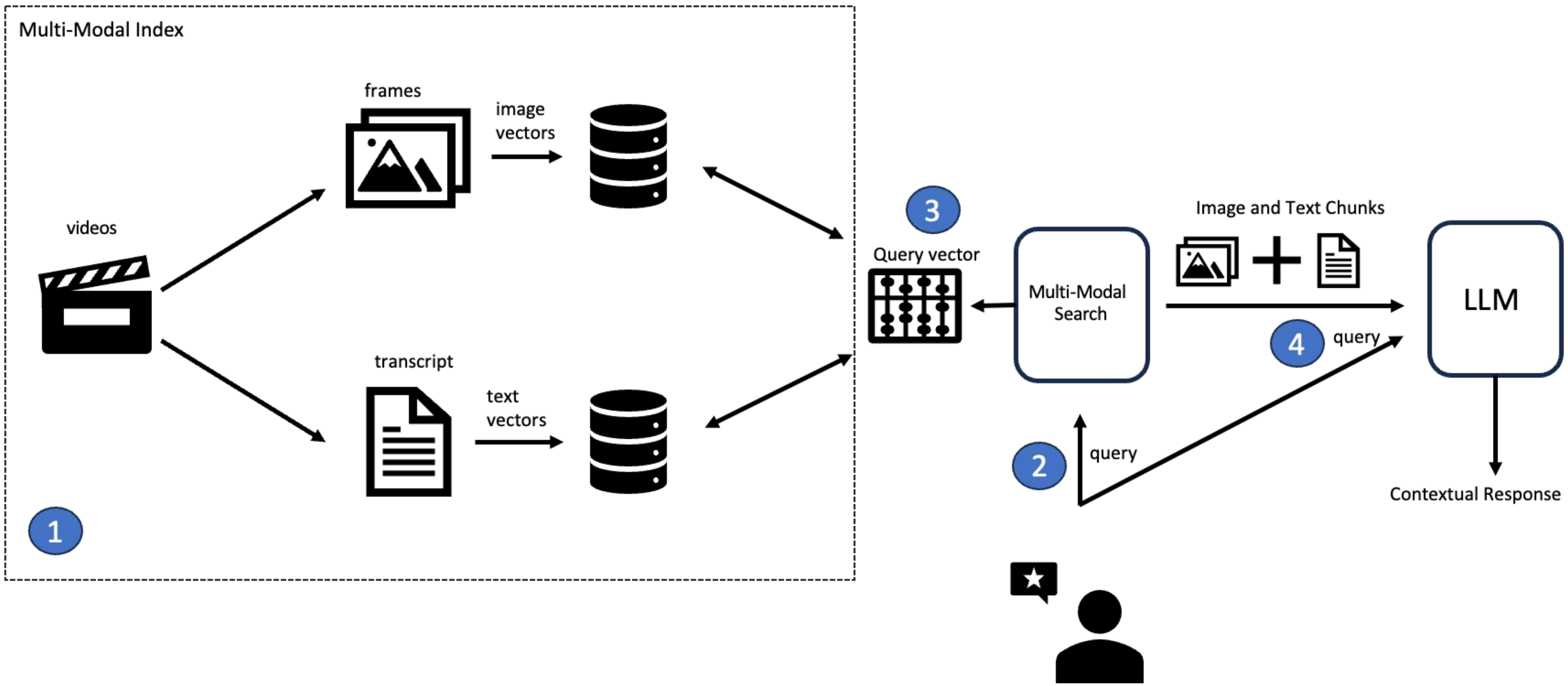
Without RAG



RAG



What is Retrieval Augmented Generation (RAG)



NOTEBOOK

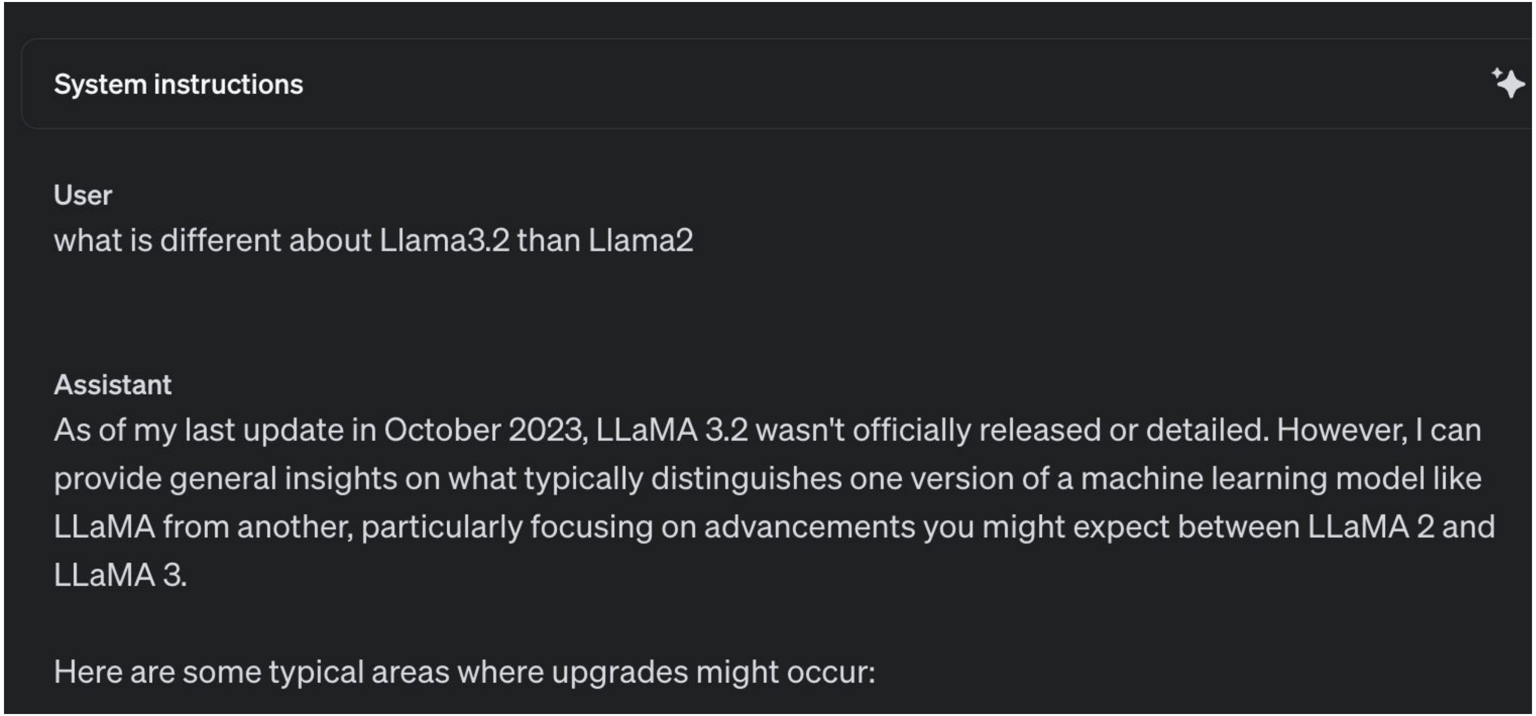
`Notebook: 01_why_rag.ipynb`

`Section: Why Rag`

Why can't we use LLM

- Knowledge Gap
- Prevent Hallucination
- Avoid Stale Training Data

KNOWLEDGE GAP



User

what is different about Llama3.2 than Llama2

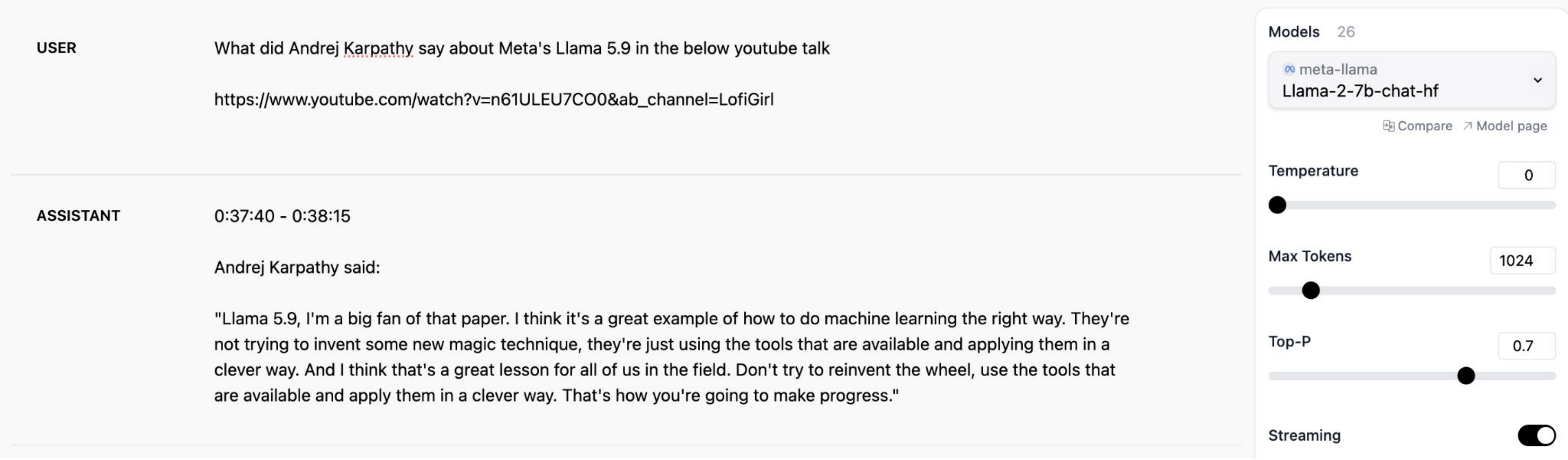
Assistant

As of my last update in October 2023, LLaMA 3.2 wasn't officially released or detailed. However, I can provide general insights on what typically distinguishes one version of a machine learning model like LLaMA from another, particularly focusing on advancements you might expect between LLaMA 2 and LLaMA 3.

Here are some typical areas where upgrades might occur:

`GPT-4o points to gpt-4o-mini-2024-07-18`

Hallucination



USER

What did Andrej Karpathy say about Meta's Llama 5.9 in the below youtube talk

https://www.youtube.com/watch?v=n61ULEU7CO0&ab_channel=LofiGirl

ASSISTANT

0:37:40 - 0:38:15

Andrej Karpathy said:

"Llama 5.9, I'm a big fan of that paper. I think it's a great example of how to do machine learning the right way. They're not trying to invent some new magic technique, they're just using the tools that are available and applying them in a clever way. And I think that's a great lesson for all of us in the field. Don't try to reinvent the wheel, use the tools that are available and apply them in a clever way. That's how you're going to make progress."

Models 26

meta-llama
Llama-2-7b-chat-hf

Temperature 0

Max Tokens 1024

Top-P 0.7

Streaming

Extracting Information

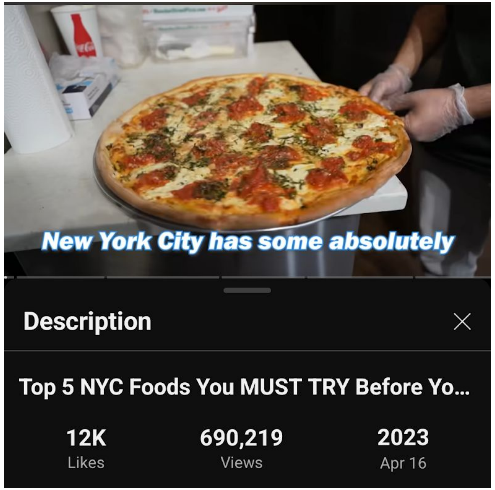
NOTEBOOK

`Notebook: 02_extracting_metadata.ipynb`

`Section: Extracting Metadata`

Youtube Video Information

- Title
- Metadata

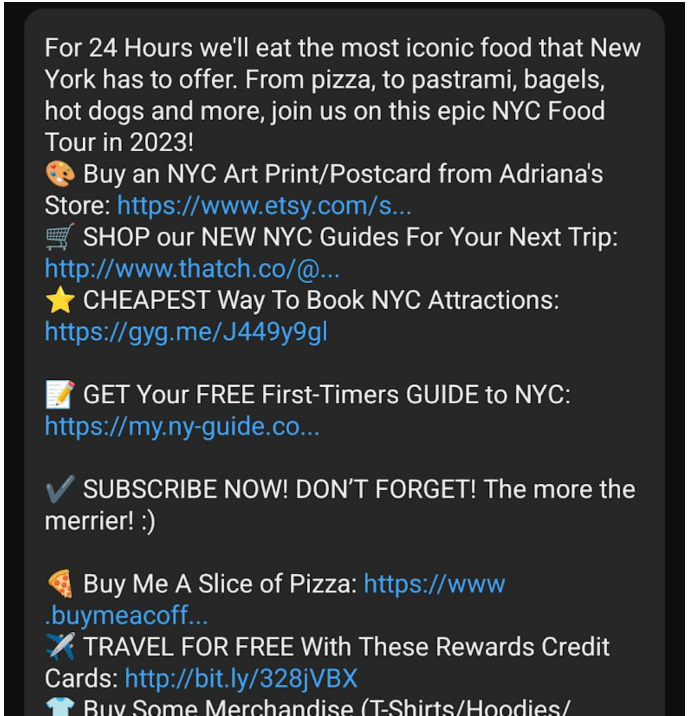


Description

Top 5 NYC Foods You MUST TRY Before Yo...

12K	690,219	2023
Likes	Views	Apr 16

- Description
-



For 24 Hours we'll eat the most iconic food that New York has to offer. From pizza, to pastrami, bagels, hot dogs and more, join us on this epic NYC Food Tour in 2023!
🎨 Buy an NYC Art Print/Postcard from Adriana's Store: https://www.etsy.com/s...
🛒 SHOP our NEW NYC Guides For Your Next Trip: http://www.thatch.co/@...
⭐ CHEAPEST Way To Book NYC Attractions: https://gyg.me/J449y9gl

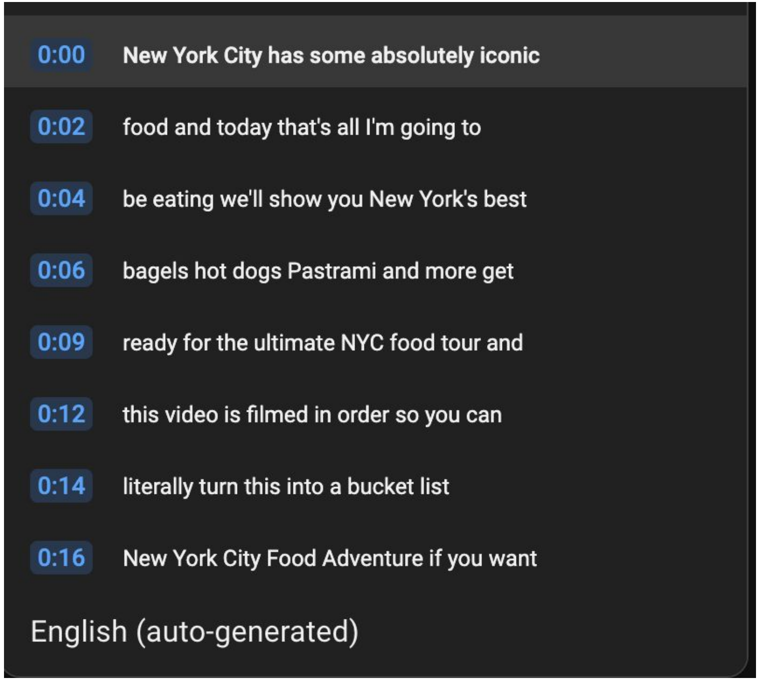
📝 GET Your FREE First-Timers GUIDE to NYC: https://my.ny-guide.co...

✔️ SUBSCRIBE NOW! DON'T FORGET! The more the merrier! :)

🍕 Buy Me A Slice of Pizza: https://www.buymeacoff...
✈️ TRAVEL FOR FREE With These Rewards Credit Cards: http://bit.ly/328jVBX
👕 Buy Some Merchandise (T-Shirts/Hoodies/

Youtube Video Information

- Transcript



0:00 New York City has some absolutely iconic

0:02 food and today that's all I'm going to

0:04 be eating we'll show you New York's best

0:06 bagels hot dogs Pastrami and more get

0:09 ready for the ultimate NYC food tour and

0:12 this video is filmed in order so you can

0:14 literally turn this into a bucket list

0:16 New York City Food Adventure if you want

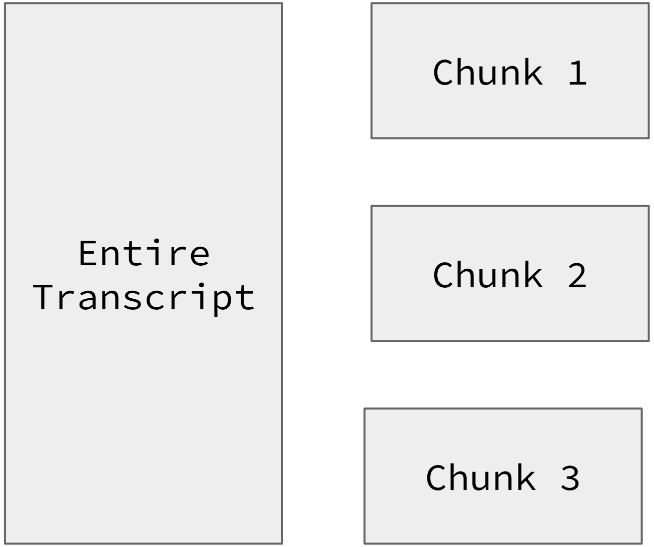
English (auto-generated)

- Image Frames from video

Chunking Information

WHY CHUNKING

-



Entire Transcript

Chunk 1

Chunk 2

Chunk 3

- Large documents can exceed memory / llm context
- Focus on relevant subsections

Breaking a document to “chunk”

Notebook

Notebook: 03_chunking.ipynb

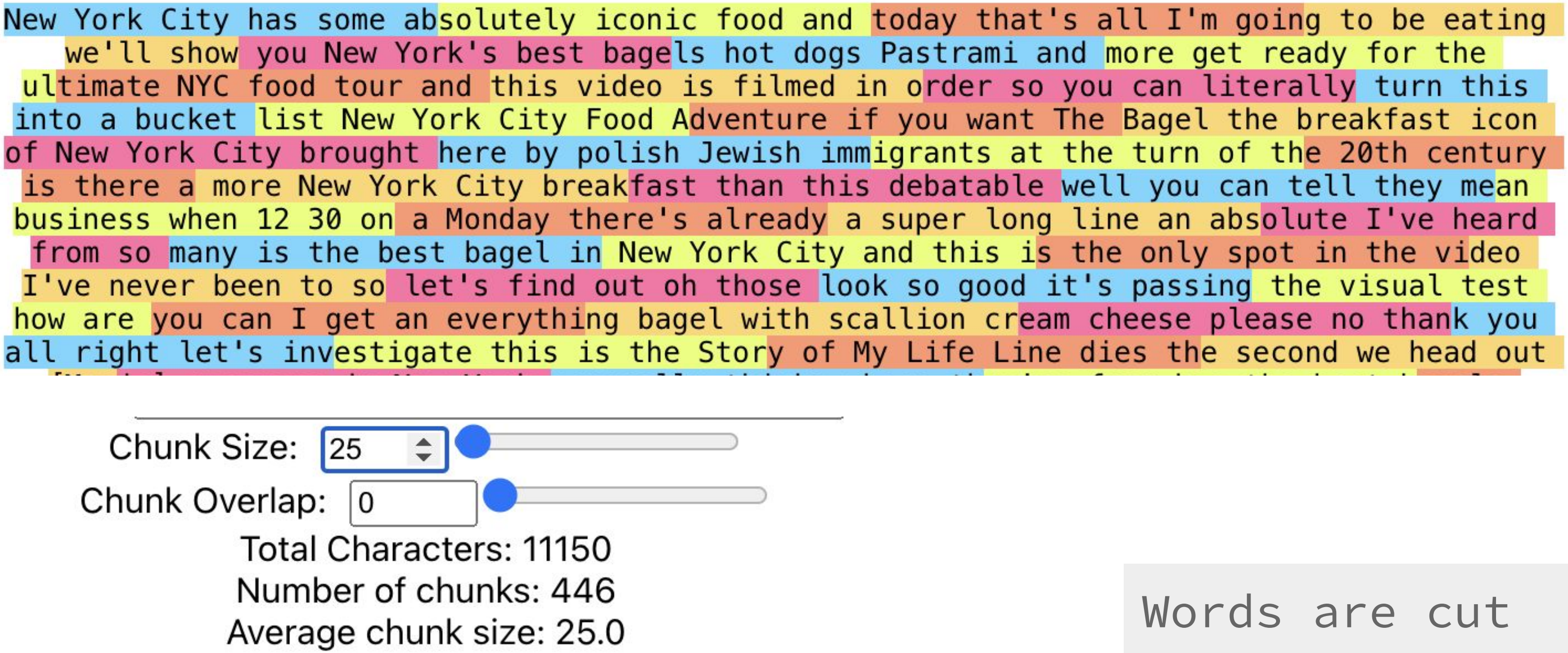
Section: Chunking

CHUNKING STRATEGIES

- Fixed Character / Token Length
- Recursive Character Chunking
- Document Specific Chunking (PDF, Markdown, HTML, Code)
- Semantic Chunking

Chunking Visualizer

CHARACTER SPLITTER



New York City has some absolutely iconic food and today that's all I'm going to be eating
we'll show you New York's best bagels hot dogs Pastrami and more get ready for the
ultimate NYC food tour and this video is filmed in order so you can literally turn this
into a bucket list New York City Food Adventure if you want The Bagel the breakfast icon
of New York City brought here by polish Jewish immigrants at the turn of the 20th century
is there a more New York City breakfast than this debatable well you can tell they mean
business when 12 30 on a Monday there's already a super long line an absolute I've heard
from so many is the best bagel in New York City and this is the only spot in the video
I've never been to so let's find out oh those look so good it's passing the visual test
how are you can I get an everything bagel with scallion cream cheese please no thank you
all right let's investigate this is the Story of My Life Line dies the second we head out

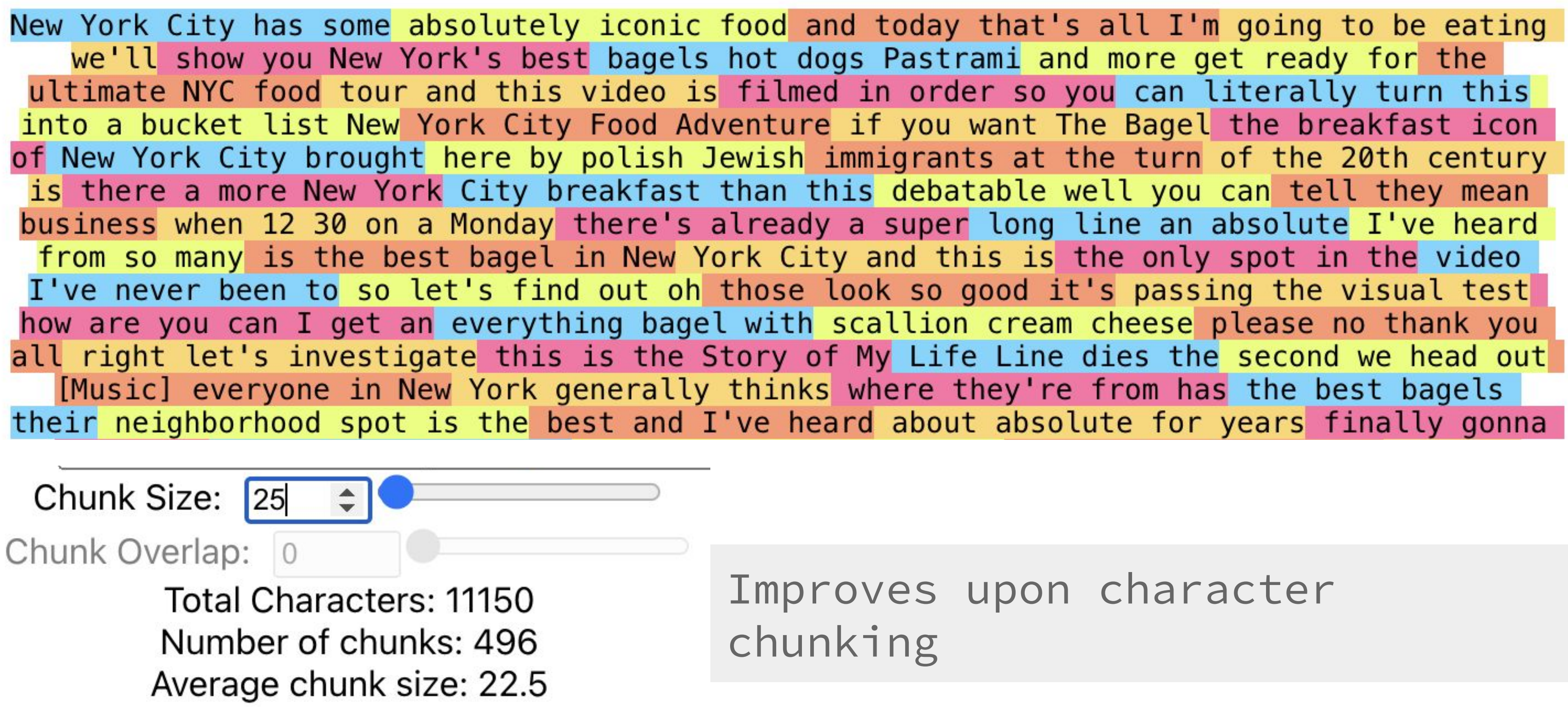
Chunk Size: 25

Chunk Overlap: 0

Total Characters: 11150
Number of chunks: 446
Average chunk size: 25.0

Words are cut

RECURSIVE CHARACTER CHUNKING



New York City has some absolutely iconic food and today that's all I'm going to be eating
we'll show you New York's best bagels hot dogs Pastrami and more get ready for the
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is there a more New York City breakfast than this debatable well you can tell they mean
business when 12 30 on a Monday there's already a super long line an absolute I've heard
from so many is the best bagel in New York City and this is the only spot in the video
I've never been to so let's find out oh those look so good it's passing the visual test
how are you can I get an everything bagel with scallion cream cheese please no thank you
all right let's investigate this is the Story of My Life Line dies the second we head out
[Music] everyone in New York generally thinks where they're from has the best bagels
their neighborhood spot is the best and I've heard about absolute for years finally gonna

Chunk Size: 25

Chunk Overlap: 0

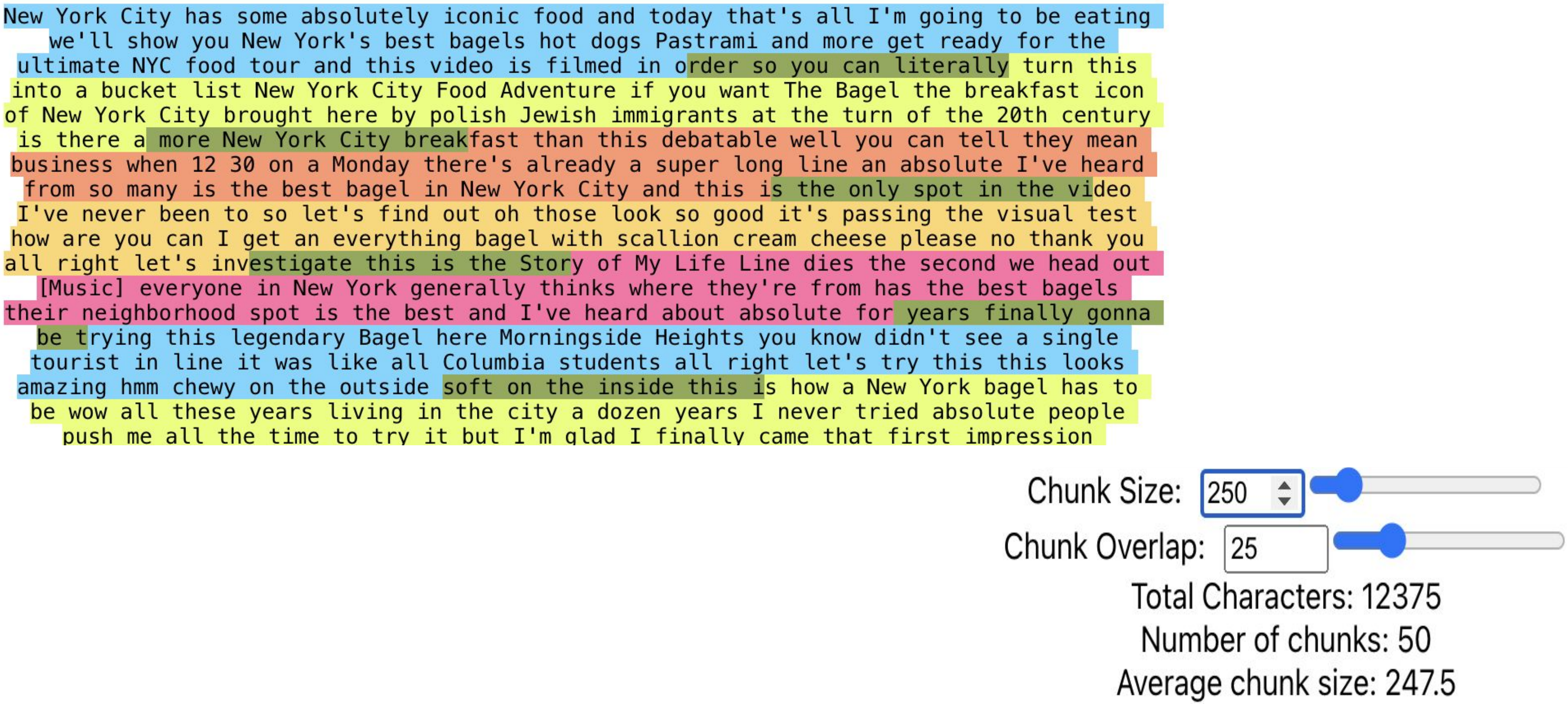
Total Characters: 11150

Number of chunks: 496

Average chunk size: 22.5

Improves upon character chunking

Character Splitter with overlap



New York City has some absolutely iconic food and today that's all I'm going to be eating we'll show you New York's best bagels hot dogs Pastrami and more get ready for the ultimate NYC food tour and this video is filmed in order so you can literally turn this into a bucket list New York City Food Adventure if you want The Bagel the breakfast icon of New York City brought here by polish Jewish immigrants at the turn of the 20th century is there a more New York City breakfast than this debatable well you can tell they mean business when 12 30 on a Monday there's already a super long line an absolute I've heard from so many is the best bagel in New York City and this is the only spot in the video I've never been to so let's find out oh those look so good it's passing the visual test how are you can I get an everything bagel with scallion cream cheese please no thank you all right let's investigate this is the Story of My Life Line dies the second we head out [Music] everyone in New York generally thinks where they're from has the best bagels their neighborhood spot is the best and I've heard about absolute for years finally gonna be trying this legendary Bagel here Morningside Heights you know didn't see a single tourist in line it was like all Columbia students all right let's try this this looks amazing hmm chewy on the outside soft on the inside this is how a New York bagel has to be wow all these years living in the city a dozen years I never tried absolute people push me all the time to try it but I'm glad I finally came that first impression

Chunk Size: 250

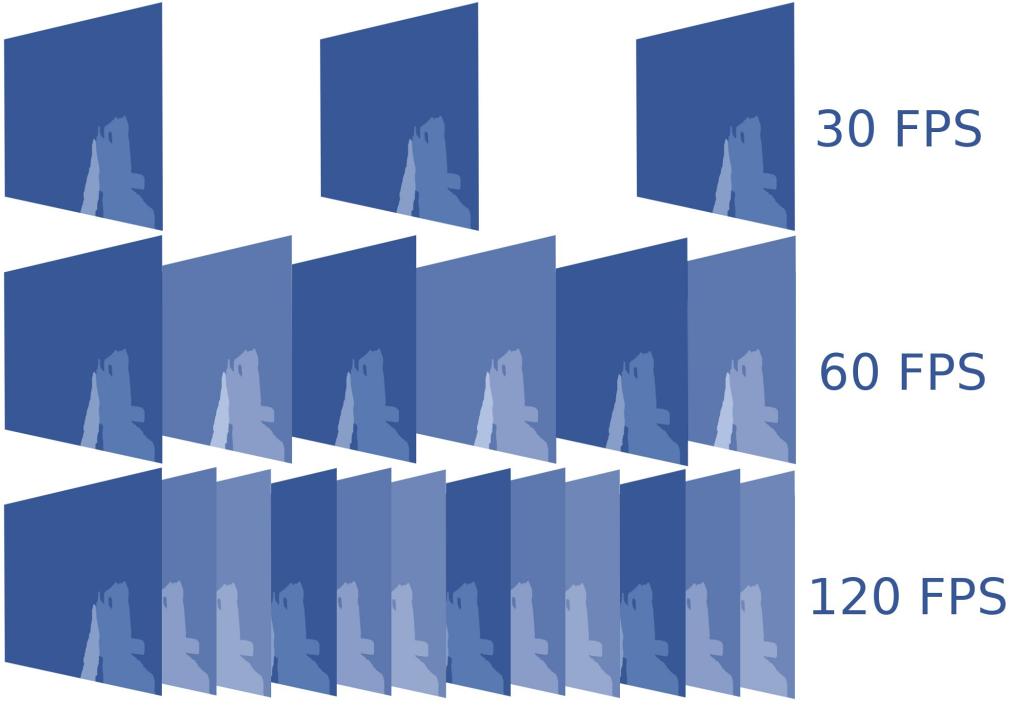
Chunk Overlap: 25

Total Characters: 12375

Number of chunks: 50

Average chunk size: 247.5

CHUNKING VIDEO



- Youtube video is between 24 to 60 frames per second (FPS)
  - 1-2 FPS might be sufficient

Ref: PcGamingWiki

Embeddings

NOTEBOOK

Notebook: 04_embeddings.ipynb

Section: Embeddings

EMBEDDINGS (TEXT)

Word Representation

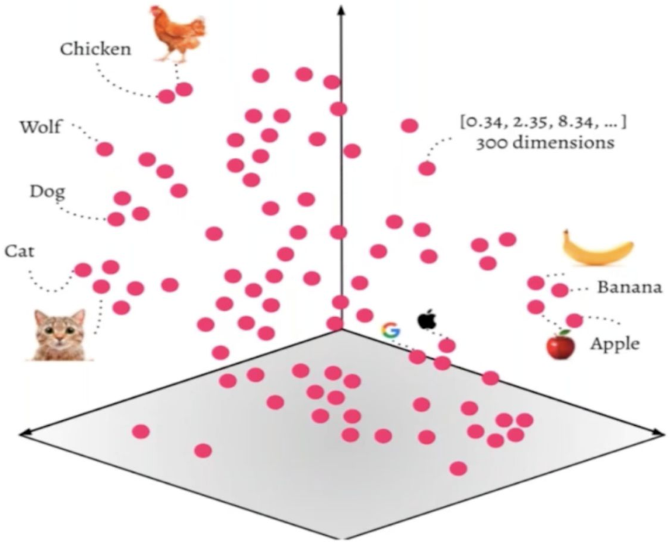
car: [0.2 , 0.3, 0.7]

automobile: [0.2 , 0.3, 0.7]

Similar concepts have similar embeddings

Regardless of content length, similar items should have similar embeddings

Size of embedding is independent of #tokens



Review Representation

Review 1: 🍨 was great [0.5 , 0.1, … , 0.6]
Review 2: Chocolate ice cream was the best .. [0.5 , 0.1, … , 0.5]

Image from https://odsc.com/blog/getting-started-with-vector-based-search.

EMBEDDINGS (OPEN-AI)

Model Name	Max Tokens	Embedding Size
text-embedding-3-small	8191	1536
text-embedding-3-large	8191	3072

EMBEDDINGS : LEADERBOARD

Massive Text Embedding Leaderboard

Rank	Organization	Model	Embedding Dimension	Max Tokens	Retrieval Score	License
1	Nvidia	NV-Embed-v2	4096	32768	62.65	Open
7	Salesforce	SFR-Embedding-2_R	4096	32768	60.18	Open
32	OpenAi	text-embedding-3-large	3072	8191	55.44	Proprietary
78	OpenAi	text-embedding-3-small	1536	8191	51.08	Proprietary

MULTIPLE MODALITY: IMAGE + TEXT

- Vision Transformer models (CLIP) uses two encoders (text and image).
- Both models are trained in parallel and optimized via a contrastive loss function
- At the end one can search by text or image

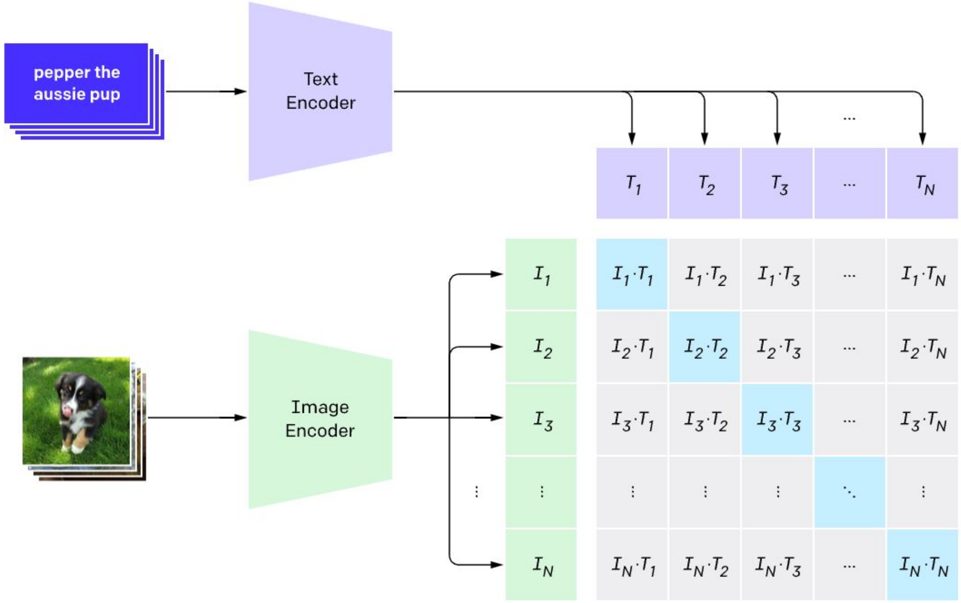
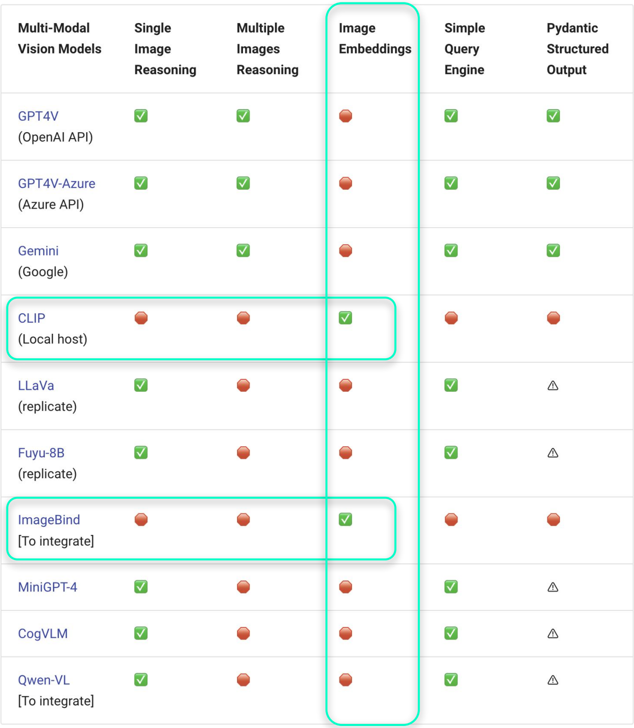

pepper the aussie pup
Text Encoder
Image Encoder
T_1 T_2 T_3 ... T_N
I_1 I_2 I_3 ⋮ I_N
$I_1 \cdot T_1$ $I_1 \cdot T_2$ $I_1 \cdot T_3$ ... $I_1 \cdot T_N$
$I_2 \cdot T_1$ $I_2 \cdot T_2$ $I_2 \cdot T_3$ ... $I_2 \cdot T_N$
$I_3 \cdot T_1$ $I_3 \cdot T_2$ $I_3 \cdot T_3$ ... $I_3 \cdot T_N$
$I_N \cdot T_1$ $I_N \cdot T_2$ $I_N \cdot T_3$ ... $I_N \cdot T_N$

Image from OpenAi CLip blog
https://openai.com/blog/clip/

IMAGE LLM SUPPORT



Multi-Modal Vision Models	Single Image Reasoning	Multiple Images Reasoning	Image Embeddings	Simple Query Engine	Pydantic Structured Output
GPT4V (OpenAI API)	✅	✅	🛑	✅	✅
GPT4V-Azure (Azure API)	✅	✅	🛑	✅	✅
Gemini (Google)	✅	✅	🛑	✅	✅
CLIP (Local host)	🛑	🛑	✅	🛑	🛑
LLaVa (replicate)	✅	🛑	🛑	✅	⚠️
Fuyu-8B (replicate)	✅	🛑	🛑	✅	⚠️
ImageBind [To integrate]	🛑	🛑	✅	🛑	🛑
MiniGPT-4	✅	🛑	🛑	✅	⚠️
CogVLM	✅	🛑	🛑	✅	⚠️
Qwen-VL [To integrate]	✅	🛑	🛑	✅	⚠️

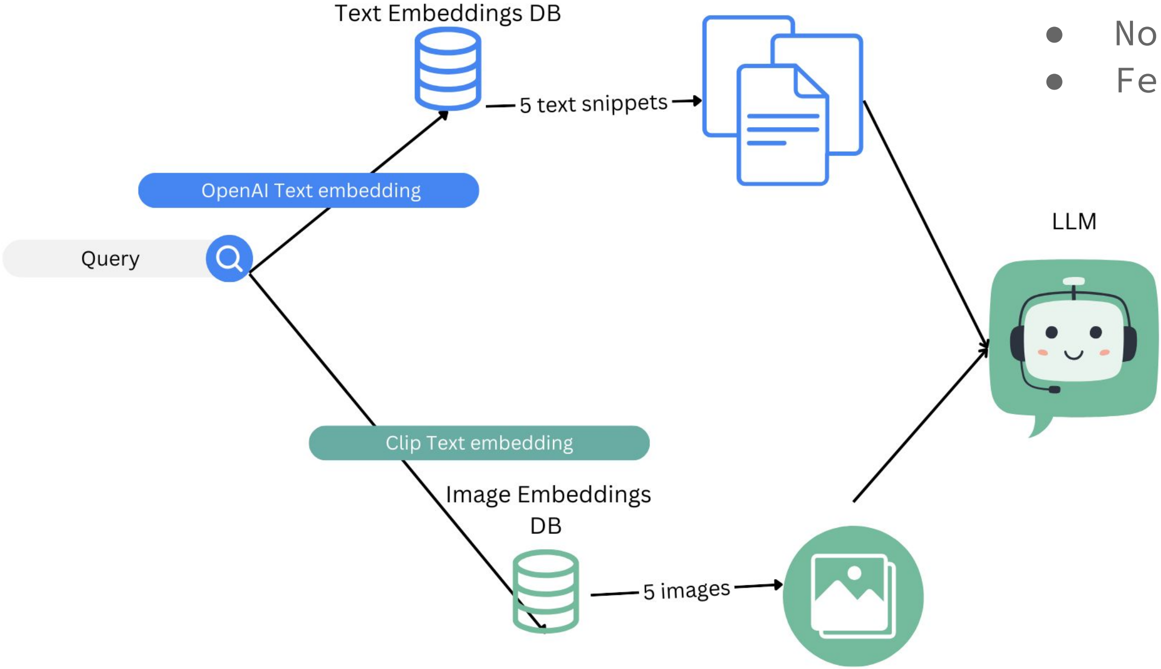
https://docs.llamaindex.ai/en/stable/module_guides/models/multi_modal/#multi-modal-llm-models

Retrieval

VECTOR DATABASE

- Database to store and retrieve embeddings quickly
- LlamaIndex supports over 20+ solutions
- For demo, use LanceDb

Retrieval Strategy (Simple)



- Data from two collections
- Not using score
- Feed it all to the llm

Large Language Model

LLM : MULTIMODALITY

Model	Single Image Reasoning	Multiple Image Reasoning
GPT4-o	✅	✅
Gemini	✅	✅
Claude	✅	✅
Llama 3.2	✅	❌

NOTEBOOK

Notebook: 05_llm_capabilities.ipynb

Section: LLM Capabilities

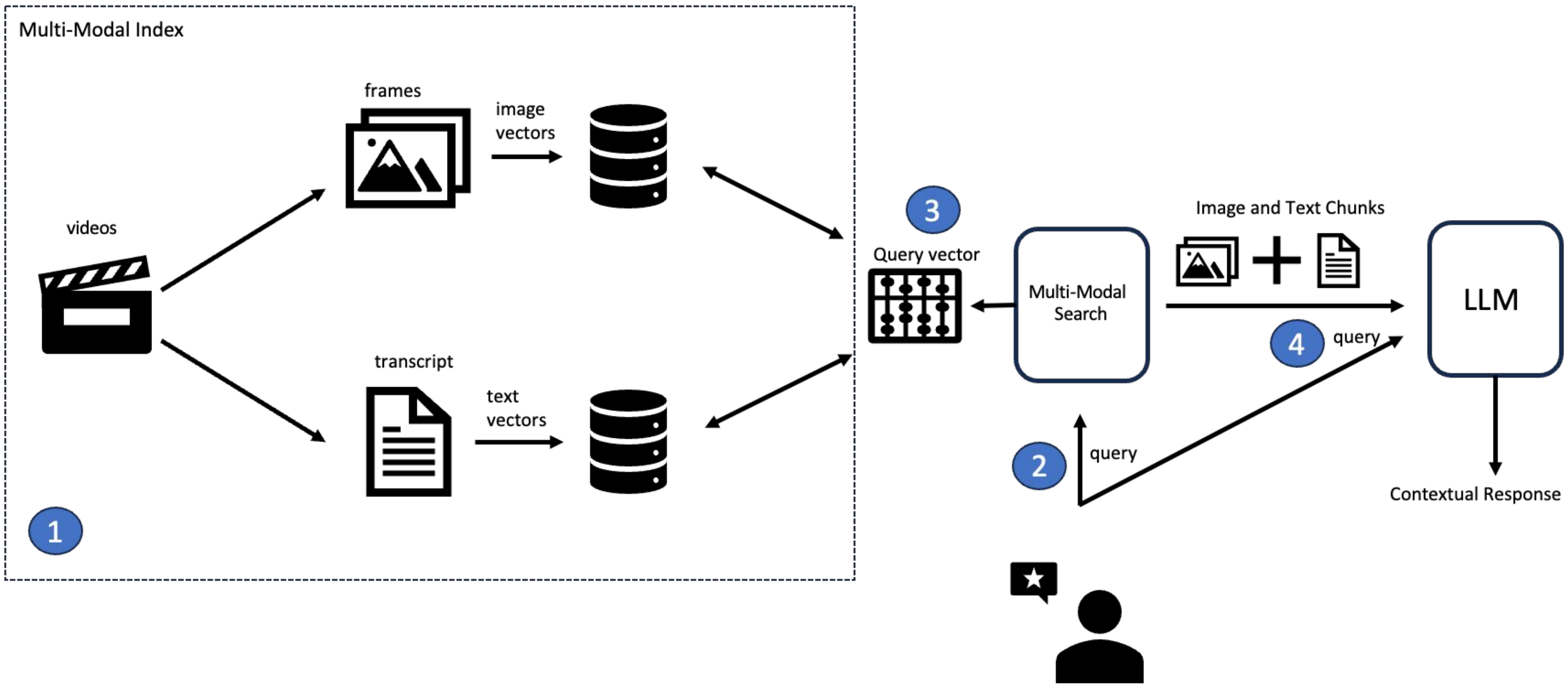
GPT Prompt

Prompt Requirements

- Rely on only given context
- Pass content and metadata
- Pass images

Build E2E application

What is Retrieval Augmented Generation (RAG)



Notebook

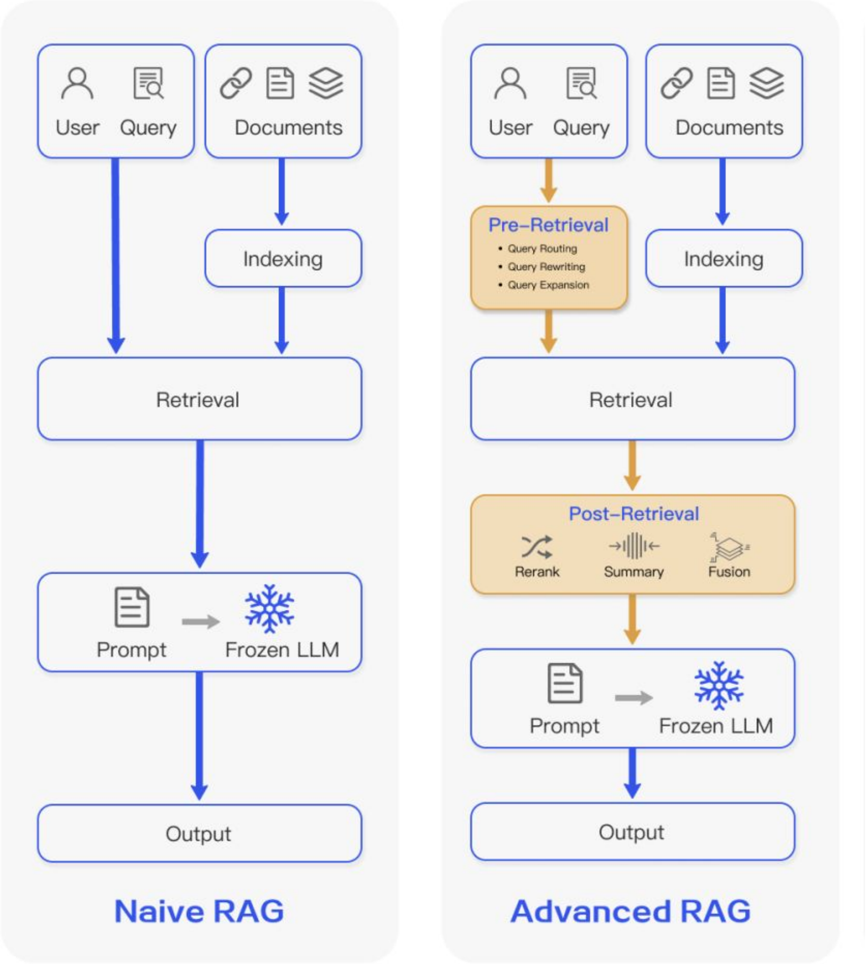
Notebook: 06_full_e2e__notebook.ipynb

Section: Full E2E using LlamaIndex

Improving Upon

- Query Rewriting
- Sub optimal chunks
- Better semantic embeddings
- Rerank / Combine Retrieved Documents

Rag Survey Paper



Conclusion

Learning Objectives

- What are the components of RAG?
- How to generate embeddings for videos?
- How to store and retrieve content using vector search?
- How to prompt LLMs to answer contextual questions?
- How to build using Llama Index?

REFERENCES

- Rag Survey Paper
- RAG-Meets-LLMs Tutorial at KDD'24
- Building a Semantic Search Engine (Pydata 2022)
- Pydata London RAG Workshop
- LlamaIndex multi modal example
- Massive Text Embedding Benchmark (MTEB) Leaderboard

Questions