Five Techniques for Improving RAG Chatbots

Improving Retrievers to Build High-Quality Conversational Assistants

Nikita Kozodoi, PhD

13.02.2024

© 2024, Amazon Web Services, Inc. or its affiliates.

About Me

https://kozodoi.me

- Applied Scientist at Amazon Web Services
- Building Generative AI solutions across industries
- Working on the frontier of research & business
- Earned PhD in ML for Credit Risk Analytics
- Won 18 Kaggle competition medals

© 2024, Amazon Web Services, Inc. or its affiliates.

My Team: Generative AI Innovation Center

Design

Deploy

Drive

Design guidance:

- Select the GenAI use case with the highest business impact
- Design how to develop, train, and deploy it to production

→

Deploy recommended solutions:

- Develop and fine-tune a GenAI solution to meet your business objectives and demonstrate what's possible

→

Drive adoption:

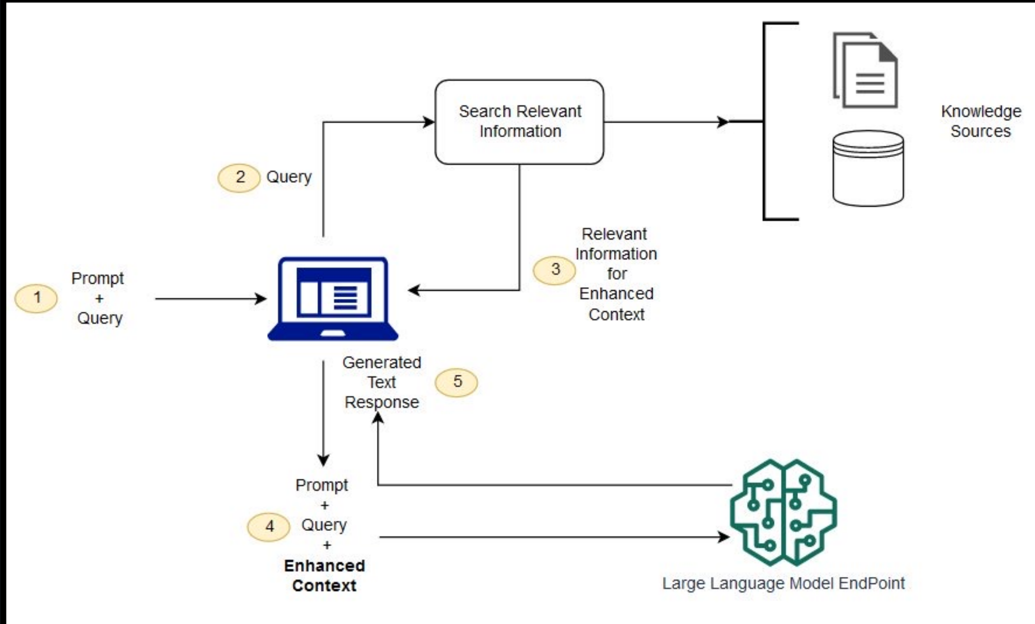
- Accelerate stickiness and adoption with a path to production for your GenAI solution integrated into your application.

https://aws.amazon.com/generative-ai/innovation-center/

© 2024, Amazon Web Services, Inc. or its affiliates.

Agenda

- **Intro to RAG Chatbots**
- **Techniques to Improve Retrieval**
    - #1: Small-to-Big Retrieval
    - #2: Leveraging Meta-Data
    - #3: Hybrid Search
    - #4: Query Rewriting & Expansion
    - #5: Document Reranking



aws
© 2024, Amazon Web Services, Inc. or its affiliates.

Intro to RAG Chatbots

(RAG = Retrieval Augmented Generation)

© 2024, Amazon Web Services, Inc. or its affiliates.

Search vs Q&A Assistant

What is self-attention? Send

[1] Attention is all you need

Attention mechanisms have become an integral part of compelling sequence modeling…

[2] Mistral 7B

The number of operations in vanilla attention is quadratic in the sequence length…

Search

What is self-attention? Send

Self-attention is a mechanism used in DL models to capture dependencies and relationships within input sequences [1].

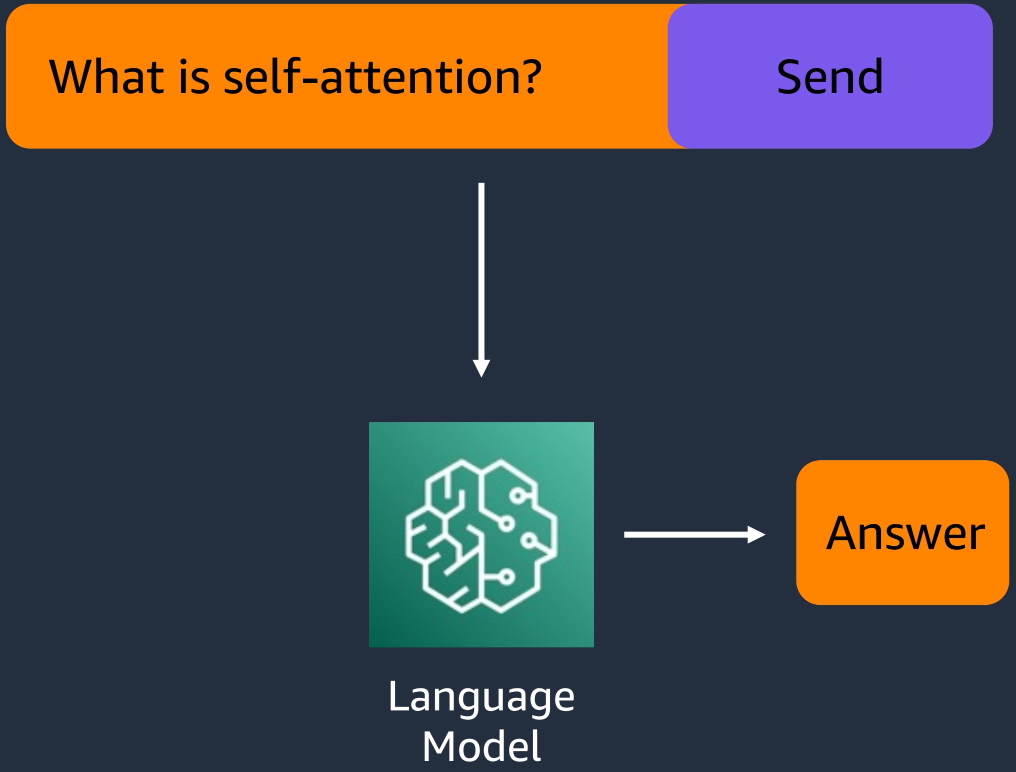
[1] Attention is all you need

Attention mechanisms have become an integral part of compelling sequence modeling…

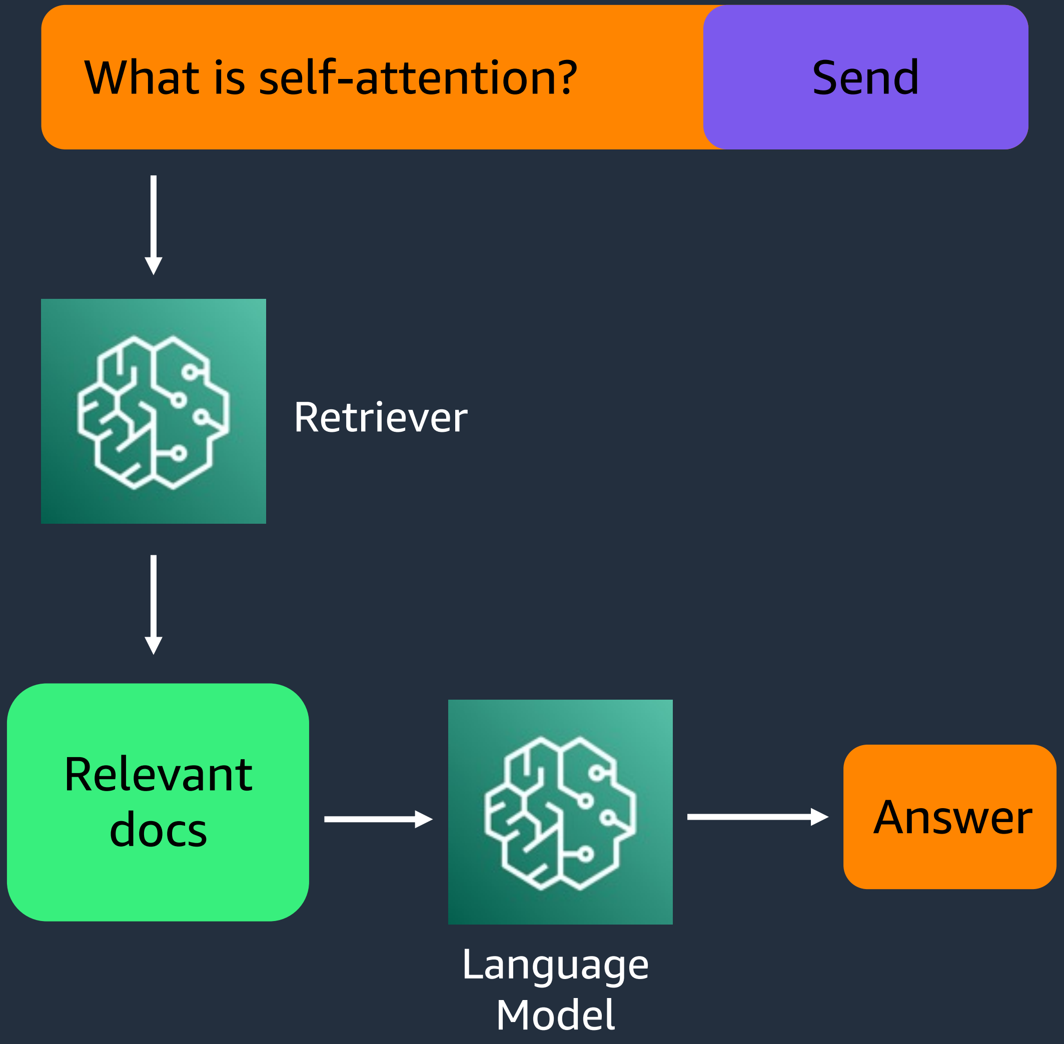
Q&A Assistant

© 2024, Amazon Web Services, Inc. or its affiliates.

Assistant with/without RAG



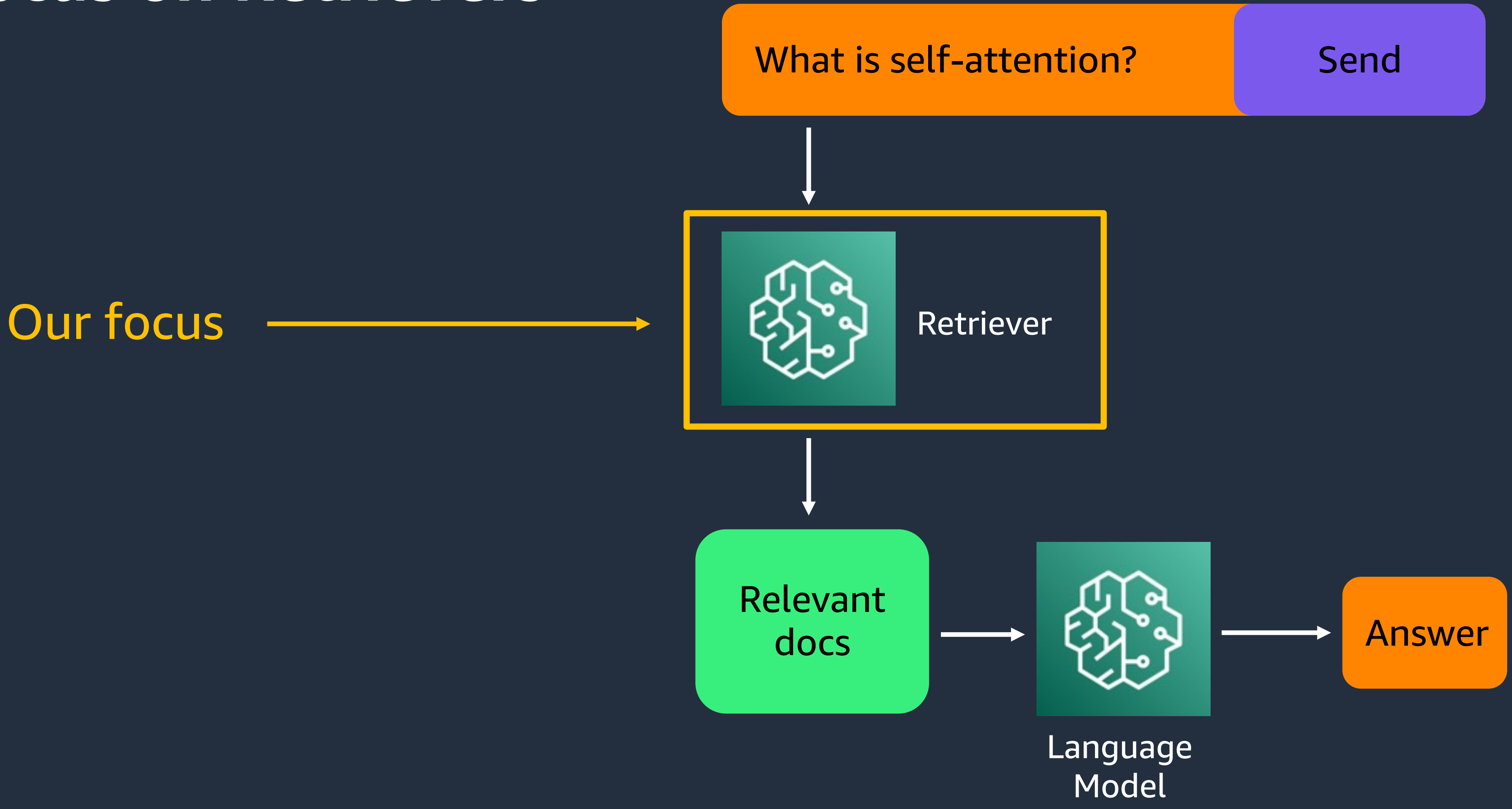
Assistant with no RAG



Assistant with RAG

aws
© 2024, Amazon Web Services, Inc. or its affiliates.

Let's Focus on Retrievers

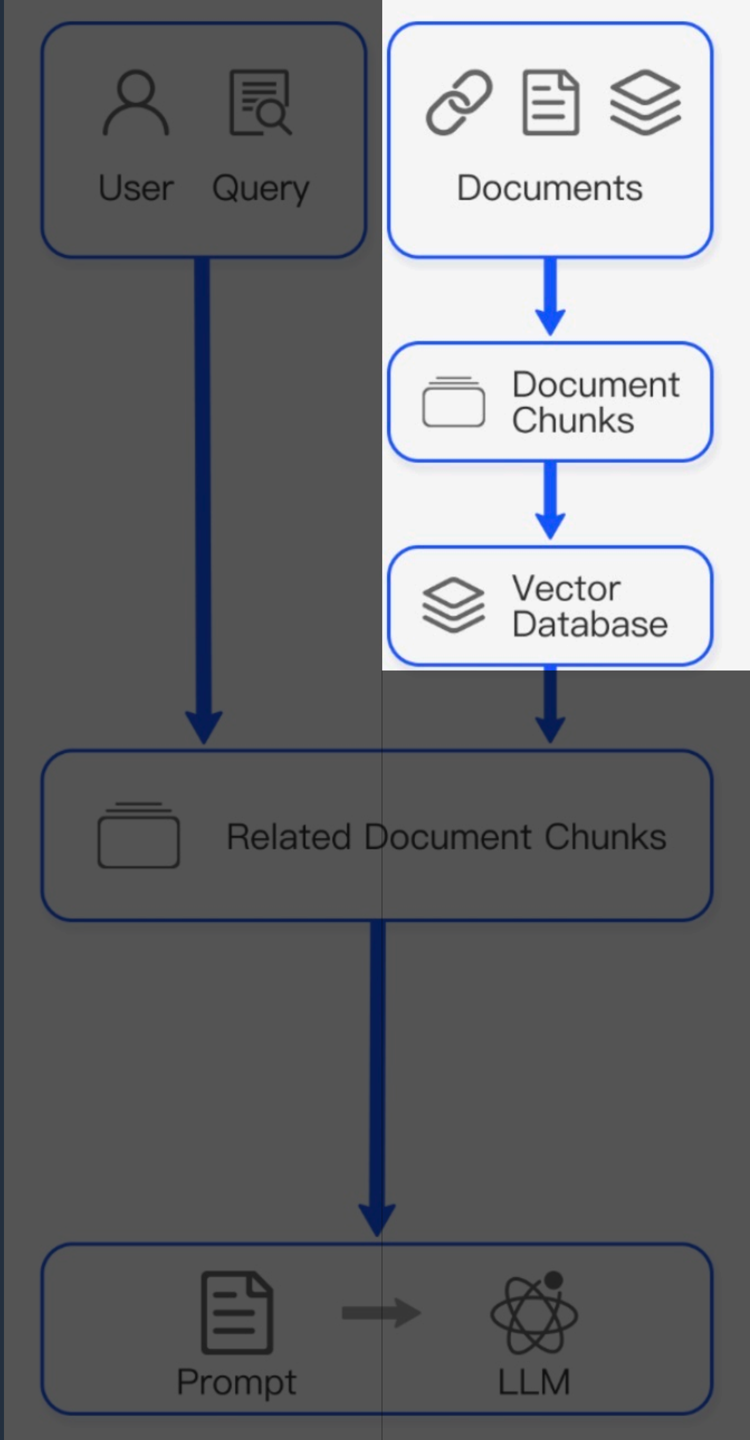


© 2024, Amazon Web Services, Inc. or its affiliates.

RAG Chatbot Architecture

1. Indexing stage:

- Each document is parsed into text
- Texts are split into chunks (e.g. paragraphs)
- Each chunk is embedded into a vector
- Vectors and text chunks are stored in a database



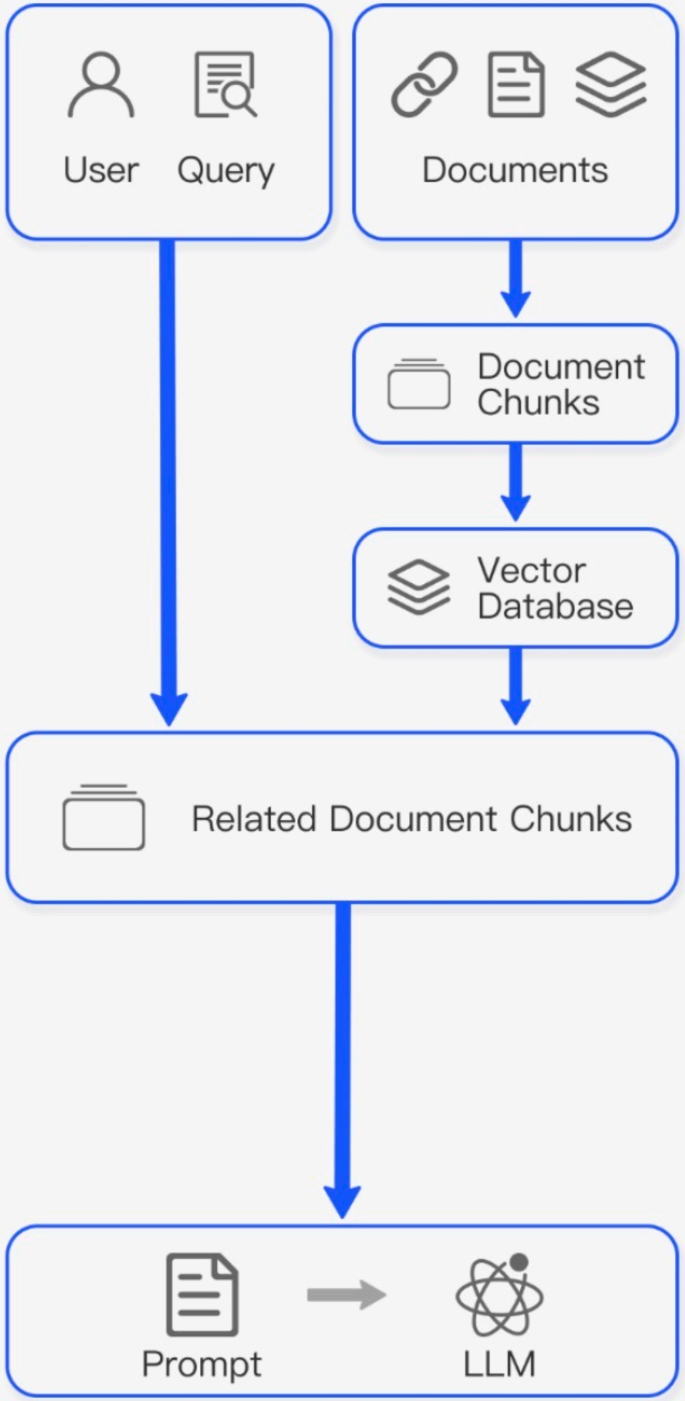
© 2024, Amazon Web Services, Inc. or its affiliates.

https://arxiv.org/abs/2312.10997

RAG Chatbot Architecture

2. Q&A stage:

- User question is embedded into a vector
- Top-K closest chunks are fetched from the database
- User question and chunks are shown to LLM
- LLM provides a response to the user



© 2024, Amazon Web Services, Inc. or its affiliates.

https://arxiv.org/abs/2312.10997

Techniques to Improve Retrievers

#1. Small-to-Big Retrieval

© 2024, Amazon Web Services, Inc. or its affiliates.

1. Small-to-Big Chunk Retrieval

Idea: use small chunk size on embedding stage and large size on Q&A stage

Why:

- Embedding very large chunks adds **too much noise** => poor recall
- Embedding small chunks leads to **very limited context** => incomplete answers

Attention mechanisms have become an integral part of compelling sequence modeling and transduction models in various tasks, allowing modeling of dependencies without regard to their distance in the input or output sequences [2, 16]. In all but a few cases [22], however, such attention mechanisms are used in conjunction with a recurrent network. In this work we propose the Transformer, a model architecture eschewing recurrence and instead relying entirely on an attention mechanism to draw global dependencies between input and output. The Transformer allows for significantly more parallelization and can reach a new state…

VS

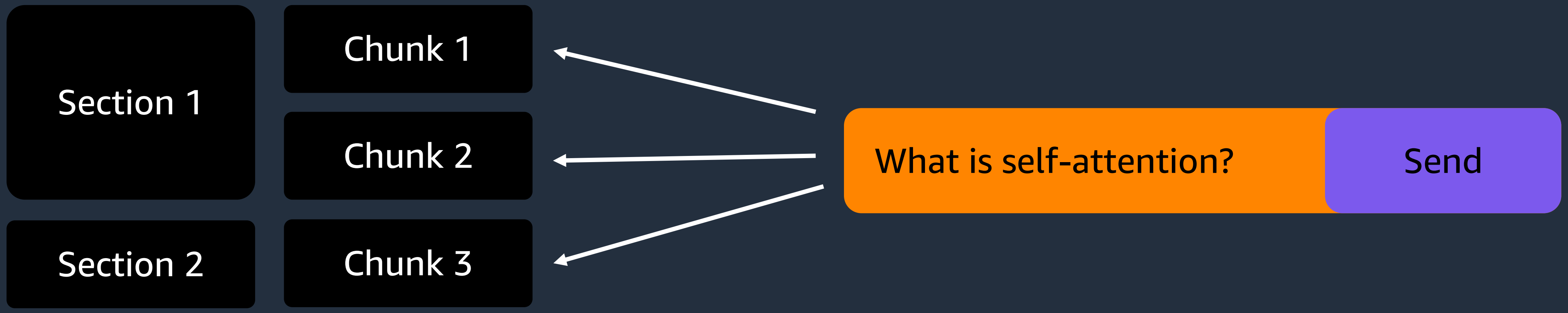
Attention mechanisms have become an integral part of compelling sequence modeling…

aws © 2024, Amazon Web Services, Inc. or its affiliates.

1. Small-to-Big Chunk Retrieval

Solution:

- Use a smaller chunk size on the embedding stage
- Append “neighbor” chunks to extend the chunk before feeding to LLM



© 2024, Amazon Web Services, Inc. or its affiliates.

1. Small-to-Big Chunk Retrieval

Solution:

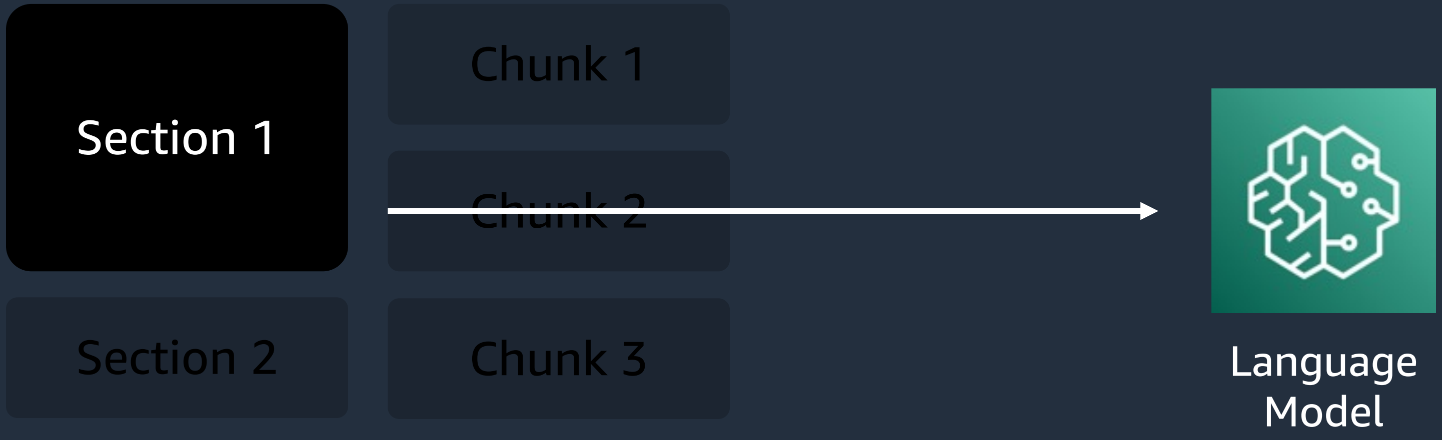
- Use a smaller chunk size on the embedding stage
- Append “neighbor” chunks to extend the chunk before feeding to LLM

© 2024, Amazon Web Services, Inc. or its affiliates.

1. Small-to-Big Chunk Retrieval

Solution:

- Use a smaller chunk size on the embedding stage
- Append "neighbor" chunks to extend the chunk before feeding to LLM



© 2024, Amazon Web Services, Inc. or its affiliates.

Techniques to Improve Retrievers

#2. Leveraging Meta-Data

© 2024, Amazon Web Services, Inc. or its affiliates.

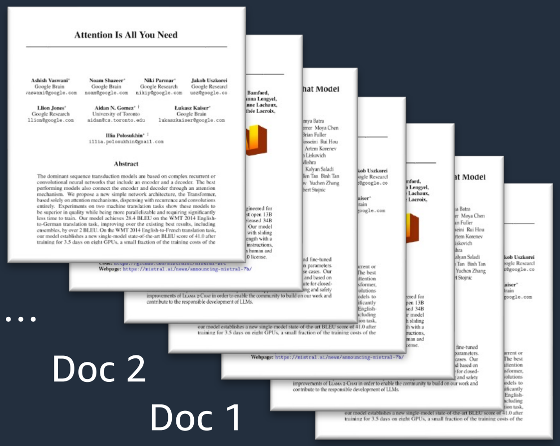
2. Leveraging Document Meta-Data

Doc N

…

Doc 2

Doc 1



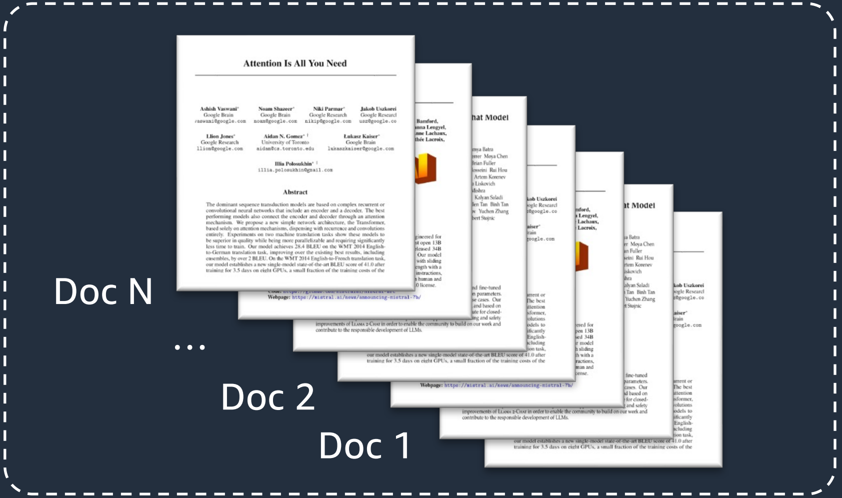
Documents

doc	author	year	…	title
1	Ashish Vaswani	2017	…	Attention is…
2	Albert Q. Jiang	2023	…	Mistral 7B
…	…	…	…	…
N	Hugo Touvron	2023	…	LLAMA 2: …

Meta-Data

© 2024, Amazon Web Services, Inc. or its affiliates.

2. Leveraging Document Meta-Data



Documents

doc	author	year	…	title
1	Ashish Vaswani	2017	…	Attention is…
2	Albert Q. Jiang	2023	…	Mistral 7B
…	…	…	…	…
N	Hugo Touvron	2023	…	LLAMA 2: …

Meta-Data

- Meta-data can start as simple as the file name and path
- You can also use LLM to generate meta-data

© 2024, Amazon Web Services, Inc. or its affiliates.

2.1. Use Filters Based on Meta-Data

Idea: let user specify filters before asking the question

Why: filters reduce the search space, leading to more precise retrieval

What is self-attention? | Send

Year: 2017 | Title: Attention is all you need

© 2024, Amazon Web Services, Inc. or its affiliates.

2.2. Include Meta-Data in Chunk Text

Idea: append document meta-data as a string to chunks before embedding

Why: relevant meta-data text improves search in the embedding space

Chunk (Before)		Chunk (After)
Attention mechanisms have become an integral part of compelling sequence modeling…	→	Year: 2017 Title: Attention is all you need Attention mechanisms have become an integral part of compelling sequence modeling…

© 2024, Amazon Web Services, Inc. or its affiliates.

Techniques to Improve Retrievers

#3. Hybrid Search

© 2024, Amazon Web Services, Inc. or its affiliates.

3. Hybrid Search

Idea: combine **vector-based** search and **keyword-based** search

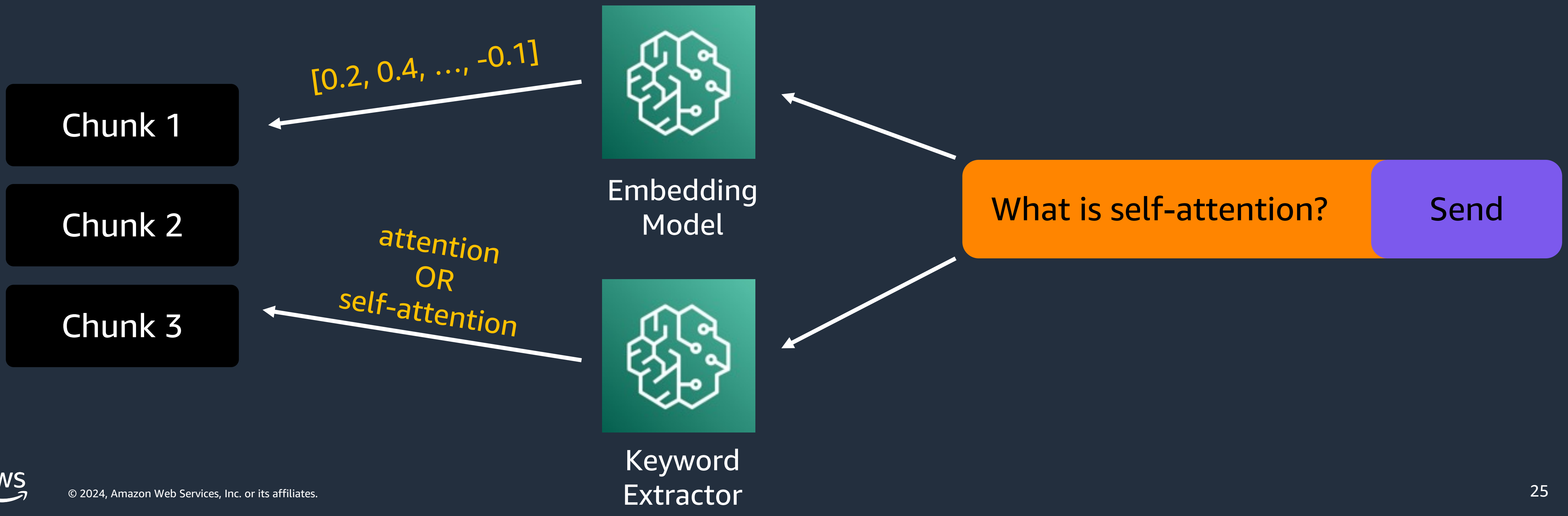
Why:

- Consider docs with domain-specific syntax and abbreviations
- Such texts may not be poorly represented in the embedding model data
- Including a few docs from **keyword-based search** helps to address this gap

© 2024, Amazon Web Services, Inc. or its affiliates.

3. Hybrid Search

Idea: combine **vector-based** search and **keyword-based** search



© 2024, Amazon Web Services, Inc. or its affiliates.

Techniques to Improve Retrievers

#4. Query Rewriting & Expansion

© 2024, Amazon Web Services, Inc. or its affiliates.

4. User Query Rewriting

Idea: reformulate user question into a better-structured search query

Why:

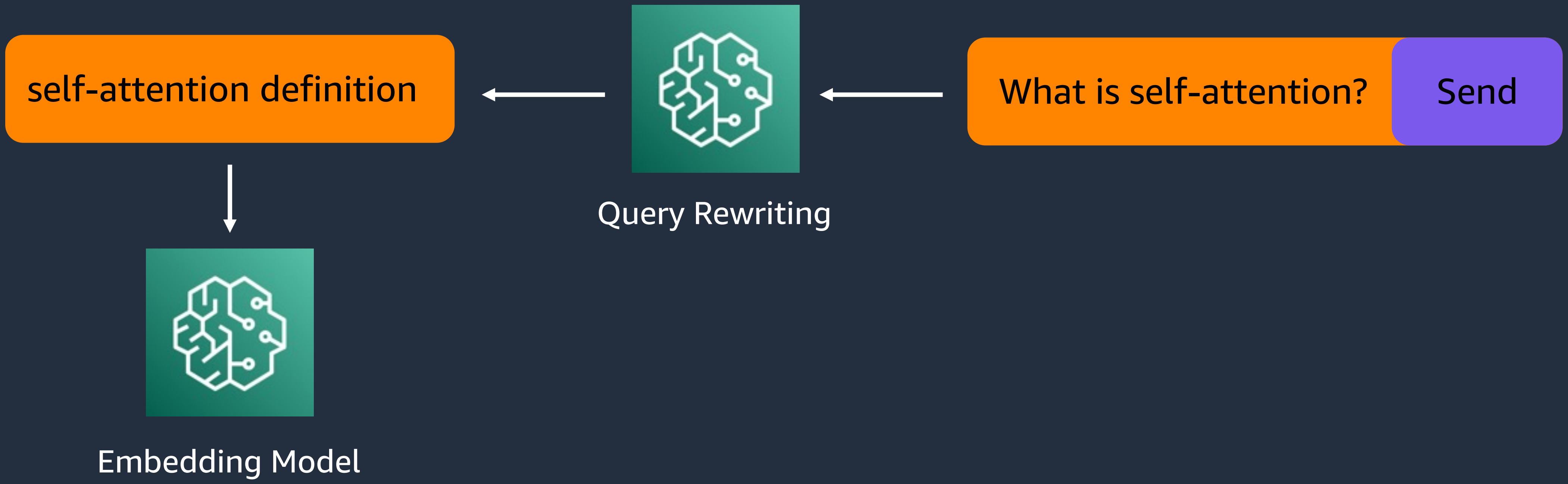
- Users are not always very good at formulating specific questions
- Especially relevant for follow-up conversations that assume certain context

Hey, can you tell me about self-attention please? I am struggling to understand it… Send

© 2024, Amazon Web Services, Inc. or its affiliates.

4.1. Simple Rewriting

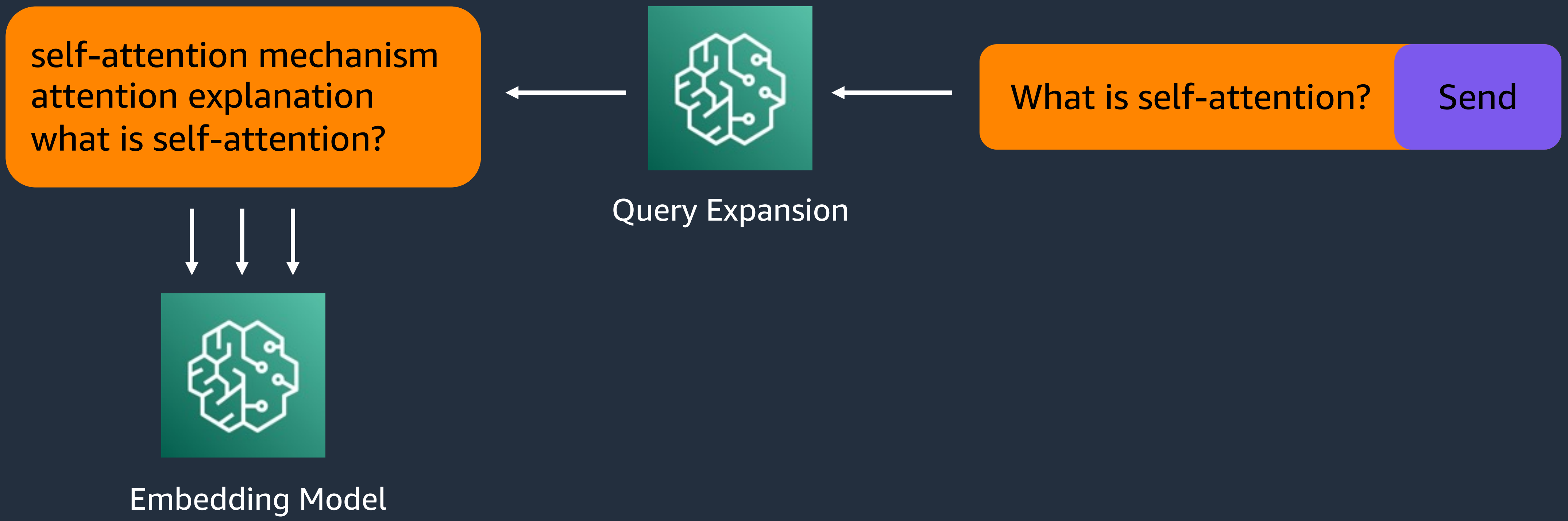
Idea: reformulate user question into a better-structured search query



© 2024, Amazon Web Services, Inc. or its affiliates.

4.2. Query Expansion

Idea: reformulate user question into MULTIPLE search queries



© 2024, Amazon Web Services, Inc. or its affiliates.

Techniques to Improve Retrievers

#5. Document Reranking

© 2024, Amazon Web Services, Inc. or its affiliates.

5. Document Reranking

Idea: rerank retrieved documents (e.g., using LLM)

Why:

- Documents with the highest embedding similarity may not be most relevant
- LLM can rerank document chunks to better match the user query

Chunk 1 | Chunk 2 | Chunk 3

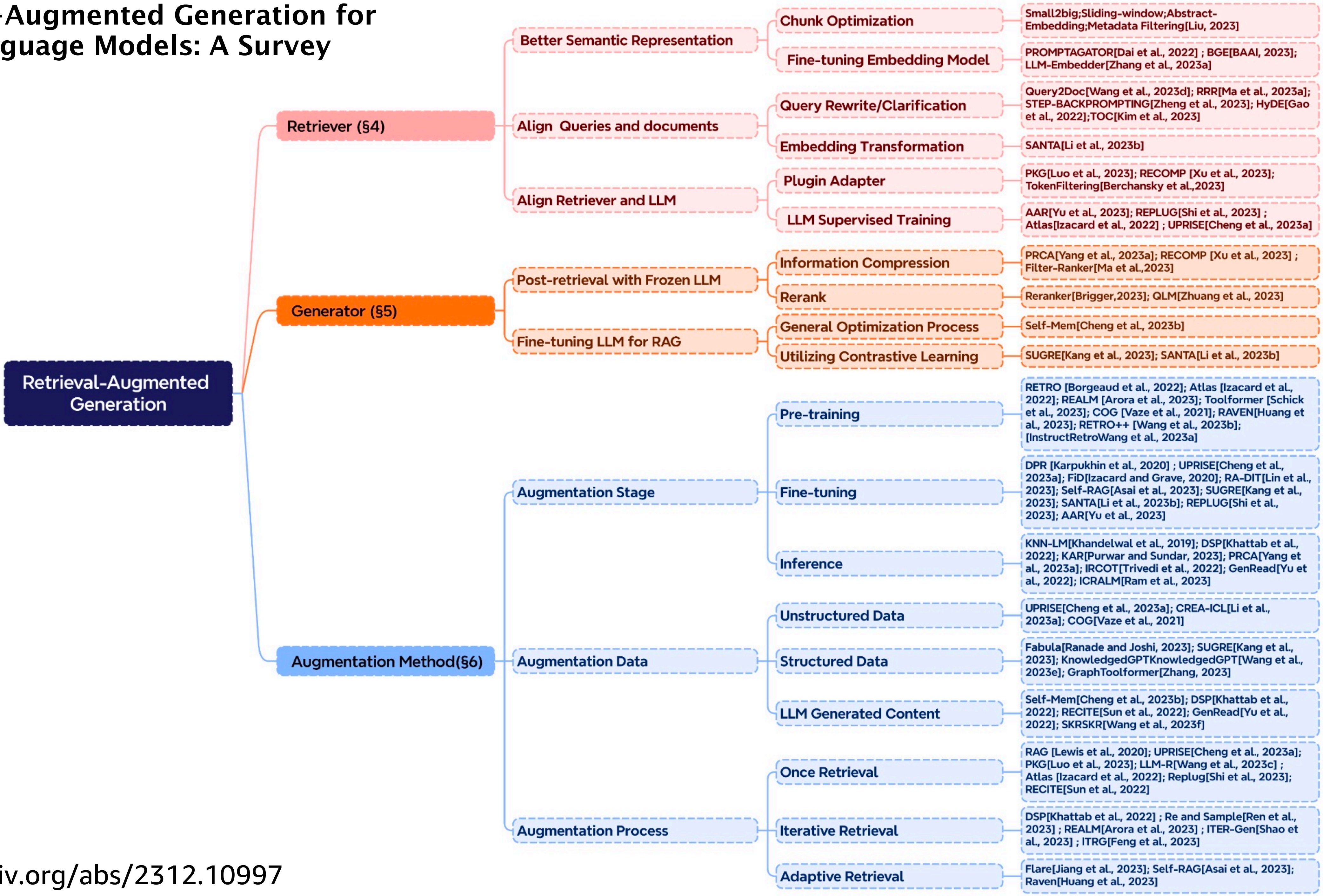
© 2024, Amazon Web Services, Inc. or its affiliates.

5. Document Reranking

Idea: rerank retrieved documents (e.g., using LLM)

aws
© 2024, Amazon Web Services, Inc. or its affiliates.

Retrieval-Augmented Generation for Large Language Models: A Survey



https://arxiv.org/abs/2312.10997

Thank You!

- **#1:** **Small-to-Big Retrieval**
- **#2:** **Leveraging Meta-Data**
- **#3:** **Hybrid Search**
- **#4:** **Query Rewriting**
- **#5:** **Document Reranking**

Nikita Kozodoi, PhD

https://kozodoi.me

© 2024, Amazon Web Services, Inc. or its affiliates.