Graph RAG: Leveraging the power of graphs to enhance retrieval

Prashanth Rao

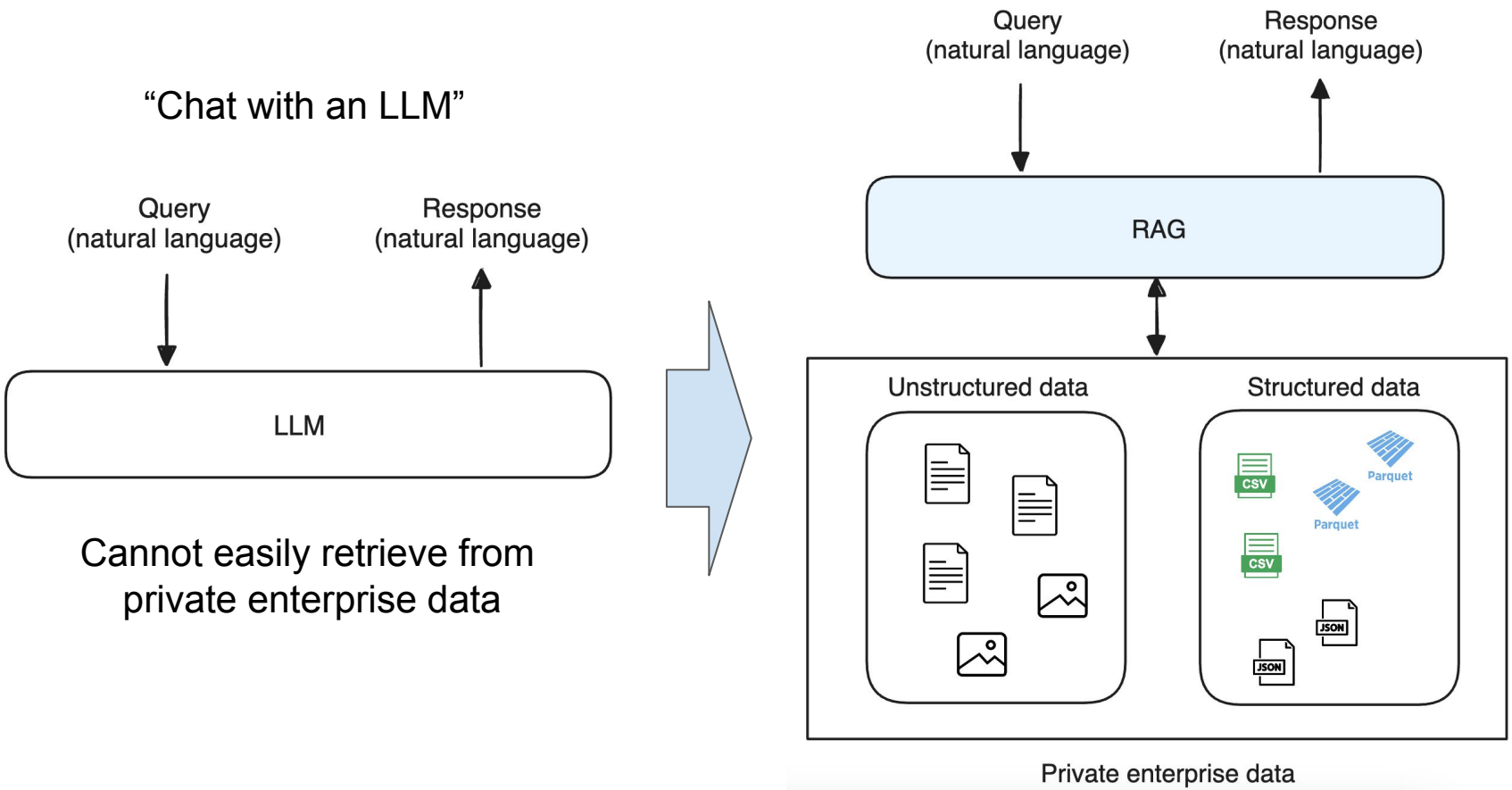
AI Engineer, Kùzu Inc. 🇨🇦

kuzudb.com

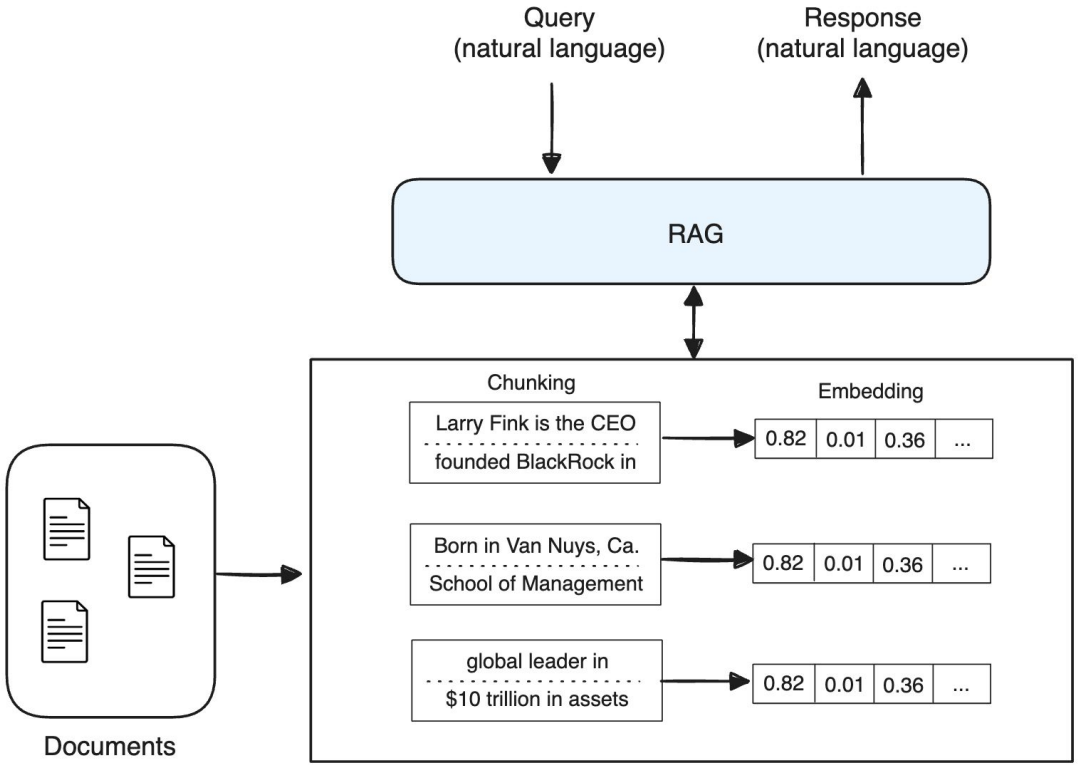
GDG Surrey DevFest

Surrey, BC | 26 Oct 2024

Retrieval in the age of LLMs



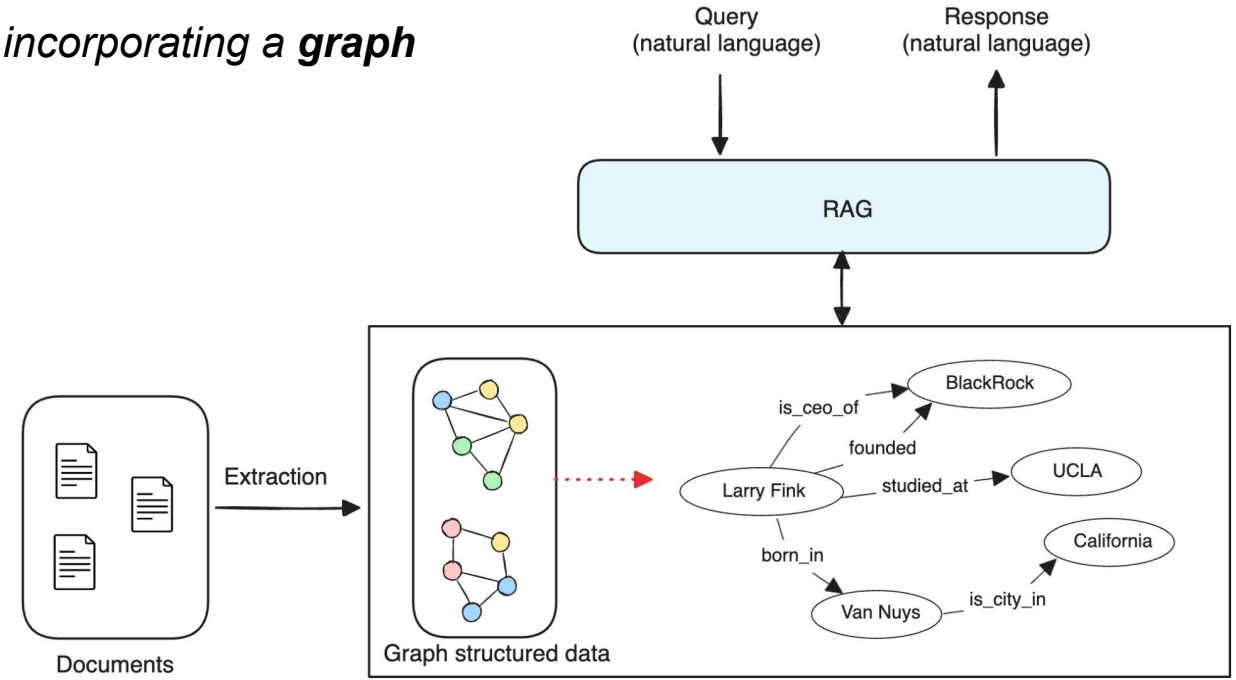
A deeper look at traditional RAG



Vector database (retrieve top-k documents)

What is Graph RAG?

*Extends traditional RAG by incorporating a **graph** as part of the retrieval step*



In any system that uses this approach:

- Question 1: What is the graph? I.e., what are its nodes and edges?
- Question 2: How is the retrieval process different from traditional RAG?

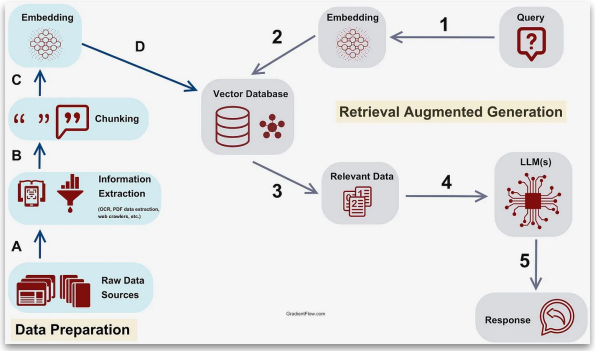
Why enhance unstructured data with a graph?

- Graphs are **object-oriented** in nature – they represent entities or objects in the real world via nodes, and how they are connected via edges
- Graphs capture relationships between entities **explicitly**
  - Traversing the vicinity of an entity to get added context is *natural and easy*
- A graph data model is a good fit to **add structure** to related entities extracted from unstructured data
- Importantly, graph triples/edges `<subject, predicate, object>`, can be represented as **simple sentences** (useful to generate context)

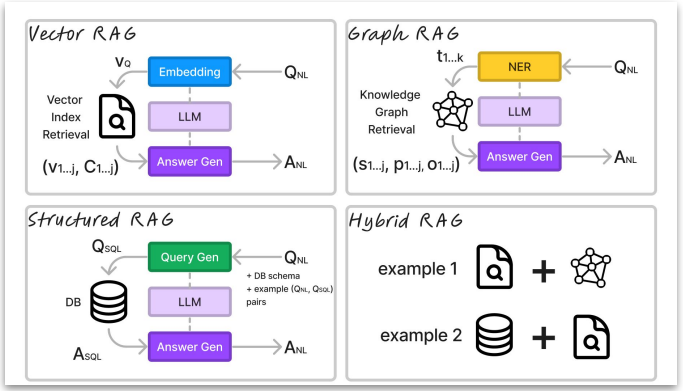
The emergence of “Hybrid RAG”

Not to be confused with “hybrid *search*”, **Hybrid RAG** is what you call RAG when you combine multiple retrieval methods

Jan 2024 [WhyHow.ai]
“Injecting Knowledge Graphs in different RAG stages”
Chia Jeng Yang

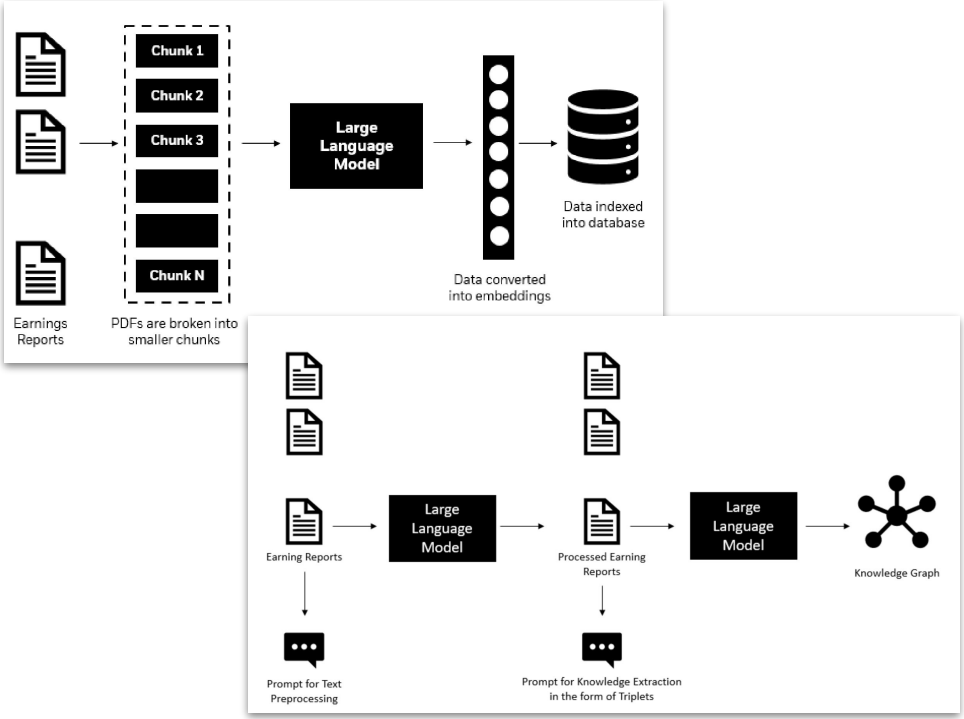


Feb 2024 [guitton.co]
“Graphs and Language”
Louis Guitton



Do graphs measurably improve RAG in practice?

HybridRAG: Integrating Knowledge Graphs and Vector Retrieval Augmented Generation for Efficient Information Extraction (BlackRock & Nvidia), Aug 2024

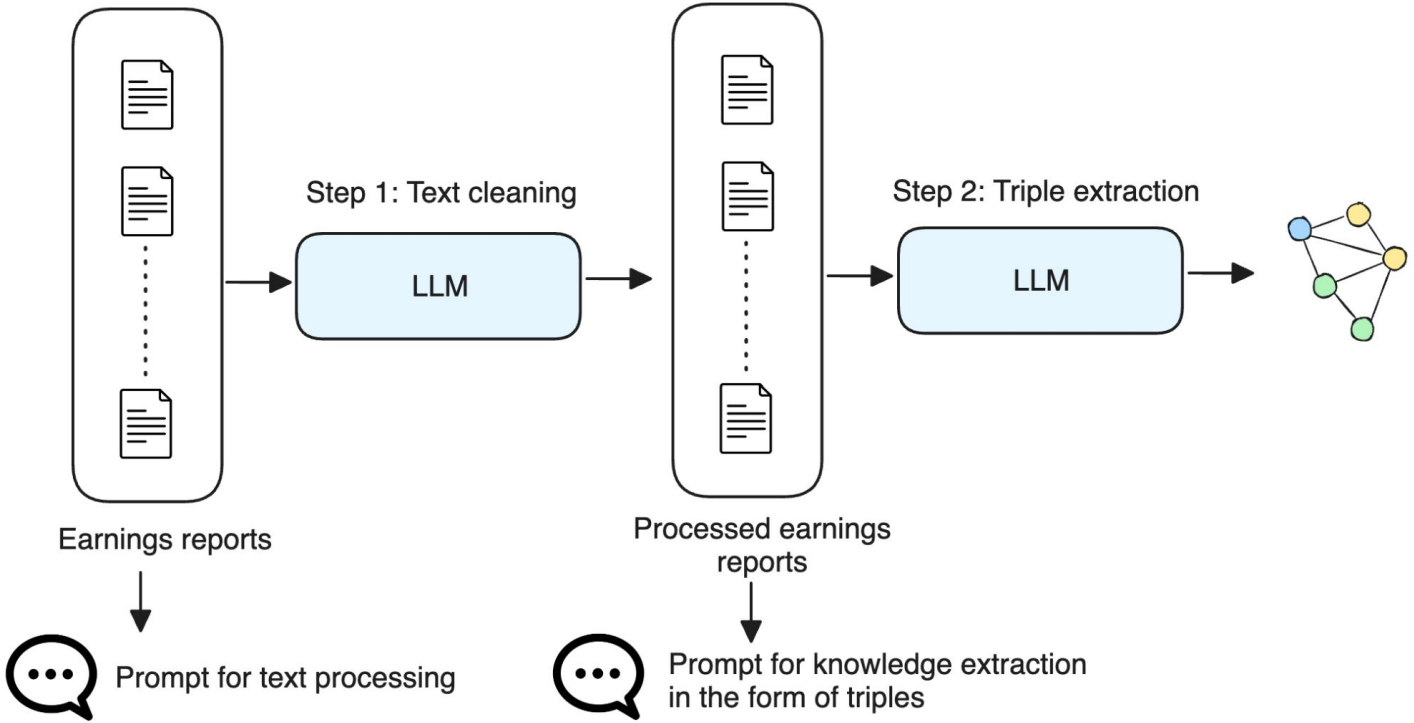


Evaluation: Hybrid RAG system **does better overall** than systems that were based on vector retrievals or graph retrievals alone

Source: https://arxiv.org/pdf/2408.04948v1

Unpacking BlackRock's Hybrid RAG (1)

Question 1: What is the graph? What do its nodes and edges represent?



Unpacking BlackRock's Hybrid RAG (2)

Example of summarization and triple extraction

Chunk 1

Larry Fink is the CEO and co-founder of BlackRock, the world's largest asset management firm, established in 1988 …

Chunk 2

Born in Los Angeles, California, in 1952, Fink grew up in Van Nuys and later earned his MBA from UCLA's Anderson School of Management …

⋮

Chunk n

…
10.0 trillions of dollars in asset management …
…

Step 1: Text processing

Processed chunk 1

Larry Fink is the CEO and co-founder of BlackRock.
BlackRock was established in 1988.

Processed chunk 2

Larry Fink was born in Los Angeles, California.
Larry Fink earned his MBA from UCLA

⋮

Processed chunk n

…
BlackRock manages 10.5 trillion dollars in assets.
…

Step 2: Triple extraction

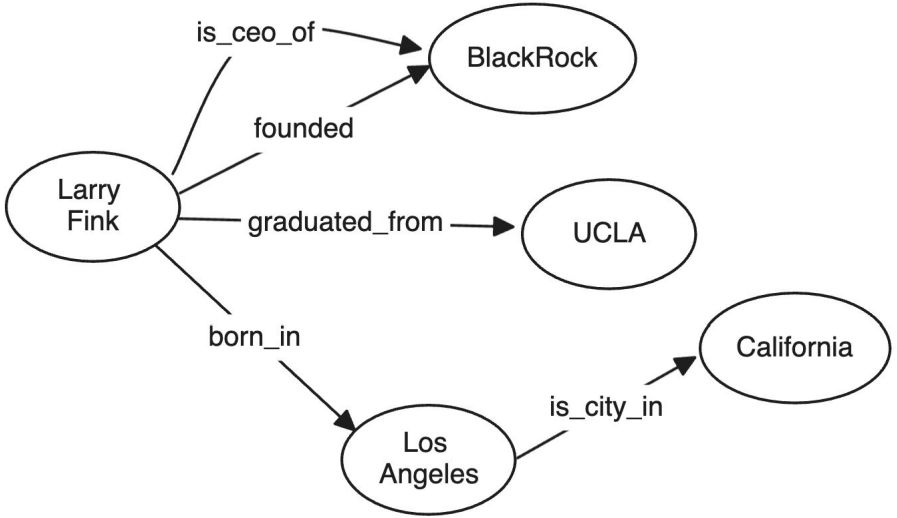
<Larry Fink, is_ceo_of, BlackRock >
<Larry Fink, founded, BlackRock >
<BlackRock, founded_in, 1988 >

<Larry Fink, born_in, Los Angeles >
<Los Angeles, is_city_in, California >
<Larry Fink, graduated_from, UCLA >

<BlackRock, asset_value, 10.5 trillion >

Unpacking BlackRock's Hybrid RAG (3)

Recall: Graphs can model simple sentences



Chunk 1

<Larry Fink, is_ceo_of, BlackRock >
<Larry Fink, founded, BlackRock >

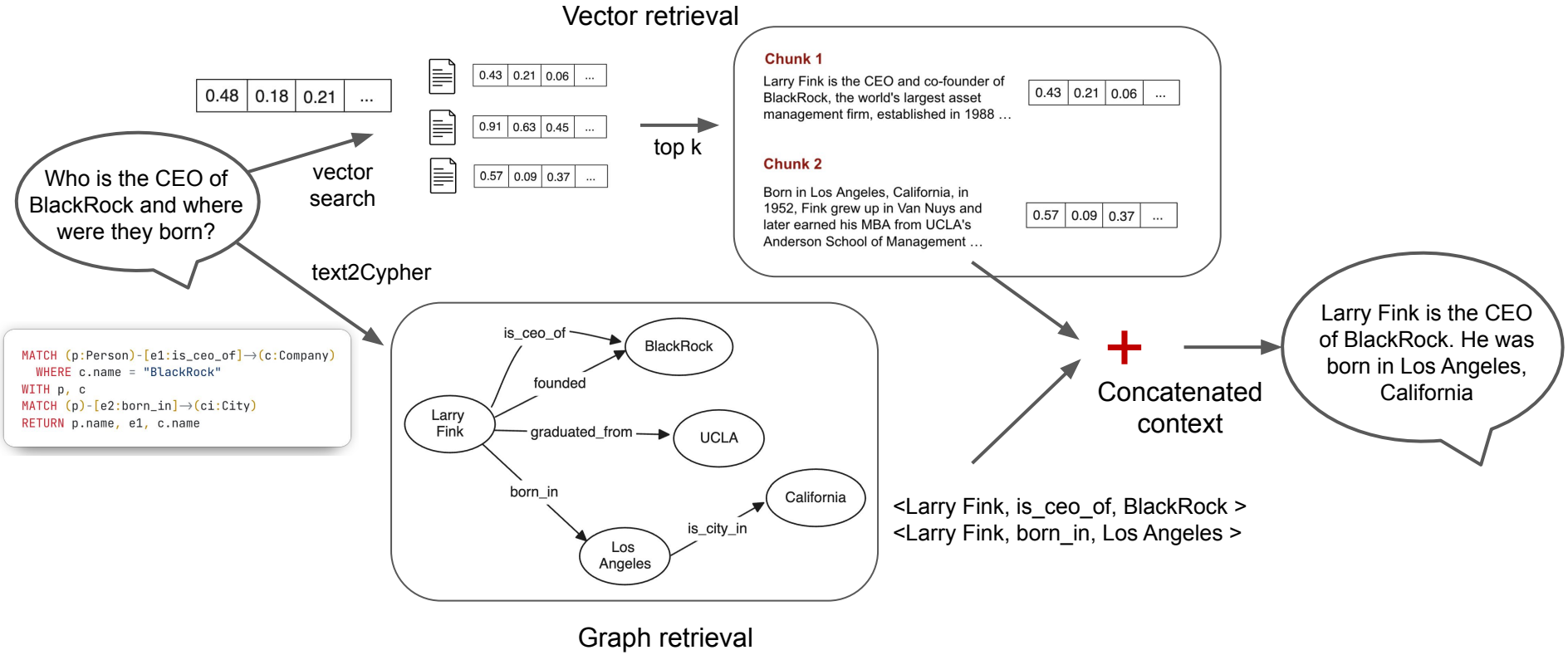
Chunk 2

<Larry Fink, born_in, Los Angeles >
<Los Angeles, is_city_in, California >
<Larry Fink, graduated_from, UCLA >

- Benefit 1: Information in disparate chunks are now **directly connected**
- Benefit 2: Triples are a form of capturing the **essence** of text chunks in very simple sentences
- Benefit 3: Can now put the triples into a graph DB where you can query it using a **query language**

Unpacking BlackRock's Hybrid RAG (4)

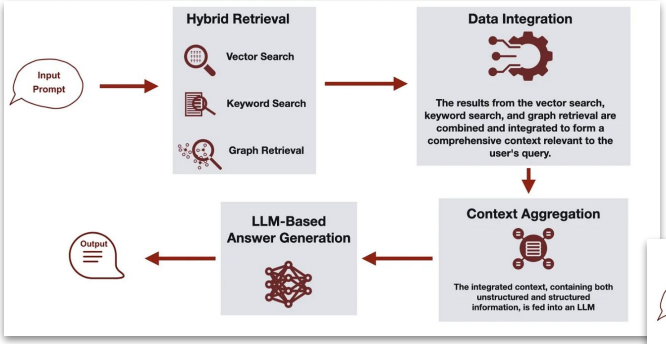
Question 2: How is retrieval different from traditional RAG?



Let’s go through some code!

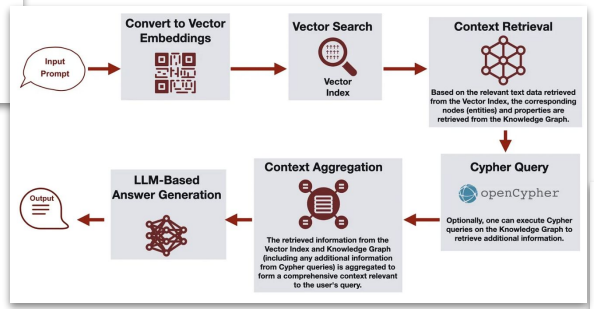
Retrieval strategies in Graph RAG

Concatenate context from a vector retrieval + graph retrieval (Hybrid RAG)

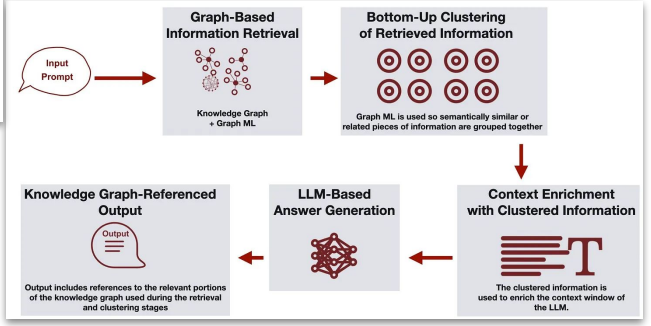


\+ *Agents, prompt tuning, query expansion, and more…*

Graph-enhanced QA:
Perform graph traversals downstream of vector/hybrid search



Semantic clustering
(Microsoft's local to global Graph RAG)

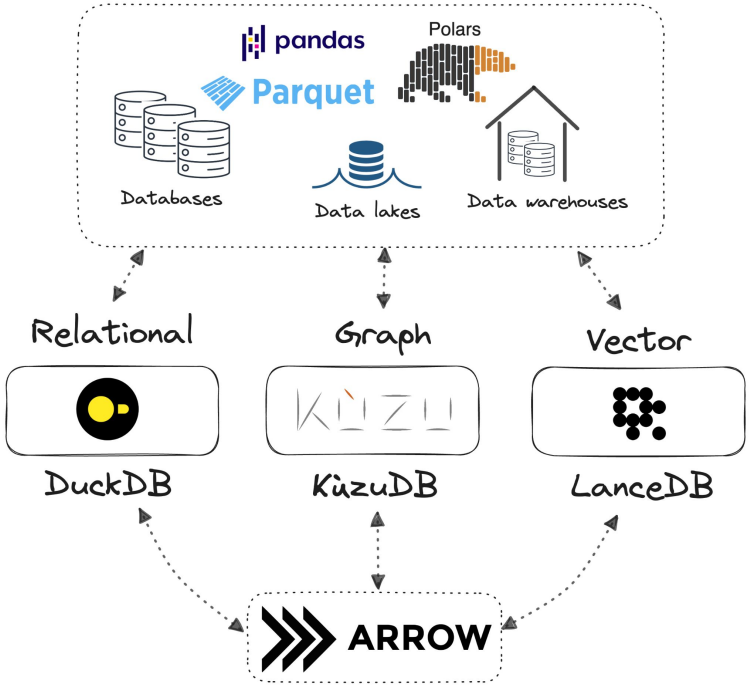


GraphRAG: Design Patterns, Challenges, Recommendations

Gradient Flow newsletter

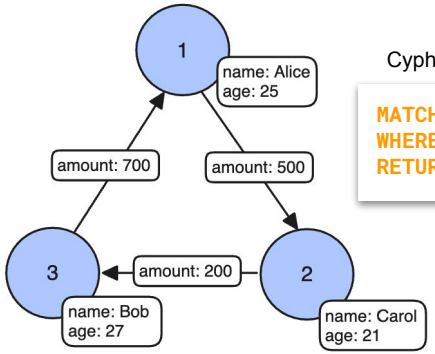
Databases are evolving alongside RAG

- Embeddability + ease of setup + interoperability + permissive licensing
- These characteristics do **not** preclude scalability or performance



Usability features of Kùzu

Property graph data model & RDF wrapper



Cypher query language

```
MATCH (a)-[:]->(b)
WHERE a.age > 25
RETURN b.name
```

Embedded
(similar philosophy to DuckDB, LanceDB)

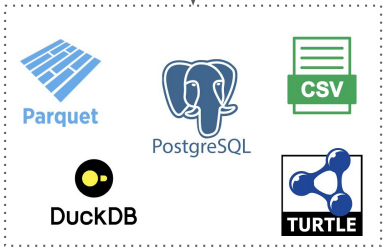
```
import kuzu

db = kuzu.Database("db")
conn = kuzu.Connection(db)
res = conn.execute("MATCH (a)-[:]->(b)")
print(res.get_as_df())
```

ACID transactions

Usability features

Integrations with ML/AI frameworks



Interoperable with many formats

Permissively licensed

Learn more at https://kuzudb.com

Takeaways

- Graphs can help *explicitly model* relationships between entities in your data
- To retrieve *factual* information, a graph can help store manually gathered data in a structured, maintainable fashion
- For better retrieval from the graph, keep the following in mind
  - Graph quality is important: improves the *retrieval* outcome
  - The choice of LLM matters: improves the *quality of Cypher generation*
  - Prompts matter: Provide *schema* in the prompt to improve Cypher generation
- The vector embedding and graph data pipelines can be *built and tuned independently*
- Design concrete **evaluation** strategies using a suite of representative questions in your domain

Thank you!

Kùzu is **open source**
Check us out on GitHub and give us a ⭐

Join our Discord!

github.com/kuzudb/kuzu

@kuzudb

We're **Kùzu Inc.** on LinkedIn!