Wisdom-Driven Knowledge Augmented Generation at Scale - Chin Keong Lam, Patho AI

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The main thesis of the video is that by using a Wisdom-Driven Knowledge Graph, we can significantly enhance the quantitative analysis capabilities of Knowledge-Augmented Generation (KAG) systems. This allows for the creation of smarter AI systems that can not only retrieve information but also understand, reason, and provide expert-level advice. The talk argues that this approach surpasses traditional Retrieval-Augmented Generation (RAG) systems, which primarily rely on unstructured vector search.

What is KAG?

Knowledge Augment Generation

Retrieval-Augmented (RAG)

KAG VS RAG
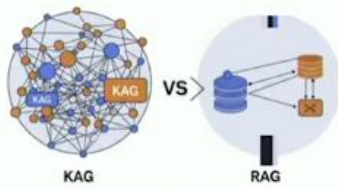
KAG doesn't just retrieve, it *understands*

KAG (Knowledge Augment Generation) enhances language models by integrating structured knowledge graphs for more accurate and insightful responses, making it a smarter, more structured approach than simple Retrieval-Augmented Generation (RAG) – KAG doesn't just retrieve, it *understands.*

Storing Wisdom - Knowledge Graph is a perfect fit.

Wisdom is like being the smartest player in the game— it doesn't just react, it finds the winning move!

Wisdom

guides synthesizes informs reflects on informs derives informs

Decision Making Knowledge Experience Insight informs

analyzes

AIE

Situation
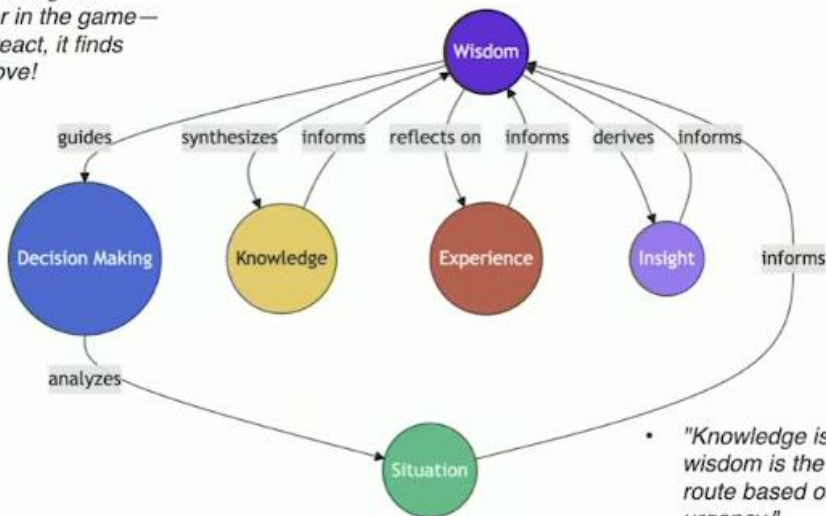
- *"Knowledge is a GPS showing roads; wisdom is the driver choosing the fastest route based on traffic, weather, and your urgency."*

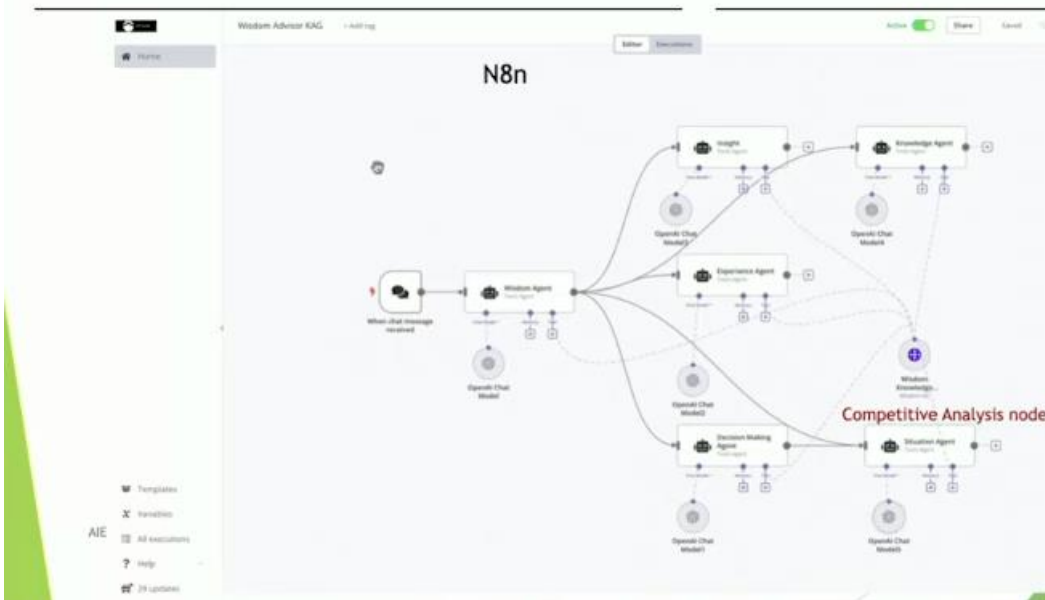# Not Just a Chat Bot - it is a Advisor? For Competitive Analysis Application.
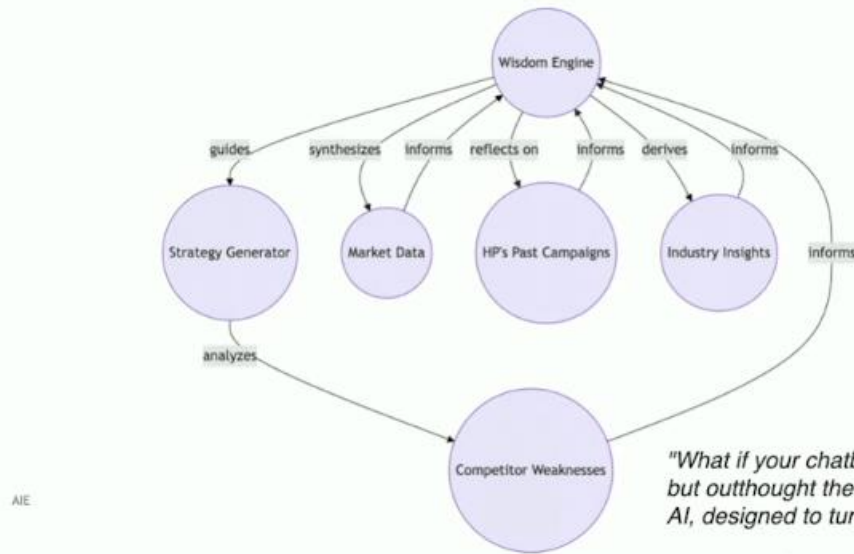
"What if your chatbot didn't just analyze competitors— but outthought them? Meet our Wisdom Graph-powered AI, designed to turn data into strategic dominance."

N8N- Multi-Agents using Wisdom Driven Knowledge Graph Taxonomy.

Anyone here heard of N8n…well, I first encounter similar solution for past IOT project, Similar to Node Red, N8n is Node JS based no code Workflow framework. It enable implementation of complicated multi agents ai system very quickly, as shown , I used the Ai Agents node to connect all my Super Smart Wisdom Advisor to nodes I mentioned in my previous slides, as shown there is the initial Chat Node which handle the chat query from user, It is feed directly to wisdom agent, this is powered by open ai model, it can also be powered by other vendors like antropic models and ollama (for local ai), the prompt in the [...] the key to making it work with other agents and get feedback from insight , knowledge, experience, decision making and finally situation agent, all accessing , constantly updating and provide the wisdom agents informed as the wisdom knowledge graph grow following the logic I mentioned in my previous [...] way, the Agents each working on their respective tasks, continue to enrich the wisdom knowledge graphs achieving the goal of storing wisdom based on the initial expertise based on past experience, insight and since it uses the taxonomy of the expert, it might in day exceed the skills of the expertise

Competitive Analysis , why use Knowledge Graph?

1.Enhanced Contextual Understanding: Knowledge Graph-based RAG (Retrieval-Augmented Generation) systems excel at capturing and representing complex relationships between entities. This leads to a deeper contextual understanding, which is crucial for competitive analysis where nuanced insights can make a significant difference.

2.Improved Accuracy and Relevance: By leveraging structured data and semantic relationships, Knowledge Graphs can provide more accurate and relevant information retrieval compared to traditional vector stores. This ensures that the generated content is not only relevant but also precise, reducing the noise and improving decision-making.

3.Scalability and Flexibility: Knowledge Graphs are inherently scalable and can easily integrate new data sources and relationships. This flexibility allows for continuous improvement and adaptation to changing market conditions, making them a robust choice for long-term competitive analysis.

4.Rich Query Capabilities: Knowledge Graphs support complex queries that can traverse multiple relationships and entities, providing richer and more detailed insights. This is particularly advantageous for competitive analysis, where multi-faceted queries can uncover hidden patterns and trends.

5.Enhanced Data Integration: Knowledge Graphs can seamlessly integrate diverse data sources, including structured, semi-structured, and unstructured data. This holistic approach ensures a comprehensive view of the competitive landscape, enabling more informed strategic decisions.

Knowledge Graphs vs. Vector Stores: A Quantitative Analysis Example

Problem: Limitations of Vector Store-Driven RAG in Quantitative Analysis

- **Limited Numerical Reasoning:** Vector stores excel at semantic similarity, but struggle with complex numerical calculations and logical reasoning.

- **Inaccurate Data Aggregation:** Without a structured understanding of data relationships, vector stores can misinterpret queries, leading to incorrect quantitative results.

Solution: Knowledge Graphs for Enhanced Quantitative Analysis

- **Structured Data Representation:** Knowledge graphs store data in a structured format, enabling precise queries and calculations.

- **Complex Query Capabilities:** Knowledge graphs can handle complex queries involving multiple entities, attributes, and numerical operations.

- **Accurate Data Aggregation:** By understanding the relationships between data points, knowledge graphs can accurately aggregate and analyze data.

A Quantitative Analysis Example

Simple Example: Financial Analysis

Vector Store-Driven RAG:

- Query: "What was Apple's revenue in 2022?"
- Response: A list of text passages mentioning Apple's revenue in 2022, but without a clear numerical answer.

Knowledge Graph-Enhanced RAG:

- Query: "What was the percentage change in Apple's revenue from 2021 to 2022?"
- Response: A precise calculation based on the stored numerical values and relationships between years and revenue figures.

Key Benefits of Knowledge Graphs in Quantitative Analysis:

- Precise Numerical Calculations: Accurate arithmetic operations on stored numerical data.
- Complex Query Handling: Ability to handle multi-hop queries and conditional logic.
- Data Aggregation and Summarization: Efficiently aggregating and summarizing large datasets.
- Trend Analysis and Forecasting: Identifying trends and making predictions based on

Normal RAG (Based on Vector Search Alone Rag Answers)

- **Passage 1:** "Apple reported another record-breaking year in 2022, with strong performance across all product categories. The iPhone 14 series was particularly popular, driving significant revenue growth."

- **Passage 2:** "Despite supply chain challenges and economic uncertainty, Apple managed to maintain its position as the world's most valuable company. The strong demand for its products, especially the iPhone and Mac, contributed to its impressive financial performance."

- **Passage 3:** "Apple's services business continued to grow rapidly in 2022, driven by the success of the App Store, Apple Music, and Apple TV+. This segment is becoming an increasingly important revenue driver for the company."

- **Passage 4:** "The global chip shortage impacted the production of certain Apple products, but the company was able to mitigate the impact through strategic sourcing and inventory management. However, it did affect overall revenue to some extent."

- **Passage 5:** "Analysts are optimistic about Apple's future prospects, citing the growing popularity of its products, especially in emerging markets. The company is also investing heavily in new technologies such as augmented reality and autonomous vehicles, which could drive significant growth in the coming years."

Knowledge Graph Driven RAG Answer to same question

Explanation:

1. **Data Source:** Assumes a knowledge graph named `Apple_Financial_Data`.
2. **Query:** Selects the revenue figures for 2021 and 2022.
3. **Calculation:** Calculates the percentage change using the formula:

```
Percentage Change = ((New Value - Old Value) / Old Value) * 100
```

4. **Result:** Returns a single value representing the percentage change in Apple's revenue from 2021 to 2022.

Example Output:

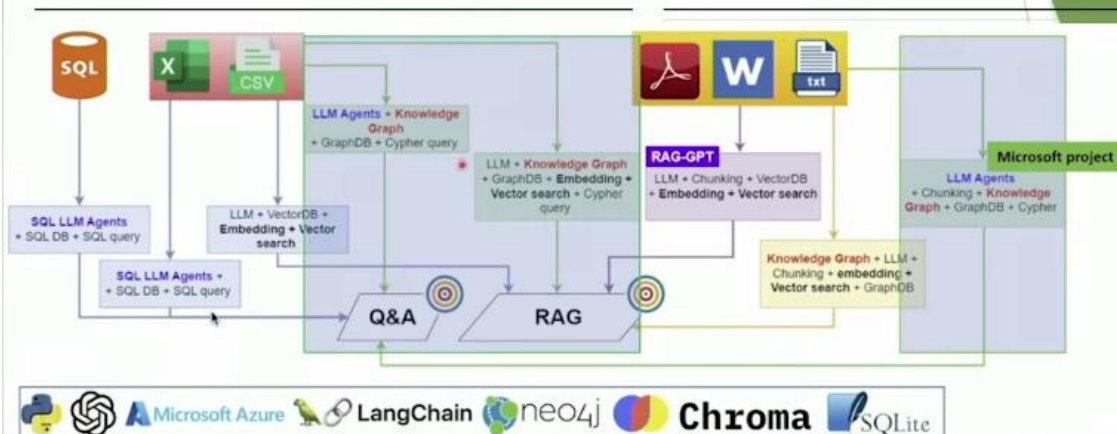| Percentage_Change |
|-------------------|
| 15.23% |

⊞ Export to Sheets

This query directly accesses the stored numerical data in the knowledge graph, providing a precise and accurate answer to the query "What was the percentage change in Apple's revenue from 2021 to 2022?"

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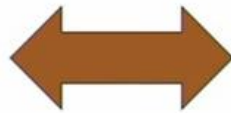# So Many Solutions, FOCUS On Red Solution

How to construct the knowledge graph?

Domain expert

Pros: Consistent graph structure

Cons: Not easy to implement

Hybrid: Use LLM's knowledge (e.g: GPT 4) to guide you in constructing the Graph Knowledge)

Pros:
- Consistent graph structure.
- Less expertise are needed in collaboration with LLM.

Cons: Still requires some basic knowledge of coding and graph knowledge implementation

LLM (e.g: LLMGraphTransformer)

Pros: Easy to use
Cons: Inconsistent graph structure (due to nondeterministic behavior of the LLMs)

No matter which approach we choose, after constructing the knowledge graph, we need to populate the GraphDB by defining the desired nodes and relationships ourselves. Therefore, this inconsistency will mostly affect the generated information rather than the structure of our GraphDB.

Benchmark Result

Key Benchmark Metrics Table

Metric	Normal RAG	GraphRAG (Hewy)	Superior System	Reason for Superiority
Accuracy (QA Score)	58%	91%	GraphRAG	Ontology extracts structured specs (e.g,, blade counts from PDF tables).
Flexibility	40%	85%	GraphRAG	Handles temporal and multi-hop queries across 2019–2025 reports.
Reproducibility	65%	97%	GraphRAG	Deterministic graph queries ensure consistency across runs.
Traceability	25%	94%	GraphRAG	Answers link to PDF sections and component nodes.
Response Time	105 ms	165 ms	Vector RAG	Faster for keyword searches in large text corpora.
Statistical Queries	15% Success	93% Success	GraphRAG	Structured properties enable exact numerical retrieval.
Scalability	Moderate	High	GraphRAG	Efficiently maps 10M+ component relationships.

Conclusion

By leveraging the structured nature of wisdom knowledge graphs, we can significantly enhance the quantitative analysis capabilities of KAG systems, enabling more accurate and insightful responses to complex queries. By using the wisdom Driven system as highlighted, together we can build smarter ai system that scale and store wisdom with the right framing potentially surpassing the intelligence of the initial Expert it meant to serve.