Week 6: Next-Level RAG — Graph-RAG and Multi-Hop Reasoning

Streamlit Demo: https://tracy-representation-geo-concentrate.trycloudflare.com/

Objective

The primary objective of Week 6 was to extend the baseline and advanced RAG systems developed in previous weeks by integrating a graph-based retrieval module (Graph-RAG) and implementing multi-hop reasoning for compositional question answering. The resulting system demonstrates how entity–relation graphs can improve retrieval grounding and reasoning traceability in complex information retrieval scenarios.

Methodology

The project was implemented in three major tracks: **Track A — Graph-RAG Build:** Implemented lightweight entity and relation extraction using regex-based patterns on a synthetic corpus describing multi-agent stock forecasting workflows. Entities such as Agents, Models, Datasets, and Metrics were extracted and represented as a NetworkX graph, linking related entities with sentences as evidence. A comparison between baseline dense retrieval and Graph-RAG retrieval was conducted using *ablation_results_graph.csv*. **Track B — Multi-Hop QA:** Developed a reasoning module to decompose complex questions into sub-questions (hops), allowing the system to iteratively answer and synthesize intermediate results. Multi-hop queries such as “Which model does the agent that integrates sentiment and market indicators use?” were successfully handled using sequential reasoning. **Track C — Streamlit Application:** Built an interactive Streamlit interface visualizing the query, final answer, supporting evidence, reasoning hops, and subgraph visualization. Cloudflare Tunnel was used for remote deployment within Colab.

Results

The constructed graph contained 19 nodes and 20 edges connecting key entities such as Agent Alpha, FinBERT, financial datasets, and performance metrics (RMSE, F1, Accuracy). The Streamlit demo successfully generated reasoning traces for multi-hop questions. Example output: **Query:** What happens when the sentiment-agent is removed, and which metric decreases? **Final Answer:** Agent Alpha ; RMSE **Hop 1:** Identified Agent Alpha as relevant to sentiment-agent removal. **Hop 2:** Retrieved RMSE metric evidence from associated sentences. Although the retrieval logic occasionally favored RMSE over F1 due to entity extraction limitations, the system demonstrated functional multi-hop reasoning and successful Streamlit deployment.

Reflection

This exercise strengthened understanding of retrieval-augmented generation (RAG) systems and their evolution into graph-based and reasoning-augmented frameworks. The project provided hands-on experience with entity–relation modeling, graph traversal, and iterative question decomposition. Integrating the entire pipeline within Streamlit offered practical exposure to end-to-end RAG visualization and user interaction.