GraphRAG

What is GraphRAG - >

**GraphRAG** is an advanced version of Retrieval-Augmented Generation (RAG) designed to handle complex questions and large datasets. Unlike traditional RAG systems that use simple search techniques, GraphRAG builds a structured **knowledge graph** to enhance how LLMs (Large Language Models) reason about information.

Steps in GraphRAG ->

**A. Indexing**

* **TextUnits Creation**:
  + **What It Is**: Breaking down your text data into manageable pieces (TextUnits).
  + **Example**: If you have a dataset of news articles, each article can be a TextUnit.
* **Entity Extraction**:
  + **What It Is**: Identifying important elements like people, places, and organizations from the TextUnits.
  + **Example**: In a news article about a new tech product, entities might include the product name, the company, and the CEO.
* **Building the Knowledge Graph**:
  + **What It Is**: Creating a visual map of relationships between these entities.
  + **Example**: A graph might show that “CEO A” works at “Company X” which makes “Product Y.”
* **Hierarchical Clustering**:
  + **What It Is**: Grouping entities into communities based on their relationships.
  + **Example**: Grouping articles about different tech products into separate communities, like “Smartphones” and “Laptops.”
* **Generating Community Summaries**:
  + **What It Is**: Creating summaries for each community to understand its overall theme.
  + **Example**: Summarizing all “Smartphones” articles into a brief overview of the latest trends and developments in smartphones.

**B. Querying**

* **Global Search**:
  + **What It Is**: Using community summaries to answer broad, thematic questions.
  + **Example**: “What are the current trends in smartphone technology?” (Uses the summary of the “Smartphones” community.)
* **Local Search**:
  + **What It Is**: Exploring specific entities and their relationships for detailed questions.
  + **Example**: “What are the features of Product Y?” (Finds details about “Product Y” and related concepts.)

**C. Prompt Tuning**

* **What It Is**: Adjusting how questions are asked to get better answers.
* **Example**: Changing the phrasing of “Tell me about Product Y” to “What are the key features of Product Y according to recent reviews?”

Key difference between Baseline RAG and GraphRAG - >

| **Feature** | **Baseline RAG** | **GraphRAG** |
| --- | --- | --- |
| **Search Mechanism** | Simple text and vector based search | Knowledge graph with community heirarchies |
| **Understanding Themes** | Poor at summarizing themes over large datasets | Excels at thematic analysis with community summaries |
| **Transparency** | No tracing | Provides traceable responses |
| **Indexing** | Not typically resource-intensive | Requires detailed and resource-intensive indexing |

Key Advantages - > GraphRAG

1. **Complex Question Handling**:
   * **Example**: “How have recent advancements in AI impacted different industries?” GraphRAG can find relevant documents and synthesize a broad answer.
   * **Why**: By using a knowledge graph, GraphRAG can connect related information across many documents.
2. **Thematic Analysis**:
   * **Example**: “What are the main themes in the latest research on renewable energy?” GraphRAG summarizes trends and themes across a large dataset.
   * **Why**: It groups information into communities and generates summaries.
3. **Enhanced Search Capabilities**:
   * **Example**: “Who are the main contributors to the open-source project XYZ?” GraphRAG can find relationships and contributions through the knowledge graph.
   * **Why**: It uses both global and local searches based on the graph.

CONS of GraphRAG -> Against Baseline RAG

1. **Resource Intensive**:
   * **Example**: Building the knowledge graph and summarizing communities takes more computational power and time.
   * **Why**: Requires extensive indexing and data processing.
2. **Requires Expert Oversight**:
   * **Example**: Ensuring that the generated summaries and responses are accurate might need domain experts.
   * **Why**: Human verification is needed for high-quality results.
3. **Content Risks**:
   * **Example**: The LLM might generate biased or inappropriate content.
   * **Why**: Additional safeguards are needed for sensitive applications.
4. **Complex Setup**:
   * **Example**: Setting up GraphRAG involves multiple steps and configurations.
   * **Why**: The process is more complex than a straightforward RAG setup.

Workflow ->

**Text Data (Articles, Documents)**

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Extract Entities & Relationships

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Build Knowledge Graph

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Hierarchical Clustering

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Generate Community Summaries

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Query with Global/Local Search

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Answer Complex Questions

GraphRAG Use Cases ->

**Academic Research Synthesis**

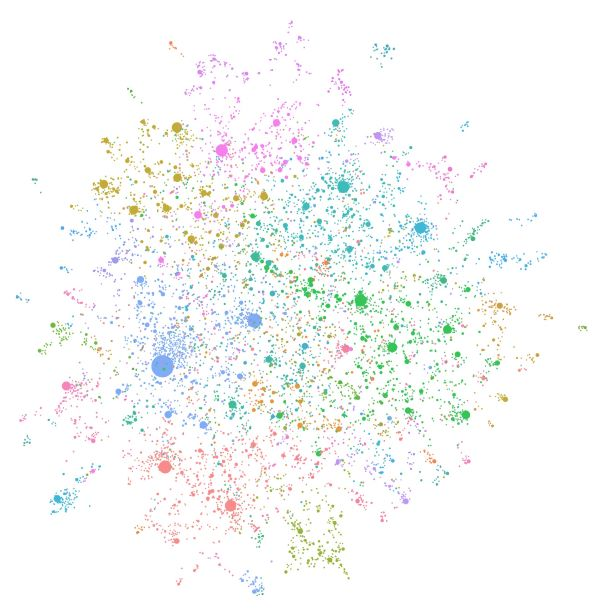
**Scenario**: A university research department needs to analyze and synthesize findings from thousands of academic papers on a specific topic like climate change.

**Enterprise Knowledge Management**

* **Scenario**: A large corporation wants to manage and query its vast internal documentation, including technical reports, meeting minutes, and project documentation.

**Healthcare Data Analysis**

* **Scenario**: A healthcare organization needs to analyze patient records, research studies, and clinical trial data to improve patient outcomes.



An LLM-generated knowledge graph built using GPT-4 Turbo

Sample Responses ->

**LOCAL SEARCH:**

(myenv) Feron.Arockiam@KIC9241:~$ python -m graphrag.query --root ./ragtest --method local "Who is Scrooge, and what are his main relationships?"

INFO: Reading settings from ragtest/settings.yaml

[2024-07-09T12:28:22Z WARN lance::dataset] No existing dataset at /home/Feron.Arockiam/lancedb/description\_embedding.lance, it will be created

creating llm client with {'api\_key': 'REDACTED,len=51', 'type': "openai\_chat", 'model': 'gpt-4-turbo-preview', 'max\_tokens': 4000, 'request\_timeout': 180.0, 'api\_base': None, 'api\_version': None, 'organization': None, 'proxy': None, 'cognitive\_services\_endpoint': None, 'deployment\_name': None, 'model\_supports\_json': True, 'tokens\_per\_minute': 0, 'requests\_per\_minute': 0, 'max\_retries': 10, 'max\_retry\_wait': 10.0, 'sleep\_on\_rate\_limit\_recommendation': True, 'concurrent\_requests': 25}

creating embedding llm client with {'api\_key': 'REDACTED,len=51', 'type': "openai\_embedding", 'model': 'text-embedding-3-small', 'max\_tokens': 4000, 'request\_timeout': 180.0, 'api\_base': None, 'api\_version': None, 'organization': None, 'proxy': None, 'cognitive\_services\_endpoint': None, 'deployment\_name': None, 'model\_supports\_json': None, 'tokens\_per\_minute': 0, 'requests\_per\_minute': 0, 'max\_retries': 10, 'max\_retry\_wait': 10.0, 'sleep\_on\_rate\_limit\_recommendation': True, 'concurrent\_requests': 25}

SUCCESS: Local Search Response: # Who is Scrooge?

Ebenezer Scrooge is a central character in Charles Dickens' "A Christmas Carol," depicted as a miserly, covetous old man who embodies the essence of greed and selfishness. Initially, Scrooge is characterized by his disdain for Christmas, lack of generosity, and solitary nature. He lives in gloomy chambers that once belonged to his deceased partner, Jacob Marley, and is known for his cold-heartedness and skepticism towards the supernatural [Data: Entities (34, 21)].

Scrooge's life undergoes a profound transformation following visits from the ghost of Jacob Marley and three spirits who guide him through various scenes of past, present, and future Christmases. These spectral journeys lead Scrooge to reflect on his actions and their consequences, catalyzing a change in his understanding and attitude towards life. By the end of his journey, Scrooge is depicted as having undergone a significant transformation, showing a newfound appreciation for life and generosity [Data: Entities (34)].

# Main Relationships

## Jacob Marley

Jacob Marley, Scrooge's former business partner, plays a pivotal role in initiating Scrooge's transformation. Marley's ghost visits Scrooge to warn him of the impending visits by three spirits and to urge him to change his ways, setting the stage for the core of the story [Data: Entities (63)].

## Bob Cratchit

Bob Cratchit, Scrooge's clerk, represents the warmth and familial love that Scrooge lacks. Despite his meager earnings, Bob maintains a positive outlook and embodies the spirit of Christmas. Scrooge's relationship with Bob and his family, particularly Tiny Tim, is central to Scrooge's transformation. By the end of the story, Scrooge promises to raise Bob's salary and assist his struggling family, marking a significant shift in their relationship [Data: Entities (12, 109)].

## Tiny Tim

Tiny Tim, Bob Cratchit's son, has a profound impact on Scrooge. Through the spirits' guidance, Scrooge becomes deeply connected to Tiny Tim, eventually becoming like a second father to him. This relationship highlights Scrooge's journey towards compassion and caring [Data: Entities (34)].

## Scrooge's Nephew

Scrooge's nephew is depicted as an optimistic individual who values the essence of Christmas and endeavors to mend the strained relationship with his uncle. Despite Scrooge's initial cold demeanor, his nephew persistently invites Scrooge to share in the Christmas celebrations, symbolizing the potential for reconciliation and change [Data: Entities (42, 151)].

## The Spirits

The spirits play a crucial role in guiding Scrooge through his journey of self-reflection and redemption. Each spirit reveals truths about Scrooge's life, the impact of his actions on others, and the potential future that awaits him if he does not change. These encounters are instrumental in Scrooge's transformation, highlighting the importance of introspection and the potential for personal growth [Data: Entities (34, 64)].

In summary, Scrooge's relationships with Jacob Marley, Bob Cratchit and his family, his nephew, and the spirits are central to his character development and transformation in "A Christmas Carol." Through these relationships, Scrooge evolves from a miserly figure into a benevolent individual, underscoring the story's themes of redemption, compassion, and the spirit of Christmas.

**GLOBAL SEARCH:**

(myenv) Feron.Arockiam@KIC9241:~$ python -m graphrag.query --data ./ragtest/output/20240709-145730/artifacts --community\_level 2 --response\_type "Single Paragraph" --method global "What are the top themes in this story?"

INFO: Reading settings from environment variables

creating llm client with {'api\_key': 'REDACTED,len=51', 'type': "openai\_chat", 'model': 'gpt-4-turbo-preview', 'max\_tokens': 4000, 'request\_timeout': 180.0, 'api\_base': None, 'api\_version': None, 'organization': None, 'proxy': None, 'cognitive\_services\_endpoint': None, 'deployment\_name': None, 'model\_supports\_json': None, 'tokens\_per\_minute': 0, 'requests\_per\_minute': 0, 'max\_retries': 10, 'max\_retry\_wait': 10.0, 'sleep\_on\_rate\_limit\_recommendation': True, 'concurrent\_requests': 25}

SUCCESS: Global Search Response: The top themes in the story revolve around transformation, redemption, the importance of family and community, and the spirit of Christmas as a catalyst for change. Scrooge's journey from miserliness to generosity, facilitated by spectral visits and reflections on his actions and their impacts, underscores the central themes of transformation and redemption [Data: Reports (29, 17, 20, +more)]. The narrative also emphasizes the significance of family and community through characters like the Cratchit family and Scrooge's nephew, highlighting compassion, empathy, and social connection [Data: Reports (22, 26, 10, +more)]. Additionally, the spirit of Christmas is portrayed as a powerful force for reflection, generosity, joy, and potential societal transformation [Data: Reports (17, 29, 3, +more)]. These themes are further enriched by the depiction of generosity and kindness as transformative powers, the impact of personal choices on others, and the broader societal implications of individual actions [Data: Reports (26, 29, 17, 20, 21, +more)].