📚✨ Building Knowledge Graphs with LightRAG ✨📚

Welcome to the **LightRAG Knowledge Graphs** notebook!
Here, you'll discover how to leverage **LightRAG**—a lightweight, efficient Retrieval-Augmented Generation (RAG) framework—for building intelligent, context-aware applications.

🚀 Why Use LightRAG?

- **Simplicity & Speed:** LightRAG is easy to set up and blazing fast, making it perfect for rapid prototyping and production.
- **Cost-Effective:** Designed to be lightweight, it reduces computational costs while maintaining high performance.
- **Flexible Integrations:** Easily connect with various data sources and LLMs (Large Language Models).

🛠️ What Can You Build?

- **Intelligent Chatbots 🤖 :** Create assistants that answer questions using your own documents and knowledge bases.
- **Semantic Search Engines 🔍 :** Retrieve relevant information from large text corpora with context-aware search.
- **Automated Knowledge Graphs 🌐 :** Extract entities and relationships from unstructured data to visualize and query knowledge.

> **LightRAG empowers you to build smarter, more context-aware AI applications with minimal effort!**

Setup

```python
In [1]:  from dotenv import load_dotenv
```

```python
In [3]:  %cd '/content/drive/MyDrive/ztm/rag_ztm/Knowledge Graphs with LightRAG'
```

```
/content/drive/MyDrive/ztm/rag_ztm/Knowledge Graphs with LightRAG
```

In [4]: ```!ls```

```
graph.html            Greek-gods-story.txt  LightRAG.
ipynb  Mair-Lao-Tzu.pdf
Greek-gods-story.pdf  greek_gods.txt        lightrag.
log     _ZEUS__graph.html
```

In [5]: ```!pip install PyPDF2 pyvis aioboto3 ollama tiktoken nano_vectordb python-dotenv -q```

```
                                              232.6/23
2.6 kB 13.1 MB/s eta 0:00:00
                                              756.0/75
6.0 kB 33.3 MB/s eta 0:00:00
                                              84.2/84.2
kB 5.9 MB/s eta 0:00:00
                                              139.9/13
9.9 kB 8.7 MB/s eta 0:00:00
                                              13.6/13.6
MB 68.4 MB/s eta 0:00:00
                                              1.6/1.6 M
B 43.8 MB/s eta 0:00:00
                                              85.3/85.3
kB 5.9 MB/s eta 0:00:00
```

In [6]: ```!pip install lightrag-hku==1.1.1```

```
Collecting lightrag-hku==1.1.1
  Downloading lightrag_hku-1.1.1-py3-none-any.whl.met
adata (71 kB)
                                              71.6/7
1.6 kB 4.1 MB/s eta 0:00:00
Downloading lightrag_hku-1.1.1-py3-none-any.whl (103
kB)
                                              103.6/10
3.6 kB 7.6 MB/s eta 0:00:00
Installing collected packages: lightrag-hku
Successfully installed lightrag-hku-1.1.1
```

In [7]:
```python
# import libraries
import os
from IPython.display import Markdown, display
from lightrag import LightRAG, QueryParam
from lightrag.llm import gpt_4o_mini_complete, gpt_4o
_complete
import PyPDF2
from google.colab import userdata
```

In [8]:
```python
# Set the OpenAI API key in the environment
api_key = userdata.get('OPENAI_API_KEY')
os.environ['OPENAI_API_KEY'] = api_key
```

Create a directory

In [9]:
```python
# Set the name for the directory
WORKING_DIR = "./working_dir"

if not os.path.exists(WORKING_DIR):
    os.makedirs(WORKING_DIR)

rag = LightRAG(
    working_dir=WORKING_DIR,
    llm_model_func= gpt_4o_complete
)
```

In [10]:
```python
# If you are using Colab / Jupyter, do this:
# When using LightRAG with Jupyter
import nest_asyncio
nest_asyncio.apply()
```

Data Preparation

- PDF => TXT
- Create RAG with TXT

In [14]:
```python
# Open the PDF and extract the text
pdf_text = []
with open("Greek-gods-story.pdf", "rb") as file:
    reader = PyPDF2.PdfReader(file)
    for page in reader.pages:
        pdf_text.append(page.extract_text())
```

In [15]:
```python
# Save (Write) a file with the data
with open("greek_gods.txt", "w") as file:
    for line in pdf_text:
        file.write(f"{line}\n")
```

In [17]:
```python
# Build the RAG
with open("greek_gods.txt", "r") as file:
    rag.insert(file.read())
```

```
Processing batch 1:   0%|          | 0/1 [00:00<?, ?i
t/s]
Generating embeddings:   0%|          | 0/1 [00:00<?,
?batch/s]
Generating embeddings: 100%|██████████| 1/1 [00:01<0
0:00,  1.95s/batch]

Extracting entities from chunks:   0%|          | 0/3
[00:00<?, ?chunk/s]

⠹ Processed 1 chunks, 3 entities(duplicated), 2 relat
ions(duplicated)

Extracting entities from chunks:  33%|███       | 1/3
[00:09<00:19,  9.72s/chunk]

⠸ Processed 2 chunks, 24 entities(duplicated), 9 rela
tions(duplicated)

Extracting entities from chunks:  67%|███████   | 2/3
[00:30<00:16, 16.52s/chunk]

⠼ Processed 3 chunks, 51 entities(duplicated), 26 rel
ations(duplicated)

Extracting entities from chunks: 100%|██████████| 3/3
[00:36<00:00, 12.19s/chunk]

Inserting entities: 100%|██████████| 40/40 [00:00<00:
00, 3271.82entity/s]

Inserting relationships: 100%|██████████| 24/24 [00:0
0<00:00, 3006.31relationship/s]

Generating embeddings:   0%|          | 0/2 [00:00<?,
?batch/s]
Generating embeddings:  50%|█████     | 1/2 [00:01<0
0:01,  1.10s/batch]
Generating embeddings: 100%|██████████| 2/2 [00:01<0
0:00,  1.12batch/s]

Generating embeddings:   0%|          | 0/1 [00:00<?,
?batch/s]
Generating embeddings: 100%|██████████| 1/1 [00:01<0
0:00,  1.23s/batch]
Processing batch 1: 100%|██████████| 1/1 [00:44<00:0
0, 44.99s/it]
```

RAG

In [18]:
```python
# PErform Naive RAG
def perform_rag(query, mode): # Changed function name
to avoid shadowing
    return Markdown(rag.query(query, # Now rag refers t
o the LightRAG object
                              param = QueryParam(mode =
mode)))
query = "Who is Hermes"
perform_rag(query, "naive") # Call the new function n
ame
```

Out[18]:
Hermes is a fascinating figure from Greek mythology, known as the messenger of the gods. He is the son of Zeus and is famous for his speed and cunning nature. According to the myth, he was born in a cave and, within hours of his birth, created the first musical instrument, the lyre, using a tortoise shell and strings. This inventive spirit is a hallmark of Hermes' character.

One intriguing story about Hermes involves him as a mischievous child. Shortly after creating the lyre, he encountered a herd of cattle belonging to Apollo, another god. Despite being a newborn, Hermes managed to steal the cattle and hide them. When Apollo discovered the theft, he was shocked to find such a young perpetrator. To resolve the issue, Hermes played the lyre for Apollo, who was so enchanted by the music that he allowed Hermes to keep the cattle in exchange for the lyre. This barter illustrates Hermes' cleverness and charm.

Throughout his life, Hermes is depicted as wearing a winged hat and winged sandals, symbolizing his role as the swift messenger who could travel quickly between the realm of the gods and mortals. This ability to move freely between worlds allowed him to convey messages and assist gods and humans alike, making him an essential figure in many Greek myths and stories.

In [19]:
```python
# Perform LightRAG with a local search
# This means we look into closer entities
perform_rag(query, "local")
```

````
```json
{
  "high_level_keywords": ["Hermes"],
  "low_level_keywords": ["Greek mythology", "Messenger god", "God of trade", "God of thieves", "God of travelers"]
}
```
````

Out[19]:

Hermes is a prominent figure in Greek mythology, known as the son of Zeus. He is often depicted as a mischievous character, playing the role of the messenger of the gods. Hermes is credited with inventing the first musical instrument, the lyre, which he created from a tortoise shell. This instrument played a significant role in one of his adventures involving Apollo.

Role and Symbolism

Hermes is renowned for his cunning and adventurous spirit. His attributes include a winged hat and sandals, which enable him to travel swiftly. These characteristics make him an ideal messenger between gods and mortals. His role as a messenger is not merely symbolic but also active, as he participates in various divine activities and schemes.

Key Myths and Activities

One famous myth involving Hermes describes his theft of Apollo's cattle. Despite being just a baby at the time, Hermes managed to steal the cattle and cleverly hide them. When Apollo confronted him, Hermes enchanted him with the music of the lyre, leading to a reconciliation where Apollo allowed Hermes to keep the cattle in exchange for the instrument. This story highlights Hermes's ingenuity and charm.

Relationships and Influence

As the son of Zeus, Hermes was often seen accompanying his father in various escapades. One noted instance was their journey together disguised as mortals, testing the hospitality of humans, which led to significant events like the transformation of Baucis and Philemon's hut into a temple.

Hermes's presence in mythology emphasizes his versatile role as a trickster, inventor, and mediator between realms, making him an enduring figure in Greek lore.

In [20]:
```python
# Perform LightRAG with Global Search
# More diverse results, global entity relationships
perform_rag(query, "global")
```

```json
{
  "high_level_keywords": ["Hermes", "Mythology"],
  "low_level_keywords": ["Greek", "Messenger god", "G
od of trade", "Winged sandals", "Olympian gods"]
}
```

```json
{
  "high_level_keywords": ["Hermes", "Mythology"],
  "low_level_keywords": ["Greek", "Messenger god", "G
od of trade", "Winged sandals", "Olympian gods"]
}
```

Overview of Hermes

Hermes is a fascinating figure in Greek mythology known primarily for his role as the messenger of the gods. He is a complex character associated with numerous traits and stories that illustrate his cunning and versatility.

Parentage and Characteristics

Hermes is the son of Zeus, the chief god of Olympus, which positions him among the revered Greek pantheon. His mother, although not specified in the provided data, is typically regarded as Maia, one of the Pleiades in mythology.

Roles and Activities

Hermes is depicted as a clever and mischievous youth, embodying the qualities of agility and intelligence. One of his notable contributions to the mythological world is the creation of the lyre, a musical instrument crafted from a tortoise shell, which demonstrates his inventive nature. Beyond his musical talent, Hermes is also known for being a cunning thief. A story highlights how he stole cattle belonging to Apollo, another prominent god, and later placated Apollo with the enchanting music of the lyre—the same instrument Hermes had created.

Symbols and Attributes

Hermes is traditionally represented with a winged hat and sandals, enabling him to travel swiftly. This imagery reinforces his role as the fast-moving messenger tasked with delivering divine messages between the gods and mortals. His ability to traverse different realms with speed and stealth further cements his status as a versatile and indispensable god within Greek mythology.

Legacy

Through his clever and often cheeky exploits, Hermes exhibits a duality; while he engages in acts of deceit and theft, he also brings innovation and charm. This duality makes him a compelling deity who bridges the gap between mortals and the divine, serving as a crucial link within the mythological narratives of Greek culture.

In [21]:
```python
# Perform LightRAG with Hybrid approach
perform_rag(query, "hybrid")
```

```json
{
  "high_level_keywords": ["Hermes", "Mythology", "Cultural significance"],
  "low_level_keywords": ["Greek god", "Messenger", "Commerce", "Travellers", "Thieves", "Symbol", "Wings", "Caduceus"]
}
```

Out[21]:
Hermes is a fascinating figure in Greek mythology, renowned for his multifaceted role among the gods. Known as the son of Zeus, Hermes occupies the position of the divine messenger, which is a role he fulfilled with notable speed and cunning. This ability to traverse swiftly between worlds is symbolized by his winged hat and sandals, allowing him to deliver messages for the gods and interact with mortals with remarkable agility.

In addition to his duties as a messenger, Hermes is depicted as a mischievous character with a knack for cleverness. One of his notable feats includes creating the first musical instrument, the lyre, fashioned from a tortoise shell. His ingenuity didn't stop there; young Hermes famously stole a herd of cattle from Apollo. This theft, however, led to an unexpected outcome. When Apollo discovered the baby Hermes as the culprit, Hermes charmed him with the enchanting music of the lyre. So beguiled was Apollo by the music that he forgave Hermes, striking a generous bargain where Hermes kept the cattle in exchange for the lyre.

Throughout various myths, Hermes is characterized by his adaptability and resourcefulness, making him an essential figure within the pantheon of Greek gods. His attributes and actions reflect not only his role as a messenger and trickster but also his importance in various domains of life and human interaction.

Graph Visualization

In [22]:
```python
# Import libraries
import networkx as nx
from pyvis.network import Network
import matplotlib.pyplot as plt
import random
from IPython.display import HTML
```

In [23]:
```python
# Load entities
G = nx.read_graphml(f"{WORKING_DIR}/graph_chunk_entit
y_relation.graphml")

# Create a network
net = Network(notebook = True, cdn_resources = "remot
e")
net.from_nx(G)

# Add colors and titles to nodes
for node in net.nodes:
  node["color"] = "#{:06x}".format(random.randint(0,
0xFFFFFF))
    if "description" in node:
      node["title"] = node["description"]

# Add titles to edges
for edge in net.edges:
    if "description" in  edge:
      edge["title"] = edge["description"]

# Save and display the netweok
net.show("graph.html")
net.save_graph("graph.html")

HTML(filename = "graph.html")
```
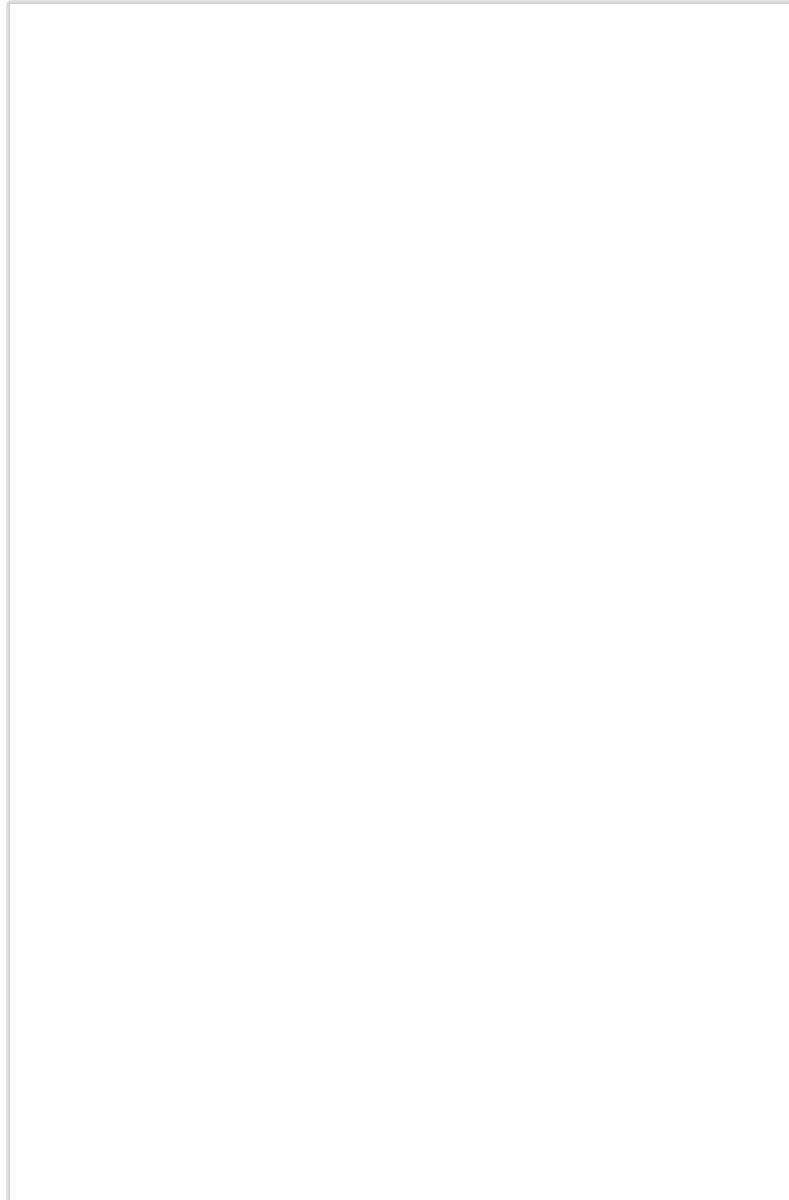
graph.html

Out[23]:

In [24]:
```python
# Print all node names
for node in G.nodes:
  print(node)
```

```
"OLIVE TREE"
"APHRODITE"
"BAUCIS"
"ZEUS"
"THESSALY"
"HEPHAESTUS"
"PARIS"
"LINDEN TREE"
"ERIS"
"PHILEMON"
"CURSE OF INSATIABLE HUNGER"
"ERYSICHTHON"
"UNDERWORLD"
"DIONYSUS"
"HELEN"
"OAK TREE"
"ATHENS"
"ATHENA"
"DEMETER"
"MOUNT OLYMPUS"
"ARTEMIS"
"KING OF SPARTA"
"FLOOD"
"TROJAN WAR"
"POSEIDON"
"NYMPHS"
"ALPHEUS"
"TROY"
"TEMPLE"
"HERA"
"APOLLO"
"HERMES"
"HESTIA"
"HADES"
"LYRE"
"GOLDEN APPLE"
"ARES"
"OLYMPUS"
"ORPHEUS"
"SEA"
```

In [25]:
```python
# Target Zeus
# Load entities
G = nx.read_graphml(f"{WORKING_DIR}/graph_chunk_entity_relation.graphml")

# Target Zeus
target_node = '"ZEUS"'

# Get neighbors for that node
subgraph_nodes = list(G.neighbors(target_node)) + [target_node]
subgraph = G.subgraph(subgraph_nodes)

# Create a network
net = Network(notebook = True, cdn_resources = "remote")
net.from_nx(subgraph)

# Save and display the netweok
graph_name = f"{target_node}_graph.html"
net.save_graph(graph_name)
HTML(filename = graph_name)
```

Out[25]: