

nodes 24

Martin O'Hanlon

Technical Curriculum Developer
Neo4j

Hi, I'm Martin

Technical Curriculum Developer at Neo4j



@martinohanlon



GenAI Beyond Chat

... with RAG, Knowledge Graphs and Python





GenAI Beyond Chat

GenerativeAI Beyond Chat

GenerativeAI Beyond Chat

Making LLMs make sense

LLMs aren't perfect!



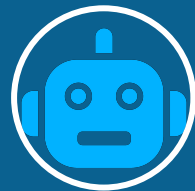


DEMO



The problem

What's the weather like?



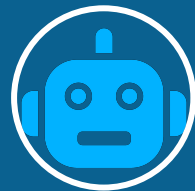
Sorry, as an AI, I don't have real-time information or access to live weather data. Please check a weather website or app for current conditions.



The problem

You are a surfer dude, having a conversation about the surf conditions on the beach.
Respond using surfer slang.

What's the weather like?



Dude, it's totally gnarly out here! The sun's gleaming, the water's blue, and the waves are firing! Totally glassy! So grab your stick, it's time to shred!



The background consists of several overlapping organic, blob-like shapes in various shades of blue, ranging from a light teal to a deep navy blue. The shapes are fluid and non-geometric, creating a modern, abstract aesthetic.

LLMs make things up

LLMs make things up



Hallucination

LLMs are...

LLMs are designed to
generate human-like text

DEMO

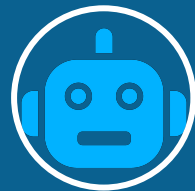


A solution

You are a surfer dude, having a conversation about the surf conditions on the beach. Respond using surfer slang.

Current weather -calm, 3 feet waves, cloudy

What's the weather like?



**Man, it's kind of mellow out here.
We've got some ankle busters rolling
in, nothing too heavy, and the sky's
looking a bit grey. Might be a chill day
to just kick back and enjoy the vibe,
bro.**



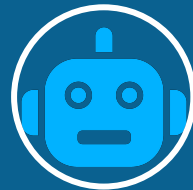
A solution

You are a surfer dude, having a conversation about the surf conditions on the beach. Respond using surfer slang.

Surf report:

```
{  
  "surf": [  
    {"beach": "Fistral", "conditions": "6ft waves and offshore winds"},  
    {"beach": "Polzeath", "conditions": "Flat and calm"},  
    {"beach": "Watergate Bay", "conditions": "3ft waves and onshore winds"}  
  ]  
}
```

What's happening at Fistral beach?



Dude, Fistral beach is totally tubular right now. We're talkin' 6ft waves and offshore winds. Perfect for some righteous carves!



Retrieval Augmented Generation

R

A

G

Retrieval

Augmented

Generation

RAG?



Retrieval Augmented Generation

G A R

Retrieval Augmented Generation

G A R

Instruct an LLM
to generate text

Retrieval Augmented Generation

G

A

R

Instruct an LLM
to generate text

that has been
augmented or
improved

Retrieval Augmented Generation

G

Instruct an LLM
to generate text

A

that has been
augmented or
improved

R

by the retrieval
of additional
information

DEMO



LangChain

```
from langchain_openai import ChatOpenAI
from langchain_core.prompts import ChatPromptTemplate
from langchain.schema import StrOutputParser

chat_llm = ChatOpenAI(openai_api_key="sk-...")

prompt = ChatPromptTemplate.from_messages(
    [
        (
            "system",
            "You are a surfer dude, having a conversation about the surf conditions on the beach. Respond using surfer slang.",
        ),
        (
            "human",
            "{question}"
        ),
    ]
)

chat_chain = prompt | chat_llm | StrOutputParser()

response = chat_chain.invoke({"question": "What is the weather like?"})

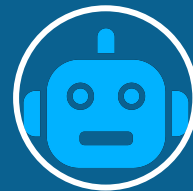
print(response)
```

```
prompt = ChatPromptTemplate.from_messages([
    (
        "system",
        "You are a surfer dude, having a conversation about the surf conditions on the beach. Respond using surfer slang.",
    ),
    ( "system", "{context}" ),
    ( "human", "{question}" ),
])

chat_chain = prompt | chat_llm | StrOutputParser()

current_weather = """
{
    "surf": [
        {"beach": "Fistral", "conditions": "6ft waves and offshore winds"},
        {"beach": "Polzeath", "conditions": "Flat and calm"},
        {"beach": "Watergate Bay", "conditions": "3ft waves and onshore winds"}
    ]
}"""

response = chat_chain.invoke(
    {
        "context": current_weather,
        "question": "What's it like at Watergate Bay"
    }
)
print(response)
```



What data should you include?



Graphs and vectors



What are **Graphs**?

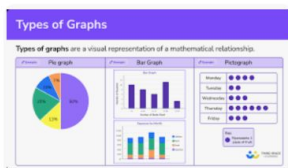




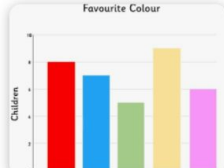
graphs

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Tools



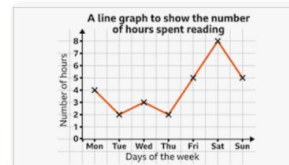
Third Space Learning
Types of Graphs - Math Steps, Examples ...



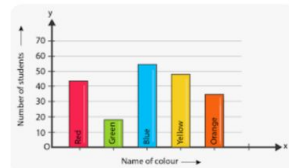
Twinkl
What is a Graph? - Maths - Twinkl



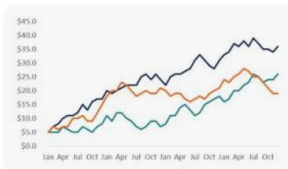
Cambridge Mathematics
Cambridge Mathematics



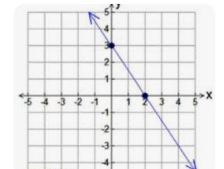
BBC
Line graphs - KS3 Maths - BBC Bitesize



BYJU'S
of Graphs in Mathematics and Statistics ...



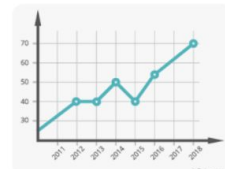
Corporate Finance Institute
Types of Graphs



MathBitsNotebook
Interpreting Graphs - MathBit...



Indeed
13 Types of Graphs and Charts (Plus ...



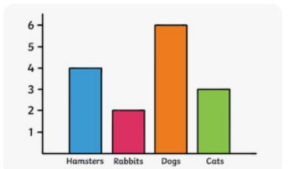
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of Graphs in Mathematics and S...



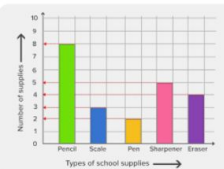
Carolina Knowledge ...
Graphs and Charts



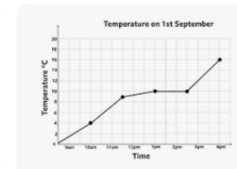
storytelling with data
verbalizing and explaining charts ...



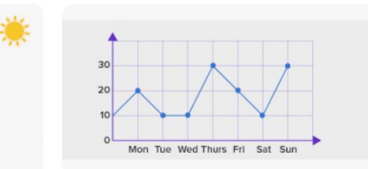
Twinkl
What is a graph? - Twinkl



SplashLearn
What is a Graph in Math? Definitio...



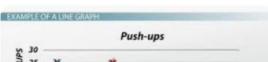
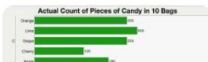
BBC
Introducing line graphs - Maths ...



SplashLearn
What is a Graph in Math? Definition ...



ChartExpo
Charts and Graphs for Data Visualization



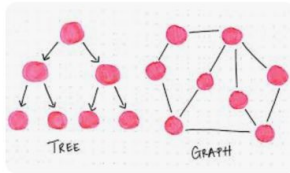


graph theory

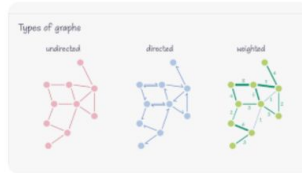
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Tools

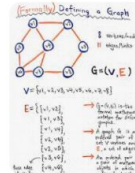
Computer science Discrete mathematics Path Brain Tree Simple Social network Connectivity



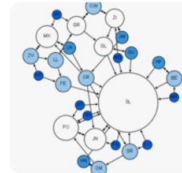
Medium
A Gentle Introduction To Graph Theory ...



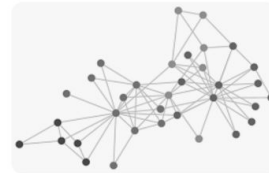
Science in the News - Harvard University
Graph Theory 101 - Science in the News



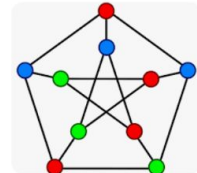
Medium
A Gentle Introduction To Graph Theory ...



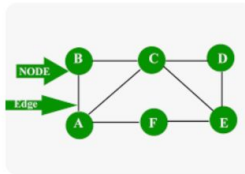
Wikipedia
Graph theory - Wikipedia



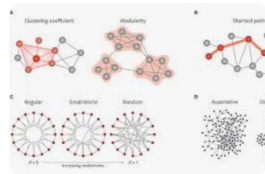
Adatis
Business Insights with Graph Theory ...



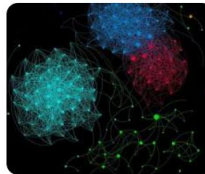
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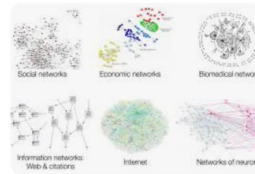
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Mathematics | Graph Theory Basics ...



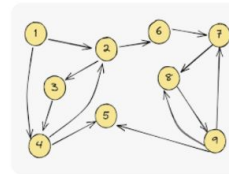
UCF College of Sciences
Dr. Richard contributes to new ...



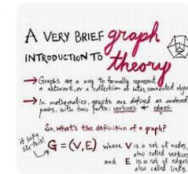
Science in the News - Harvard U...
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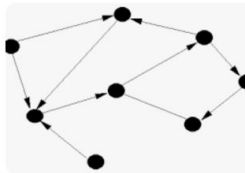
Towards Data Science
A Gentle Introduction to Graph theory ...



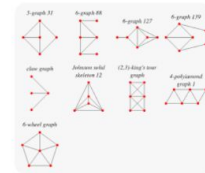
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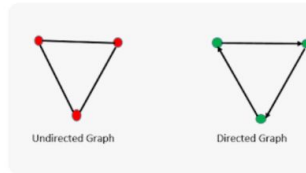
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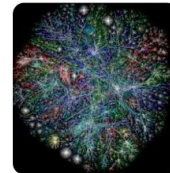
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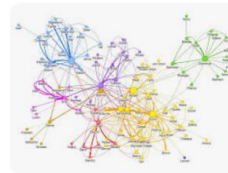
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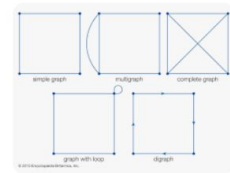
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Graph Theory-Discrete Mathematics ...



KDnuggets
What is Graph Theory, ...



ResearchGate
Graph theory analysis in social ne...



Britannica
Graph theory | Problems & Appli...



What are **Vectors**?

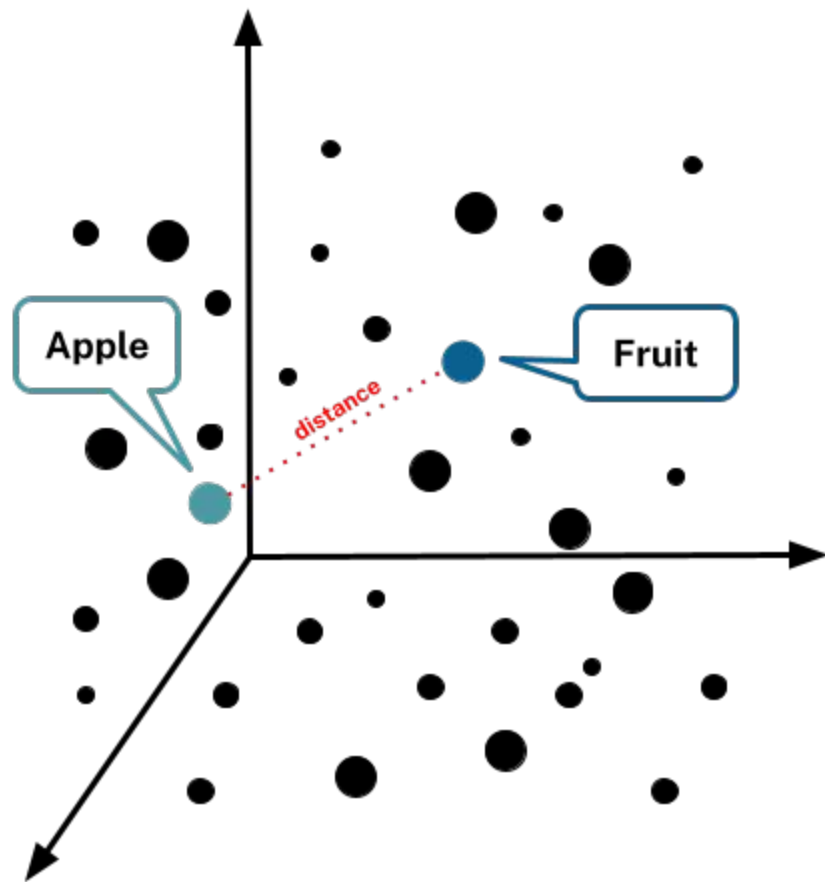






“apple”

0.0077788467, -0.02306925, -0.007360777, -0.027743412, -0.0045747845, 0.01289164, -0.021863015, -0.008587573, 0.01892967, -0.029854324, -0.0027962727, 0.020108491, -0.004530236, 0.009129008, -0.021451797, 0.002030382, 0.030813828, 9.744976e-05, 0.0019172973, -0.02568733, -0.020985752, -0.008066699, 0.02134214, -0.01222684, 0.0009980568, 0.005105939, 0.009999417, -0.000107408916, 0.015845545, -0.012980737, 0.020574536, -0.016160812, -0.018518453, 0.005263572, -0.019286057, -0.009293495, -0.012096621, -0.008854863, -0.005753605, -0.006157968, 0.010540851, 0.007724018, -0.0065554776, 0.00052944134, -0.023453051, 0.011089141, -0.021671113, -0.00061425474, -0.012754567, 0.015489157, -0.0054520466, -0.0020355221, -0.015050527, -0.0052944133, -0.0028082666, 0.0027431573, -0.019450543, 0.0063807103, -0.010725899, 0.0049243183, 0.005266999, 0.01513277, -0.027921606, 0.0055754115, -0.009183837, 0.00380718, -0.013624975, -0.0084710615, 0.012905347, 0.015667351, 0.033363372, 0.013268588, 0.014036193, 0.0063464423, 0.004454846, 0.0014820931, -0.03396649, -0.0062779062, -0.00314238, 0.01818948, 0.0075389706, -0.02637269, 0.009574492, 0.024974553, 0.024823774, 0.009882905, -0.021657405, 0.010109074, -0.007970748, 0.0028887964, 0.011849891, 0.0054726074, 0.0078336755, 0.016448664, -0.026975807, 0.016599443, -0.012713445, 0.026345275, 0.004667308, -0.03736588, 0.0009834929, 0.006089432, -0.028730331, -0.011198798, -0.020396343, 0.0019738395, 0.012459862, -0.003738644, 0.015448036, -0.019902883, 0.0064389664, 0.00926608, 0.021945259, -0.051648803, -0.016448664, -0.01744929, 0.0091099103, 0.0021713076, 0.022705105, 0.025556525, 0.021021318, 0.025802028, 0.028107627,



DEMO



```
neo4j$ MATCH (m:Movie {title: "Toy Story"}) RETURN m
```



Graph



Table



Text



Code



Node properties



Movie

movieId	1	
plot	A cowboy doll is profoundly threatened and jealous when a new spaceman figure supplants him as top toy in a boy's room.	
plotEmbedding	<p>$[-0.026989128440618515, -0.024155009537935257, 0.006058253347873688, -0.024324016645550728, -0.022516941651701927, -0.0050864629447460175, -0.013442561961710...$</p> Show all	
poster	https://image.tmdb.org/t/p/w440_and_h660_face/uXDfjjbdP4ijW5hWSBrPrIKpxab.jpg	
released	1995-11-22	
revenue	373554033	
runtime	84	



```

1 MATCH (m:Movie {title: 'Toy Story'})
2
3 CALL db.index.vector.queryNodes('moviePlots', 6, m.plotEmbedding)
4 YIELD node, score
5
6 RETURN node.title AS title, score, node.plot AS plot

```



Table



Text



Code

	title	score	plot
1	"Toy Story"	1.0	"A cowboy doll is profoundly threatened and jealous when a new spaceman figure supplants him as top
2	"Little Rascals, The"	0.9214558601379395	"Alfalfa is wooing Darla and his He-Man-Woman-Hating friends attempt to sabotage the relationship."
3	"NeverEnding Story III, The"	0.920598566532135	"A young boy must restore order when a group of bullies steal the magical book that acts as a portal bet
4	"Drop Dead Fred"	0.9200617074966431	"A young woman finds her already unstable life rocked by the presence of a rambunctious imaginary frie
5	"E.T. the Extra-Terrestrial"	0.9191048741340637	"A troubled child summons the courage to help a friendly alien escape Earth and return to his home-wor
6	"Gumby: The Movie"	0.9181168079376221	"In this offshoot of the 1950s claymation cartoon series, the crazy Blockheads threaten to ruin Gumby's

Started streaming 6 records after 8 ms and completed after 11 ms.

```

1 WITH genai.vector.encode(
2   "A mysterious spaceship lands Earth",
3   "OpenAI",
4   { token: $token }) AS myMoviePlot
5 CALL db.index.vector.queryNodes('moviePlots', 6, myMoviePlot)
6 YIELD node, score
7 RETURN node.title, node.plot, score

```

Table

Text

Code

	node.title	node.plot
1	"2001: A Space Odyssey"	"Humanity finds a mysterious, obviously artificial object buried beneath the Lunar surface and, with the intelligent computer H.A.L. 9
2	"Alien"	"The commercial vessel Nostromo receives a distress call from an unexplored planet. After searching for survivors, the crew heads I
3	"Arrival, The"	"Zane, an astronomer, discovers intelligent alien life. But the aliens are keeping a deadly secret, and will do anything to stop Zane fr
4	"Coneheads"	"Aliens with conical crania crash land on Earth."
5	"Aliens"	"The planet from Alien (1979) has been colonized, but contact is lost. This time, the rescue team has impressive firepower, but will it
6	"E.T. the Extra-Terrestrial"	"A troubled child summons the courage to help a friendly alien escape Earth and return to his home-world."

Started streaming 6 records after 10 ms and completed after 849 ms.

```

6 YIELD node, score
7 RETURN
8 node.title + "-" + node.plot AS text,
9 score,
10 {
11     title: node.title,
12     directors: [ (person)-[:DIRECTED]→(node) | person.name ],
13     actors: [ (person)-[r:ACTED_IN]→(node) | [person.name, r.role] ],
14     genres: [ (node)-[:IN_GENRE]→(genre) | genre.name ],
15     tmdbId: node.tmdbId,
16     source: 'https://www.themoviedb.org/movie/' + node.tmdbId
17 } AS metadata

```

Table

Text

Code

score

metadata

```

"https://www.themoviedb.org/movie/62",
"actors": [
  [
    "Keir Dullea",
    "Dr. David Bowman"
  ],
  [
    "Gary Lockwood",
    "Dr. Frank Poole"
  ],
  [
    "William Sylvester",
    "Dr. Heywood Floyd"
  ],
  [
    "Daniel Richter",

```

Embedding non-text data

(extension)

It doesn't just have to be text, you can embed other data such as images

```

1 MATCH (m:Movie{title: 'Babe'})
2
3 CALL db.index.vector.queryNodes('moviePosters', 6, m.posterEmbedding)
4 YIELD node, score
5
6 RETURN node.title, score, node.poster

```



Table

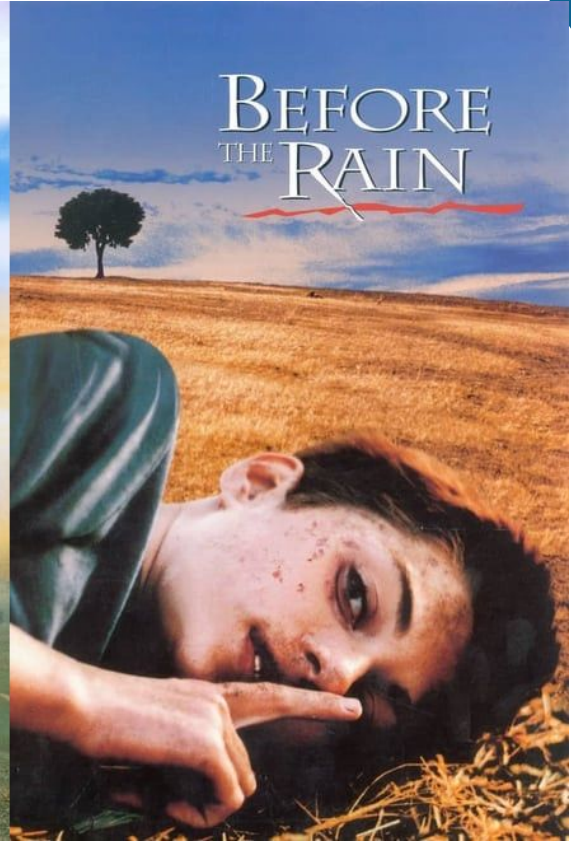
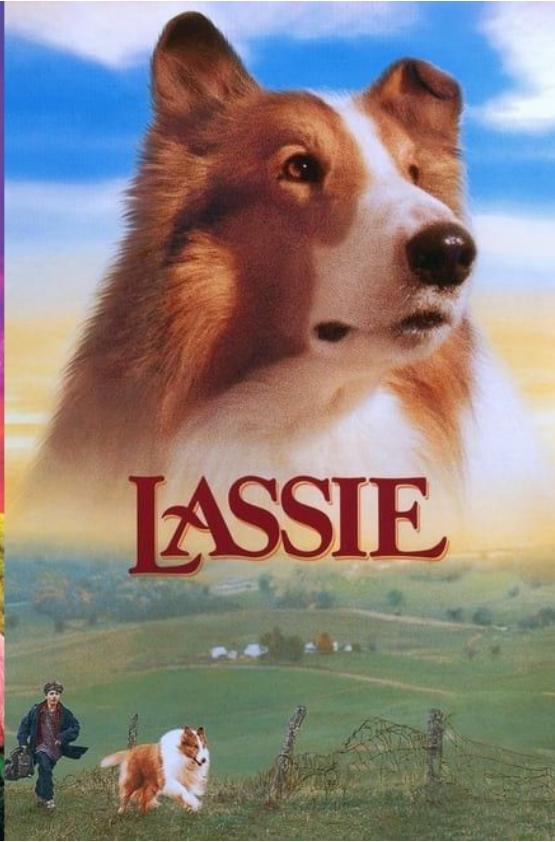
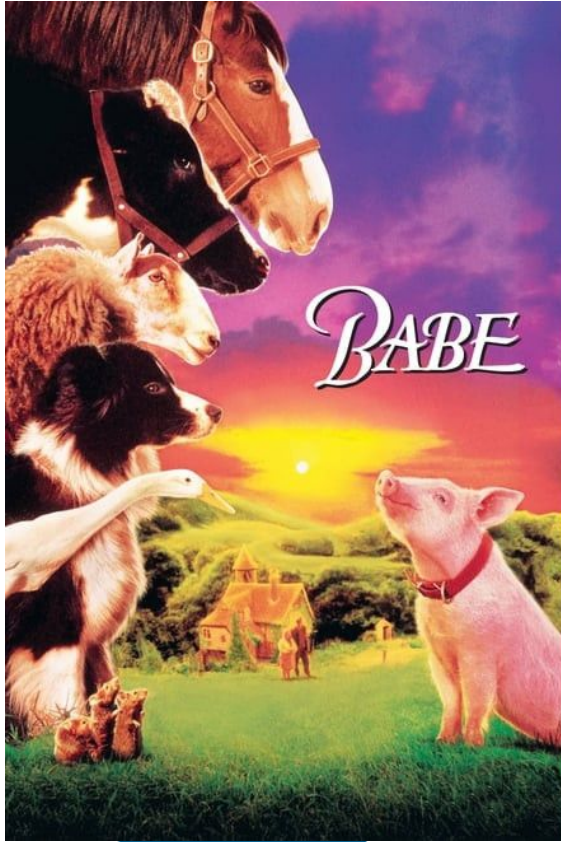


Text

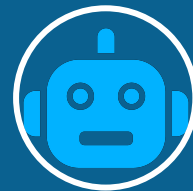


Code

	node.title	score	node.poster
1	"Babe"	1.0	"https://image.tmdb.org/t/p/w440_and_h660_face/bjDlp0b5TQRx4kF8i9TKeUANLTp.jpg"
2	"Lassie"	0.873661994934082	"https://image.tmdb.org/t/p/w440_and_h660_face/5Tz2rzFivQKmMBz5T8Cj7M7CdnI.jpg"
3	"Before the Rain (Pred dozhdot)"	0.8410471081733704	"https://image.tmdb.org/t/p/w440_and_h660_face/rSdjBP0UfJsaju4XcV64oTCQ2ZL.jpg"
4	"Balto"	0.8397032618522644	"https://image.tmdb.org/t/p/w440_and_h660_face/tpoaKJMRjOZI9cbZRR2aiKikyRC.jpg"
5	"Amazing Panda Adventure, The"	0.8371400833129883	"https://image.tmdb.org/t/p/w440_and_h660_face/tIK40vCE9i8g4VhyJ3LLr5y1ROJ.jpg"
6	"Bad Girls"	0.832358181476593	"https://image.tmdb.org/t/p/w440_and_h660_face/m2689gml09K6y92Ffb5lGVQlqRu.jpg"





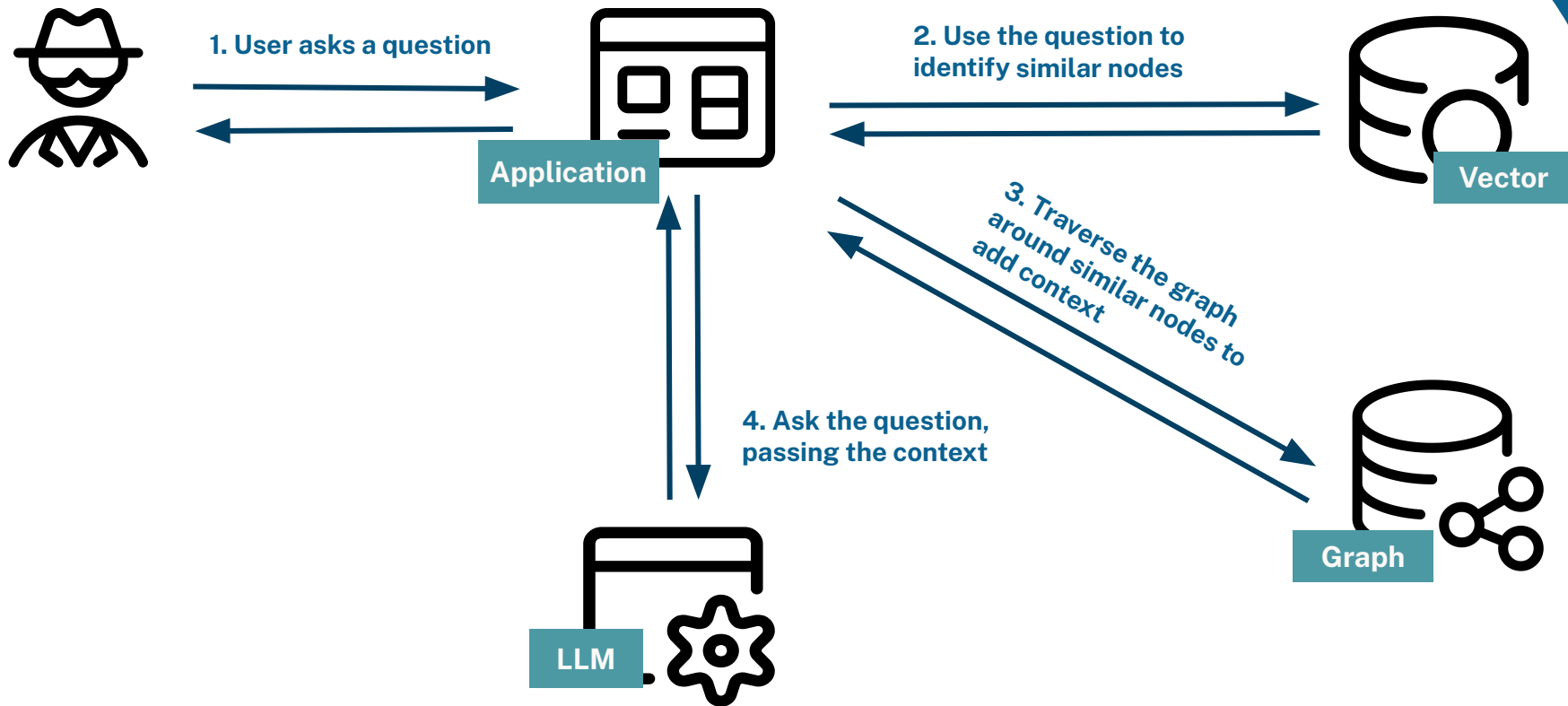


What data should you include?



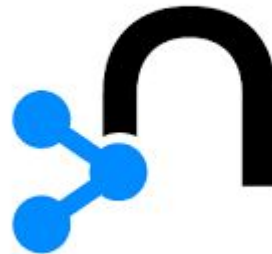


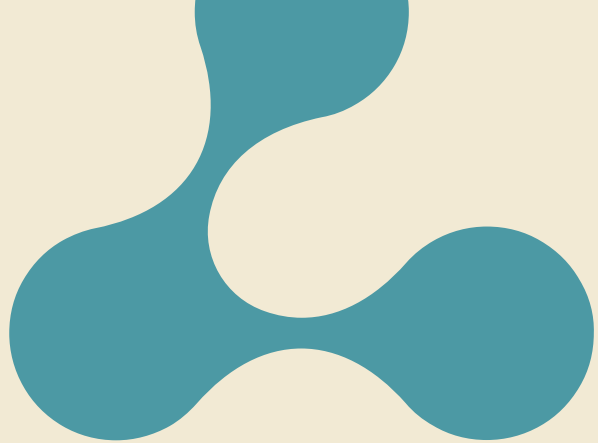
Vector + Graph = GraphRAG



Agents, retrievers, and tools

DEMO





Agents



DEMO




```

llm = ChatOpenAI(
    openai_api_key=os.getenv('OPENAI_API_KEY'),
    model="gpt-4")

chat_prompt = ChatPromptTemplate.from_messages(
    [
        ("system", "You are a movie expert providing information about movies."),
        ("human", "{input}"),
    ]
)

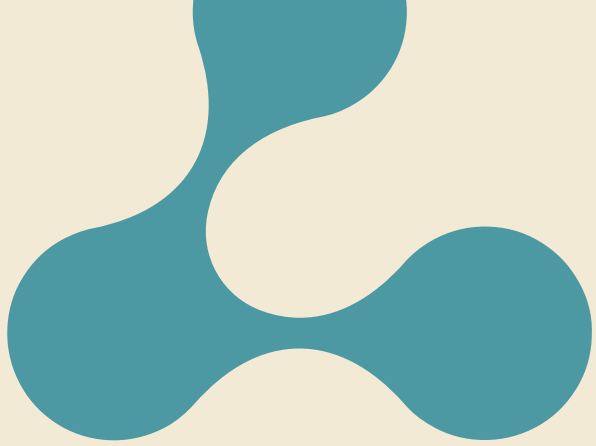
movie_chat = chat_prompt | llm | StrOutputParser()

tools = [
    Tool.from_function(
        name="General Chat",
        description="For general movie chat not covered by other tools",
        func=movie_chat.invoke,
    ),
]

agent_prompt = hub.pull("hwchase17/react")
agent = create_react_agent(llm, tools, agent_prompt)
agent_executor = AgentExecutor(
    agent=agent,
    tools=tools,
    verbose=True
)

question = input("> ")
response = agent_executor.invoke({"input": question})
print(response["output"])

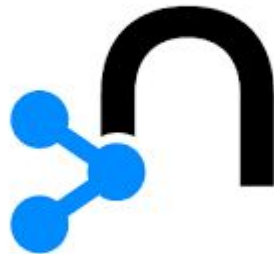
```



Retrievers



DEMO



```

llm = ChatOpenAI(
    openai_api_key=os.getenv('OPENAI_API_KEY'),
    model="gpt-4"
)

embeddings = OpenAIEmbeddings(openai_api_key=os.getenv('OPENAI_API_KEY'))

graph = Neo4jGraph(
    url=os.getenv("NEO4J_URI"),
    username=os.getenv("NEO4J_USERNAME"),
    password=os.getenv("NEO4J_PASSWORD"),
)

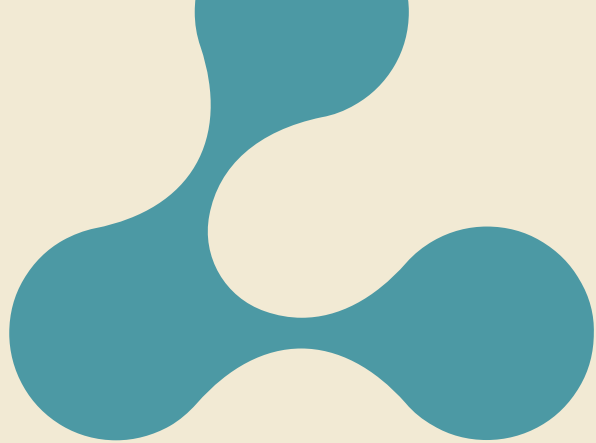
neo4jvector = Neo4jVector.from_existing_index(
    embeddings,
    graph=graph,
    index_name="moviePlots",
    node_label="Movie",
    text_node_property="plot",
    embedding_node_property="plotEmbedding",
    retrieval_query=""
)

RETURN
node.title + " - " + node.plot AS text,
score,
{
    title: node.title,
    tmdbId: node.tmdbId,
    source: 'https://www.themoviedb.org/movie/' + node.tmdbId
} AS metadata
"""
)

retriever = neo4jvector.as_retriever()

instructions = (
    "Use the given context to answer the question."
    "If you don't know the answer, say you don't know."
    "Context: {context}"
)

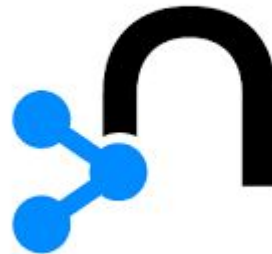
```



Tools



DEMO



```
from plot_retriever import get_movie_plot

tools = [
    Tool.from_function(
        name="General Chat",
        description="For general movie chat not covered by other tools",
        func=movie_chat.invoke,
    ),
    Tool.from_function(
        name="Movie Plot Search",
        description="For when you need to find information about movies based on a plot",
        func=get_movie_plot,
    )
]
```

```
    retrieval_query=""
RETURN
    node.title + " - " + node.plot AS text,
    score,
    {
        title: node.title,
        directors: [ (person)-[:DIRECTED]->(node) | person.name ],
        actors: [ (person)-[r:ACTED_IN]->(node) | [person.name, r.role] ],
        genres: [ (node)-[:IN_GENRE]->(genre) | genre.name ],
        tmdbId: node.tmdbId,
        source: 'https://www.themoviedb.org/movie/' + node.tmdbId
    } AS metadata
"""
```


The background is a solid blue color with large, flowing, wavy shapes in a slightly darker shade of blue, creating a sense of movement and depth. The text is centered horizontally and vertically.

Thoughts, comments, questions?

The code

github.com/martinothanol/genai-beyond-chat

Learn more

graphacademy.neo4j.com



Thank you ❤️



@martinohanlon