Natural Language Processing: CSCI 89b

Final Project: Retrieval Augmented Generation Chatbot: 89B Course Materials

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Sources:

Getting Started: Storing and Managing Environment Variables https://www.youtube.com/watch?v=wpL7z8rYShg

Rag Chain Model References: The Basic framework for the project below draws heavily on the example below: https://towardsdatascience.com/retrieval-augmented-generation-rag-from-theory-to-langchain-implementation-4e9bd5f6a4f2

Additional RAG Implmentation Options and Explanations: https://www.youtube.com/watch?v=aNj-1wehoEo&t=0s

https://towardsdatascience.com/building-a-rag-chain-using-langchain-expression-language-lcel-3688260cad05

https://github.com/Judy-Choi/ragas_tutorial/blob/main/ragas_tutorial.ipynb

Section 1: Imports and Installation

```
In [1]:   #https://stackoverflow.com/questions/14463277/how-to-disable-python-warnings
          import warnings

          def fxn():
              warnings.warn("deprecated", DeprecationWarning)

          with warnings.catch_warnings():
              warnings.simplefilter("ignore")
              fxn()

          # Or if you are using > Python 3.11:
          with warnings.catch_warnings(action="ignore"):
              fxn()
```

```
In [2]:   # A number of the packages have warnings for depreciations and future versions. This will ignore

          import warnings

          warnings.filterwarnings("ignore")
```

```
In [3]:   ### Pip install -- can avoid this by using the 'nlp_89b.yml' file
          #!pip install openai
          #!pip install python-dotenv
          #!pip install langchain
          #!pip install -U langchain-community
          #!pip install -U langchain-openai
          #!pip install weaviate
          #!pip install -U weaviate-client
          #!pip install tiktoken
```

```
#!pip install pypdf
#!pip install chromadb
```

In [4]:
```python
from openai import OpenAI # pip install openai
import os
from dotenv import load_dotenv # pip install python-dotenv
import openai
import requests
from langchain.document_loaders import TextLoader
```

Section 2: Open AI LLM Exploration

OPEN_API KEY and Environment Variable Storage

In [5]:
```python
load_dotenv()

openai_api_key = os.getenv('OPENAI_API_KEY')

if openai_api_key is None:
    raise ValueError("No API key found. Set the OPENAI_API_KEY environment variable.")

openai_client = OpenAI()
```

TEST API QUERYS FOR GPT 3.5 and 4

In [6]:
```python
def query_gpt_3_5(prompt):
    response = openai_client.chat.completions.create(
      model= "gpt-3.5-turbo",
      messages=[
        {"role": "user", "content": prompt}
        ]
      )
    return response.choices[0].message.content

def query_gpt_4(prompt):
    response = openai_client.chat.completions.create(
      model= "gpt-4-turbo",
      messages=[
        {"role": "user", "content": prompt}
        ]
      )
    return response.choices[0].message.content
```

In [7]:
```python
# Example usage
prompt = "Explain variational autencoders in simple terms."
print(query_gpt_3_5(prompt))
```

Variational autoencoders (VAEs) are a type of neural network model that can learn to generate new data that is similar to the data it was trained on.

VAEs work by learning to encode input data into a lower-dimensional representation called a "latent space", and then decoding this representation back into the original data. The key difference between VAEs and traditional autoencoders is that VAEs also learn the distribution of the latent space, allowing them to generate new data samples by sampling from this distribution.

In simple terms, VAEs can be thought of as a way to learn the underlying structure of a set of data and then use this knowledge to generate new, similar data points. They are commonly used in tasks such as image generation, natural language processing, and recommendation systems.

In [8]:
```python
# Example usage
prompt = "Explain variational autencoders in simple terms."
```

```
print(query_gpt_4(prompt))
```

Variational Autoencoders (VAEs) are a type of artificial neural network used for unsupervised lear
ning — that is, learning hidden or underlying patterns in data without needing labeled data. They
are particularly powerful for tasks like generating new data that is similar to the data they were
trained on. Common applications include generating realistic human faces, creating fictional yet p
lausible text, or designing new molecular structures.

To explain VAEs in simple terms, here are the key points and concepts:

1. **Autoencoder Basics**:
   - **Objective**: An autoencoder is designed to compress data (encoding) into a smaller, compact
representation and then reconstruct (decode) the data back to its original form. The idea is simil
ar to compression software, but it's learned from the data itself.
   - **Architecture**: Generally consists of two main parts:
     - **Encoder**: This part takes the original data and compresses it into a smaller form, known
as the latent space or latent representation.
     - **Decoder**: This part attempts to reconstruct the original data from the compressed form.

2. **Variational Aspect**:
   - **Difference from Standard Autoencoders**: In standard autoencoders, the encoded data is a fi
xed point in the latent space. In variational autoencoders, each point in the latent space is not
fixed but instead is a distribution (typically Gaussian). This means that instead of encoding an i
nput into a single point, we encode it into a distribution over the latent space.
   - **Generating new data**: By sampling from the distributions in the latent space, VAEs can gen
erate new data points. The randomness in sampling is key to generating varied and diverse outputs.

3. **Math Behind VAEs**:
   - VAEs are built on principles from probability theory and statistics, particularly Bayesian in
ference. The key mathematical concept is learning the distributions (i.e., the mean and variance)
from which the encoded representations are sampled.
   - They aim to optimize two main things simultaneously:
     - How well the decoded outputs match the original inputs (reconstruction quality).
     - How closely the learned distributions in the latent space match a prior distribution (typic
ally a Gaussian), which is measured using something called the Kullback-Leibler divergence.

4. **Training VAEs**:
   - During training, VAEs adjust the parameters of the encoder and decoder so that the output clo
sely reconstructs the original data while also regularizing the distributions in the latent space
to be as "normal" (i.e., standard Gaussian) as possible.
   - This regularization helps in not letting the model memorize the data (overfit) and ensures th
e model generalizes well, which is crucial for generating new, coherent data samples.

5. **Application Examples**:
   - **Image Generation**: Generate new images that look like realistic photographs.
   - **Text Generation**: Create readable, stylistically consistent text in various genres.
   - **Drug Discovery**: Help in designing molecular structures that could be viable as new drugs.

In summary, variational autoencoders are a sophisticated blend of neural networks and statistical
modeling, allowing them to not only learn complex data distributions but also generate new data sa
mples from those learned distributions. They offer a blend of robust data understanding and creati
ve data generation capabilities in machine learning.

Section 3: RAG with Langchain and OpenAI

3.a. Load Model Data Into Memory

```
In [9]:   #### Test with single pdf ####
```

```
In [10]:  from langchain.document_loaders import PyPDFLoader
          from langchain.text_splitter import RecursiveCharacterTextSplitter

          data_load=PyPDFLoader('data/ed3bookaug20_2024.pdf')
```

```
data_test=data_load.load_and_split()
data_split=RecursiveCharacterTextSplitter(separators=["\n\n","\n", " ", ""], chunk_size=500, chun
chunks = data_split.split_documents(data_test)

print('Chunk example: ',chunks[100])
```

```
Chunk example:  page_content='a followed by 24 dots followed by z (but not a followed by 23 or 25
dots followed
by a z).
Regex Expansion Match First Matches
\d [0-9] any digit Party_of_5
\D [ˆ0-9] any non-digit Blue_moon
\w [a-zA-Z0-9_] any alphanumeric/underscore Daiyu
\W [ˆ\w] a non-alphanumeric !!!!
\s [_\r\t\n\f] whitespace (space, tab) in Concord
\S [ˆ\s] Non-whitespace in_Concord
Figure 2.8 Aliases for common sets of characters.
A range of numbers can also be specified. So /{n,m}/ specifies from n to m' metadata={'source': 'dat
a/ed3bookaug20_2024.pdf', 'page': 17}
```

In [11]:
```
len(chunks),len(data_test)
```

Out[11]: (4293, 657)

In [12]:
```
###  Load the full data directory with .pdfs. If file is not a pdf, 'wrong pointing object' error
```

In [13]:
```
from langchain_community.document_loaders import PyPDFDirectoryLoader

loader = PyPDFDirectoryLoader("data/")
docs = loader.load()
```

```
Ignoring wrong pointing object 25 0 (offset 0)
Ignoring wrong pointing object 27 0 (offset 0)
Ignoring wrong pointing object 44 0 (offset 0)
Ignoring wrong pointing object 273 0 (offset 0)
Ignoring wrong pointing object 284 0 (offset 0)
Ignoring wrong pointing object 408 0 (offset 0)
Ignoring wrong pointing object 432 0 (offset 0)
Ignoring wrong pointing object 915 0 (offset 0)
Ignoring wrong pointing object 944 0 (offset 0)
Ignoring wrong pointing object 1180 0 (offset 0)
Ignoring wrong pointing object 1355 0 (offset 0)
Ignoring wrong pointing object 1562 0 (offset 0)
Ignoring wrong pointing object 1907 0 (offset 0)
Ignoring wrong pointing object 1911 0 (offset 0)
```

In [14]:
```
from langchain.document_loaders import PyPDFLoader
from langchain.text_splitter import RecursiveCharacterTextSplitter

dir_split=RecursiveCharacterTextSplitter(separators=["\n\n","\n", " ", ""], chunk_size=500, chunk
dir_chunks = dir_split.split_documents(docs)

print('Chunk example: ',dir_chunks[100])
```

```
Chunk example:  page_content='R> poliblogPrevFit <- stm(documents = out$documents, vocab = out$voc
ab,
+ K = 20, prevalence =~ rating + s(day), max.em.its = 75,
+ data = out$meta, init.type = "Spectral")
The model is set to run for a maximum of 75 EM iterations (controlled bymax.em.its).
Convergence is monitored by the change in the approximate variational lower bound. Once
the bound has a small enough change between iterations, the model is considered converged.' metada
ta={'source': 'data/stmVignette.pdf', 'page': 8}
```

In [15]:
```
len(dir_chunks),len(docs)
```

Out[15]: (7580, 1413)

Section 3b. Create embeddings and vectore store for retrieval of materials

In [16]:
```python
#Create embedddings using OpenAIEmbeddings and
#then create a vector store to store the embeddings for retrieval
#https://weaviate.io/developers/weaviate/client-libraries/python/v3_v4_migration
#https://forum.weaviate.io/t/deprication-warning/1383

warnings.filterwarnings(action='ignore', category=ResourceWarning)



from langchain_openai import OpenAIEmbeddings
#from langchain.embeddings import OpenAIEmbeddings  ##depreciated
from langchain.vectorstores import Weaviate
import weaviate
from weaviate.embedded import EmbeddedOptions

weaviate_client = weaviate.Client(
  embedded_options = EmbeddedOptions()
)

vectorstore = Weaviate.from_documents(
    client = weaviate_client,
    documents = dir_chunks,
    embedding = OpenAIEmbeddings(),
    by_text = False
)
```

```
/tmp/ipykernel_248299/1579232709.py:16: DeprecationWarning:
Python client v3 `weaviate.Client(...)` connections and methods are deprecated and will
        be removed by 2024-11-30.

        Upgrade your code to use Python client v4 `weaviate.WeaviateClient` connections and me
thods.
            - For Python Client v4 usage, see: https://weaviate.io/developers/weaviate/client-
libraries/python
            - For code migration, see: https://weaviate.io/developers/weaviate/client-librarie
s/python/v3_v4_migration

        If you have to use v3 code, install the v3 client and pin the v3 dependency in your re
quirements file: `weaviate-client>=3.26.7;<4.0.0`
  weaviate_client = weaviate.Client(
/home/erinr/anaconda3/envs/nlp89b/lib/python3.11/site-packages/weaviate/warnings.py:186: Deprecati
onWarning: Dep016: Python client v3 `weaviate.Client(...)` connections and methods are deprecated
and will
        be removed by 2024-11-30.

        Upgrade your code to use Python client v4 `weaviate.WeaviateClient` connections and me
thods.
            - For Python Client v4 usage, see: https://weaviate.io/developers/weaviate/client-
libraries/python
            - For code migration, see: https://weaviate.io/developers/weaviate/client-librarie
s/python/v3_v4_migration

        If you have to use v3 code, install the v3 client and pin the v3 dependency in your re
quirements file: `weaviate-client>=3.26.7;<4.0.0`
  warnings.warn(
```

```
{"action":"startup","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image
_tag":"localhost","build_wv_version":"1.26.6","default_vectorizer_module":"none","level":"info","m
sg":"the default vectorizer modules is set to \"none\", as a result all new schema classes without
an explicit vectorizer setting, will use this vectorizer","time":"2024-12-16T14:10:06-05:00"}
{"action":"startup","auto_schema_enabled":true,"build_git_commit":"'\"$GITHASH\"'","build_go_versi
on":"go1.22.0","build_image_tag":"localhost","build_wv_version":"1.26.6","level":"info","msg":"aut
o schema enabled setting is set to \"true\"","time":"2024-12-16T14:10:06-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"info","msg":"No resource limits set, weaviate will use all
available memory and CPU. To limit resources, set LIMIT_RESOURCES=true","time":"2024-12-16T14:10:0
6-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"info","msg":"module offload-s3 is enabled","time":"2024-12
-16T14:10:06-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"warning","msg":"Multiple vector spaces are present, GraphQ
L Explore and REST API list objects endpoint module include params has been disabled as a resul
t.","time":"2024-12-16T14:10:06-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"info","msg":"open cluster service","servers":{"Embedded_at
_8079":42531},"time":"2024-12-16T14:10:06-05:00"}
{"address":"172.27.241.139:42532","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.
0","build_image_tag":"localhost","build_wv_version":"1.26.6","level":"info","msg":"starting cloud
rpc server ...","time":"2024-12-16T14:10:06-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"info","msg":"starting raft sub-system ...","time":"2024-12
-16T14:10:06-05:00"}
{"address":"172.27.241.139:42531","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.
0","build_image_tag":"localhost","build_wv_version":"1.26.6","level":"info","msg":"tcp transpor
t","tcpMaxPool":3,"tcpTimeout":10000000000,"time":"2024-12-16T14:10:06-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"info","msg":"loading local db","time":"2024-12-16T14:10:06
-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
```

t","build_wv_version":"1.26.6","level":"info","msg":"local DB successfully loaded","time":"2024-12
-16T14:10:06-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"info","msg":"schema manager loaded","n":0,"time":"2024-12-
16T14:10:06-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"info","metadata_only_voters":false,"msg":"construct a new
raft node","name":"Embedded_at_8079","time":"2024-12-16T14:10:06-05:00"}
{"action":"raft","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_ta
g":"localhost","build_wv_version":"1.26.6","index":61,"level":"info","msg":"raft initial configura
tion","servers":"[[{Suffrage:Voter ID:Embedded_at_8079 Address:172.27.241.139:50191}]]","time":"20
24-12-16T14:10:07-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","last_snapshot_index":0,"last_store_applied_index_on_start":63,"lev
el":"info","msg":"raft node constructed","raft_applied_index":0,"raft_last_index":63,"time":"2024-
12-16T14:10:07-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","hasState":true,"level":"info","msg":"raft init","time":"2024-12-16
T14:10:07-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"info","msg":"attempting to join","remoteNodes":["172.27.24
1.139:42531"],"time":"2024-12-16T14:10:07-05:00"}
{"action":"raft","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_ta
g":"localhost","build_wv_version":"1.26.6","follower":{},"leader-address":"","leader-id":"","leve
l":"info","msg":"raft entering follower state","time":"2024-12-16T14:10:07-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"info","msg":"attempted to join and failed","remoteNode":"1
72.27.241.139:42531","status":8,"time":"2024-12-16T14:10:07-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"info","msg":"attempting to join","remoteNodes":["172.27.24
1.139:42531"],"time":"2024-12-16T14:10:08-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"info","msg":"attempted to join and failed","remoteNode":"1
72.27.241.139:42531","status":8,"time":"2024-12-16T14:10:08-05:00"}
{"action":"raft","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_ta
g":"localhost","build_wv_version":"1.26.6","last-leader-addr":"","last-leader-id":"","level":"warn
ing","msg":"raft heartbeat timeout reached, starting election","time":"2024-12-16T14:10:08-05:00"}
{"action":"raft","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_ta
g":"localhost","build_wv_version":"1.26.6","level":"info","msg":"raft entering candidate state","n
ode":{},"term":16,"time":"2024-12-16T14:10:08-05:00"}
{"action":"raft","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_ta
g":"localhost","build_wv_version":"1.26.6","level":"info","msg":"raft pre-vote successful, startin
g election","refused":0,"tally":1,"term":16,"time":"2024-12-16T14:10:08-05:00","votesNeeded":1}
{"action":"raft","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_ta
g":"localhost","build_wv_version":"1.26.6","level":"info","msg":"raft election won","tally":1,"ter
m":16,"time":"2024-12-16T14:10:08-05:00"}
{"action":"raft","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_ta
g":"localhost","build_wv_version":"1.26.6","leader":{},"level":"info","msg":"raft entering leader
state","time":"2024-12-16T14:10:08-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"info","msg":"reload local db: update schema ...","time":"2
024-12-16T14:10:08-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","index":"LangChain_a168d360ce744c94aabf4bcc778d2dea","level":"inf
o","msg":"reload local index","time":"2024-12-16T14:10:08-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","docker_image_tag":"localhost","level":"info","msg":"configured ver
sions","server_version":"1.26.6","time":"2024-12-16T14:10:08-05:00"}
{"action":"grpc_startup","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_
image_tag":"localhost","build_wv_version":"1.26.6","level":"info","msg":"grpc server listening at
[::]:50060","time":"2024-12-16T14:10:08-05:00"}
{"action":"restapi_management","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.
0","build_image_tag":"localhost","build_wv_version":"1.26.6","docker_image_tag":"localhost","leve
l":"info","msg":"Serving weaviate at http://127.0.0.1:8079","time":"2024-12-16T14:10:09-05:00"}

{"address":"172.27.241.139:42531","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.
0","build_image_tag":"localhost","build_wv_version":"1.26.6","level":"info","msg":"current Leade
r","time":"2024-12-16T14:10:09-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"info","msg":"attempting to join","remoteNodes":["172.27.24
1.139:42531"],"time":"2024-12-16T14:10:09-05:00"}
{"action":"raft","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_ta
g":"localhost","build_wv_version":"1.26.6","command":0,"level":"info","msg":"raft updating configu
ration","server-addr":"172.27.241.139:42531","server-id":"Embedded_at_8079","servers":"[[{Suffrag
e:Voter ID:Embedded_at_8079 Address:172.27.241.139:42531}]]","time":"2024-12-16T14:10:09-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","index":"LangChain_8eb0ef6c5f0f47bd9c248013675394ee","level":"inf
o","msg":"reload local index","time":"2024-12-16T14:10:09-05:00"}
{"action":"telemetry_push","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","buil
d_image_tag":"localhost","build_wv_version":"1.26.6","level":"info","msg":"telemetry started","pay
load":"\u0026{MachineID:8578ad93-4e4e-4997-ac2f-c9b869d0f691 Type:INIT Version:1.26.6 NumObjects:0
OS:linux Arch:amd64 UsedModules:[]}","time":"2024-12-16T14:10:09-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","index":"LangChain_3aa8b665e0cc42bf8340fd35acc883ef","level":"inf
o","msg":"reload local index","time":"2024-12-16T14:10:09-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","index":"LangChain_51d45740fdad46f2a419a64f0fe1ff42","level":"inf
o","msg":"reload local index","time":"2024-12-16T14:10:09-05:00"}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","index":"LangChain_2e177f504f3e4361b6c4b0a31421ba9a","level":"inf
o","msg":"reload local index","time":"2024-12-16T14:10:10-05:00"}
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{"action":"lsm_recover_from_active_wal","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go 1.22.0","build_image_tag":"localhost","build_wv_version":"1.26.6","class":"LangChain_08ec8458f82c4 3b8b328e11d83727218","index":"langchain_08ec8458f82c43b8b328e11d83727218","level":"warning","ms g":"empty write-ahead-log found. Did weaviate crash prior to this or the tenant on/loaded from the cloud? Nothing to recover from this file.","path":"/home/erinr/.local/share/weaviate/langchain_08e c8458f82c43b8b328e11d83727218/VNIOqxqLTUeI/lsm/property__id/segment-1733361298876054346","shar d":"VNIOqxqLTUeI","time":"2024-12-16T14:10:15-05:00"}
{"action":"lsm_recover_from_active_wal","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go 1.22.0","build_image_tag":"localhost","build_wv_version":"1.26.6","class":"LangChain_08ec8458f82c4 3b8b328e11d83727218","index":"langchain_08ec8458f82c43b8b328e11d83727218","level":"warning","ms g":"empty write-ahead-log found. Did weaviate crash prior to this or the tenant on/loaded from the cloud? Nothing to recover from this file.","path":"/home/erinr/.local/share/weaviate/langchain_08e c8458f82c43b8b328e11d83727218/VNIOqxqLTUeI/lsm/property_text/segment-1733349639739450031","shar d":"VNIOqxqLTUeI","time":"2024-12-16T14:10:15-05:00"}
{"action":"lsm_recover_from_active_wal","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go 1.22.0","build_image_tag":"localhost","build_wv_version":"1.26.6","class":"LangChain_08ec8458f82c4 3b8b328e11d83727218","index":"langchain_08ec8458f82c43b8b328e11d83727218","level":"warning","ms g":"empty write-ahead-log found. Did weaviate crash prior to this or the tenant on/loaded from the cloud? Nothing to recover from this file.","path":"/home/erinr/.local/share/weaviate/langchain_08e c8458f82c43b8b328e11d83727218/VNIOqxqLTUeI/lsm/property_text/segment-1733361298878472213","shar d":"VNIOqxqLTUeI","time":"2024-12-16T14:10:15-05:00"}
{"action":"lsm_recover_from_active_wal","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go 1.22.0","build_image_tag":"localhost","build_wv_version":"1.26.6","class":"LangChain_08ec8458f82c4 3b8b328e11d83727218","index":"langchain_08ec8458f82c43b8b328e11d83727218","level":"warning","ms g":"empty write-ahead-log found. Did weaviate crash prior to this or the tenant on/loaded from the cloud? Nothing to recover from this file.","path":"/home/erinr/.local/share/weaviate/langchain_08e c8458f82c43b8b328e11d83727218/VNIOqxqLTUeI/lsm/property_source_searchable/segment-1733349639740636 765","shard":"VNIOqxqLTUeI","time":"2024-12-16T14:10:15-05:00"}
{"action":"lsm_recover_from_active_wal","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go 1.22.0","build_image_tag":"localhost","build_wv_version":"1.26.6","class":"LangChain_08ec8458f82c4 3b8b328e11d83727218","index":"langchain_08ec8458f82c43b8b328e11d83727218","level":"warning","ms g":"empty write-ahead-log found. Did weaviate crash prior to this or the tenant on/loaded from the cloud? Nothing to recover from this file.","path":"/home/erinr/.local/share/weaviate/langchain_08e c8458f82c43b8b328e11d83727218/VNIOqxqLTUeI/lsm/property_source_searchable/segment-1733361298884483 533","shard":"VNIOqxqLTUeI","time":"2024-12-16T14:10:15-05:00"}
{"action":"lsm_recover_from_active_wal","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go 1.22.0","build_image_tag":"localhost","build_wv_version":"1.26.6","class":"LangChain_08ec8458f82c4 3b8b328e11d83727218","index":"langchain_08ec8458f82c43b8b328e11d83727218","level":"warning","ms g":"empty write-ahead-log found. Did weaviate crash prior to this or the tenant on/loaded from the cloud? Nothing to recover from this file.","path":"/home/erinr/.local/share/weaviate/langchain_08e c8458f82c43b8b328e11d83727218/VNIOqxqLTUeI/lsm/property_text_searchable/segment-173334963974258394 0","shard":"VNIOqxqLTUeI","time":"2024-12-16T14:10:15-05:00"}
{"action":"lsm_recover_from_active_wal","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go 1.22.0","build_image_tag":"localhost","build_wv_version":"1.26.6","class":"LangChain_08ec8458f82c4 3b8b328e11d83727218","index":"langchain_08ec8458f82c43b8b328e11d83727218","level":"warning","ms g":"empty write-ahead-log found. Did weaviate crash prior to this or the tenant on/loaded from the cloud? Nothing to recover from this file.","path":"/home/erinr/.local/share/weaviate/langchain_08e c8458f82c43b8b328e11d83727218/VNIOqxqLTUeI/lsm/property_text_searchable/segment-173336129888453754 3","shard":"VNIOqxqLTUeI","time":"2024-12-16T14:10:15-05:00"}
{"action":"lsm_recover_from_active_wal","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go 1.22.0","build_image_tag":"localhost","build_wv_version":"1.26.6","class":"LangChain_08ec8458f82c4 3b8b328e11d83727218","index":"langchain_08ec8458f82c43b8b328e11d83727218","level":"warning","ms g":"empty write-ahead-log found. Did weaviate crash prior to this or the tenant on/loaded from the

cloud? Nothing to recover from this file.","path":"/home/erinr/.local/share/weaviate/langchain_08e
c8458f82c43b8b328e11d83727218/VNIOqxqLTUeI/lsm/objects/segment-1733349639746326059","shard":"VNIOq
xqLTUeI","time":"2024-12-16T14:10:15-05:00"}
{"action":"lsm_recover_from_active_wal","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go
1.22.0","build_image_tag":"localhost","build_wv_version":"1.26.6","class":"LangChain_08ec8458f82c4
3b8b328e11d83727218","index":"langchain_08ec8458f82c43b8b328e11d83727218","level":"warning","ms
g":"empty write-ahead-log found. Did weaviate crash prior to this or the tenant on/loaded from the
cloud? Nothing to recover from this file.","path":"/home/erinr/.local/share/weaviate/langchain_08e
c8458f82c43b8b328e11d83727218/VNIOqxqLTUeI/lsm/objects/segment-1733361298888025773","shard":"VNIOq
xqLTUeI","time":"2024-12-16T14:10:15-05:00"}
{"action":"hnsw_prefill_cache_async","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.2
2.0","build_image_tag":"localhost","build_wv_version":"1.26.6","level":"info","msg":"not waiting f
or vector cache prefill, running in background","time":"2024-12-16T14:10:15-05:00","wait_for_cache
_prefill":false}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"info","msg":"Completed loading shard langchain_08ec8458f82
c43b8b328e11d83727218_VNIOqxqLTUeI in 22.425817ms","time":"2024-12-16T14:10:15-05:00"}
{"action":"hnsw_vector_cache_prefill","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.
22.0","build_image_tag":"localhost","build_wv_version":"1.26.6","count":11000,"index_id":"main","l
evel":"info","limit":1000000000000,"msg":"prefilled vector cache","time":"2024-12-16T14:10:15-05:0
0","took":321783055}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"warning","msg":"prop len tracker file /home/erinr/.local/s
hare/weaviate/langchain_f121c026b5df4677bd78591e868c6d4b/pOFj4WzOgLeo/proplengths does not exist,
creating new tracker","time":"2024-12-16T14:10:16-05:00"}
{"action":"hnsw_prefill_cache_async","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.2
2.0","build_image_tag":"localhost","build_wv_version":"1.26.6","level":"info","msg":"not waiting f
or vector cache prefill, running in background","time":"2024-12-16T14:10:16-05:00","wait_for_cache
_prefill":false}
{"build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.22.0","build_image_tag":"localhos
t","build_wv_version":"1.26.6","level":"info","msg":"Created shard langchain_f121c026b5df4677bd785
91e868c6d4b_pOFj4WzOgLeo in 1.665009ms","time":"2024-12-16T14:10:16-05:00"}
{"action":"hnsw_vector_cache_prefill","build_git_commit":"'\"$GITHASH\"'","build_go_version":"go1.
22.0","build_image_tag":"localhost","build_wv_version":"1.26.6","count":1000,"index_id":"main","le
vel":"info","limit":1000000000000,"msg":"prefilled vector cache","time":"2024-12-16T14:10:16-05:0
0","took":63856}

Section 3c. Create RAG Model Prompt, Context

In [17]:
```python
#Initiate a retriever object to retrieve the embeddings data
retriever = vectorstore.as_retriever()
```

In [18]:
```python
#Create a prompt template to use to answer a question with the given context

from langchain.prompts import ChatPromptTemplate

template = """You are an assistant for question-answering tasks.
Use the following pieces of retrieved context to answer the question.
If you don't know the answer, just say that you don't know.
Provide specific text references.
Use three sentences maximum and keep the answer concise.
Question: {question}
Context: {context}
Answer:
"""
prompt = ChatPromptTemplate.from_template(template)

print(prompt)
```

input_variables=['context', 'question'] input_types={} partial_variables={} messages=[HumanMessage
PromptTemplate(prompt=PromptTemplate(input_variables=['context', 'question'], input_types={}, part
ial_variables={}, template="You are an assistant for question-answering tasks. \nUse the following
pieces of retrieved context to answer the question. \nIf you don't know the answer, just say that
you don't know.\nProvide specific text references.\nUse three sentences maximum and keep the answe
r concise.\nQuestion: {question} \nContext: {context} \nAnswer:\n"), additional_kwargs={})]

In [19]:
```python
from langchain_openai import ChatOpenAI
from langchain.schema.runnable import RunnablePassthrough
from langchain.schema.output_parser import StrOutputParser

llm = ChatOpenAI(model_name="gpt-3.5-turbo", temperature=0)

rag_chain = (
    {"context": retriever,  "question": RunnablePassthrough()}
    | prompt
    | llm
    | StrOutputParser()
)
```

Section 4a. General Content Questions

In [20]:
```python
query_1 = "What is semantic role labeling?"
rag_1 = rag_chain.invoke(query_1)
gpt_1 = query_gpt_3_5(query_1)

print('Rag model answer: ',rag_1)
print('GPT 3.5 answer: ', gpt_1)
```

Rag model answer: Semantic role labeling is the task of assigning semantic role labels to the con
stituents of a sentence. It is generally treated as a supervised machine learning task, with model
s trained on PropBank or FrameNet. Algorithms start by parsing a sentence and then automatically t
ag each parse tree node with a semantic role (source: data/ed3bookaug20_2024.pdf, page 485).
GPT 3.5 answer: Semantic role labeling is the task of identifying the relationships between words
in a sentence and classifying them into different semantic roles or categories based on their role
s in the event described by the sentence. This helps in understanding the underlying meaning of a
sentence and is commonly used in natural language processing tasks such as information extraction,
question answering, and machine translation.

In [21]:
```python
query_2 = "What is the attention mechanism?"
rag_2 = rag_chain.invoke(query_2)
gpt_2 = query_gpt_3_5(query_2)
print('Rag model answer: ',rag_2)
print('GPT 3.5 answer: ', gpt_2)
```

Rag model answer: The attention mechanism is a solution to the bottleneck problem in the encoder-
decoder model, allowing the decoder to access information from all hidden states of the encoder. I
t is a way of enhancing efficiency by utilizing grouped-query attention mechanisms in models like
Llama-3-8B2 and InternLM2-20B. Neural attention has become a significant concept in deep learning,
proving effective for sequence data.
GPT 3.5 answer: The attention mechanism is a component of neural networks that allows the model t
o focus on specific parts of the input sequence when making predictions. It enables the model to w
eigh the importance of each input element and give more attention to certain elements that are mor
e relevant to the task at hand. This mechanism has been widely used in natural language processing
tasks such as machine translation and text summarization, as well as in computer vision tasks such
as image captioning and object detection.

In [22]:
```python
query_3 = "What is the professors name for natural language processing 89b?"
rag_3 = rag_chain.invoke(query_3)
gpt_3 = query_gpt_3_5(query_3)
print('Rag model answer: ',rag_3)
print('GPT 3.5 answer: ', gpt_3)
```

Rag model answer: The professor's name for natural language processing 89b is Dmitry Kurochkin. (Source: data/IntroNLP_Lecture8.pdf, data/IntroNLP_Lecture1.pdf, data/IntroNLP_Lecture4.pdf, data/IntroNLP_Lecture2.pdf)
GPT 3.5 answer: I'm sorry, but I do not have that information. You may need to check your course materials or contact the department for the name of the professor teaching Natural Language Processing 89b.

```
In [23]: import pandas as pd
         gen_df = pd.DataFrame({'Query':[query_1, query_2, query_3],'GPT_3_5_Answer':[gpt_1,gpt_2,gpt_3],
                                'RAG_MODEL_Answer':[rag_1,rag_2,rag_3]})
```

```
In [24]: gen_df.to_csv('general.csv')
```

Section 4b. Specific Quiz Questions

```
In [25]: #### Change prompt template to answer quiz questions based on RAG and then the GPT 3.5 Model ####
```

```
In [26]: #Create a prompt template to use to answer a question with the given context

         from langchain.prompts import ChatPromptTemplate

         template = """You are answering a quiz with multiple choice and true / false
         questions. If you don't know the answer, just say that you don't know.
         Answer with the specific letter or true/false answer.
         Provide a one sentence rationale for your answer.
         Question: {question}
         Context: {context}
         Answer:
         """
         prompt = ChatPromptTemplate.from_template(template)

         print(prompt)
```

input_variables=['context', 'question'] input_types={} partial_variables={} messages=[HumanMessage
PromptTemplate(prompt=PromptTemplate(input_variables=['context', 'question'], input_types={}, part
ial_variables={}, template="You are answering a quiz with multiple choice and true / false\nquesti
ons. If you don't know the answer, just say that you don't know. \nAnswer with the specific letter
or true/false answer.\nProvide a one sentence rationale for your answer.\nQuestion: {question} \nC
ontext: {context} \nAnswer:\n"), additional_kwargs={})]

```
In [27]: from langchain.chat_models import ChatOpenAI
         from langchain.schema.runnable import RunnablePassthrough
         from langchain.schema.output_parser import StrOutputParser

         llm = ChatOpenAI(model_name="gpt-3.5-turbo", temperature=0)

         rag_chain = (
             {"context": retriever,  "question": RunnablePassthrough()}
             | prompt
             | llm
             | StrOutputParser()
         )
```

```
/tmp/ipykernel_248299/3471154451.py:5: LangChainDeprecationWarning: The class `ChatOpenAI` was dep
recated in LangChain 0.0.10 and will be removed in 1.0. An updated version of the class exists in
the :class:`~langchain-openai package and should be used instead. To use it run `pip install -U :c
lass:`~langchain-openai` and import as `from :class:`~langchain_openai import ChatOpenAI``.
  llm = ChatOpenAI(model_name="gpt-3.5-turbo", temperature=0)
```

```
In [28]: ### Compare answers to quiz questions using our rag chain model, compared to gpt 3.5###
```

```
In [29]: q1_5 = "If learning rate  of the Gradient Descent is too large, then the training algorithm will
         (A) converge to a local minimum and the convergence will be fast\
```

```
(B) converge to a local minimum, but the convergence will be slow\
(C) diverge\
(D) none of these"
print('Rag model answer: ',rag_chain.invoke(q1_5))
print('GPT 3.5 answer: ', query_gpt_3_5(q1_5))
```

/home/erinr/anaconda3/envs/nlp89b/lib/python3.11/site-packages/langchain_community/chat_models/ope
nai.py:495: PydanticDeprecatedSince20: The `dict` method is deprecated; use `model_dump` instead.
Deprecated in Pydantic V2.0 to be removed in V3.0. See Pydantic V2 Migration Guide at https://erro
rs.pydantic.dev/2.10/migration/
  response = response.dict()
Rag model answer: (C) diverge

Rationale: If the learning rate of the Gradient Descent is too large, the algorithm will overshoot
the minimum of the loss function and diverge.
GPT 3.5 answer: (C) diverge

When the learning rate is too large, the algorithm may skip over the optimal solution and start os
cillating around it, or even diverge completely. This can prevent the algorithm from converging to
a solution, causing it to diverge instead.

In [30]:
```python
import pandas as pd

quiz_df = pd.DataFrame({'Quiz_Question':['q1_5'] , 'Question Text':[q1_5],
                        'GPT_Answer':[query_gpt_3_5(q1_5)],'RAG_Model':[rag_chain.invoke(q1_5)]})
```

/home/erinr/anaconda3/envs/nlp89b/lib/python3.11/site-packages/langchain_community/chat_models/ope
nai.py:495: PydanticDeprecatedSince20: The `dict` method is deprecated; use `model_dump` instead.
Deprecated in Pydantic V2.0 to be removed in V3.0. See Pydantic V2 Migration Guide at https://erro
rs.pydantic.dev/2.10/migration/
  response = response.dict()

In [31]:
```python
#### Question 6.1 ####
q6_1 = 'Disadvantages of one-hot encoding of words is that the representations are:\
(A) sparse\
(B) high dimensional\
(C) both (A) and (B)\
(D) none of (A), (B)'
print('Rag model answer: ',rag_chain.invoke(q6_1))
print('GPT 3.5 answer: ', query_gpt_3_5(q6_1))
```

/home/erinr/anaconda3/envs/nlp89b/lib/python3.11/site-packages/langchain_community/chat_models/ope
nai.py:495: PydanticDeprecatedSince20: The `dict` method is deprecated; use `model_dump` instead.
Deprecated in Pydantic V2.0 to be removed in V3.0. See Pydantic V2 Migration Guide at https://erro
rs.pydantic.dev/2.10/migration/
  response = response.dict()
Rag model answer: (C) both (A) and (B)

Rationale: The text explicitly states that one-hot encoding of words leads to sparse representatio
ns (mostly zeros) and very high-dimensional vectors, making both statements true.
GPT 3.5 answer: (C) both (A) and (B)

In [32]:
```python
interim = pd.DataFrame({'Quiz_Question':['q6_1'] , 'Question Text':[q6_1],
                        'GPT_Answer':[query_gpt_3_5(q6_1)],'RAG_Model':[rag_chain.invoke(q6_1)]})
quiz_df = pd.concat([quiz_df, interim], axis=0, ignore_index = True)
```

/home/erinr/anaconda3/envs/nlp89b/lib/python3.11/site-packages/langchain_community/chat_models/ope
nai.py:495: PydanticDeprecatedSince20: The `dict` method is deprecated; use `model_dump` instead.
Deprecated in Pydantic V2.0 to be removed in V3.0. See Pydantic V2 Migration Guide at https://erro
rs.pydantic.dev/2.10/migration/
  response = response.dict()

In [33]:
```python
#### Question 6.2 ####
q6_2= "An autoencoder is called undercomplete if\
```

```
(A) dimensionality of internal representations is higher\
(B) dimensionality of internal representations is lower\
(C) some of the layers are frozen\
(D) some of the connections are broken\
(E) none of (A), (B), (C), (D)"
print('Rag model answer: ',rag_chain.invoke(q6_2))
print('GPT 3.5 answer: ', query_gpt_3_5(q6_2))
```

/home/erinr/anaconda3/envs/nlp89b/lib/python3.11/site-packages/langchain_community/chat_models/ope
nai.py:495: PydanticDeprecatedSince20: The `dict` method is deprecated; use `model_dump` instead.
Deprecated in Pydantic V2.0 to be removed in V3.0. See Pydantic V2 Migration Guide at https://erro
rs.pydantic.dev/2.10/migration/
  response = response.dict()

```
Rag model answer:  (B) dimensionality of internal representations is lower

Rationale: An autoencoder is called undercomplete when the dimensionality of the internal represen
tations is lower, forcing it to learn the most important features.
GPT 3.5 answer:  (B) dimensionality of internal representations is lower
```

In [34]:
```python
interim = pd.DataFrame({'Quiz_Question':['q6_2'] , 'Question Text':[q6_2],
                        'GPT_Answer':[query_gpt_3_5(q6_2)],'RAG_Model':[rag_chain.invoke(q6_2)]})
quiz_df = pd.concat([quiz_df, interim], axis=0, ignore_index = True)
```

/home/erinr/anaconda3/envs/nlp89b/lib/python3.11/site-packages/langchain_community/chat_models/ope
nai.py:495: PydanticDeprecatedSince20: The `dict` method is deprecated; use `model_dump` instead.
Deprecated in Pydantic V2.0 to be removed in V3.0. See Pydantic V2 Migration Guide at https://erro
rs.pydantic.dev/2.10/migration/
  response = response.dict()

In [35]:
```python
#### Question 6.3 ####
q6_3 = "True or False: Stacked autoencoder refers to an autoencoder which represents a deep neura
print('Rag model answer: ',rag_chain.invoke(q6_3))
print('GPT 3.5 answer: ', query_gpt_3_5(q6_3))
```

/home/erinr/anaconda3/envs/nlp89b/lib/python3.11/site-packages/langchain_community/chat_models/ope
nai.py:495: PydanticDeprecatedSince20: The `dict` method is deprecated; use `model_dump` instead.
Deprecated in Pydantic V2.0 to be removed in V3.0. See Pydantic V2 Migration Guide at https://erro
rs.pydantic.dev/2.10/migration/
  response = response.dict()

```
Rag model answer:  True

Rationale: The text specifically mentions that one can stack all autoencoders into one stacked aut
oencoder to build a very deep network.
GPT 3.5 answer:  True
```

In [36]:
```python
interim = pd.DataFrame({'Quiz_Question':['q6_3'] , 'Question Text':[q6_3],
                        'GPT_Answer':[query_gpt_3_5(q6_3)],'RAG_Model':[rag_chain.invoke(q6_3)]})
quiz_df = pd.concat([quiz_df, interim], axis=0, ignore_index = True)
```

/home/erinr/anaconda3/envs/nlp89b/lib/python3.11/site-packages/langchain_community/chat_models/ope
nai.py:495: PydanticDeprecatedSince20: The `dict` method is deprecated; use `model_dump` instead.
Deprecated in Pydantic V2.0 to be removed in V3.0. See Pydantic V2 Migration Guide at https://erro
rs.pydantic.dev/2.10/migration/
  response = response.dict()

In [37]:
```python
#### Question 8.2 ####
q8_2 = "Which function is used to preprocess text data for analysis in the 'stm' R package?\
(A) `selectModel()`\
(B) `prepareModel()`\
(C) `textProcessor()`\
(D) `stm()`"
print('Rag model answer: ',rag_chain.invoke(q8_2))
print('GPT 3.5 answer: ', query_gpt_3_5(q8_2))
```

```
/home/erinr/anaconda3/envs/nlp89b/lib/python3.11/site-packages/langchain_community/chat_models/ope
nai.py:495: PydanticDeprecatedSince20: The `dict` method is deprecated; use `model_dump` instead.
Deprecated in Pydantic V2.0 to be removed in V3.0. See Pydantic V2 Migration Guide at https://erro
rs.pydantic.dev/2.10/migration/
  response = response.dict()
Rag model answer:  (C) `textProcessor()`
Rationale: The `textProcessor()` function is specifically mentioned as a pre-processing function f
or cleaning and preparing text data in the 'stm' package.
GPT 3.5 answer:  (C) `textProcessor()`
```

In [38]:
```python
interim = pd.DataFrame({'Quiz_Question':['q8_2'] , 'Question Text':[q8_2],
                        'GPT_Answer':[query_gpt_3_5(q8_2)],'RAG_Model':[rag_chain.invoke(q8_2)]})
quiz_df = pd.concat([quiz_df, interim], axis=0, ignore_index = True)
```

```
/home/erinr/anaconda3/envs/nlp89b/lib/python3.11/site-packages/langchain_community/chat_models/ope
nai.py:495: PydanticDeprecatedSince20: The `dict` method is deprecated; use `model_dump` instead.
Deprecated in Pydantic V2.0 to be removed in V3.0. See Pydantic V2 Migration Guide at https://erro
rs.pydantic.dev/2.10/migration/
  response = response.dict()
```

In [39]:
```python
q10_3 = "What role does the SpaCy library play in Named Entity Recognition (NER) tasks?\
Please select all that apply:\
(A) It provides datasets for training machine learning models.\
(B) It visualizes NLP pipelines in a graphical user interface.\
(C) It offers built-in, trained NER models for various languages.\
(D) It translates text between different languages."
print('Rag model answer: ',rag_chain.invoke(q10_3))
print('GPT 3.5 answer: ', query_gpt_3_5(q10_3))
```

```
/home/erinr/anaconda3/envs/nlp89b/lib/python3.11/site-packages/langchain_community/chat_models/ope
nai.py:495: PydanticDeprecatedSince20: The `dict` method is deprecated; use `model_dump` instead.
Deprecated in Pydantic V2.0 to be removed in V3.0. See Pydantic V2 Migration Guide at https://erro
rs.pydantic.dev/2.10/migration/
  response = response.dict()
Rag model answer:  (C) It offers built-in, trained NER models for various languages.
SpaCy library provides built-in, trained NER models for various languages, making it easier to per
form Named Entity Recognition tasks.
GPT 3.5 answer:  (C) It offers built-in, trained NER models for various languages.
```

In [40]:
```python
interim = pd.DataFrame({'Quiz_Question':['q10_3'] , 'Question Text':[q10_3],
                        'GPT_Answer':[query_gpt_3_5(q10_3)],'RAG_Model':[rag_chain.invoke(q10_3)]
quiz_df = pd.concat([quiz_df, interim], axis=0, ignore_index = True)
```

```
/home/erinr/anaconda3/envs/nlp89b/lib/python3.11/site-packages/langchain_community/chat_models/ope
nai.py:495: PydanticDeprecatedSince20: The `dict` method is deprecated; use `model_dump` instead.
Deprecated in Pydantic V2.0 to be removed in V3.0. See Pydantic V2 Migration Guide at https://erro
rs.pydantic.dev/2.10/migration/
  response = response.dict()
```

In [41]:
```python
quiz_df
```

Out[41]:

	Quiz_Question	Question Text	GPT_Answer	RAG_Model
0	q1_5	If learning rate of the Gradient Descent is t...	(C) diverge\n\nIf the learning rate is too lar...	(C) diverge\nIf the learning rate of the Gradi...
1	q6_1	Disadvantages of one-hot encoding of words is ...	(C) both (A) and (B)	(C) both (A) and (B)\n\nRationale: The text ex...
2	q6_2	An autoencoder is called undercomplete if(A) d...	(B) dimensionality of internal representations...	(B) dimensionality of internal representations...
3	q6_3	True or False: Stacked autoencoder refers to a...	True.	True\n\nRationale: The text specifically menti...
4	q8_2	Which function is used to preprocess text data...	(C) `textProcessor()`	(C) `textProcessor()`\nRationale: The `textPro...
5	q10_3	What role does the SpaCy library play in Named...	(C) It offers built-in, trained NER models for...	(C) It offers built-in, trained NER models for...

In [42]:
```python
quiz_df.to_csv('quiz.csv')
```

Section 5. Emebdding Visualization

Code adapted heavily from: https://github.com/Renumics/renumics-rag/blob/main/notebooks/visualize_rag_tutorial_qs.ipynb https://towardsdatascience.com/visualize-your-rag-data-evaluate-your-retrieval-augmented-generation-system-with-ragas-fc2486308557

In [43]:
```python
#Re-run vector store to generate embeddings
from pathlib import Path
import pickle
import numpy as np
import pandas as pd
from langchain_openai import OpenAIEmbeddings
from langchain.vectorstores.chroma import Chroma

# create embeddings model and vector store
embeddings_model = OpenAIEmbeddings(model="text-embedding-ada-002")
docs_vectorstore = Chroma(
    collection_name="docs_store",
    embedding_function=embeddings_model,
    persist_directory="docs-db",
)

# Index chunks and add to vector store
_ = docs_vectorstore.add_documents(documents=dir_chunks)

# #set of meta data, content and embeddings for for the documents

all_docs = docs_vectorstore.get(include=["metadatas", "documents", "embeddings"])
df_docs = pd.DataFrame(
    {
        "ids": all_docs["ids"],
        "source": [metadata['source'] for metadata in all_docs["metadatas"]],
        "page": [metadata['page'] for metadata in all_docs["metadatas"]],
        "document": all_docs["documents"],
        "embedding": list(all_docs["embeddings"])
    }
)
```

```
/tmp/ipykernel_248299/1081252188.py:11: LangChainDeprecationWarning: The class `Chroma` was deprec
ated in LangChain 0.2.9 and will be removed in 1.0. An updated version of the class exists in the
:class:`~langchain-chroma package and should be used instead. To use it run `pip install -U :clas
s:`~langchain-chroma` and import as `from :class:`~langchain_chroma import Chroma``.
  docs_vectorstore = Chroma(
```

In [44]:
```python
### Create a plot-friendly data frame for embeddings visualization
df_docs_ex = df_docs.iloc[:,0:4].sort_values(['source','page'], ascending=False)

#Rename sources to friendly names for plots
source_idx = {'data/IntroNLP_Lecture1.pdf':'Lecture1',
              'data/IntroNLP_Lecture2.pdf':'Lecture2',
              'data/IntroNLP_Lecture3.pdf':'Lecture3',
              'data/IntroNLP_Lecture4.pdf':'Lecture4',
              'data/IntroNLP_Lecture5.pdf':'Lecture5',
              'data/IntroNLP_Lecture6.pdf':'Lecture6',
              'data/IntroNLP_Lecture7.pdf':'Lecture7',
              'data/IntroNLP_Lecture8.pdf':'Lecture8',
              'data/deep_learning_chollet_2021.pdf':'Deep_Learning_Chollet',
              'data/ed3bookaug20_2024.pdf':'Speech and Language Processing',
              'data/stmVignette.pdf':'stmVignette',
              'data/syllabus.pdf': 'syllabus'}

source_short = [source_idx[source] for source in df_docs_ex.source]
source_df = pd.DataFrame({'sources_short':source_short})
```

In [45]:
```python
#Merge data frames with emebddings as sepatate columns
df_embed = pd.DataFrame(all_docs["embeddings"])
df_docs_ex = pd.concat([df_docs_ex,source_df], axis=1)
df_docs_ex = pd.concat([df_docs_ex,df_embed], axis=1)

#Isolate embeddings columns for X features
features_to_transform = df_docs_ex.iloc[:,5:]
```

In [46]:
```python
#### Embedding Visualization ####
```

In [47]:
```python
from sklearn.manifold import TSNE
import seaborn as sns
import matplotlib.pyplot as plt
import numpy as np

# Metrics
from sklearn.metrics import euclidean_distances
```

In [48]:
```python
%%time

def tsne_fit_transform(data):
    #tsne = TSNE(n_components=2, random_state=0, perplexity=43, n_iter=5000, learning_rate=100, i
    tsne = TSNE(n_components=2, perplexity=50)
    return tsne.fit_transform(data)

X_tsne = tsne_fit_transform(features_to_transform)
```

```
CPU times: user 6min 45s, sys: 2.08 s, total: 6min 47s
Wall time: 1min 42s
```

In [49]:
```python
#https://towardsdatascience.com/an-introduction-to-t-sne-with-python-example-5a3a293108d1

def tsne_plot(data, title):
    # Plot Digits t-SNE
    sns.set_context("notebook", font_scale=1.1)
    sns.set_style("ticks")
    sns.set_theme(style="whitegrid", palette="pastel")
```
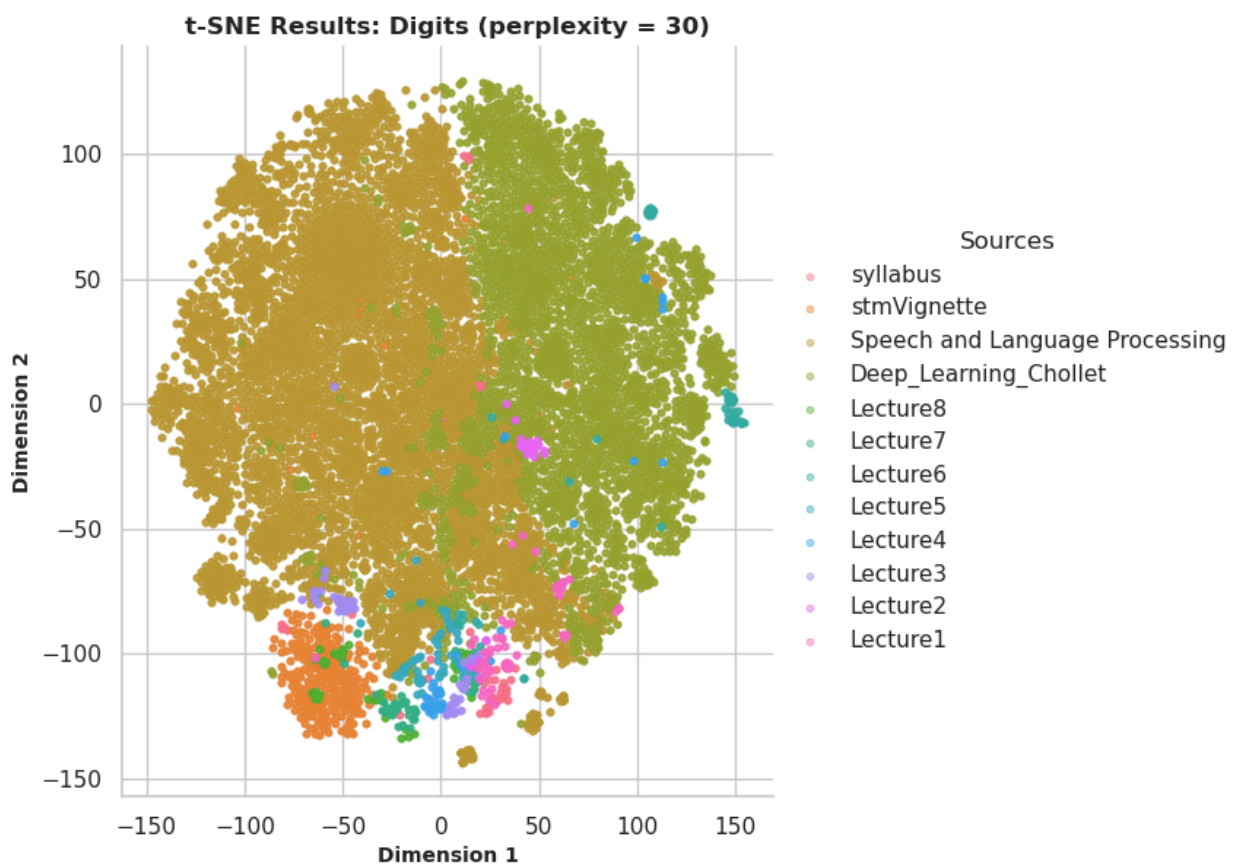
```
        sns.lmplot(x='_DIM_1_',
                   y='_DIM_2_',
                   data=data,
                   fit_reg=False,
                   legend=True,
                   height=6,
                   hue='Sources',
                   scatter_kws={"s":10, "alpha":0.4})

        plt.title(title, weight='bold').set_fontsize('12')
        plt.xlabel('Dimension 1', weight='bold').set_fontsize('10')
        plt.ylabel('Dimension 2', weight='bold').set_fontsize('10')
```

In [50]:
```
X_tsne_df = pd.DataFrame(X_tsne)
X_tsne_df.columns = ['_DIM_1_','_DIM_2_']
X_tsne_df['Sources'] = df_docs_ex.sources_short

tsne_plot(X_tsne_df, 't-SNE Results: Digits (perplexity = 30)')
```


t-SNE Results: Digits (perplexity = 30)

In [51]:
```
print('The End')
```

The End