017518709_PrithviElancherran_NLP_Project

December 8, 2024

[1]:
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pip install yfinance pandas pandas-datareader
```

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Requirement already satisfied: yfinance in /usr/local/lib/python3.10/dist-
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Requirement already satisfied: pandas in /usr/local/lib/python3.10/dist-packages
(2.2.2)
Requirement already satisfied: pandas-datareader in
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Requirement already satisfied: numpy>=1.16.5 in /usr/local/lib/python3.10/dist-
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(2024.8.30)
```

###Select list of 500 company stocks for which we will be preparing documents for RAG.

[2]:
```
import pandas as pd
import pandas_datareader as pdr

def fetch_sp500_tickers():
    # Fetch the S&P 500 table from Wikipedia
    table = pd.read_html('https://en.wikipedia.org/wiki/
 ↪List_of_S%26P_500_companies')
    sp500_df = table[0]
    tickers = sp500_df['Symbol'].tolist()
    # Adjust tickers for specific API requirements (e.g., replace '.' with '-')
    tickers = [ticker.replace('.', '-') for ticker in tickers]
    return tickers

sp500_tickers = fetch_sp500_tickers()
print(sp500_tickers)
```

```
['MMM', 'AOS', 'ABT', 'ABBV', 'ACN', 'ADBE', 'AMD', 'AES', 'AFL', 'A', 'APD',
'ABNB', 'AKAM', 'ALB', 'ARE', 'ALGN', 'ALLE', 'LNT', 'ALL', 'GOOGL', 'GOOG',
'MO', 'AMZN', 'AMCR', 'AMTM', 'AEE', 'AEP', 'AXP', 'AIG', 'AMT', 'AWK', 'AMP',
'AME', 'AMGN', 'APH', 'ADI', 'ANSS', 'AON', 'APA', 'AAPL', 'AMAT', 'APTV',
'ACGL', 'ADM', 'ANET', 'AJG', 'AIZ', 'T', 'ATO', 'ADSK', 'ADP', 'AZO', 'AVB',
'AVY', 'AXON', 'BKR', 'BALL', 'BAC', 'BAX', 'BDX', 'BRK-B', 'BBY', 'TECH',
'BIIB', 'BLK', 'BX', 'BK', 'BA', 'BKNG', 'BWA', 'BSX', 'BMY', 'AVGO', 'BR',
'BRO', 'BF-B', 'BLDR', 'BG', 'BXP', 'CHRW', 'CDNS', 'CZR', 'CPT', 'CPB', 'COF',
'CAH', 'KMX', 'CCL', 'CARR', 'CTLT', 'CAT', 'CBOE', 'CBRE', 'CDW', 'CE', 'COR',
'CNC', 'CNP', 'CF', 'CRL', 'SCHW', 'CHTR', 'CVX', 'CMG', 'CB', 'CHD', 'CI',
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'DAY', 'DECK', 'DE', 'DELL', 'DAL', 'DVN', 'DXCM', 'FANG', 'DLR', 'DFS', 'DG',
'DLTR', 'D', 'DPZ', 'DOV', 'DOW', 'DHI', 'DTE', 'DUK', 'DD', 'EMN', 'ETN',
'EBAY', 'ECL', 'EIX', 'EW', 'EA', 'ELV', 'EMR', 'ENPH', 'ETR', 'EOG', 'EPAM',
'EQT', 'EFX', 'EQIX', 'EQR', 'ERIE', 'ESS', 'EL', 'EG', 'EVRG', 'ES', 'EXC',
'EXPE', 'EXPD', 'EXR', 'XOM', 'FFIV', 'FDS', 'FICO', 'FAST', 'FRT', 'FDX',
'FIS', 'FITB', 'FSLR', 'FE', 'FI', 'FMC', 'F', 'FTNT', 'FTV', 'FOXA', 'FOX',
'BEN', 'FCX', 'GRMN', 'IT', 'GE', 'GEHC', 'GEV', 'GEN', 'GNRC', 'GD', 'GIS',
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'GM', 'GPC', 'GILD', 'GPN', 'GL', 'GDDY', 'GS', 'HAL', 'HIG', 'HAS', 'HCA',
'DOC', 'HSIC', 'HSY', 'HES', 'HPE', 'HLT', 'HOLX', 'HD', 'HON', 'HRL', 'HST',
'HWM', 'HPQ', 'HUBB', 'HUM', 'HBAN', 'HII', 'IBM', 'IEX', 'IDXX', 'ITW', 'INCY',
'IR', 'PODD', 'INTC', 'ICE', 'IFF', 'IP', 'IPG', 'INTU', 'ISRG', 'IVZ', 'INVH',
'IQV', 'IRM', 'JBHT', 'JBL', 'JKHY', 'J', 'JNJ', 'JCI', 'JPM', 'JNPR', 'K',
'KVUE', 'KDP', 'KEY', 'KEYS', 'KMB', 'KIM', 'KMI', 'KKR', 'KLAC', 'KHC', 'KR',
'LHX', 'LH', 'LRCX', 'LW', 'LVS', 'LDOS', 'LEN', 'LLY', 'LIN', 'LYV', 'LKQ',
'LMT', 'L', 'LOW', 'LULU', 'LYB', 'MTB', 'MPC', 'MKTX', 'MAR', 'MMC', 'MLM',
'MAS', 'MA', 'MTCH', 'MKC', 'MCD', 'MCK', 'MDT', 'MRK', 'META', 'MET', 'MTD',
'MGM', 'MCHP', 'MU', 'MSFT', 'MAA', 'MRNA', 'MHK', 'MOH', 'TAP', 'MDLZ', 'MPWR',
'MNST', 'MCO', 'MS', 'MOS', 'MSI', 'MSCI', 'NDAQ', 'NTAP', 'NFLX', 'NEM',
'NWSA', 'NWS', 'NEE', 'NKE', 'NI', 'NDSN', 'NSC', 'NTRS', 'NOC', 'NCLH', 'NRG',
'NUE', 'NVDA', 'NVR', 'NXPI', 'ORLY', 'OXY', 'ODFL', 'OMC', 'ON', 'OKE', 'ORCL',
'OTIS', 'PCAR', 'PKG', 'PLTR', 'PANW', 'PARA', 'PH', 'PAYX', 'PAYC', 'PYPL',
'PNR', 'PEP', 'PFE', 'PCG', 'PM', 'PSX', 'PNW', 'PNC', 'POOL', 'PPG', 'PPL',
'PFG', 'PG', 'PGR', 'PLD', 'PRU', 'PEG', 'PTC', 'PSA', 'PHM', 'QRVO', 'PWR',
'QCOM', 'DGX', 'RL', 'RJF', 'RTX', 'O', 'REG', 'REGN', 'RF', 'RSG', 'RMD',
'RVTY', 'ROK', 'ROL', 'ROP', 'ROST', 'RCL', 'SPGI', 'CRM', 'SBAC', 'SLB', 'STX',
'SRE', 'NOW', 'SHW', 'SPG', 'SWKS', 'SJM', 'SW', 'SNA', 'SOLV', 'SO', 'LUV',
'SWK', 'SBUX', 'STT', 'STLD', 'STE', 'SYK', 'SMCI', 'SYF', 'SNPS', 'SYY',
'TMUS', 'TROW', 'TTWO', 'TPR', 'TRGP', 'TGT', 'TEL', 'TDY', 'TFX', 'TER',
'TSLA', 'TXN', 'TPL', 'TXT', 'TMO', 'TJX', 'TSCO', 'TT', 'TDG', 'TRV', 'TRMB',
'TFC', 'TYL', 'TSN', 'USB', 'UBER', 'UDR', 'ULTA', 'UNP', 'UAL', 'UPS', 'URI',
'UNH', 'UHS', 'VLO', 'VTR', 'VLTO', 'VRSN', 'VRSK', 'VZ', 'VRTX', 'VTRS',
'VICI', 'V', 'VST', 'VMC', 'WRB', 'GWW', 'WAB', 'WBA', 'WMT', 'DIS', 'WBD',
'WM', 'WAT', 'WEC', 'WFC', 'WELL', 'WST', 'WDC', 'WY', 'WMB', 'WTW', 'WYNN',
'XEL', 'XYL', 'YUM', 'ZBRA', 'ZBH', 'ZTS']
```

#Preparing Data/Documents for RAG - From Yahoo Finance

[3]:
```python
import yfinance as yf
from datetime import datetime, timedelta

def download_ticker_data(tickers):
    end_date = datetime.now()
    start_date = end_date - timedelta(days=90)  # Using 3 months for data size␣
 ↪management
    data = {}
    # Attempt to download each ticker individually to handle failures
    for ticker in tickers:
        try:
            data[ticker] = yf.download(ticker, start=start_date, end=end_date)
            print(f"Downloaded data for {ticker}")
        except Exception as e:
            print(f"Failed to download data for {ticker}: {e}")
            # Retry logic can be added here if desired
    return data
```

```
# Fetch and download data
sp500_tickers = fetch_sp500_tickers()  # Assuming this function is defined␣
 ↪elsewhere
financial_data = download_ticker_data(sp500_tickers)
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[4]:
```python
import os

def save_financial_data(data, folder="financial_data"):
    if not os.path.exists(folder):
        os.makedirs(folder)
    for ticker, df in data.items():
        file_path = os.path.join(folder, f"{ticker}.csv")
        df.to_csv(file_path)
        print(f"Saved data for {ticker} at {file_path}")

save_financial_data(financial_data)
```

```
Saved data for MMM at financial_data/MMM.csv
Saved data for AOS at financial_data/AOS.csv
Saved data for ABT at financial_data/ABT.csv
Saved data for ABBV at financial_data/ABBV.csv
Saved data for ACN at financial_data/ACN.csv
Saved data for ADBE at financial_data/ADBE.csv
Saved data for AMD at financial_data/AMD.csv
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Saved data for AES at financial_data/AES.csv
Saved data for AFL at financial_data/AFL.csv
Saved data for A at financial_data/A.csv
Saved data for APD at financial_data/APD.csv
Saved data for ABNB at financial_data/ABNB.csv
Saved data for AKAM at financial_data/AKAM.csv
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#Data Cleaning and Preprocessing

[5]:
```
import os
import pandas as pd

def load_and_clean_data(folder="financial_data"):
    all_data = {}
    files = os.listdir(folder)

    for file in files:
        if file.endswith(".csv"):
            file_path = os.path.join(folder, file)
            ticker = file.replace(".csv", "")

            try:
                # Skip first two rows, set proper headers
                columns = ['Date', 'Adj Close', 'Close', 'High', 'Low', 'Open',␣
 ↪'Volume']
                df = pd.read_csv(file_path, skiprows=2, names=columns)

                # Drop any rows with missing data
                df.dropna(inplace=True)

                # Ensure correct data types
                df['Date'] = pd.to_datetime(df['Date'])
                df[['Adj Close', 'Close', 'High', 'Low', 'Open', 'Volume']] =␣
 ↪df[
                    ['Adj Close', 'Close', 'High', 'Low', 'Open', 'Volume']
                ].apply(pd.to_numeric, errors='coerce')

                all_data[ticker] = df
```

```
                print(f"Loaded and cleaned data for {ticker}")
            except Exception as e:
                print(f"Failed to process {file}: {e}")

    return all_data

# Run the loading and cleaning process
financial_data_cleaned = load_and_clean_data()
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[6]:
```python
def preprocess_for_embeddings(data):
    processed_data = []

    for ticker, df in data.items():
        if df.empty:
            continue

        # Calculate financial statistics
        summary = {
            "Ticker": ticker,
            "Mean_Close": df['Close'].mean(),
            "Max_Close": df['Close'].max(),
            "Min_Close": df['Close'].min(),
```

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            "Std_Close": df['Close'].std(),
            "Return_3m": (df['Close'].iloc[-1] - df['Close'].iloc[0]) /␣
 ↪df['Close'].iloc[0],
            "Latest_Close": df['Close'].iloc[-1],
            "Latest_Volume": df['Volume'].iloc[-1],
            "Latest_Date": df['Date'].iloc[-1].strftime("%Y-%m-%d"),
        }

        processed_data.append(summary)
        print(f"Processed data for {ticker}")

    # Convert to DataFrame and save
    processed_df = pd.DataFrame(processed_data)
    processed_df.to_csv("processed_financial_data.csv", index=False)
    return processed_df

# Run preprocessing
processed_financial_data = preprocess_for_embeddings(financial_data_cleaned)
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Processed data for WMB
Processed data for HII
Processed data for FTV
Processed data for CINF
Processed data for PPL
Processed data for SNA
Processed data for AEP
Processed data for GILD
```

```
Processed data for AFL
Processed data for ALB
Processed data for KIM
Processed data for MMC
Processed data for META
Processed data for EMR
Processed data for AXP
Processed data for BLDR
Processed data for ADP
Processed data for PRU
Processed data for CPB
Processed data for OTIS
Processed data for BRO
Processed data for GEHC
Processed data for MET
Processed data for BG
Processed data for BAX
Processed data for INCY
Processed data for POOL
Processed data for AVGO
Processed data for XEL
Processed data for CDW
Processed data for PFG
Processed data for UNH
Processed data for TTWO
Processed data for LNT
Processed data for ACGL
Processed data for HPQ
Processed data for HSIC
Processed data for ROK
Processed data for CVX
Processed data for PYPL
Processed data for TFC
Processed data for CL
Processed data for RSG
Processed data for CME
Processed data for KMI
Processed data for BDX
Processed data for ECL
Processed data for IPG
Processed data for TXT
Processed data for CNP
Processed data for LOW
Processed data for AKAM
Processed data for PKG
Processed data for EFX
Processed data for APTV
Processed data for PSA
```

```
Processed data for STT
Processed data for VRSK
Processed data for APH
Processed data for ESS
Processed data for KLAC
Processed data for KDP
Processed data for CNC
Processed data for LDOS
Processed data for PARA
Processed data for HON
Processed data for LYB
Processed data for MNST
Processed data for EXR
Processed data for AVY
Processed data for SNPS
Processed data for ICE
Processed data for KHC
Processed data for VRSN
Processed data for SCHW
Processed data for ALLE
Processed data for ERIE
Processed data for WELL
Processed data for ENPH
Processed data for EOG
Processed data for MOS
Processed data for CHD
Processed data for WEC
Processed data for UPS
Processed data for ZBH
Processed data for CFG
Processed data for CSGP
Processed data for OKE
Processed data for FAST
Processed data for VRTX
Processed data for PM
Processed data for MAA
Processed data for IDXX
Processed data for BA
Processed data for KMB
Processed data for LIN
Processed data for AMD
Processed data for PNR
Processed data for NEM
```

#Generate Vector Embeddings for RAG

[7]:
```
!pip install sentence-transformers
```

```
Requirement already satisfied: sentence-transformers in
/usr/local/lib/python3.10/dist-packages (3.2.1)
Requirement already satisfied: transformers<5.0.0,>=4.41.0 in
/usr/local/lib/python3.10/dist-packages (from sentence-transformers) (4.46.3)
Requirement already satisfied: tqdm in /usr/local/lib/python3.10/dist-packages
(from sentence-transformers) (4.66.6)
Requirement already satisfied: torch>=1.11.0 in /usr/local/lib/python3.10/dist-
packages (from sentence-transformers) (2.5.1+cu121)
Requirement already satisfied: scikit-learn in /usr/local/lib/python3.10/dist-
packages (from sentence-transformers) (1.5.2)
Requirement already satisfied: scipy in /usr/local/lib/python3.10/dist-packages
(from sentence-transformers) (1.13.1)
Requirement already satisfied: huggingface-hub>=0.20.0 in
/usr/local/lib/python3.10/dist-packages (from sentence-transformers) (0.26.3)
Requirement already satisfied: Pillow in /usr/local/lib/python3.10/dist-packages
(from sentence-transformers) (11.0.0)
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-
packages (from huggingface-hub>=0.20.0->sentence-transformers) (3.16.1)
Requirement already satisfied: fsspec>=2023.5.0 in
/usr/local/lib/python3.10/dist-packages (from huggingface-hub>=0.20.0->sentence-
transformers) (2024.10.0)
Requirement already satisfied: packaging>=20.9 in
/usr/local/lib/python3.10/dist-packages (from huggingface-hub>=0.20.0->sentence-
transformers) (24.2)
Requirement already satisfied: pyyaml>=5.1 in /usr/local/lib/python3.10/dist-
packages (from huggingface-hub>=0.20.0->sentence-transformers) (6.0.2)
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-
packages (from huggingface-hub>=0.20.0->sentence-transformers) (2.32.3)
Requirement already satisfied: typing-extensions>=3.7.4.3 in
/usr/local/lib/python3.10/dist-packages (from huggingface-hub>=0.20.0->sentence-
transformers) (4.12.2)
Requirement already satisfied: networkx in /usr/local/lib/python3.10/dist-
packages (from torch>=1.11.0->sentence-transformers) (3.4.2)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.10/dist-packages
(from torch>=1.11.0->sentence-transformers) (3.1.4)
Requirement already satisfied: sympy==1.13.1 in /usr/local/lib/python3.10/dist-
packages (from torch>=1.11.0->sentence-transformers) (1.13.1)
Requirement already satisfied: mpmath<1.4,>=1.1.0 in
/usr/local/lib/python3.10/dist-packages (from
sympy==1.13.1->torch>=1.11.0->sentence-transformers) (1.3.0)
Requirement already satisfied: numpy>=1.17 in /usr/local/lib/python3.10/dist-
packages (from transformers<5.0.0,>=4.41.0->sentence-transformers) (1.26.4)
Requirement already satisfied: regex!=2019.12.17 in
/usr/local/lib/python3.10/dist-packages (from
transformers<5.0.0,>=4.41.0->sentence-transformers) (2024.9.11)
Requirement already satisfied: tokenizers<0.21,>=0.20 in
/usr/local/lib/python3.10/dist-packages (from
transformers<5.0.0,>=4.41.0->sentence-transformers) (0.20.3)
```

```
Requirement already satisfied: safetensors>=0.4.1 in
/usr/local/lib/python3.10/dist-packages (from
transformers<5.0.0,>=4.41.0->sentence-transformers) (0.4.5)
Requirement already satisfied: joblib>=1.2.0 in /usr/local/lib/python3.10/dist-
packages (from scikit-learn->sentence-transformers) (1.4.2)
Requirement already satisfied: threadpoolctl>=3.1.0 in
/usr/local/lib/python3.10/dist-packages (from scikit-learn->sentence-
transformers) (3.5.0)
Requirement already satisfied: MarkupSafe>=2.0 in
/usr/local/lib/python3.10/dist-packages (from jinja2->torch>=1.11.0->sentence-
transformers) (3.0.2)
Requirement already satisfied: charset-normalizer<4,>=2 in
/usr/local/lib/python3.10/dist-packages (from requests->huggingface-
hub>=0.20.0->sentence-transformers) (3.4.0)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-
packages (from requests->huggingface-hub>=0.20.0->sentence-transformers) (3.10)
Requirement already satisfied: urllib3<3,>=1.21.1 in
/usr/local/lib/python3.10/dist-packages (from requests->huggingface-
hub>=0.20.0->sentence-transformers) (2.2.3)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.10/dist-packages (from requests->huggingface-
hub>=0.20.0->sentence-transformers) (2024.8.30)
```

[8]:
```python
from sentence_transformers import SentenceTransformer

# Initialize embedding model
embedding_model = SentenceTransformer('all-MiniLM-L6-v2')

# Create text descriptions for embeddings
def generate_embedding_descriptions(df):
    descriptions = []
    for _, row in df.iterrows():
        desc = (f"{row['Ticker']} had a mean close price of {row['Mean_Close']:.
 ↪2f}, "
                f"with a maximum close of {row['Max_Close']:.2f}, minimum close␣
 ↪of {row['Min_Close']:.2f}, "
                f"and a 3-month return of {row['Return_3m']:.2%}. "
                f"The latest close price was {row['Latest_Close']:.2f} on␣
 ↪{row['Latest_Date']} "
                f"with a trading volume of {row['Latest_Volume']}.")
        descriptions.append((row['Ticker'], desc))
    return descriptions

# Create embeddings
descriptions = generate_embedding_descriptions(processed_financial_data)
tickers, text_descriptions = zip(*descriptions)
embeddings = embedding_model.encode(text_descriptions)
```

```
# Save embeddings to a file
import numpy as np
np.save("financial_embeddings.npy", embeddings)
np.save("financial_tickers.npy", tickers)

print("Embeddings and tickers saved.")
```

```
/usr/local/lib/python3.10/dist-
packages/sentence_transformers/cross_encoder/CrossEncoder.py:13:
TqdmExperimentalWarning: Using `tqdm.autonotebook.tqdm` in notebook mode. Use
`tqdm.tqdm` instead to force console mode (e.g. in jupyter console)
  from tqdm.autonotebook import tqdm, trange
/usr/local/lib/python3.10/dist-packages/huggingface_hub/utils/_auth.py:94:
UserWarning:
The secret `HF_TOKEN` does not exist in your Colab secrets.
To authenticate with the Hugging Face Hub, create a token in your settings tab
(https://huggingface.co/settings/tokens), set it as secret in your Google Colab
and restart your session.
You will be able to reuse this secret in all of your notebooks.
Please note that authentication is recommended but still optional to access
public models or datasets.
  warnings.warn(
modules.json:   0%|          | 0.00/349 [00:00<?, ?B/s]
config_sentence_transformers.json:   0%|          | 0.00/116 [00:00<?, ?B/s]
README.md:   0%|          | 0.00/10.7k [00:00<?, ?B/s]
sentence_bert_config.json:   0%|          | 0.00/53.0 [00:00<?, ?B/s]
config.json:   0%|          | 0.00/612 [00:00<?, ?B/s]
model.safetensors:   0%|          | 0.00/90.9M [00:00<?, ?B/s]
tokenizer_config.json:   0%|          | 0.00/350 [00:00<?, ?B/s]
vocab.txt:   0%|          | 0.00/232k [00:00<?, ?B/s]
tokenizer.json:   0%|          | 0.00/466k [00:00<?, ?B/s]
special_tokens_map.json:   0%|          | 0.00/112 [00:00<?, ?B/s]
1_Pooling/config.json:   0%|          | 0.00/190 [00:00<?, ?B/s]
Embeddings and tickers saved.
```

#Create vector database by storing vector embeddings using Pinecone

[9]:
```
!pip install -U pinecone-client
```

```
Collecting pinecone-client
  Downloading pinecone_client-5.0.1-py3-none-any.whl.metadata (19 kB)
```

```
Requirement already satisfied: certifi>=2019.11.17 in
/usr/local/lib/python3.10/dist-packages (from pinecone-client) (2024.8.30)
Collecting pinecone-plugin-inference<2.0.0,>=1.0.3 (from pinecone-client)
  Downloading pinecone_plugin_inference-1.1.0-py3-none-any.whl.metadata (2.2 kB)
Collecting pinecone-plugin-interface<0.0.8,>=0.0.7 (from pinecone-client)
  Downloading pinecone_plugin_interface-0.0.7-py3-none-any.whl.metadata (1.2 kB)
Requirement already satisfied: tqdm>=4.64.1 in /usr/local/lib/python3.10/dist-
packages (from pinecone-client) (4.66.6)
Requirement already satisfied: typing-extensions>=3.7.4 in
/usr/local/lib/python3.10/dist-packages (from pinecone-client) (4.12.2)
Requirement already satisfied: urllib3>=1.26.0 in
/usr/local/lib/python3.10/dist-packages (from pinecone-client) (2.2.3)
Downloading pinecone_client-5.0.1-py3-none-any.whl (244 kB)
                         244.8/244.8 kB
5.6 MB/s eta 0:00:00
Downloading pinecone_plugin_inference-1.1.0-py3-none-any.whl (85 kB)
                         85.4/85.4 kB
5.8 MB/s eta 0:00:00
Downloading pinecone_plugin_interface-0.0.7-py3-none-any.whl (6.2 kB)
Installing collected packages: pinecone-plugin-interface, pinecone-plugin-
inference, pinecone-client
Successfully installed pinecone-client-5.0.1 pinecone-plugin-inference-1.1.0
pinecone-plugin-interface-0.0.7
```

[10]:
```python
import os
from pinecone import Pinecone, ServerlessSpec
import numpy as np
import pandas as pd

# Load saved embeddings and tickers
embeddings = np.load("financial_embeddings.npy")
tickers = np.load("financial_tickers.npy", allow_pickle=True)

# Load the processed financial data CSV for metadata
processed_df = pd.read_csv("processed_financial_data.csv")
processed_data = {row['Ticker']: row.to_dict() for _, row in processed_df.
 ↪iterrows()}

# Initialize Pinecone
pc =␣
 ↪Pinecone(api_key="pcsk_61Bjni_Qpge2ZniRoyXPZwzExHqo6BkWXGjUGem4wMER7SRKsdGaafmpmXEUAGUcc4cH

# Create or connect to the index
index_name = "finance-index"

# Check if the index exists
if index_name not in [idx.name for idx in pc.list_indexes()]:
```

```
    pc.create_index(
        name=index_name,
        dimension=embeddings.shape[1],
        metric="cosine",
        spec=ServerlessSpec(
            cloud="aws",
            region="us-east-1"
        )
    )

# Connect to the index
index = pc.Index(index_name)

# Prepare and upsert vectors with metadata
vectors_to_upsert = []
for ticker, embedding in zip(tickers, embeddings):
    # Extract relevant metadata from the DataFrame
    metadata = processed_data.get(ticker, {})

    # Format for upsert
    vector = {
        "id": str(ticker),
        "values": embedding.tolist(),
        "metadata": {
            "Latest_Close": metadata.get("Latest_Close", "N/A"),
            "Return_3m": metadata.get("Return_3m", "N/A"),
            "Latest_Volume": metadata.get("Latest_Volume", "N/A"),
            "Latest_Date": metadata.get("Latest_Date", "N/A"),
        }
    }
    vectors_to_upsert.append(vector)

# Perform upsert
index.upsert(vectors=vectors_to_upsert)

print("Embeddings with metadata uploaded to Pinecone.")
```

```
Embeddings with metadata uploaded to Pinecone.
```

#Query Vector Database (RAG)

[51]:
```
from sentence_transformers import SentenceTransformer

# Initialize the embedding model
embedding_model = SentenceTransformer('all-MiniLM-L6-v2')

# Query Pinecone Function
def query_pinecone(user_query, top_k=5):
```

```
    # Generate embedding for the query
    query_embedding = embedding_model.encode(user_query).tolist()

    # Search in Pinecone
    search_results = index.query(
        vector=query_embedding,
        top_k=top_k,
        include_metadata=True  # Include data fields
    )

    return search_results
```

[52]:
```
# Test the query system
test_query = "What is the latest performance of AAPL stock?"
search_results=query_pinecone(test_query)
print(search_results)
```

```
{'matches': [{'id': 'AAPL',
              'metadata': {'Latest_Close': 247.75030517578125,
                           'Latest_Date': '2024-12-10',
                           'Latest_Volume': 18279599.0,
                           'Return_3m': 0.1126843667520409},
              'score': 0.680406451,
              'values': []},
             {'id': 'ABT',
              'metadata': {'Latest_Close': 115.48999786376952,
                           'Latest_Date': '2024-12-10',
                           'Latest_Volume': 1566470.0,
                           'Return_3m': -0.0095197309166169},
              'score': 0.501015723,
              'values': []},
             {'id': 'AOS',
              'metadata': {'Latest_Close': 73.08499908447266,
                           'Latest_Date': '2024-12-10',
                           'Latest_Volume': 334991.0,
                           'Return_3m': -0.0685062460198743},
              'score': 0.468043029,
              'values': []},
             {'id': 'AON',
              'metadata': {'Latest_Close': 359.7449951171875,
                           'Latest_Date': '2024-12-10',
                           'Latest_Volume': 553191.0,
                           'Return_3m': 0.043343990293852},
              'score': 0.466181695,
              'values': []},
             {'id': 'APD',
              'metadata': {'Latest_Close': 314.79998779296875,
```

```
                            'Latest_Date': '2024-12-10',
                            'Latest_Volume': 328845.0,
                            'Return_3m': 0.1335565787300462},
               'score': 0.45967862,
               'values': []}],
 'namespace': '',
 'usage': {'read_units': 6}}
```

[13]:
```python
# Correct the metadata extraction logic
def extract_financial_data_from_pinecone(search_results):
    # Ensure matches exist
    if search_results and 'matches' in search_results and␣
 ↪len(search_results['matches']) > 0:
        best_match = search_results['matches'][0]  # First result
        ticker = best_match['id']

        # Check if metadata exists
        if 'metadata' in best_match:
            metadata = best_match['metadata']
            # Format the response using metadata fields
            response = (
                f"{ticker} stock's latest performance:\n"
                f"- Latest Close Price: ${metadata.get('Latest_Close', 'N/A'):.
 ↪2f}\n"
                f"- 3-Month Return: {metadata.get('Return_3m', 'N/A'):.2%}\n"
                f"- Latest Trading Volume: {metadata.get('Latest_Volume', 'N/
 ↪A')}\n"
                f"- Date: {metadata.get('Latest_Date', 'N/A')}\n"
            )
            return response
        else:
            return f"Ticker {ticker} found, but no financial data is available."

    return "Sorry, no relevant financial data could be retrieved at this time."
```

[14]:
```python
response = extract_financial_data_from_pinecone(search_results)
print(response)
```

```
AAPL stock's latest performance:
- Latest Close Price: $243.60
- 3-Month Return: 10.67%
- Latest Trading Volume: 2830922.0
- Date: 2024-12-09
```

Successfully retrieving desired records from vector DB

#Large Language Model 1 - Gemini 1.5 Flash

####**Implementing Virtual Assistant using Gemini with RAG pipeline**

- Introducing a standardized prompt for the LLM to generate desired response.

[1]:
```
!pip install google-generativeai
```

```
Requirement already satisfied: google-generativeai in
/usr/local/lib/python3.10/dist-packages (0.8.3)
Requirement already satisfied: google-ai-generativelanguage==0.6.10 in
/usr/local/lib/python3.10/dist-packages (from google-generativeai) (0.6.10)
Requirement already satisfied: google-api-core in
/usr/local/lib/python3.10/dist-packages (from google-generativeai) (2.19.2)
Requirement already satisfied: google-api-python-client in
/usr/local/lib/python3.10/dist-packages (from google-generativeai) (2.151.0)
Requirement already satisfied: google-auth>=2.15.0 in
/usr/local/lib/python3.10/dist-packages (from google-generativeai) (2.27.0)
Requirement already satisfied: protobuf in /usr/local/lib/python3.10/dist-
packages (from google-generativeai) (4.25.5)
Requirement already satisfied: pydantic in /usr/local/lib/python3.10/dist-
packages (from google-generativeai) (2.10.3)
Requirement already satisfied: tqdm in /usr/local/lib/python3.10/dist-packages
(from google-generativeai) (4.66.6)
Requirement already satisfied: typing-extensions in
/usr/local/lib/python3.10/dist-packages (from google-generativeai) (4.12.2)
Requirement already satisfied: proto-plus<2.0.0dev,>=1.22.3 in
/usr/local/lib/python3.10/dist-packages (from google-ai-
generativelanguage==0.6.10->google-generativeai) (1.25.0)
Requirement already satisfied: googleapis-common-protos<2.0.dev0,>=1.56.2 in
/usr/local/lib/python3.10/dist-packages (from google-api-core->google-
generativeai) (1.66.0)
Requirement already satisfied: requests<3.0.0.dev0,>=2.18.0 in
/usr/local/lib/python3.10/dist-packages (from google-api-core->google-
generativeai) (2.32.3)
Requirement already satisfied: cachetools<6.0,>=2.0.0 in
/usr/local/lib/python3.10/dist-packages (from google-auth>=2.15.0->google-
generativeai) (5.5.0)
Requirement already satisfied: pyasn1-modules>=0.2.1 in
/usr/local/lib/python3.10/dist-packages (from google-auth>=2.15.0->google-
generativeai) (0.4.1)
Requirement already satisfied: rsa<5,>=3.1.4 in /usr/local/lib/python3.10/dist-
packages (from google-auth>=2.15.0->google-generativeai) (4.9)
Requirement already satisfied: httplib2<1.dev0,>=0.19.0 in
/usr/local/lib/python3.10/dist-packages (from google-api-python-client->google-
generativeai) (0.22.0)
Requirement already satisfied: google-auth-httplib2<1.0.0,>=0.2.0 in
/usr/local/lib/python3.10/dist-packages (from google-api-python-client->google-
generativeai) (0.2.0)
Requirement already satisfied: uritemplate<5,>=3.0.1 in
```

```
/usr/local/lib/python3.10/dist-packages (from google-api-python-client->google-
generativeai) (4.1.1)
Requirement already satisfied: annotated-types>=0.6.0 in
/usr/local/lib/python3.10/dist-packages (from pydantic->google-generativeai)
(0.7.0)
Requirement already satisfied: pydantic-core==2.27.1 in
/usr/local/lib/python3.10/dist-packages (from pydantic->google-generativeai)
(2.27.1)
Requirement already satisfied: grpcio<2.0dev,>=1.33.2 in
/usr/local/lib/python3.10/dist-packages (from google-api-core[grpc]!=2.0.*,!=2.1
.*,!=2.10.*,!=2.2.*,!=2.3.*,!=2.4.*,!=2.5.*,!=2.6.*,!=2.7.*,!=2.8.*,!=2.9.*,<3.0
.0dev,>=1.34.1->google-ai-generativelanguage==0.6.10->google-generativeai)
(1.68.1)
Requirement already satisfied: grpcio-status<2.0.dev0,>=1.33.2 in
/usr/local/lib/python3.10/dist-packages (from google-api-core[grpc]!=2.0.*,!=2.1
.*,!=2.10.*,!=2.2.*,!=2.3.*,!=2.4.*,!=2.5.*,!=2.6.*,!=2.7.*,!=2.8.*,!=2.9.*,<3.0
.0dev,>=1.34.1->google-ai-generativelanguage==0.6.10->google-generativeai)
(1.62.3)
Requirement already satisfied:
pyparsing!=3.0.0,!=3.0.1,!=3.0.2,!=3.0.3,<4,>=2.4.2 in
/usr/local/lib/python3.10/dist-packages (from httplib2<1.dev0,>=0.19.0->google-
api-python-client->google-generativeai) (3.2.0)
Requirement already satisfied: pyasn1<0.7.0,>=0.4.6 in
/usr/local/lib/python3.10/dist-packages (from pyasn1-modules>=0.2.1->google-
auth>=2.15.0->google-generativeai) (0.6.1)
Requirement already satisfied: charset-normalizer<4,>=2 in
/usr/local/lib/python3.10/dist-packages (from
requests<3.0.0.dev0,>=2.18.0->google-api-core->google-generativeai) (3.4.0)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-
packages (from requests<3.0.0.dev0,>=2.18.0->google-api-core->google-
generativeai) (3.10)
Requirement already satisfied: urllib3<3,>=1.21.1 in
/usr/local/lib/python3.10/dist-packages (from
requests<3.0.0.dev0,>=2.18.0->google-api-core->google-generativeai) (2.2.3)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.10/dist-packages (from
requests<3.0.0.dev0,>=2.18.0->google-api-core->google-generativeai) (2024.8.30)
```

[16]:
```python
import google.generativeai as genai

# Replace 'YOUR_API_KEY' with your actual API key
genai.configure(api_key='AIzaSyAovQlg-UAnqIp_NdNZ_6ntX6yIDm13HYs')
```

[20]:
```python
def generate_response_with_gemini(user_query, top_k=5):
    # Retrieve financial data
    search_results = query_pinecone(user_query, top_k)
    extracted_data = extract_financial_data_from_pinecone(search_results)
```

```
    # Handle missing data case
    if "No relevant financial data found" in extracted_data:
        return "Sorry, I couldn't find relevant financial data for your query."

    # Create a detailed prompt
    prompt = (
        f"Based on the following financial data retrieved from our database:\n"
        f"{extracted_data}\n\n"
        f"User Question :{user_query}\n"
        f"Please provide a detailed, professional answer summarizing the␣
↪stock's latest "
        f"performance, including any relevant analysis such as trends, recent␣
↪activity, or "
        f"market conditions."
    )

    # Generate response using Gemini
    model = genai.GenerativeModel("gemini-1.5-flash")
    response = model.generate_content(prompt)

    return response.text
```

###Gemini Response for sample question

[21]:
```
user_query = "What is the latest performance of AAPL stock?"
response = generate_response_with_gemini(user_query)
print("Response:", response)
```

```
Response: As of December 9th, 2024, Apple (AAPL) stock closed at $243.60.  Over
the past three months, the stock has exhibited a strong performance, yielding a
10.67% return.  The latest trading volume of 2,830,922 shares suggests moderate
trading activity on this particular day.

While a single day's closing price and volume provide a snapshot, the 3-month
return of 10.67% indicates a positive trend in AAPL's performance during that
period.  To provide a more comprehensive analysis, additional data points would
be needed.  This includes:

* **Longer-term performance:** Examining returns over 6-month, 1-year, and
5-year periods would reveal broader trends and help contextualize the recent
3-month gain.  A comparison to the overall market performance (e.g., S&P 500)
during these periods would also be valuable in assessing AAPL's relative
strength.
* **Volatility:** Measuring the standard deviation of returns over different
time periods would quantify the risk associated with AAPL's price fluctuations.
High volatility suggests greater price swings and risk.
```

```
* **Market conditions:** Understanding the broader macroeconomic environment
(interest rates, inflation, economic growth) and sector-specific factors
(technology industry trends) is crucial to interpret the performance.  Positive
market conditions could contribute to the positive 3-month return, while
negative conditions might suggest AAPL is outperforming the market.
* **Analyst ratings and price targets:** Consulting analyst reports and their
price targets for AAPL would offer further insights into future expectations for
the stock.
* **News and events:** Reviewing recent news and events affecting AAPL (e.g.,
product launches, earnings announcements, regulatory changes) would help explain
the performance.

In conclusion, the provided data shows positive recent performance for AAPL, but
a complete picture requires a more in-depth analysis encompassing the factors
listed above.  The 10.67% 3-month return is a strong indication of positive
momentum, but further investigation is necessary to assess its sustainability
and underlying drivers.
```

[15]:
```
from huggingface_hub import notebook_login

notebook_login()
```

```
VBox(children=(HTML(value='<center> <img\nsrc=https://huggingface.co/front/
↪assets/huggingface_logo-noborder.sv…
```

[16]:
```
!pip install transformers accelerate
```

```
Requirement already satisfied: transformers in /usr/local/lib/python3.10/dist-
packages (4.46.3)
Requirement already satisfied: accelerate in /usr/local/lib/python3.10/dist-
packages (1.1.1)
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-
packages (from transformers) (3.16.1)
Requirement already satisfied: huggingface-hub<1.0,>=0.23.2 in
/usr/local/lib/python3.10/dist-packages (from transformers) (0.26.3)
Requirement already satisfied: numpy>=1.17 in /usr/local/lib/python3.10/dist-
packages (from transformers) (1.26.4)
Requirement already satisfied: packaging>=20.0 in
/usr/local/lib/python3.10/dist-packages (from transformers) (24.2)
Requirement already satisfied: pyyaml>=5.1 in /usr/local/lib/python3.10/dist-
packages (from transformers) (6.0.2)
Requirement already satisfied: regex!=2019.12.17 in
/usr/local/lib/python3.10/dist-packages (from transformers) (2024.9.11)
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-
packages (from transformers) (2.32.3)
Requirement already satisfied: tokenizers<0.21,>=0.20 in
/usr/local/lib/python3.10/dist-packages (from transformers) (0.20.3)
```

```
Requirement already satisfied: safetensors>=0.4.1 in
/usr/local/lib/python3.10/dist-packages (from transformers) (0.4.5)
Requirement already satisfied: tqdm>=4.27 in /usr/local/lib/python3.10/dist-
packages (from transformers) (4.66.6)
Requirement already satisfied: psutil in /usr/local/lib/python3.10/dist-packages
(from accelerate) (5.9.5)
Requirement already satisfied: torch>=1.10.0 in /usr/local/lib/python3.10/dist-
packages (from accelerate) (2.5.1+cu121)
Requirement already satisfied: fsspec>=2023.5.0 in
/usr/local/lib/python3.10/dist-packages (from huggingface-
hub<1.0,>=0.23.2->transformers) (2024.10.0)
Requirement already satisfied: typing-extensions>=3.7.4.3 in
/usr/local/lib/python3.10/dist-packages (from huggingface-
hub<1.0,>=0.23.2->transformers) (4.12.2)
Requirement already satisfied: networkx in /usr/local/lib/python3.10/dist-
packages (from torch>=1.10.0->accelerate) (3.4.2)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.10/dist-packages
(from torch>=1.10.0->accelerate) (3.1.4)
Requirement already satisfied: sympy==1.13.1 in /usr/local/lib/python3.10/dist-
packages (from torch>=1.10.0->accelerate) (1.13.1)
Requirement already satisfied: mpmath<1.4,>=1.1.0 in
/usr/local/lib/python3.10/dist-packages (from
sympy==1.13.1->torch>=1.10.0->accelerate) (1.3.0)
Requirement already satisfied: charset-normalizer<4,>=2 in
/usr/local/lib/python3.10/dist-packages (from requests->transformers) (3.4.0)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-
packages (from requests->transformers) (3.10)
Requirement already satisfied: urllib3<3,>=1.21.1 in
/usr/local/lib/python3.10/dist-packages (from requests->transformers) (2.2.3)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.10/dist-packages (from requests->transformers)
(2024.8.30)
Requirement already satisfied: MarkupSafe>=2.0 in
/usr/local/lib/python3.10/dist-packages (from jinja2->torch>=1.10.0->accelerate)
(3.0.2)
```

#**Large Language Model 2 : Flan-t5-large (google)**

####**Implementing Virtual Assistant using Flan-t5-large with RAG pipeline**

- Introducing a standardized prompt for the LLM to generate desired response.

[17]:
```
from transformers import AutoTokenizer, AutoModelForSeq2SeqLM
import torch

model_name = "google/flan-t5-large"

device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
```

```
tokenizer = AutoTokenizer.from_pretrained(model_name)
model = AutoModelForSeq2SeqLM.from_pretrained(model_name, device_map="auto").
 ↪to(device)
```

```
tokenizer_config.json:   0%|          | 0.00/2.54k [00:00<?, ?B/s]
spiece.model:   0%|          | 0.00/792k [00:00<?, ?B/s]
tokenizer.json:   0%|          | 0.00/2.42M [00:00<?, ?B/s]
special_tokens_map.json:   0%|          | 0.00/2.20k [00:00<?, ?B/s]
config.json:   0%|          | 0.00/662 [00:00<?, ?B/s]
model.safetensors:   0%|          | 0.00/3.13G [00:00<?, ?B/s]
generation_config.json:   0%|          | 0.00/147 [00:00<?, ?B/s]
```

[56]:
```
def generate_response_with_flan_t5(user_query, top_k=5):
    # Query Pinecone and extract data
    search_results = query_pinecone(user_query, top_k)
    extracted_data = extract_financial_data_from_pinecone(search_results)

    # Handle missing data case
    if "No relevant financial data found" in extracted_data:
        return "Sorry, I couldn't find relevant financial data for your query."

    # Create a detailed prompt
    prompt = (
        f"Based on the following financial data retrieved from our database:\n"
        f"{extracted_data}\n\n"
        f"{user_query}\n"
        f"Please provide a detailed, professional answer summarizing the␣
 ↪stock's latest "
        f"performance, including any relevant analysis such as trends, recent␣
 ↪activity, or "
        f"market conditions."
    )

    # Tokenize and generate response
    inputs = tokenizer(prompt, return_tensors="pt", truncation=True).to(device)
    # Generate response
    output = model.generate(
        **inputs,
        max_length=1024,              # Allow long responses
        num_beams=5,                  # Use beam search for better answers
        length_penalty=1.0,           # Avoid very short answers
        early_stopping=True           # Stop when done
    )
```

```
    # Decode the Response
    response = tokenizer.decode(output[0], skip_special_tokens=True)
    return response
```

###Flan-t5-large model's response for sample questions

[19]:
```
query = "What is the latest performance of AAPL stock?"
response = generate_response_with_flan_t5(query)
print("Response from the Model:")
print(response)
```

```
Response from the Model:
The latest close price of AAPL stock was $247.75 and the 3-Month return was
11.27%. The stock has a current trading volume of 18279599.0.
```

[63]:
```
query = "How has TSLA performed over the last 3 months?"
response = generate_response_with_flan_t5(query)
print("Response from the Model:")
print(response)
```

```
Response from the Model:
TSLA stock has returned 78.29% over the last 3 months.
```

#**Gradio UI**

- Used Flan-t5-large model

[20]:
```
!pip install gradio
```

```
Collecting gradio
  Downloading gradio-5.8.0-py3-none-any.whl.metadata (16 kB)
Collecting aiofiles<24.0,>=22.0 (from gradio)
  Downloading aiofiles-23.2.1-py3-none-any.whl.metadata (9.7 kB)
Requirement already satisfied: anyio<5.0,>=3.0 in
/usr/local/lib/python3.10/dist-packages (from gradio) (3.7.1)
Collecting fastapi<1.0,>=0.115.2 (from gradio)
  Downloading fastapi-0.115.6-py3-none-any.whl.metadata (27 kB)
Collecting ffmpy (from gradio)
  Downloading ffmpy-0.4.0-py3-none-any.whl.metadata (2.9 kB)
Collecting gradio-client==1.5.1 (from gradio)
  Downloading gradio_client-1.5.1-py3-none-any.whl.metadata (7.1 kB)
Requirement already satisfied: httpx>=0.24.1 in /usr/local/lib/python3.10/dist-
packages (from gradio) (0.28.0)
Requirement already satisfied: huggingface-hub>=0.25.1 in
/usr/local/lib/python3.10/dist-packages (from gradio) (0.26.3)
Requirement already satisfied: jinja2<4.0 in /usr/local/lib/python3.10/dist-
packages (from gradio) (3.1.4)
Collecting markupsafe~=2.0 (from gradio)
  Downloading MarkupSafe-2.1.5-cp310-cp310-
```

```
manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (3.0 kB)
Requirement already satisfied: numpy<3.0,>=1.0 in
/usr/local/lib/python3.10/dist-packages (from gradio) (1.26.4)
Requirement already satisfied: orjson~=3.0 in /usr/local/lib/python3.10/dist-
packages (from gradio) (3.10.12)
Requirement already satisfied: packaging in /usr/local/lib/python3.10/dist-
packages (from gradio) (24.2)
Requirement already satisfied: pandas<3.0,>=1.0 in
/usr/local/lib/python3.10/dist-packages (from gradio) (2.2.2)
Requirement already satisfied: pillow<12.0,>=8.0 in
/usr/local/lib/python3.10/dist-packages (from gradio) (11.0.0)
Requirement already satisfied: pydantic>=2.0 in /usr/local/lib/python3.10/dist-
packages (from gradio) (2.10.3)
Collecting pydub (from gradio)
  Downloading pydub-0.25.1-py2.py3-none-any.whl.metadata (1.4 kB)
Collecting python-multipart>=0.0.18 (from gradio)
  Downloading python_multipart-0.0.19-py3-none-any.whl.metadata (1.8 kB)
Requirement already satisfied: pyyaml<7.0,>=5.0 in
/usr/local/lib/python3.10/dist-packages (from gradio) (6.0.2)
Collecting ruff>=0.2.2 (from gradio)
  Downloading ruff-0.8.2-py3-none-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (25 kB)
Collecting safehttpx<0.2.0,>=0.1.6 (from gradio)
  Downloading safehttpx-0.1.6-py3-none-any.whl.metadata (4.2 kB)
Collecting semantic-version~=2.0 (from gradio)
  Downloading semantic_version-2.10.0-py2.py3-none-any.whl.metadata (9.7 kB)
Collecting starlette<1.0,>=0.40.0 (from gradio)
  Downloading starlette-0.41.3-py3-none-any.whl.metadata (6.0 kB)
Collecting tomlkit<0.14.0,>=0.12.0 (from gradio)
  Downloading tomlkit-0.13.2-py3-none-any.whl.metadata (2.7 kB)
Requirement already satisfied: typer<1.0,>=0.12 in
/usr/local/lib/python3.10/dist-packages (from gradio) (0.15.0)
Requirement already satisfied: typing-extensions~=4.0 in
/usr/local/lib/python3.10/dist-packages (from gradio) (4.12.2)
Collecting uvicorn>=0.14.0 (from gradio)
  Downloading uvicorn-0.32.1-py3-none-any.whl.metadata (6.6 kB)
Requirement already satisfied: fsspec in /usr/local/lib/python3.10/dist-packages
(from gradio-client==1.5.1->gradio) (2024.10.0)
Collecting websockets<15.0,>=10.0 (from gradio-client==1.5.1->gradio)
  Downloading websockets-14.1-cp310-cp310-
manylinux_2_5_x86_64.manylinux1_x86_64.manylinux_2_17_x86_64.manylinux2014_x86_6
4.whl.metadata (6.7 kB)
Requirement already satisfied: idna>=2.8 in /usr/local/lib/python3.10/dist-
packages (from anyio<5.0,>=3.0->gradio) (3.10)
Requirement already satisfied: sniffio>=1.1 in /usr/local/lib/python3.10/dist-
packages (from anyio<5.0,>=3.0->gradio) (1.3.1)
Requirement already satisfied: exceptiongroup in /usr/local/lib/python3.10/dist-
packages (from anyio<5.0,>=3.0->gradio) (1.2.2)
```

```
Requirement already satisfied: certifi in /usr/local/lib/python3.10/dist-
packages (from httpx>=0.24.1->gradio) (2024.8.30)
Requirement already satisfied: httpcore==1.* in /usr/local/lib/python3.10/dist-
packages (from httpx>=0.24.1->gradio) (1.0.7)
Requirement already satisfied: h11<0.15,>=0.13 in
/usr/local/lib/python3.10/dist-packages (from
httpcore==1.*->httpx>=0.24.1->gradio) (0.14.0)
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-
packages (from huggingface-hub>=0.25.1->gradio) (3.16.1)
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-
packages (from huggingface-hub>=0.25.1->gradio) (2.32.3)
Requirement already satisfied: tqdm>=4.42.1 in /usr/local/lib/python3.10/dist-
packages (from huggingface-hub>=0.25.1->gradio) (4.66.6)
Requirement already satisfied: python-dateutil>=2.8.2 in
/usr/local/lib/python3.10/dist-packages (from pandas<3.0,>=1.0->gradio) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-
packages (from pandas<3.0,>=1.0->gradio) (2024.2)
Requirement already satisfied: tzdata>=2022.7 in /usr/local/lib/python3.10/dist-
packages (from pandas<3.0,>=1.0->gradio) (2024.2)
Requirement already satisfied: annotated-types>=0.6.0 in
/usr/local/lib/python3.10/dist-packages (from pydantic>=2.0->gradio) (0.7.0)
Requirement already satisfied: pydantic-core==2.27.1 in
/usr/local/lib/python3.10/dist-packages (from pydantic>=2.0->gradio) (2.27.1)
Requirement already satisfied: click>=8.0.0 in /usr/local/lib/python3.10/dist-
packages (from typer<1.0,>=0.12->gradio) (8.1.7)
Requirement already satisfied: shellingham>=1.3.0 in
/usr/local/lib/python3.10/dist-packages (from typer<1.0,>=0.12->gradio) (1.5.4)
Requirement already satisfied: rich>=10.11.0 in /usr/local/lib/python3.10/dist-
packages (from typer<1.0,>=0.12->gradio) (13.9.4)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-
packages (from python-dateutil>=2.8.2->pandas<3.0,>=1.0->gradio) (1.16.0)
Requirement already satisfied: markdown-it-py>=2.2.0 in
/usr/local/lib/python3.10/dist-packages (from
rich>=10.11.0->typer<1.0,>=0.12->gradio) (3.0.0)
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in
/usr/local/lib/python3.10/dist-packages (from
rich>=10.11.0->typer<1.0,>=0.12->gradio) (2.18.0)
Requirement already satisfied: charset-normalizer<4,>=2 in
/usr/local/lib/python3.10/dist-packages (from requests->huggingface-
hub>=0.25.1->gradio) (3.4.0)
Requirement already satisfied: urllib3<3,>=1.21.1 in
/usr/local/lib/python3.10/dist-packages (from requests->huggingface-
hub>=0.25.1->gradio) (2.2.3)
Requirement already satisfied: mdurl~=0.1 in /usr/local/lib/python3.10/dist-
packages (from markdown-it-py>=2.2.0->rich>=10.11.0->typer<1.0,>=0.12->gradio)
(0.1.2)
Downloading gradio-5.8.0-py3-none-any.whl (57.2 MB)
                           57.2/57.2 MB
```

```
11.6 MB/s eta 0:00:00
Downloading gradio_client-1.5.1-py3-none-any.whl (320 kB)
                         320.2/320.2 kB
21.0 MB/s eta 0:00:00
Downloading aiofiles-23.2.1-py3-none-any.whl (15 kB)
Downloading fastapi-0.115.6-py3-none-any.whl (94 kB)
                         94.8/94.8 kB
6.6 MB/s eta 0:00:00
Downloading
MarkupSafe-2.1.5-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (25
kB)
Downloading python_multipart-0.0.19-py3-none-any.whl (24 kB)
Downloading ruff-0.8.2-py3-none-manylinux_2_17_x86_64.manylinux2014_x86_64.whl
(11.2 MB)
                         11.2/11.2 MB
94.9 MB/s eta 0:00:00
Downloading safehttpx-0.1.6-py3-none-any.whl (8.7 kB)
Downloading semantic_version-2.10.0-py2.py3-none-any.whl (15 kB)
Downloading starlette-0.41.3-py3-none-any.whl (73 kB)
                         73.2/73.2 kB
5.5 MB/s eta 0:00:00
Downloading tomlkit-0.13.2-py3-none-any.whl (37 kB)
Downloading uvicorn-0.32.1-py3-none-any.whl (63 kB)
                         63.8/63.8 kB
5.1 MB/s eta 0:00:00
Downloading ffmpy-0.4.0-py3-none-any.whl (5.8 kB)
Downloading pydub-0.25.1-py2.py3-none-any.whl (32 kB)
Downloading websockets-14.1-cp310-cp310-
manylinux_2_5_x86_64.manylinux1_x86_64.manylinux_2_17_x86_64.manylinux2014_x86_6
4.whl (168 kB)
                         168.2/168.2 kB
11.9 MB/s eta 0:00:00
Installing collected packages: pydub, websockets, uvicorn, tomlkit,
semantic-version, ruff, python-multipart, markupsafe, ffmpy, aiofiles,
starlette, safehttpx, gradio-client, fastapi, gradio
  Attempting uninstall: markupsafe
    Found existing installation: MarkupSafe 3.0.2
    Uninstalling MarkupSafe-3.0.2:
      Successfully uninstalled MarkupSafe-3.0.2
Successfully installed aiofiles-23.2.1 fastapi-0.115.6 ffmpy-0.4.0 gradio-5.8.0
gradio-client-1.5.1 markupsafe-2.1.5 pydub-0.25.1 python-multipart-0.0.19
ruff-0.8.2 safehttpx-0.1.6 semantic-version-2.10.0 starlette-0.41.3
tomlkit-0.13.2 uvicorn-0.32.1 websockets-14.1
```

[21]:
```
import gradio as gr

# Example Function Connecting Backend Logic
```

```
def get_stock_performance(query):
    # Query Pinecone and Generate Answer (Replace with Your Existing Function)
    response = generate_response_with_flan_t5(query)
    return response

# Create a Beautiful Gradio UI
with gr.Blocks() as demo:
    # Header Section
    gr.Markdown(""
        """
        #  **Finance Chatbot**
        Ask questions about **stock performance**, **market trends**, and␣
 ↪**financial data analysis**.
        """
    )

    # Create Input and Output Sections
    user_input = gr.Textbox(
        label="Ask Your Financial Question",
        placeholder="e.g., What is the latest performance of AAPL stock?",
        lines=2,
        interactive=True  # Make input field dynamic
    )

    submit_btn = gr.Button("Ask")

    # Output Section
    output_text = gr.Textbox(
        label="Model's Response",
        placeholder="The answer will appear here...",
        lines=6
    )

    # Link the Submit Button to Backend Function
    submit_btn.click(fn=get_stock_performance, inputs=user_input,␣
 ↪outputs=output_text)

# Launch the Gradio UI
demo.launch()
```

```
Running Gradio in a Colab notebook requires sharing enabled. Automatically
setting `share=True` (you can turn this off by setting `share=False` in
`launch()` explicitly).

Colab notebook detected. To show errors in colab notebook, set debug=True in
launch()
* Running on public URL: https://46e01108b38b26e00f.gradio.live
```

```
This share link expires in 72 hours. For free permanent hosting and GPU
upgrades, run `gradio deploy` from the terminal in the working directory to
deploy to Hugging Face Spaces (https://huggingface.co/spaces)
```

```
<IPython.core.display.HTML object>
```

[21]:

#**Evaluation**

- Used flan-t5-large
- Challenge Faced: Gemini quota getting exceeded

####Set/Define 30 Evaluation Questions

[79]:
```
import pandas as pd
import numpy as np
from sklearn.metrics import accuracy_score, precision_score, recall_score

# Define 30 Evaluation Questions
questions = [
    "What is the latest performance of AAPL stock?",
    "How has TSLA performed over the last 3 months?",
    "What is the latest performance of MSFT stock?",
    "Can you summarize the recent activity of GOOGL stock?",
    "How is AMZN stock performing currently?",
    "What is the latest closing price of AAPL stock?",
    "What was the highest closing price of TSLA in the last 3 months?",
    "What was the lowest closing price of MSFT recently?",
    "How does GOOGL's latest close compare to 3 months ago?",
    "What is the current price of AMZN stock?",
    "What is the latest trading volume for AAPL stock?",
    "How many shares of TSLA were traded most recently?",
    "What was the average trading volume of MSFT over the last 3 months?",
    "How does GOOGL's trading volume compare to AMZN's?",
    "What was the highest trading volume for TSLA in the past 3 months?",
    "What is the 3-month return of AAPL stock?",
    "How much has TSLA's stock value changed in the last 3 months?",
    "What is the percentage return of MSFT over the past quarter?",
    "How does the 3-month return of GOOGL compare to AAPL's?",
    "What is AMZN's stock return over the last 3 months?",
    "Which stock performed better in the last 3 months: AAPL or TSLA?",
    "Compare the 3-month returns of MSFT and GOOGL.",
    "Which company had the highest trading volume recently: AMZN or TSLA?",
    "How does AAPL's latest performance compare to its average over the past 3␣
 ↪months?",
    "Is GOOGL's 3-month return higher than AMZN's?",
    "What was the closing price of AAPL stock 3 months ago?",
```

```
    "What is the historical trend for TSLA stock over the last 3 months?",
    "Can you provide the last 3 closing prices for MSFT stock?",
    "How has GOOGL's price changed week over week in the last month?",
    "What were the 3-month trading volumes for AMZN stock?",
]
```

####Generate ground truth for all the questions

[80]:
```
import re

def get_ground_truth(question):
    # Identify the ticker symbol from the question
    if "AAPL" in question:
        ticker = "AAPL"
    elif "TSLA" in question:
        ticker = "TSLA"
    elif "MSFT" in question:
        ticker = "MSFT"
    elif "GOOGL" in question:
        ticker = "GOOGL"
    elif "AMZN" in question:
        ticker = "AMZN"
    else:
        return "Ground truth not available"

    # Get the data for the identified ticker
    row = financial_data[financial_data["Ticker"] == ticker]
    if row.empty:
        return "Ground truth not available"

    # Extract relevant data based on the type of question
    # Adaptive Ground Truth Logic
    if re.search(r"\bperform", question.lower()):
        return (
            f"The latest close price of {ticker} is ${row['Latest_Close'].
 ↪values[0]:.2f}, "
            f"with a 3-month return of {row['Return_3m'].values[0]:.2%}, "
            f"and a trading volume of {row['Latest_Volume'].values[0]}."
        )

    elif re.search(r"\b(price|closing price)", question.lower()):
        return f"The latest closing price of {ticker} is ${row['Latest_Close'].
 ↪values[0]:.2f}."

    elif re.search(r"\btrading volume", question.lower()):
        return f"The latest trading volume of {ticker} is {row['Latest_Volume'].
 ↪values[0]}."
```

```
    elif re.search(r"\breturn|3-month|3 month", question.lower()):
        return f"The 3-month return of {ticker} is {row['Return_3m'].values[0]:.
↪2%}."

    elif re.search(r"\b(compare|better)", question.lower()):
        return (
            f"{ticker} stock's latest metrics: Closing Price:␣
↪${row['Latest_Close'].values[0]:.2f}, "
            f"3-Month Return: {row['Return_3m'].values[0]:.2%}, "
            f"Trading Volume: {row['Latest_Volume'].values[0]}."
        )
    else:
      # Default Case for Other Queries
      return (
            f"The latest close price of {ticker} is ${row['Latest_Close'].
↪values[0]:.2f}, "
            f"with a 3-month return of {row['Return_3m'].values[0]:.2%}, "
            f"and a trading volume of {row['Latest_Volume'].values[0]}."
        )
```

####Generate model response for all the 30 questions

[81]:
```
def generate_response(query):
    response = generate_response_with_flan_t5(query)
    return response
```

####Compare ground truth and model response using cosine similarity

[82]:
```
from sentence_transformers import SentenceTransformer
from sklearn.metrics.pairwise import cosine_similarity

# Load Pre-trained Sentence Transformer
embedding_model = SentenceTransformer('all-MiniLM-L6-v2')

# Function to Calculate Cosine Similarity
def cosine_similarity_score(response, ground_truth):
    # Generate embeddings
    response_emb = embedding_model.encode(response, convert_to_tensor=True)
    ground_truth_emb = embedding_model.encode(ground_truth,␣
↪convert_to_tensor=True)

    # Calculate cosine similarity
    similarity = cosine_similarity(response_emb.unsqueeze(0), ground_truth_emb.
↪unsqueeze(0))[0][0]
    return similarity
```

####Evaluate with cosine similarity

[83]:
```
# Updated Evaluation Function with Cosine Similarity
def evaluate_question_with_cosine(question):
    ground_truth = get_ground_truth(question)
    model_response = generate_response_with_flan_t5(question)

    # Calculate Cosine Similarity
    cosine_similarity_val = cosine_similarity_score(model_response,␣
 ↪ground_truth)

    # Consider correct if cosine similarity > 0.7
    is_correct = cosine_similarity_val > 0.7

    return {
        "question": question,
        "ground_truth": ground_truth,
        "model_response": model_response,
        "cosine_similarity": cosine_similarity_val,
        "is_correct": is_correct
    }
```

[84]:
```
# Run Evaluation for All Questions
results_with_cosine = [evaluate_question_with_cosine(q) for q in questions]

# Convert Results to DataFrame
results_with_cosine_df = pd.DataFrame(results_with_cosine)
```

####Evaluation metrics and visualization

[85]:
```
# Metrics Calculation
accuracy_cosine = results_with_cosine_df["is_correct"].mean()
average_cosine_similarity = results_with_cosine_df["cosine_similarity"].mean()

# Print Metrics
print("Evaluation Results with Cosine Similarity:")
print(results_with_cosine_df[["question", "ground_truth", "model_response",␣
 ↪"cosine_similarity", "is_correct"]])
print(f"\nOverall Accuracy (Cosine): {accuracy_cosine * 100:.2f}%")
print(f"Average Cosine Similarity: {average_cosine_similarity:.2f}")
```

```
Evaluation Results with Cosine Similarity:
                                              question  \
0       What is the latest performance of AAPL stock?
1      How has TSLA performed over the last 3 months?
2       What is the latest performance of MSFT stock?
3   Can you summarize the recent activity of GOOGL…
4             How is AMZN stock performing currently?
5     What is the latest closing price of AAPL stock?
6   What was the highest closing price of TSLA in …
```

```
7   What was the lowest closing price of MSFT rece…
8   How does GOOGL's latest close compare to 3 mon…
9            What is the current price of AMZN stock?
10  What is the latest trading volume for AAPL stock?
11  How many shares of TSLA were traded most recen…
12  What was the average trading volume of MSFT ov…
13  How does GOOGL's trading volume compare to AMZ…
14  What was the highest trading volume for TSLA i…
15          What is the 3-month return of AAPL stock?
16  How much has TSLA's stock value changed in the…
17  What is the percentage return of MSFT over the…
18  How does the 3-month return of GOOGL compare t…
19  What is AMZN's stock return over the last 3 mo…
20  Which stock performed better in the last 3 mon…
21     Compare the 3-month returns of MSFT and GOOGL.
22  Which company had the highest trading volume r…
23  How does AAPL's latest performance compare to …
24      Is GOOGL's 3-month return higher than AMZN's?
25  What was the closing price of AAPL stock 3 mon…
26  What is the historical trend for TSLA stock ov…
27  Can you provide the last 3 closing prices for …
28  How has GOOGL's price changed week over week i…
29  What were the 3-month trading volumes for AMZN…

                                          ground_truth  \
0   The latest close price of AAPL is $247.75, wit…
1   The latest close price of TSLA is $406.73, wit…
2   The latest close price of MSFT is $444.23, wit…
3   The latest close price of GOOGL is $184.57, wi…
4   The latest close price of AMZN is $225.63, wit…
5        The latest closing price of AAPL is $247.75.
6        The latest closing price of TSLA is $406.73.
7        The latest closing price of MSFT is $444.23.
8              The 3-month return of GOOGL is 22.10%.
9        The latest closing price of AMZN is $225.63.
10   The latest trading volume of AAPL is 18279599.0.
11  The latest close price of TSLA is $406.73, wit…
12    The latest trading volume of MSFT is 8066770.0.
13  The latest trading volume of GOOGL is 37286206.0.
14   The latest trading volume of TSLA is 70894686.0.
15             The 3-month return of AAPL is 11.27%.
16             The 3-month return of TSLA is 78.29%.
17              The 3-month return of MSFT is 5.01%.
18             The 3-month return of AAPL is 11.27%.
19             The 3-month return of AMZN is 22.28%.
20  The latest close price of AAPL is $247.75, wit…
21              The 3-month return of MSFT is 5.01%.
22   The latest trading volume of TSLA is 70894686.0.
```

```
23  The latest close price of AAPL is $247.75, wit…
24             The 3-month return of GOOGL is 22.10%.
25       The latest closing price of AAPL is $247.75.
26              The 3-month return of TSLA is 78.29%.
27       The latest closing price of MSFT is $444.23.
28      The latest closing price of GOOGL is $184.57.
29   The latest trading volume of AMZN is 17373460.0.

                                       model_response  cosine_similarity  \
0   The latest close price of AAPL stock was $247…           0.959086
1   TSLA stock has returned 78.29% over the last 3…           0.670150
2   The latest close price of MSFT stock was $444…           0.952956
3   GOOGL has a 3-month return of 22.10% and a cur…           0.888633
4   The stock has a 3-month return of 22.28% and a…           0.536378
5   The latest closing price of AAPL stock was $24…           0.943775
6   $406.73 was the highest closing price of TSLA …           0.913727
7   The latest closing price of MSFT stock was $44…           0.938103
8   GOOGL's latest close price was $184.57 and its…           0.794186
9         The current price of AMZN stock is $225.63.             0.860560
10  The latest trading volume for AAPL stock is 18…           0.964851
11  The stock has a 3-month return of 78.29%. The …           0.429140
12  The average volume of MSFT over the last 3 mon…           0.718691
13  GOOGL has a 3-month return of 22.10% and a tra…           0.809683
14  70894686.0 was the highest volume traded for T…           0.848304
15        The 3-month return of AAPL stock is 11.27%.             0.940478
16  TSLA's stock has changed 78.29% in the last 3 …           0.803259
17          MSFT stock has a 3-month return of 5.01%.             0.910694
18  GOOGL's 3-month return is 11.27% compared to A…           0.763654
19  AMZN stock has returned 22.28% over the last 3…           0.880022
20               AAPL has a 3-month return of 11.27%.             0.684981
21  GOOGL has a 3-month return of 22.10% and a tra…           0.510786
22               AMZN has a 3-month return of 22.28%.             0.212964
23  The stock's average return over the past 3 mon…           0.428252
24                                              Yes             0.126927
25  The latest closing price of AAPL stock was $24…           0.911988
26          The stock has a 3-month return of 78.29%.             0.636317
27  The latest closing price of MSFT stock was $44…           0.899995
28  GOOGL has a 3-Month return of 22.10% and a tra…           0.631068
29  The latest trading volume for AMZN stock was 1…           0.957112

    is_correct
0         True
1        False
2         True
3         True
4        False
5         True
6         True
```

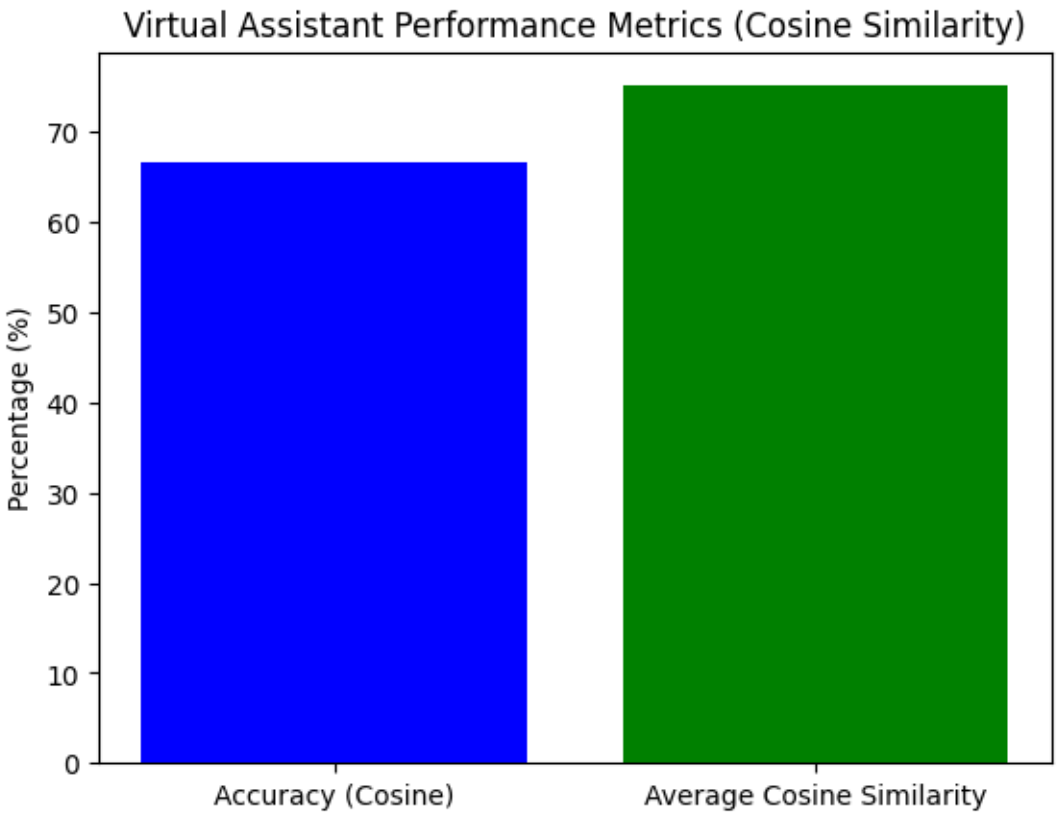
```
7         True
8         True
9         True
10        True
11       False
12        True
13        True
14        True
15        True
16        True
17        True
18        True
19        True
20       False
21       False
22       False
23       False
24       False
25        True
26       False
27        True
28       False
29        True

Overall Accuracy (Cosine): 66.67%
Average Cosine Similarity: 0.75
```

[86]:
```
print(f"\nOverall Accuracy (Cosine): {accuracy_cosine * 100:.2f}%")
print(f"Average Cosine Similarity: {average_cosine_similarity * 100:.2f}%")
```

```
Overall Accuracy (Cosine): 66.67%
Average Cosine Similarity: 75.09%
```

[87]:
```
# Visualization
plt.bar(["Accuracy (Cosine)", "Average Cosine Similarity"], [accuracy_cosine *␣
 ↪100, average_cosine_similarity * 100], color=["blue", "green"])
plt.title("Virtual Assistant Performance Metrics (Cosine Similarity)")
plt.ylabel("Percentage (%)")
plt.show()
```



#Improving Performance of Virtual Assistant

###Introducing Adaptive Prompting, revising VA response and applied filtering

####Introducing Adaptive prompting

[98]:
```
import re

def create_adaptive_prompt(user_query, extracted_data):
    """
    Creates an adaptive prompt with sentence-based instructions for␣
 ↪completeness.
    """

    # Sentence-Enforced Adaptive Instructions
    if re.search(r"\bperform", user_query.lower()):
        instruction = (
            f"Please provide a complete, professional sentence summarizing the␣
 ↪stock's latest performance, "
            f"including its closing price, 3-month return, trading volume, and␣
 ↪any relevant market analysis."
        )
```

```
    elif re.search(r"\b(price|closing price)", user_query.lower()):
        instruction = (
            f"Please provide a complete sentence stating the stock's latest␣
↪closing price, "
            f"mentioning the ticker symbol and the specific closing value."
        )

    elif re.search(r"\btrading volume", user_query.lower()):
        instruction = (
            f"Please provide a sentence describing the stock's latest trading␣
↪volume, "
            f"including the trading date, stock symbol, and the exact number of␣
↪shares traded."
        )

    elif re.search(r"\breturn", user_query.lower()):
        instruction = (
            f"Please provide a sentence stating the stock's 3-month return␣
↪percentage, "
            f"including its ticker symbol and precise return value."
        )

    elif re.search(r"\b(compare|better)", user_query.lower()):
        instruction = (
            f"Please compare the stocks' recent performances in a clear␣
↪sentence based on their closing prices, "
            f"3-month returns, and trading volumes, mentioning the␣
↪better-performing stock."
        )

    else:
        instruction = (
            f"Please provide a professional summary of the stock's key␣
↪financial metrics, including closing price, "
            f"returns, trading volume, and any relevant market context in a␣
↪complete sentence."
        )

    # Final Context-Aware Prompt
    prompt = (
        f"Based on the following financial data retrieved from our system:\n\n"
        f"{extracted_data}\n\n"
        f"User Question: {user_query}\n\n"
        f"{instruction}\n"
    )
```

```
    return prompt
```

####Generating model response with improved prompting

[99]:
```
def generate_response_with_flan_t5_adaptive_prompting(user_query, top_k=5):
    # Query Pinecone and extract data
    search_results = query_pinecone(user_query, top_k)
    extracted_data = extract_financial_data_from_pinecone(search_results)

    # Handle missing data case
    if "No relevant financial data found" in extracted_data:
        return "Sorry, I couldn't find relevant financial data for your query."

    prompt= create_adaptive_prompt(user_query, extracted_data)

    # Tokenize and generate response
    inputs = tokenizer(prompt, return_tensors="pt", truncation=True).to(device)
    # Generate response
    output = model.generate(
        **inputs,
        max_length=1024,              # Allow long responses
        num_beams=5,                  # Use beam search for better answers
        length_penalty=1.0,           # Avoid very short answers
        early_stopping=True           # Stop when done
    )

    # Decode the Response
    response = tokenizer.decode(output[0], skip_special_tokens=True)
    return response
```

[92]:
```
query = "What is the latest performance of AAPL stock?"
response = generate_response_with_flan_t5_adaptive_prompting(query)
print("Response from the Model:")
print(response)
```

```
Response from the Model:
The latest closing price of AAPL stock was $247.75 and its 3-month return was
11.27%. The stock has a recent trading volume of 18279599.0.
```

[91]:
```
query = "How has TSLA performed over the last 3 months?"
response = generate_response_with_flan_t5_adaptive_prompting(query)
print("Response from the Model:")
print(response)
```

```
Response from the Model:
The stock has a 3-month return of 78.29% and a recent trading volume of
70894686.0.
```

####Revising Virtual Assistant Response

[101]:
```
def reformat_response(question, response):
    """
    Reformat model responses if only numerical values are returned.
    """
    if re.match(r"^\$?\d+(\.\d+)?%?$", response.strip()):
        # Response is a number; reformat based on query type
        if re.search(r"\b(price|closing price)", question.lower()):
            return f"The latest closing price of the stock is {response.
 ↪strip()}."

        elif re.search(r"\btrading volume", question.lower()):
            return f"The latest trading volume of the stock is {response.
 ↪strip()}."

        elif re.search(r"\breturn|3 month|3-month", question.lower()):
            return f"The 3-month return of the stock is {response.strip()}."

    # Return Original Response if Already Properly Formatted
    return response.strip()
```

####Apply Filtering - Grammar Checker

[103]:
```
# Install and Initialize Language Tool
!pip install language-tool-python
import language_tool_python

# Initialize Grammar Checker
tool = language_tool_python.LanguageTool('en-US')

# Filter Responses Using Grammar Check
def filter_response(response):
    corrected_response = tool.correct(response)
    return corrected_response
```

```
Collecting language-tool-python
  Downloading language_tool_python-2.8.1-py3-none-any.whl.metadata (12 kB)
Requirement already satisfied: pip in /usr/local/lib/python3.10/dist-packages
(from language-tool-python) (24.1.2)
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-
packages (from language-tool-python) (2.32.3)
Requirement already satisfied: tqdm in /usr/local/lib/python3.10/dist-packages
(from language-tool-python) (4.66.6)
Requirement already satisfied: wheel in /usr/local/lib/python3.10/dist-packages
(from language-tool-python) (0.45.1)
Requirement already satisfied: charset-normalizer<4,>=2 in
/usr/local/lib/python3.10/dist-packages (from requests->language-tool-python)
```

```
(3.4.0)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-
packages (from requests->language-tool-python) (3.10)
Requirement already satisfied: urllib3<3,>=1.21.1 in
/usr/local/lib/python3.10/dist-packages (from requests->language-tool-python)
(2.2.3)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.10/dist-packages (from requests->language-tool-python)
(2024.8.30)
Downloading language_tool_python-2.8.1-py3-none-any.whl (35 kB)
Installing collected packages: language-tool-python
Successfully installed language-tool-python-2.8.1

Downloading LanguageTool 6.4: 100%|      | 246M/246M [00:06<00:00, 40.2MB/s]
INFO:language_tool_python.download_lt:Unzipping /tmp/tmp39mnarwi.zip to
/root/.cache/language_tool_python.
INFO:language_tool_python.download_lt:Downloaded
https://www.languagetool.org/download/LanguageTool-6.4.zip to
/root/.cache/language_tool_python.
```

####Evaluate with cosine similarity

####Compare ground truth and improved model response

[104]:
```python
# Updated Evaluation Function with Cosine Similarity
def evaluate_question_with_cosine(question):
    ground_truth = get_ground_truth(question)
    model_response = generate_response_with_flan_t5_adaptive_prompting(question)
    # Reformat Incomplete Responses
    # Revising VA response text prior to showing it to the user
    corrected_response = reformat_response(question, model_response)

    # Post-process with Grammar Correction
    corrected_response = filter_response(corrected_response)

    # Calculate Cosine Similarity
    cosine_similarity_val = cosine_similarity_score(corrected_response,␣
 ↪ground_truth)

    # Consider correct if cosine similarity > 0.7
    is_correct = cosine_similarity_val > 0.7

    return {
        "question": question,
        "ground_truth": ground_truth,
        "model_response": corrected_response,
        "cosine_similarity": cosine_similarity_val,
        "is_correct": is_correct
    }
```

[105]:
```
# Run Evaluation for All Questions
results_with_cosine = [evaluate_question_with_cosine(q) for q in questions]

# Convert Results to DataFrame
results_with_cosine_df = pd.DataFrame(results_with_cosine)
```

####Evaluation Metrics and Visualization

[106]:
```
# Metrics Calculation
accuracy_cosine = results_with_cosine_df["is_correct"].mean()
average_cosine_similarity = results_with_cosine_df["cosine_similarity"].mean()

# Print Metrics
print("Evaluation Results with Cosine Similarity:")
print(results_with_cosine_df[["question", "ground_truth", "model_response",␣
 ↪"cosine_similarity", "is_correct"]])
print(f"\nOverall Accuracy (Cosine): {accuracy_cosine * 100:.2f}%")
print(f"Average Cosine Similarity: {average_cosine_similarity:.2f}")
```

```
Evaluation Results with Cosine Similarity:
                                              question  \
0       What is the latest performance of AAPL stock?
1      How has TSLA performed over the last 3 months?
2       What is the latest performance of MSFT stock?
3   Can you summarize the recent activity of GOOGL…
4             How is AMZN stock performing currently?
5     What is the latest closing price of AAPL stock?
6   What was the highest closing price of TSLA in …
7   What was the lowest closing price of MSFT rece…
8   How does GOOGL's latest close compare to 3 mon…
9           What is the current price of AMZN stock?
10  What is the latest trading volume for AAPL stock?
11  How many shares of TSLA were traded most recen…
12  What was the average trading volume of MSFT ov…
13  How does GOOGL's trading volume compare to AMZ…
14  What was the highest trading volume for TSLA i…
15         What is the 3-month return of AAPL stock?
16  How much has TSLA's stock value changed in the…
17  What is the percentage return of MSFT over the…
18  How does the 3-month return of GOOGL compare t…
19  What is AMZN's stock return over the last 3 mo…
20  Which stock performed better in the last 3 mon…
21     Compare the 3-month returns of MSFT and GOOGL.
22  Which company had the highest trading volume r…
23  How does AAPL's latest performance compare to …
24      Is GOOGL's 3-month return higher than AMZN's?
25  What was the closing price of AAPL stock 3 mon…
26  What is the historical trend for TSLA stock ov…
```

```
27  Can you provide the last 3 closing prices for …
28  How has GOOGL's price changed week over week i…
29  What were the 3-month trading volumes for AMZN…

                                          ground_truth  \
0   The latest close price of AAPL is $247.75, wit…
1   The latest close price of TSLA is $406.73, wit…
2   The latest close price of MSFT is $444.23, wit…
3   The latest close price of GOOGL is $184.57, wi…
4   The latest close price of AMZN is $225.63, wit…
5        The latest closing price of AAPL is $247.75.
6        The latest closing price of TSLA is $406.73.
7        The latest closing price of MSFT is $444.23.
8              The 3-month return of GOOGL is 22.10%.
9        The latest closing price of AMZN is $225.63.
10  The latest trading volume of AAPL is 18279599.0.
11  The latest close price of TSLA is $406.73, wit…
12   The latest trading volume of MSFT is 8066770.0.
13  The latest trading volume of GOOGL is 37286206.0.
14  The latest trading volume of TSLA is 70894686.0.
15             The 3-month return of AAPL is 11.27%.
16             The 3-month return of TSLA is 78.29%.
17              The 3-month return of MSFT is 5.01%.
18             The 3-month return of AAPL is 11.27%.
19             The 3-month return of AMZN is 22.28%.
20  The latest close price of AAPL is $247.75, wit…
21              The 3-month return of MSFT is 5.01%.
22  The latest trading volume of TSLA is 70894686.0.
23  The latest close price of AAPL is $247.75, wit…
24             The 3-month return of GOOGL is 22.10%.
25       The latest closing price of AAPL is $247.75.
26              The 3-month return of TSLA is 78.29%.
27       The latest closing price of MSFT is $444.23.
28      The latest closing price of GOOGL is $184.57.
29  The latest trading volume of AMZN is 17373460.0.

                                      model_response  cosine_similarity  \
0   AAPL stock's latest performance, including its…           0.885402
1   The stock TSLA has a 3-month return of 78.29%,…           0.899864
2   MSFT stock's latest performance, including its…           0.868436
3   GOOGLE stock closed at $184.57 on 2024-12-10, …           0.672570
4   The latest closing price of AMZN stock was $22…           0.948299
5   AAPL stock's latest performance: - Latest Clos…           0.831292
6   TSLA stock's latest performance: Latest Close …           0.828089
7   MSFT stock has a recent closing price of $444.23.           0.920747
8   GOOGLE stock's latest close price was $184.57 …           0.585514
9   The latest closing price of AMZN stock was $22…           0.946401
10  The latest trading volume for AAPL stock was 1…           0.946556
```

11	TSLA stock's latest performance: - Latest Clos…	0.878180
12	MSFT stock has a 3-month return of 5.01%. The …	0.674922
13	GOOGLE has a trading volume of 37286206.0 shar…	0.676569
14	TSLA stock's latest performance: - Latest Clos…	0.689828
15	AAPL stock has a 3-month return of 11.27%, its…	0.846759
16	TSLA stock's latest performance: - Latest Clos…	0.700637
17	MSFT stock's latest performance: - Latest Clos…	0.648773
18	GOOGLE has a 3-month return of 11.27%.	0.605600
19	AMZN stock has a 3-month return of 22.28%, its…	0.862514
20	AAPL stock has a 3-month return of 11.27% and …	0.887384
21	GOOGLE has a 3-month return of 22.10%, its tic…	0.565793
22	AMZN has the highest volume with 17373460.0 sh…	0.481239
23	AAPL stock's latest performance, including its…	0.788612
24	GOOGLE stock has a 3-month return of 22.10%.	0.703213
25	AAPL stock's latest performance: - Latest Clos…	0.832447
26	TSLA stock has a 3-month return of 78.29%.	0.893421
27	MSFT stock's latest closing price, mentioning …	0.890102
28	GOOGLE stock's latest closing price, mentionin…	0.761335
29	AMZN stock's latest performance: - Latest Clos…	0.745395

	is_correct
0	True
1	True
2	True
3	False
4	True
5	True
6	True
7	True
8	False
9	True
10	True
11	True
12	False
13	False
14	False
15	True
16	True
17	False
18	False
19	True
20	True
21	False
22	False
23	True
24	True
25	True
26	True

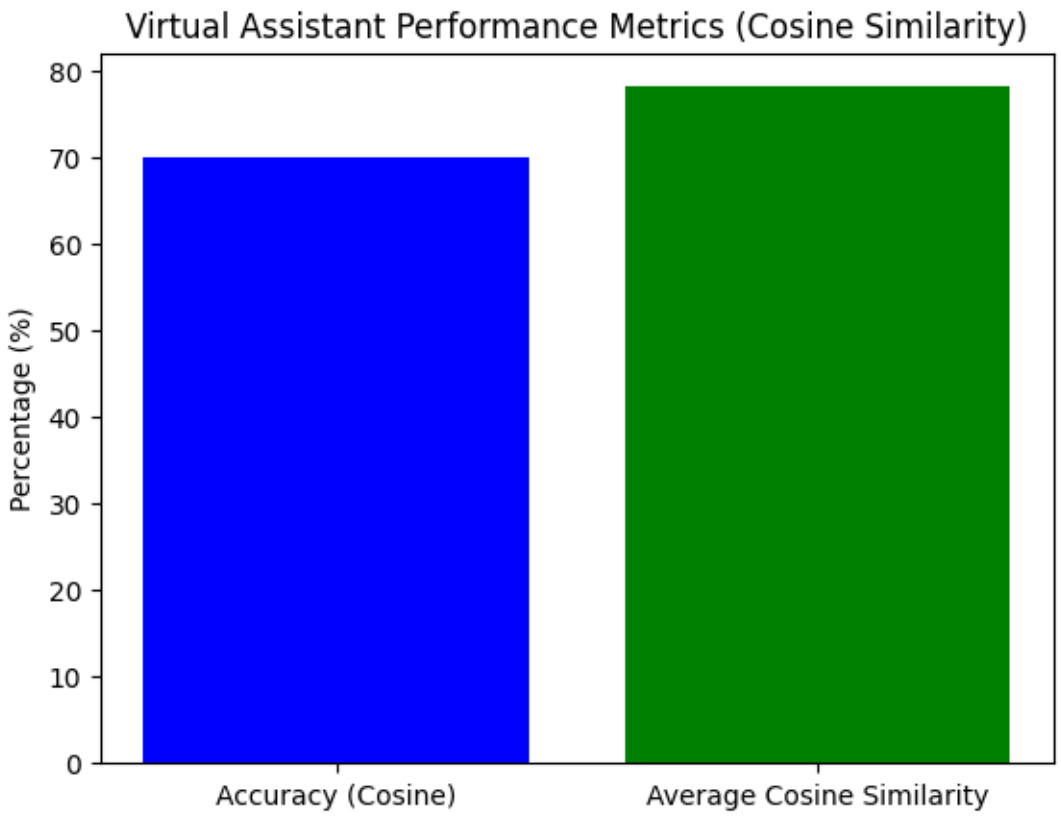
```
27        True
28        True
29        True

Overall Accuracy (Cosine): 70.00%
Average Cosine Similarity: 0.78
```

[107]:
```
print(f"\nOverall Accuracy (Cosine): {accuracy_cosine * 100:.2f}%")
print(f"Average Cosine Similarity: {average_cosine_similarity * 100:.2f}%")
```

```
Overall Accuracy (Cosine): 70.00%
Average Cosine Similarity: 78.22%
```

[108]:
```
# Visualization
plt.bar(["Accuracy (Cosine)", "Average Cosine Similarity"], [accuracy_cosine *␣
↪100, average_cosine_similarity * 100], color=["blue", "green"])
plt.title("Virtual Assistant Performance Metrics (Cosine Similarity)")
plt.ylabel("Percentage (%)")
plt.show()
```



Virtual Assistant's Performance Significantly improved after applying certain techniques (introduc-

ing adaptive prompting, revising VA response and apply filtering).

#**Challenges Faced So Far**

- **Creating embeddings as the data is numerical** - Overcame by converting each row of numerical data to a meaningful string representation to understand the financial data and then generating embeddings.
- **Choosing lightweight models**, as most of the models are either running for long time or not giving response since the query/prompt is quite large - Overcame by trying out more than 10 models and fixing the best ones.
- **Flan-t5-large was generating multiple or redundant responses** - Overcame by tweaking model parameters and applying early stopping.
- **Writing ground truth manually for evaluation**, as it is time consuming and repetitive - Overcame by generating adaptive ground truth based on the question.
- **Improving performance of VA.** Tried various methods individually and tested the performance and was still not able to improve - Finally was able to improve the performance by combining 3 different approaches together after numerous attempts.