```
"""
This cell imports all the required libraries for
text preprocessing, vectorization, and similarity computation.
"""

import numpy as np
import pandas as pd
import re

# NLP tools
import nltk
from nltk.corpus import stopwords, wordnet
from nltk.tokenize import word_tokenize
from nltk.stem import WordNetLemmatizer

# Feature extraction and similarity
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.metrics.pairwise import cosine_similarity

# Download required NLTK datasets
nltk.download('punkt')
nltk.download('stopwords')
nltk.download('wordnet')
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Unzipping tokenizers/punkt.zip.
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Unzipping corpora/stopwords.zip.
[nltk_data] Downloading package wordnet to /root/nltk_data...
True
```

```
"""
This dataset contains 30 short documents across
four domains: sports, politics, health, and technology.
"""

documents = [

    # -------- SPORTS --------
    "The football team won the final match",
    "Cricket players practiced for the tournament",
    "The athlete broke the world record",
    "Basketball is a popular indoor sport",
    "The coach planned strategies for the game",
    "Olympic players trained daily for excellence",
    "The referee controlled the football match",
    "Fans celebrated the team victory",

    # -------- POLITICS --------
    "The government introduced a new policy",
    "Election campaigns influence voters",
    "The prime minister addressed the public",
    "Political parties debated economic reforms",
    "Parliament passed a new bill",
    "Democracy allows citizens to vote",
    "The minister discussed foreign relations",
    "The opposition criticized the budget",

    # -------- HEALTH --------
    "Doctors recommend exercise for fitness",
    "A balanced diet improves health",
    "Hospitals provide treatment to patients",
    "Mental health awareness is important",
    "Vaccination prevents serious diseases",
    "Healthy sleep improves immunity",
    "Nutrition plays a vital role in wellness",

    # -------- TECHNOLOGY --------
    "Artificial intelligence improves automation",
    "Machine learning analyzes large data",
    "Cybersecurity protects digital systems",
    "Smartphones use advanced processors",
    "Technology evolves rapidly every year",
    "Software development requires logical thinking"
]

# Create DataFrame
df = pd.DataFrame(documents, columns=["Text"])
df.head()
```

1 to 5 of 5 entries Filter

index	Text
0	The football team won the final match
1	Cricket players practiced for the tournament
2	The athlete broke the world record
3	Basketball is a popular indoor sport
4	The coach planned strategies for the game

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Next steps: Generate code with df New interactive sheet

```
import nltk
nltk.download('punkt_tab')
"""
This step cleans and preprocesses text data by:
- converting to lowercase
- removing punctuation and numbers
- removing stopwords
- tokenizing words
- lemmatizing tokens
"""

# Initialize stopwords and lemmatizer
stop_words = set(stopwords.words('english'))
lemmatizer = WordNetLemmatizer()

def preprocess_text(text):
    """
    Preprocesses a given text string.

    Parameters:
    text (str): Input sentence

    Returns:
    str: Cleaned and preprocessed sentence
    """

    # Convert text to lowercase
    text = text.lower()

    # Remove punctuation and numbers
    text = re.sub(r'[^a-z\s]', '', text)

    # Tokenize the text
    tokens = word_tokenize(text)

    # Remove stopwords and lemmatize tokens
    tokens = [
        lemmatizer.lemmatize(word)
        for word in tokens
        if word not in stop_words
    ]

    # Join tokens back to string
    return " ".join(tokens)

# Apply preprocessing
df["Processed_Text"] = df["Text"].apply(preprocess_text)
df.head()
```

```
[nltk_data] Downloading package punkt_tab to /root/nltk_data...
[nltk_data]   Unzipping tokenizers/punkt_tab.zip.
```

1 to 5 of 5 entries Filter

index	Text	Processed_Text
0	The football team won the final match	football team final match
1	Cricket players practiced for the tournament	cricket player practiced tournament
2	The athlete broke the world record	athlete broke world record
3	Basketball is a popular indoor sport	basketball popular indoor sport
4	The coach planned strategies for the game	coach planned strategy game

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Next steps: Generate code with df New interactive sheet

```
"""
```

```
TF-IDF converts text into numerical vectors by
assigning importance to words based on frequency.
"""

# Initialize TF-IDF vectorizer
vectorizer = TfidfVectorizer()

# Create TF-IDF matrix
tfidf_matrix = vectorizer.fit_transform(df["Processed_Text"])

# Display matrix shape
tfidf_matrix.shape
```

```
(29, 112)
```

```
"""
Cosine similarity measures the angle between
TF-IDF vectors to determine similarity.
"""

# Compute cosine similarity matrix
cosine_sim_matrix = cosine_similarity(tfidf_matrix)

# Convert to DataFrame for readability
cosine_df = pd.DataFrame(cosine_sim_matrix)

# Display first few rows
cosine_df.head()
```

	0	1	2	3	4	5	6	7	8	9	...	19	20	21	22	23	24	25	26	27	28
0	1.0	0.0	0.0	0.0	0.0	0.000000	0.455686	0.221547	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	1.0	0.0	0.0	0.0	0.186035	0.000000	0.000000	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	1.0	0.0	0.0	0.000000	0.000000	0.000000	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	1.0	0.0	0.000000	0.000000	0.000000	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	1.0	0.000000	0.000000	0.000000	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

5 rows × 29 columns

```
"""
Jaccard similarity compares word overlap
between two documents.
"""

def jaccard_similarity(text1, text2):
    """
    Computes Jaccard similarity between two texts.

    Parameters:
    text1 (str), text2 (str)

    Returns:
    float: Jaccard similarity score
    """
    set1 = set(text1.split())
    set2 = set(text2.split())

    return len(set1.intersection(set2)) / len(set1.union(set2))

# Compute Jaccard similarity for sample pairs
for i in range(5):
    score = jaccard_similarity(
        df["Processed_Text"][i],
        df["Processed_Text"][i+1]
    )
    print(f"Jaccard similarity Doc {i} & Doc {i+1}: {score}")
```

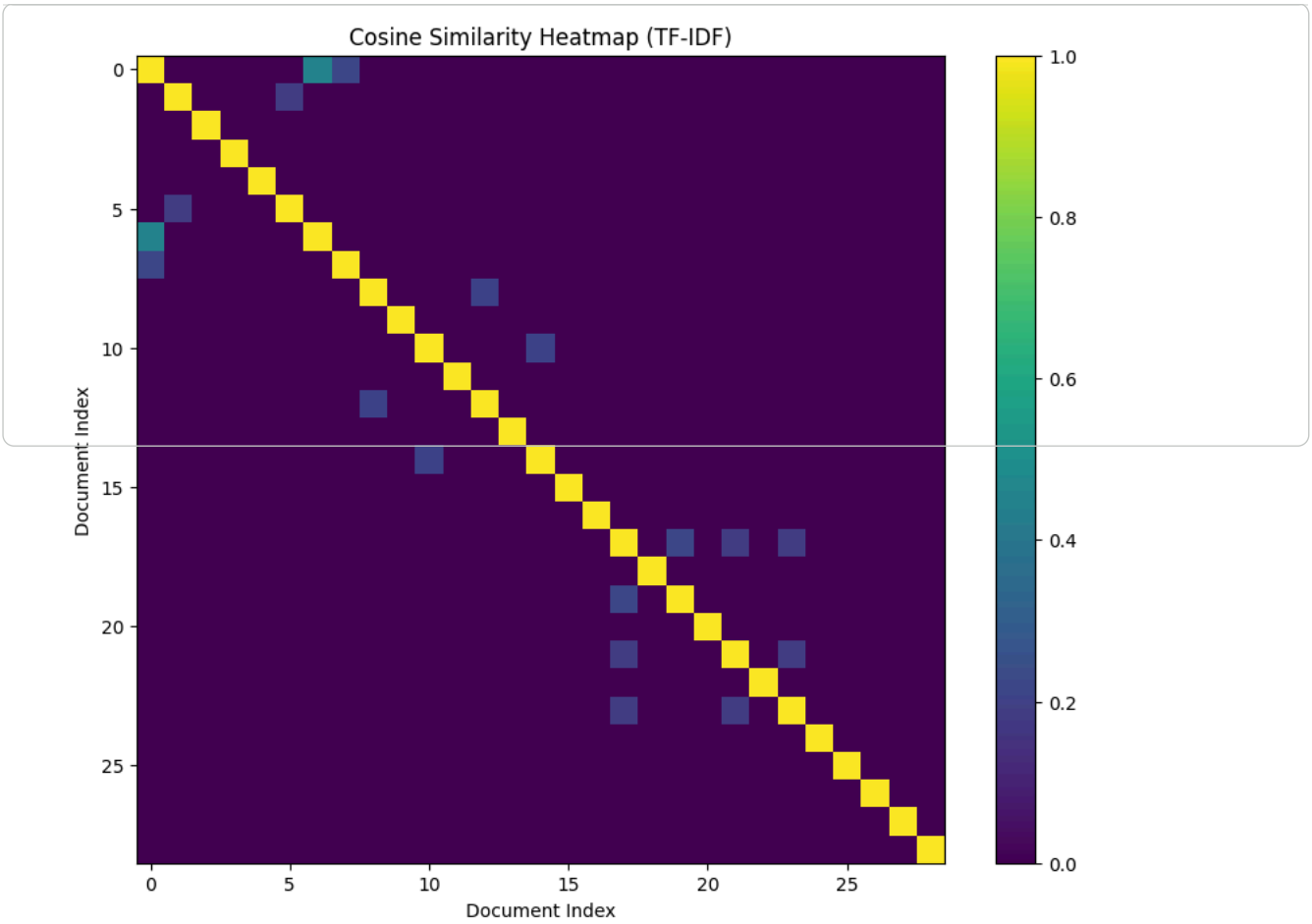
```
Jaccard similarity Doc 0 & Doc 1: 0.0
Jaccard similarity Doc 1 & Doc 2: 0.0
Jaccard similarity Doc 2 & Doc 3: 0.0
Jaccard similarity Doc 3 & Doc 4: 0.0
Jaccard similarity Doc 4 & Doc 5: 0.0
```

```
"""
WordNet similarity measures semantic closeness
between words using lexical databases.
```

```
"""

def wordnet_similarity(word1, word2):
    """
    Computes Wu-Palmer similarity between two words.

    Parameters:
    word1 (str), word2 (str)

    Returns:
    float or None
    """
    synsets1 = wordnet.synsets(word1)
    synsets2 = wordnet.synsets(word2)

    if synsets1 and synsets2:
        return synsets1[0].wup_similarity(synsets2[0])
    return None

# Test semantic similarity on word pairs
word_pairs = [
    ("doctor", "physician"),
    ("football", "soccer"),
    ("diet", "nutrition"),
    ("government", "administration"),
    ("technology", "innovation")
]

for w1, w2 in word_pairs:
    print(f"{w1} - {w2} :", wordnet_similarity(w1, w2))
```

```
doctor - physician : 1.0
football - soccer : 0.96
diet - nutrition : 0.3333333333333333
government - administration : 0.26666666666666666
technology - innovation : 0.125
```

```
"""
Visualization of cosine similarity matrix using a heatmap.
Brighter colors indicate higher similarity between documents.
"""

import matplotlib.pyplot as plt

# Create a figure
plt.figure(figsize=(10, 8))

# Display cosine similarity as an image
plt.imshow(cosine_sim_matrix)

# Add color bar
plt.colorbar()

# Add labels
plt.title("Cosine Similarity Heatmap (TF-IDF)")
plt.xlabel("Document Index")
plt.ylabel("Document Index")

# Show plot
plt.show()
```


Cosine Similarity Heatmap (TF-IDF)
Document Index
Document Index
0
5
10
15
20
25
1.0
0.8
0.6
0.4
0.2
0.0