Output

August 18, 2024

1 ADA - ETE-3

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1.1 Import Libraries

[ ]:
```
import asyncpraw
import nest_asyncio
import asyncio
import pandas as pd
import re
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.preprocessing import LabelEncoder
from sklearn.linear_model import LogisticRegression
from sklearn.svm import SVC
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score, precision_score, recall_score,␣
 ↪f1_score
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import LSTM, Dense, Embedding, SpatialDropout1D
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.preprocessing.text import Tokenizer
import matplotlib.pyplot as plt
from wordcloud import WordCloud
import seaborn as sns
import gensim
import pyLDAvis
import pyLDAvis.gensim_models as gensimvis
from gensim import corpora
import warnings
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize, sent_tokenize
from nltk.stem import WordNetLemmatizer


warnings.filterwarnings("ignore")
```

```
# Allow nested event loops
nest_asyncio.apply()
```

1.2 Set up the reddit environment

[ ]:
```
reddit = asyncpraw.Reddit(
    client_id="",
    client_secret="",
    user_agent="",
    username="",
    password="",
)
```

1.3 Scrape the comments data from the subreddit

[ ]:
```
async def get_comments(subreddit_name, num_comments=2000):
    subreddit = await reddit.subreddit(subreddit_name)
    comments = []
    async for comment in subreddit.comments(limit=num_comments):
        comments.append(
            {
                "subreddit": subreddit_name,
                "comment_body": comment.body,
                "upvotes": comment.score,
            }
        )
    return comments


async def main():
    subreddits = [
        "Python",
        "DataScience",
        "MachineLearning",
        "DataAnalysis",
        "DataMining",
        "Data",
        "DataSets",
        "DataCenter"]

    all_comments = []

    for subreddit in subreddits:
        comments = await get_comments(
            subreddit, num_comments=5000
        )  # Adjust the number as needed
        all_comments.extend(comments)
```

```
    # Convert to DataFrame
    df = pd.DataFrame(all_comments)
    df.to_csv("reddit_comments_new.csv", index=False)
    print(f"Extracted {len(df)} comments.")

loop = asyncio.get_event_loop()
loop.run_until_complete(main())
```

```
Extracted 7444 comments.
```

1.4 Data Cleaning and Data Information

[ ]:
```
# Load the extracted data
df = pd.read_csv('reddit_comments_new.csv')

# Step 1: Handle missing values
df.dropna(subset=['comment_body'], inplace=True)

# Step 2: Handle duplicates
df.drop_duplicates(subset=['comment_body'], inplace=True)
#   outliers  and  perform  necessary transformations.
# Step 3: Handle outliers
df = df[df['comment_body'].apply(lambda x: len(x.split()) > 2)]


print(df.head())

print(df['subreddit'].value_counts())
```

```
  subreddit                                       comment_body  upvotes
0    Python                  Do you set any internal API keys?         1
2    Python                                        Beat me to it        1
3    Python  No disrespect intended, but you're trying to r…         1
4    Python  Hi there, from the /r/Python mods.\n\nIt looks…         1
5    Python  * Scraping courses and tours from a website to…         1
subreddit
DataCenter         934
Python             859
DataMining         847
Data               803
DataScience        763
DataSets           763
MachineLearning    733
DataAnalysis       645
Name: count, dtype: int64
```

2 Data Preprocessing

[ ]:
```
# Step 3: Clean the text data
def clean_text(text):
    # tokenize the text
    text = word_tokenize(text)
    # remove special characters
    text = [re.sub(r"[^a-zA-Z0-9]+", ' ', word) for word in text]
    # remove words with digits
    text = [word for word in text if not any(c.isdigit() for c in word)]
    # convert to lower case
    text = [word.lower() for word in text]
    # remove stopwords
    text = [word for word in text if word not in stopwords.words('english')]
    # lemmatize the words
    lemmatizer = WordNetLemmatizer()
    text = [lemmatizer.lemmatize(word) for word in text]
    # join the words
    text = ' '.join(text)
    # remove some special characters
    text = re.sub(r'[^\w\s]', '', text)
    # remove specific words
    words =␣
 ↪['http','com','www','reddit','comment','comments','http','https','org','jpg','png','gif','j
    text = ' '.join(word for word in text.split() if word not in words)
    return text


# Apply the cleaning function to the 'comment_body' column
df["cleaned_comment"] = df["comment_body"].apply(clean_text)

df.head()
```

[ ]:
```
  subreddit                                       comment_body  upvotes  \
0    Python                  Do you set any internal API keys?        1
2    Python                                        Beat me to it        1
3    Python  No disrespect intended, but you're trying to r…        1
4    Python  Hi there, from the /r/Python mods.\n\nIt looks…        1
5    Python  * Scraping courses and tours from a website to…        1

                                  cleaned_comment
0                              set internal api key
2                                             beat
3  disrespect intended re trying reinvent wheel r…
4  hi r python mod look like asking help suggest …
5  scraping course tour website make r feed makin…
```

2.1 Display the count of comments for each subreddits

[ ]:
```
print(df['subreddit'].value_counts())
```

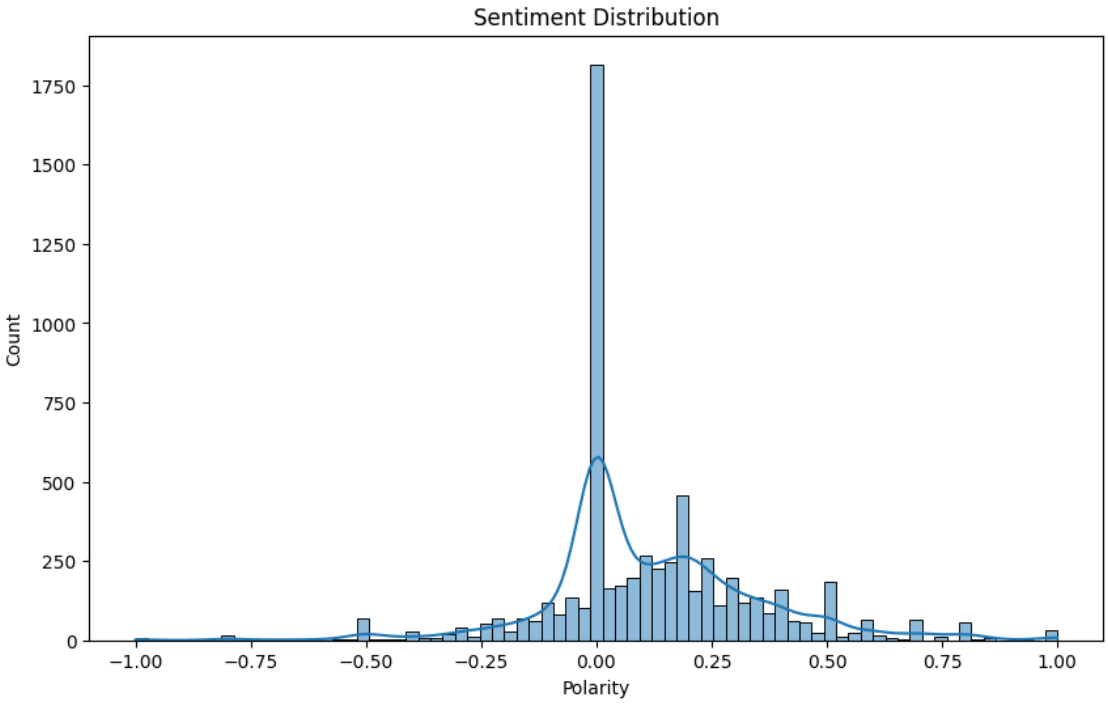
```
subreddit
DataCenter          934
Python              859
DataMining          847
Data                803
DataScience         763
DataSets            763
MachineLearning     733
DataAnalysis        645
Name: count, dtype: int64
```

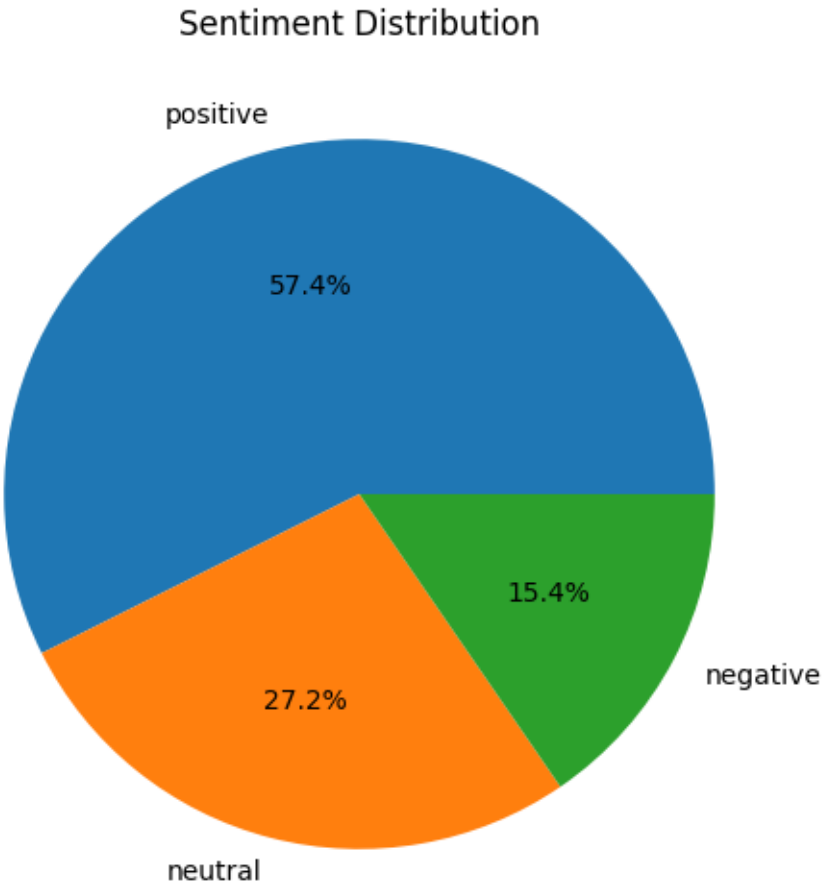
2.2 Display WordCloud

[ ]:
```
# Combine all comments into a single string
text = " ".join(comment for comment in df.cleaned_comment)

# Generate the word cloud
wordcloud = WordCloud(width=800, height=400, background_color ='white').
 ↪generate(text)

# Display the word cloud
plt.figure(figsize=(10, 6))
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```

2.3 1. Sentiment Analysis using TextBlob

[ ]:
```
# Sentiment Analysis
from textblob import TextBlob

# Calculate the sentiment of each comment
df['polarity'] = df['cleaned_comment'].apply(lambda x: TextBlob(x).sentiment.
 ↪polarity)

# categorize the sentiment
df['sentiment'] = df['polarity'].apply(lambda x: 'positive' if x > 0 else␣
 ↪'negative' if x < 0 else 'neutral')

# Display the sentiment distribution
plt.figure(figsize=(10, 6))
sns.histplot(df['polarity'], kde=True)
plt.title('Sentiment Distribution')
plt.xlabel('Polarity')
plt.ylabel('Count')
plt.show()

# pie chart
plt.figure(figsize=(10, 6))
df['sentiment'].value_counts().plot.pie(autopct='%1.1f%%')
plt.title('Sentiment Distribution')
plt.ylabel('')
plt.show()
```





2.4 2. Topic Modelling using LDA

[ ]:
```
stop_words = set(stopwords.words("english"))

def preprocess(text):
    # Tokenize the text
    tokens = word_tokenize(text.lower())
    # Remove stopwords and non-alphabetic tokens
    tokens = [word for word in tokens if word.isalpha() and word not in␣
 ↪stop_words]
    return tokens


# Apply preprocessing to the cleaned comments
```

```
df["tokens"] = df["cleaned_comment"].apply(preprocess)

# Create a dictionary and corpus for LDA
dictionary = corpora.Dictionary(df["tokens"])
corpus = [dictionary.doc2bow(text) for text in df["tokens"]]

# Set parameters for LDA
num_topics = 5  # You can adjust the number of topics
passes = 15  # Number of passes through the corpus during training

# Train the LDA model
lda_model = gensim.models.ldamodel.LdaModel(
    corpus, num_topics=num_topics, id2word=dictionary, passes=passes
)

# Print the topics
topics = lda_model.print_topics(num_words=5)
for topic in topics:
    print(topic)

import pyLDAvis
import pyLDAvis.gensim_models as gensimvis
import gensim

# Assuming your LDA model and other variables are already defined
lda_display = gensimvis.prepare(lda_model, corpus, dictionary,␣
 ↪sort_topics=False)
pyLDAvis.display(lda_display)
```

```
(0, '0.032*"post" + 0.021*"please" + 0.021*"r" + 0.018*"message" +
0.015*"thank"')
(1, '0.014*"cooling" + 0.010*"power" + 0.010*"rack" + 0.007*"ups" +
0.007*"system"')
(2, '0.016*"data" + 0.011*"n" + 0.010*"like" + 0.010*"would" + 0.010*"get"')
(3, '0.018*"data" + 0.011*"n" + 0.011*"use" + 0.009*"would" + 0.009*"need"')
(4, '0.015*"data" + 0.014*"power" + 0.013*"center" + 0.009*"get" +
0.007*"like"')
```

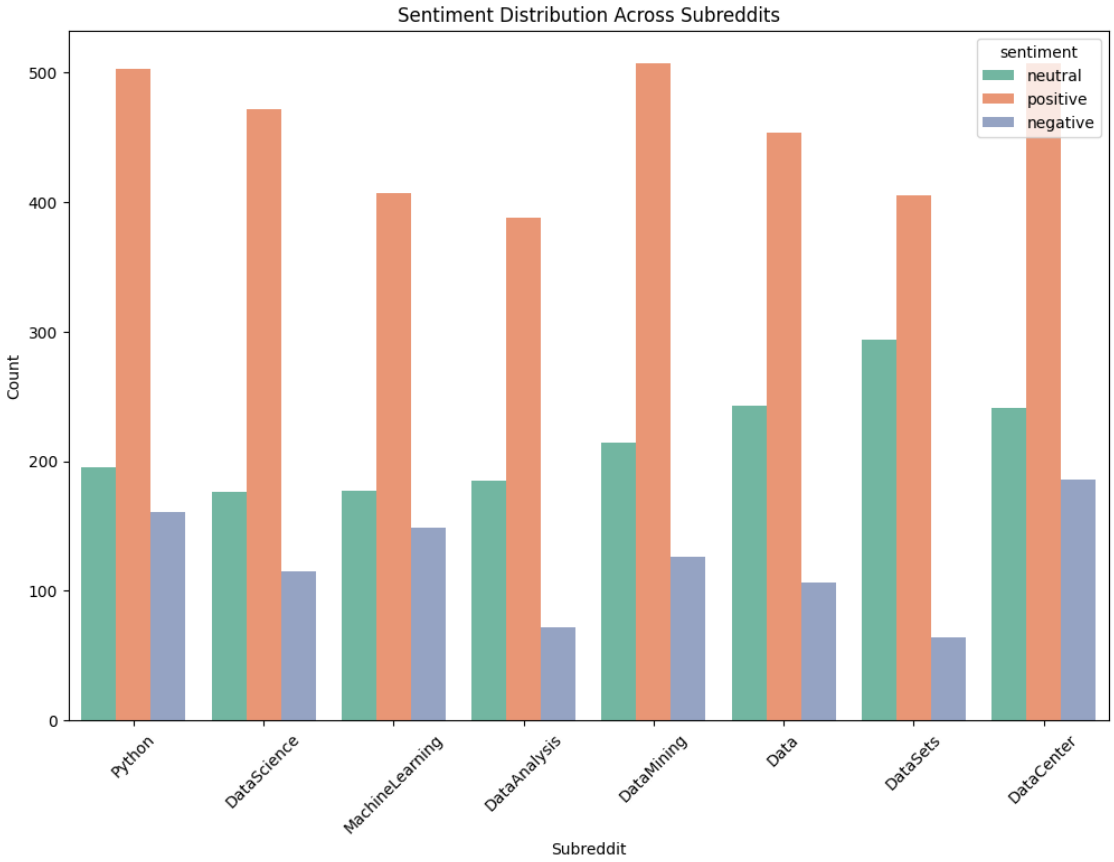
```
/home/visesh/miniconda3/lib/python3.12/site-packages/pytz/tzinfo.py:27:
DeprecationWarning: datetime.datetime.utcfromtimestamp() is deprecated and
scheduled for removal in a future version. Use timezone-aware objects to
represent datetimes in UTC: datetime.datetime.fromtimestamp(timestamp,
datetime.UTC).
  _epoch = datetime.utcfromtimestamp(0)
/home/visesh/miniconda3/lib/python3.12/site-packages/pytz/tzinfo.py:27:
DeprecationWarning: datetime.datetime.utcfromtimestamp() is deprecated and
scheduled for removal in a future version. Use timezone-aware objects to
represent datetimes in UTC: datetime.datetime.fromtimestamp(timestamp,
```

```
datetime.UTC).
  _epoch = datetime.utcfromtimestamp(0)
/home/visesh/miniconda3/lib/python3.12/site-packages/pytz/tzinfo.py:27:
DeprecationWarning: datetime.datetime.utcfromtimestamp() is deprecated and
scheduled for removal in a future version. Use timezone-aware objects to
represent datetimes in UTC: datetime.datetime.fromtimestamp(timestamp,
datetime.UTC).
  _epoch = datetime.utcfromtimestamp(0)
/home/visesh/miniconda3/lib/python3.12/site-packages/pytz/tzinfo.py:27:
DeprecationWarning: datetime.datetime.utcfromtimestamp() is deprecated and
scheduled for removal in a future version. Use timezone-aware objects to
represent datetimes in UTC: datetime.datetime.fromtimestamp(timestamp,
datetime.UTC).
  _epoch = datetime.utcfromtimestamp(0)
```

[ ]:
```
<IPython.core.display.HTML object>
```

2.5 3. Subreddit-Specific Analysis

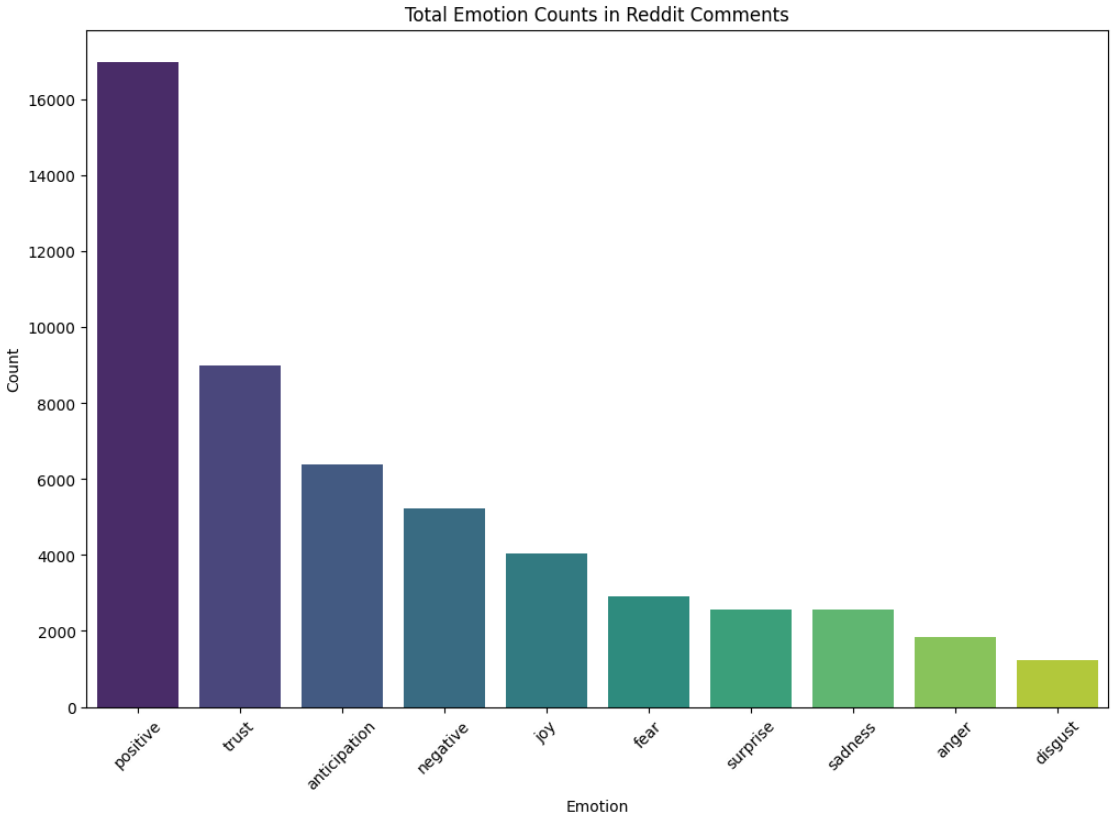
[ ]:
```python
# Display sentiment distribution across subreddits
plt.figure(figsize=(12, 8))
sns.countplot(x="subreddit", hue="sentiment", data=df, palette="Set2")
plt.title("Sentiment Distribution Across Subreddits")
plt.xlabel("Subreddit")
plt.ylabel("Count")
plt.xticks(rotation=45)
plt.show()
```



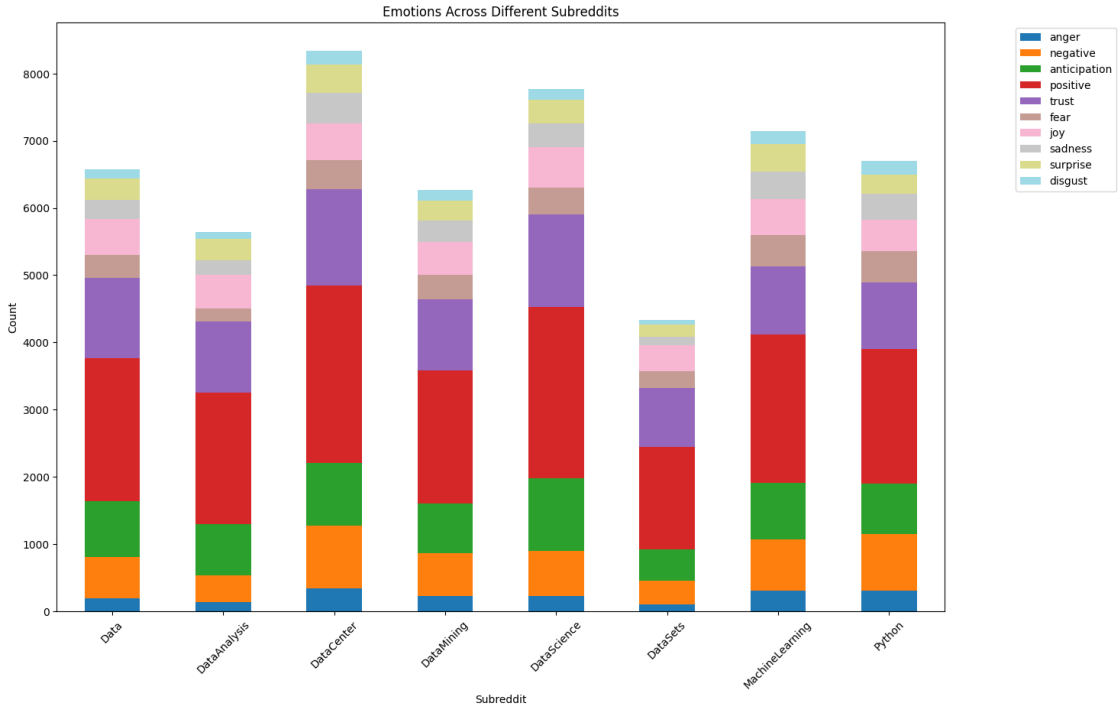
2.6 4. Emotion Analysis

[ ]:
```
from nrclex import NRCLex

# Function to perform emotion analysis
def analyze_emotions(text):
    emotion = NRCLex(text)
    return emotion.raw_emotion_scores


# Apply the emotion analysis to each cleaned comment
df["emotions"] = df["cleaned_comment"].apply(analyze_emotions)

# Convert the dictionary of emotions into individual columns
emotion_df = df["emotions"].apply(pd.Series).fillna(0)

# Add the emotion columns back to the original dataframe
df = pd.concat([df, emotion_df], axis=1)
```

```
# Display the sum of each emotion across the entire dataset
emotion_totals = emotion_df.sum().sort_values(ascending=False)
plt.figure(figsize=(12, 8))
sns.barplot(x=emotion_totals.index, y=emotion_totals.values, palette="viridis")
plt.title("Total Emotion Counts in Reddit Comments")
plt.xlabel("Emotion")
plt.ylabel("Count")
plt.xticks(rotation=45)
plt.show()

# If you want to visualize emotions across different subreddits:
plt.figure(figsize=(12, 8))
emotion_sums_by_subreddit = emotion_df.groupby(df["subreddit"]).sum()
emotion_sums_by_subreddit.plot(
    kind="bar", stacked=True, figsize=(15, 10), colormap="tab20"
)
plt.title("Emotions Across Different Subreddits")
plt.xlabel("Subreddit")
plt.ylabel("Count")
plt.xticks(rotation=45)
plt.legend(loc="upper right", bbox_to_anchor=(1.2, 1))
plt.show()
```



<Figure size 1200x800 with 0 Axes>

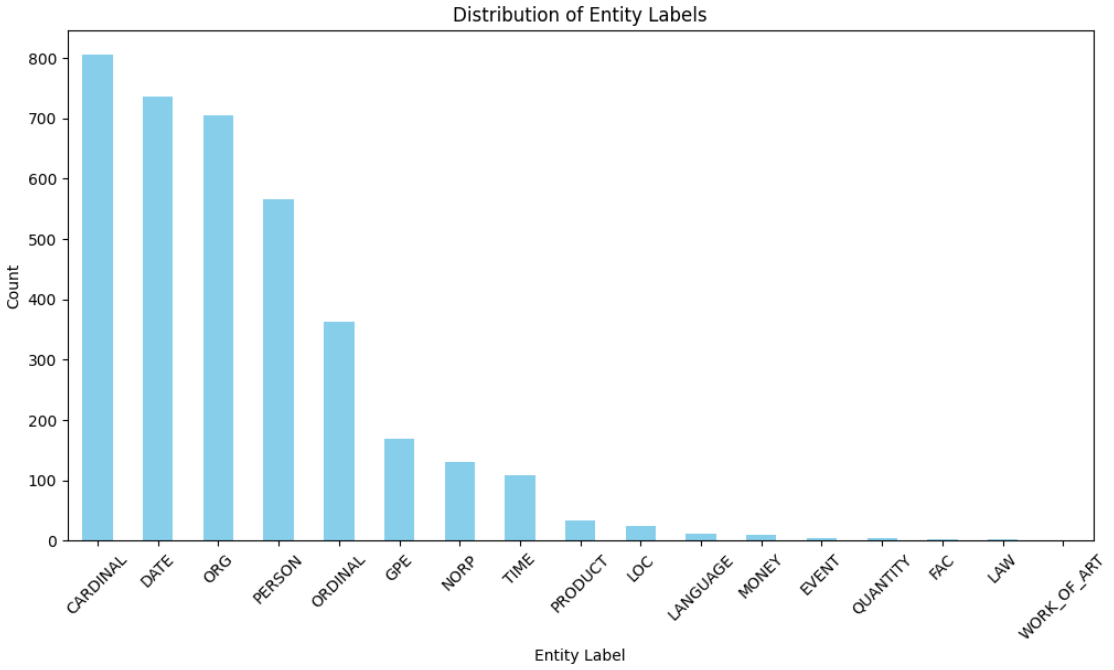


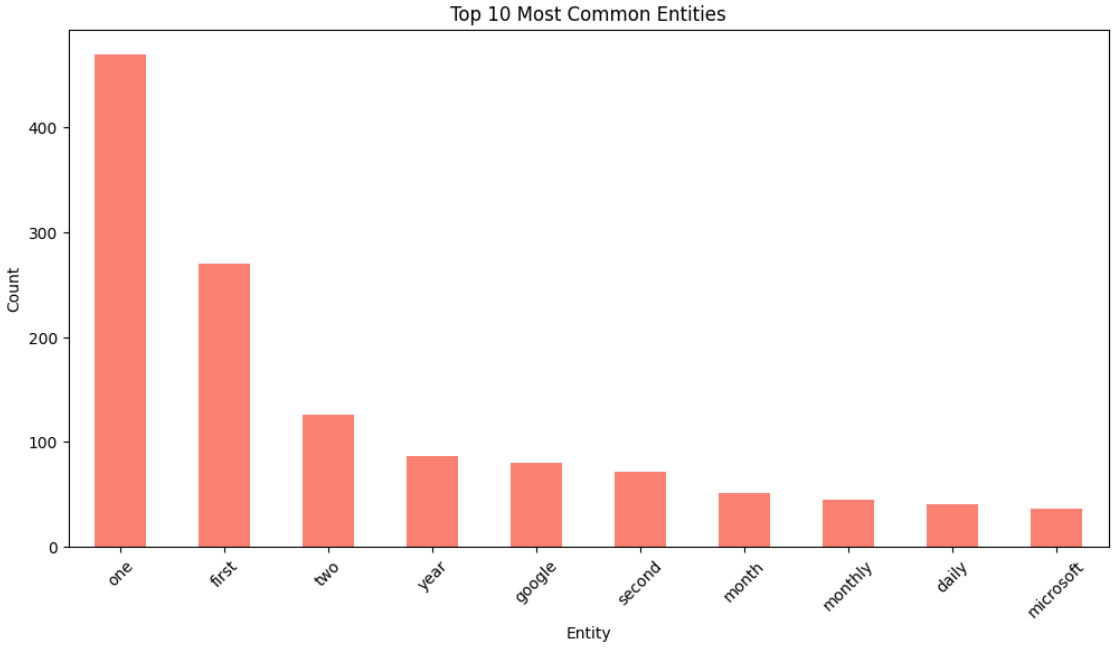
3 5. Named Entity Recognition

[ ]:
```
import spacy
import pandas as pd
import matplotlib.pyplot as plt
from collections import Counter

# Load the spaCy model
nlp = spacy.load("en_core_web_sm")


# Function to perform NER and extract entities
def extract_entities(text):
    doc = nlp(text)
    entities = [(ent.text, ent.label_) for ent in doc.ents]
    return entities


# Apply the NER function to each comment
df["entities"] = df["cleaned_comment"].apply(extract_entities)
```

```python
# Display the first few rows to see the extracted entities
print(df[["cleaned_comment", "entities"]].head())

# Flatten the list of entities to analyze them
all_entities = [entity for sublist in df["entities"] for entity in sublist]

# Create a DataFrame of entities and their labels
entities_df = pd.DataFrame(all_entities, columns=["Entity", "Label"])

# Count the frequency of each entity label
label_counts = entities_df["Label"].value_counts()

# Plot the distribution of entity labels
plt.figure(figsize=(12, 6))
label_counts.plot(kind="bar", color="skyblue")
plt.title("Distribution of Entity Labels")
plt.xlabel("Entity Label")
plt.ylabel("Count")
plt.xticks(rotation=45)
plt.show()

# If you want to see the most common entities
top_entities = entities_df["Entity"].value_counts().head(10)

# Plot the most common entities
plt.figure(figsize=(12, 6))
top_entities.plot(kind="bar", color="salmon")
plt.title("Top 10 Most Common Entities")
plt.xlabel("Entity")
plt.ylabel("Count")
plt.xticks(rotation=45)
plt.show()
```

```
                                cleaned_comment entities
0                            set internal api key       []
2                                            beat       []
3  disrespect intended re trying reinvent wheel r…       []
4  hi r python mod look like asking help suggest …       []
5  scraping course tour website make r feed makin…       []
```


Distribution of Entity Labels
Count
Entity Label
0
100
200
300
400
500
600
700
800
CARDINAL
DATE
ORG
PERSON
ORDINAL
GPE
NORP
TIME
PRODUCT
LOC
LANGUAGE
MONEY
EVENT
QUANTITY
FAC
LAW
WORK_OF_ART


Top 10 Most Common Entities
Count
Entity
0
100
200
300
400
one
first
two
year
google
second
month
monthly
daily
microsoft

4 1. SVM Classifier

[ ]:
```
# SVM
from sklearn.metrics import roc_auc_score, accuracy_score, precision_score,␣
 ↪recall_score, f1_score
from sklearn.preprocessing import LabelEncoder
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.svm import SVC

# Encode the target variable
label_encoder = LabelEncoder()
df["subreddit_label"] = label_encoder.fit_transform(df["subreddit"])

# Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(
    df["cleaned_comment"], df["subreddit_label"], test_size=0.2, random_state=42
)

# Vectorize the text data
vectorizer = TfidfVectorizer()
X_train_vectorized = vectorizer.fit_transform(X_train)
X_test_vectorized = vectorizer.transform(X_test)

# Train the SVM model
svm_model = SVC(kernel="linear", probability=True)  # Enable probability␣
 ↪estimates
svm_model.fit(X_train_vectorized, y_train)

# Make predictions
y_pred = svm_model.predict(X_test_vectorized)

# Evaluate the model
accuracy = accuracy_score(y_test, y_pred)
precision = precision_score(y_test, y_pred, average="weighted")
recall = recall_score(y_test, y_pred, average="weighted")
f1 = f1_score(y_test, y_pred, average="weighted")

# Calculate ROC AUC Score
if hasattr(svm_model, "predict_proba"):
    y_prob = svm_model.predict_proba(X_test_vectorized)
    roc_auc = roc_auc_score(y_test, y_prob, multi_class="ovr",␣
 ↪average="weighted")
else:
    roc_auc = None

print(f"SVM Model Accuracy: {accuracy}")
```

```
print(f"SVM Model Precision: {precision}")
print(f"SVM Model Recall: {recall}")
print(f"SVM Model F1 Score: {f1}")
print(f"SVM Model ROC AUC Score: {roc_auc}")
```

```
SVM Model Accuracy: 0.5236220472440944
SVM Model Precision: 0.5334834104292766
SVM Model Recall: 0.5236220472440944
SVM Model F1 Score: 0.5257469696915541
SVM Model ROC AUC Score: 0.8535771718938111
```

5 2. Logistic Regression Classifier

[ ]:
```
# logistic regression

# Encode the target variable
label_encoder = LabelEncoder()
df["subreddit_label"] = label_encoder.fit_transform(df["subreddit"])

# Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(
    df["cleaned_comment"], df["subreddit_label"], test_size=0.2, random_state=42
)

# Vectorize the text data
vectorizer = TfidfVectorizer()
X_train_vectorized = vectorizer.fit_transform(X_train)
X_test_vectorized = vectorizer.transform(X_test)

# Train the Logistic Regression model
lr_model = LogisticRegression(max_iter=1000)
lr_model.fit(X_train_vectorized, y_train)

# Make predictions
y_pred_lr = lr_model.predict(X_test_vectorized)

# Evaluate the model
accuracy_lr = accuracy_score(y_test, y_pred_lr)
precision_lr = precision_score(y_test, y_pred_lr, average="weighted")
recall_lr = recall_score(y_test, y_pred_lr, average="weighted")
f1_lr = f1_score(y_test, y_pred_lr, average="weighted")

# Calculate ROC AUC Score using predict_proba
if hasattr(lr_model, "predict_proba"):
    y_prob_lr = lr_model.predict_proba(X_test_vectorized)
    roc_auc_lr = roc_auc_score(y_test, y_prob_lr, multi_class="ovr",␣
 ↪average="weighted")
```

```
else:
    roc_auc_lr = None

print(f"Logistic Regression Model Accuracy: {accuracy_lr}")
print(f"Logistic Regression Model Precision: {precision_lr}")
print(f"Logistic Regression Model Recall: {recall_lr}")
print(f"Logistic Regression Model F1 Score: {f1_lr}")
print(f"Logistic Regression Model ROC AUC Score: {roc_auc_lr}")
```

```
Logistic Regression Model Accuracy: 0.5417322834645669
Logistic Regression Model Precision: 0.5451372094171405
Logistic Regression Model Recall: 0.5417322834645669
Logistic Regression Model F1 Score: 0.5361759238916388
Logistic Regression Model ROC AUC Score: 0.8576761060692843
```

5.1 3. Random Forest Classifier

[ ]:
```
# random forest
# Train the Random Forest model
rf_model = RandomForestClassifier()
rf_model.fit(X_train_vectorized, y_train)

# Make predictions
y_pred_rf = rf_model.predict(X_test_vectorized)

# Evaluate the model
accuracy_rf = accuracy_score(y_test, y_pred_rf)
precision_rf = precision_score(y_test, y_pred_rf, average="weighted")
recall_rf = recall_score(y_test, y_pred_rf, average="weighted")
f1_rf = f1_score(y_test, y_pred_rf, average="weighted")

# Calculate ROC AUC Score using predict_proba
if hasattr(rf_model, "predict_proba"):
    y_prob_rf = rf_model.predict_proba(X_test_vectorized)
    roc_auc_rf = roc_auc_score(y_test, y_prob_rf, multi_class="ovr",␣
 ↪average="weighted")
else:
    roc_auc_rf = None


print(f"Random Forest Model Accuracy: {accuracy_rf}")
print(f"Random Forest Model Precision: {precision_rf}")
print(f"Random Forest Model Recall: {recall_rf}")
print(f"Random Forest Model F1 Score: {f1_rf}")
print(f"Random Forest Model ROC AUC Score: {roc_auc_rf}")
```

```
Random Forest Model Accuracy: 0.48503937007874015
Random Forest Model Precision: 0.4884237407707543
```

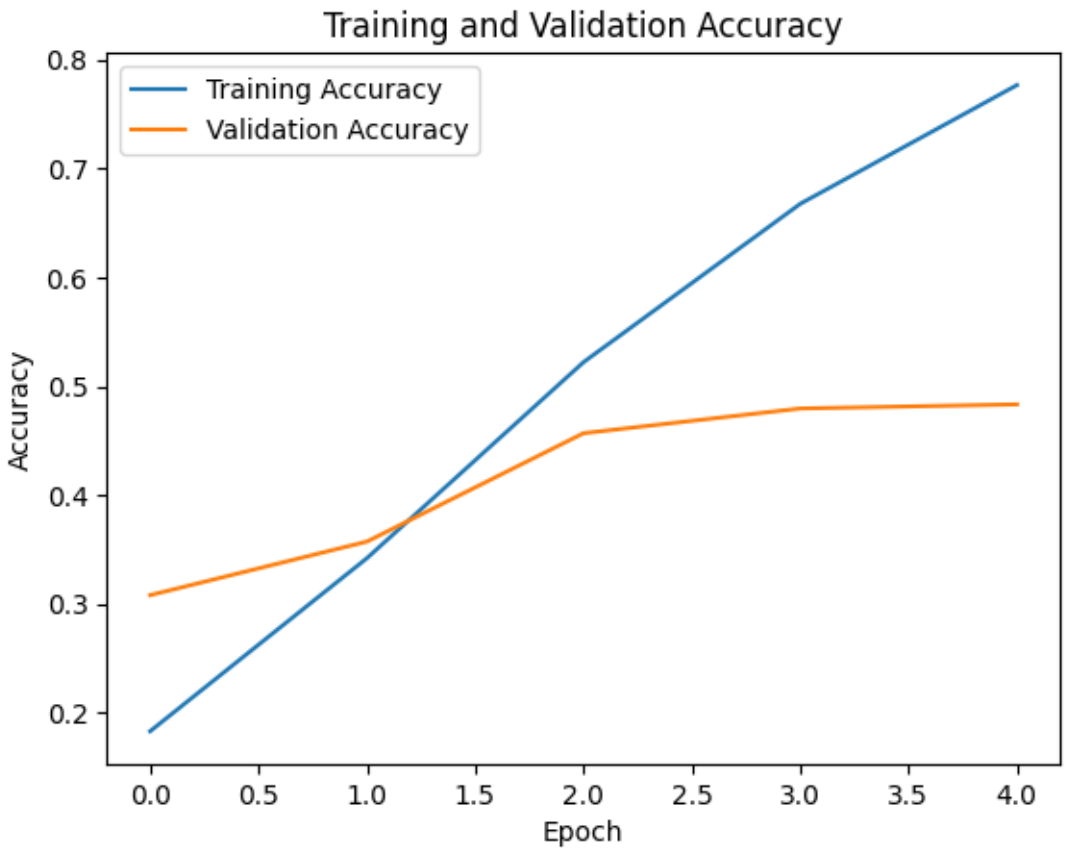
```
Random Forest Model Recall: 0.48503937007874015
Random Forest Model F1 Score: 0.4778307445701116
Random Forest Model ROC AUC Score: 0.8191243941901507
```

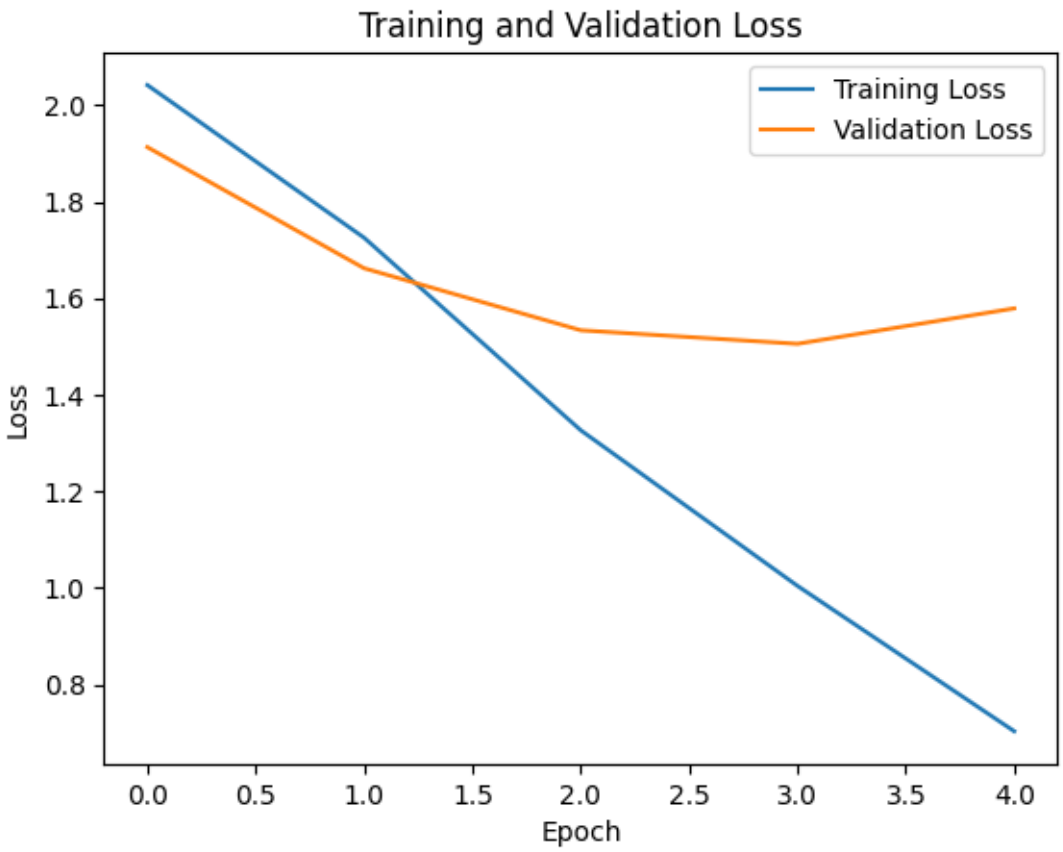
5.2 4. LSTM Model

[ ]:
```
# LSTM
# Tokenize the text data
tokenizer = Tokenizer()
tokenizer.fit_on_texts(df["cleaned_comment"])
X = tokenizer.texts_to_sequences(df["cleaned_comment"])
X = pad_sequences(X)

# Split the data into training and testing sets
X_train_lstm, X_test_lstm, y_train_lstm, y_test_lstm = train_test_split(
    X, df["subreddit_label"], test_size=0.2, random_state=42
)

# Create the LSTM model
lstm_model = Sequential()
lstm_model.add(Embedding(len(tokenizer.word_index) + 1, 128))
lstm_model.add(SpatialDropout1D(0.2))
lstm_model.add(LSTM(196, dropout=0.2, recurrent_dropout=0.2))
lstm_model.add(Dense(8, activation="softmax"))

lstm_model.compile(loss="sparse_categorical_crossentropy", optimizer="adam",␣
 ↪metrics=["accuracy"])

# Train the LSTM model
history = lstm_model.fit(
    X_train_lstm, y_train_lstm, epochs=5, batch_size=64,␣
 ↪validation_data=(X_test_lstm, y_test_lstm)
)

# Evaluate the LSTM model
loss, accuracy_lstm = lstm_model.evaluate(X_test_lstm, y_test_lstm)
print(f"LSTM Model Accuracy: {accuracy_lstm}")

# Plot the training and validation accuracy
plt.plot(history.history["accuracy"], label="Training Accuracy")
plt.plot(history.history["val_accuracy"], label="Validation Accuracy")
plt.title("Training and Validation Accuracy")
plt.xlabel("Epoch")
plt.ylabel("Accuracy")
plt.legend()
plt.show()
```

```
# Plot the training and validation loss
plt.plot(history.history["loss"], label="Training Loss")
plt.plot(history.history["val_loss"], label="Validation Loss")
plt.title("Training and Validation Loss")
plt.xlabel("Epoch")
plt.ylabel("Loss")
plt.legend()
plt.show()
```

```
Epoch 1/5
75/75             121s 2s/step -
accuracy: 0.1536 - loss: 2.0680 - val_accuracy: 0.3081 - val_loss: 1.9128
Epoch 2/5
75/75             121s 2s/step -
accuracy: 0.3182 - loss: 1.8124 - val_accuracy: 0.3573 - val_loss: 1.6621
Epoch 3/5
75/75             114s 2s/step -
accuracy: 0.4873 - loss: 1.3854 - val_accuracy: 0.4568 - val_loss: 1.5337
Epoch 4/5
75/75             114s 2s/step -
accuracy: 0.6590 - loss: 1.0377 - val_accuracy: 0.4795 - val_loss: 1.5056
Epoch 5/5
75/75             115s 2s/step -
accuracy: 0.7753 - loss: 0.7152 - val_accuracy: 0.4833 - val_loss: 1.5790
50/50             16s 314ms/step -
accuracy: 0.4742 - loss: 1.5975
LSTM Model Accuracy: 0.4833018183708191
```


Training and Validation Accuracy
Training Accuracy
Validation Accuracy
Accuracy
Epoch
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0



[ ]:
```python
# Score the LSTM model
import numpy as np

def score_model(model, X_test, y_test):
    y_pred = model.predict(X_test)
    y_pred = [np.argmax(pred) for pred in y_pred]
    accuracy = accuracy_score(y_test, y_pred)
    precision = precision_score(y_test, y_pred, average="weighted")
    recall = recall_score(y_test, y_pred, average="weighted")
    f1 = f1_score(y_test, y_pred, average="weighted")
    # Calculate ROC AUC Score using predict_proba
    if hasattr(model, "predict_proba"):
        y_prob = model.predict_proba(X_test)
        roc_auc = roc_auc_score(y_test, y_prob, multi_class="ovr",␣
 ↪average="weighted")
    else:
        roc_auc = None
    return accuracy, precision, recall, f1, roc_auc
```

```
# Score the LSTM model
accuracy_lstm, precision_lstm, recall_lstm, f1_lstm, roc_auc_lstm = score_model(
    lstm_model, X_test_lstm, y_test_lstm
)

print(f"LSTM Model Accuracy: {accuracy_lstm}")
print(f"LSTM Model Precision: {precision_lstm}")
print(f"LSTM Model Recall: {recall_lstm}")
print(f"LSTM Model F1 Score: {f1_lstm}")
print(f"LSTM Model ROC AUC Score: {roc_auc_lstm}")
```

```
50/50             16s 324ms/step
LSTM Model Accuracy: 0.48330182734719596
LSTM Model Precision: 0.4831033085454357
LSTM Model Recall: 0.48330182734719596
LSTM Model F1 Score: 0.47826518387389827
LSTM Model ROC AUC Score: None
```

5.3 5. KNN Classifier

[ ]:
```
# knn
from sklearn.neighbors import KNeighborsClassifier

# Train the KNN model
knn_model = KNeighborsClassifier(n_neighbors=5)
knn_model.fit(X_train_vectorized, y_train)

# Make predictions
y_pred_knn = knn_model.predict(X_test_vectorized)

# Evaluate the model
accuracy_knn = accuracy_score(y_test, y_pred_knn)
precision_knn = precision_score(y_test, y_pred_knn, average="weighted")
recall_knn = recall_score(y_test, y_pred_knn, average="weighted")
f1_knn = f1_score(y_test, y_pred_knn, average="weighted")
# Calculate ROC AUC Score using predict_proba
if hasattr(knn_model, "predict_proba"):
    y_prob_knn = knn_model.predict_proba(X_test_vectorized)
    roc_auc_knn = roc_auc_score(y_test, y_prob_knn, multi_class="ovr",␣
 ↪average="weighted")
else:
    roc_auc_knn = None

print(f"KNN Model Accuracy: {accuracy_knn}")
print(f"KNN Model Precision: {precision_knn}")
print(f"KNN Model Recall: {recall_knn}")
```

```
print(f"KNN Model F1 Score: {f1_knn}")
print(f"KNN Model ROC AUC Score: {roc_auc_knn}")
```

```
KNN Model Accuracy: 0.23070866141732282
KNN Model Precision: 0.32654453546842
KNN Model Recall: 0.23070866141732282
KNN Model F1 Score: 0.15102816632882568
KNN Model ROC AUC Score: 0.7203185418876082
```

5.4 Comparison of all the models

[ ]:
```
# Compare the performance of different models
models = ["SVM", "Logistic Regression", "Random Forest", "KNN", "LSTM"]
accuracies = [accuracy, accuracy_lr, accuracy_rf, accuracy_knn, accuracy_lstm]
precisions = [precision, precision_lr, precision_rf, precision_knn,␣
 ↪precision_lstm]
recalls = [recall, recall_lr, recall_rf, recall_knn, recall_lstm]
f1_scores = [f1, f1_lr, f1_rf, f1_knn, f1_lstm]
roc_auc_scores = [
    roc_auc,
    roc_auc_lr,
    roc_auc_rf,
    roc_auc_knn,
    roc_auc_lstm,
]

model_comparison = pd.DataFrame(
    {
        "Model": models,
        "Accuracy": accuracies,
        "Precision": precisions,
        "Recall": recalls,
        "F1 Score": f1_scores,
        "Rou_AUC": roc_auc_scores,
    }
)

print(model_comparison)

# Plot the model comparison
plt.figure(figsize=(12, 6))
plt.plot(models, accuracies, marker="o", label="Accuracy")
plt.plot(models, precisions, marker=".", label="Precision")
plt.plot(models, recalls, marker=".", label="Recall")
plt.plot(models, f1_scores, marker=".", label="F1 Score")
plt.plot(models, roc_auc_scores, marker=".", label="ROC AUC")
plt.title("Model Comparison")
```

```
plt.xlabel("Model")
plt.ylabel("Score")
plt.legend()
plt.xticks(rotation=45)
plt.show()
```

	Model	Accuracy	Precision	Recall	F1 Score	Rou_AUC
0	SVM	0.523622	0.533483	0.523622	0.525747	0.853577
1	Logistic Regression	0.541732	0.545137	0.541732	0.536176	0.857676
2	Random Forest	0.485039	0.488424	0.485039	0.477831	0.819124
3	KNN	0.230709	0.326545	0.230709	0.151028	0.720319
4	LSTM	0.483302	0.483103	0.483302	0.478265	NaN