Loading Libraries

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import nltk
from nltk.sentiment.vader import SentimentIntensityAnalyzer
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import classification_report, confusion_matrix, accuracy_score, precision_recall_fscore_support
from transformers import AutoTokenizer, AutoModel, AutoModelForSequenceClassification, Trainer, TrainingArguments
from torch.utils.data import DataLoader, Dataset
import torch
import torch.nn as nn
from datasets import Dataset, DatasetDict
```

Loading Data

```
data_review = pd.read_json("yelp_academic_dataset_review.json", nrows=50000, lines=True)
```

```
data_review.head()
```

	review_id	user_id	business_id	stars	useful	funny	cool	text	date
0	KU_O5udG6zpxOg-VcAEodg	mh_-eMZ6K5RLWhZyISBhwA	XQfwVwDr-v0ZS3_CbbE5Xw	3	0	0	0	If you decide to eat here, just be aware it is...	2018-07-07 22:09:11
1	BiTunyQ73aT9WBnpR9DZGw	OyoGAe7OKpv6SyGZT5g77Q	7ATYjTIgM3jUlt4UM3IypQ	5	1	0	1	I've taken a lot of spin classes over the year...	2012-01-03 15:28:18

```
data_review.shape
```

```
(50000, 9)
```

```
data_review.columns
```

```
Index(['review_id', 'user_id', 'business_id', 'stars', 'useful', 'funny',
       'cool', 'text', 'date'],
      dtype='object')
```

```
data = data_review.copy(deep=True)
```

Preprocess Data

```
print("\nPreprocessing Text Data...")
data['text_cleaned'] = (
    data['text']
    .str.lower()
    .str.replace(r'http\S+', '', regex=True)  # Remove URLs
    .str.replace(r'[^\w\s]', '', regex=True)  # Remove punctuation
    .str.replace(r'\d+', '', regex=True)     # Remove numbers
)
```

```

Preprocessing Text Data...
```

```
nltk.download('vader_lexicon')
```

```
[nltk_data] Downloading package vader_lexicon to
[nltk_data]     /home/dgilkey/nltk_data...
[nltk_data]   Package vader_lexicon is already up-to-date!
True
```

Sentiment Mapping

```
def map_sentiment(stars):
    if stars > 2:
        return 2  # Positive
    elif stars ==2:
        return 1  # Neutral
    else:
        return 0  # Negative
```

```
data['sentiment_label'] = data['stars'].apply(map_sentiment)
```

```
data.sentiment_label.value_counts()
```

```
2    40618
0     5379
1     4003
Name: sentiment_label, dtype: int64
```

```
data.stars.value_counts()
```

```
5    22220
4    12721
3     5677
1     5379
2     4003
Name: stars, dtype: int64
```

Data Preparation

```
X = data['text_cleaned']
y = data['sentiment_label']
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42,stratify=y)
```

Loading Transformer

```
print("\nLoading Transformer Model...")
model_name = "distilbert-base-uncased"
tokenizer = AutoTokenizer.from_pretrained(model_name)
model = AutoModel.from_pretrained(model_name)
```

```
/home/dgilkey/.local/lib/python3.10/site-packages/huggingface_hub/file_download.py:1132: FutureWarning: `resume_download
  warnings.warn(

Loading Transformer Model...
```

```
def generate_embeddings(texts, tokenizer, model, max_length=128):
    """Generate sentence embeddings using a transformer model."""
    tokens = tokenizer(texts, padding=True, truncation=True, max_length=max_length, return_tensors="pt")
    with torch.no_grad():
        outputs = model(**tokens)


    embeddings = outputs.last_hidden_state[:, 0, :].numpy()
    return embeddings
```

Embedding Generation

```
print("\nGenerating Embeddings for Training Data...")
X_train_embeddings = generate_embeddings(X_train.tolist(), tokenizer, model)
```

```

Generating Embeddings for Training Data...
```

```
print("Generating Embeddings for Testing Data...")
X_test_embeddings = generate_embeddings(X_test.tolist(), tokenizer, model)
```

Data Loader Preparation

```
from torch.utils.data import DataLoader, Dataset


class SentimentDataset(Dataset):
    def __init__(self, embeddings, labels):
        self.embeddings = torch.tensor(embeddings, dtype=torch.float32)
        # Convert labels to PyTorch long tensors
        self.labels = torch.tensor(labels.values, dtype=torch.long)

    def __len__(self):
        return len(self.labels)

    def __getitem__(self, idx):
        return self.embeddings[idx], self.labels[idx]


# Create Dataset
train_dataset = SentimentDataset(train_datasetX_train_embeddings, batch_size=32, shuffle=True)
test_loader = DataLoader(test_dataset, batch_size=32)
, y_train)
test_dataset = SentimentDataset(X_test_embeddings, y_test)

# Create DataLoaders
train_loader = DataLoader(
```

Sentiment Classifier

```
class SentimentClassifier(nn.Module):
    def __init__(self, input_dim, num_classes):
        super(SentimentClassifier, self).__init__()
        self.fc = nn.Sequential(
            nn.Linear(input_dim, 128),
            nn.ReLU(),
            nn.Dropout(0.3),
            nn.Linear(128, num_classes)
        )

    def forward(self, x):
        return self.fc(x)


input_dim = X_train_embeddings.shape[1]
num_classes = 3  # Negative, Neutral, Positive
model = SentimentClassifier(input_dim, num_classes)


criterion = nn.CrossEntropyLoss()
optimizer = torch.optim.Adam(model.parameters(), lr=1e-4)
```

Model Training

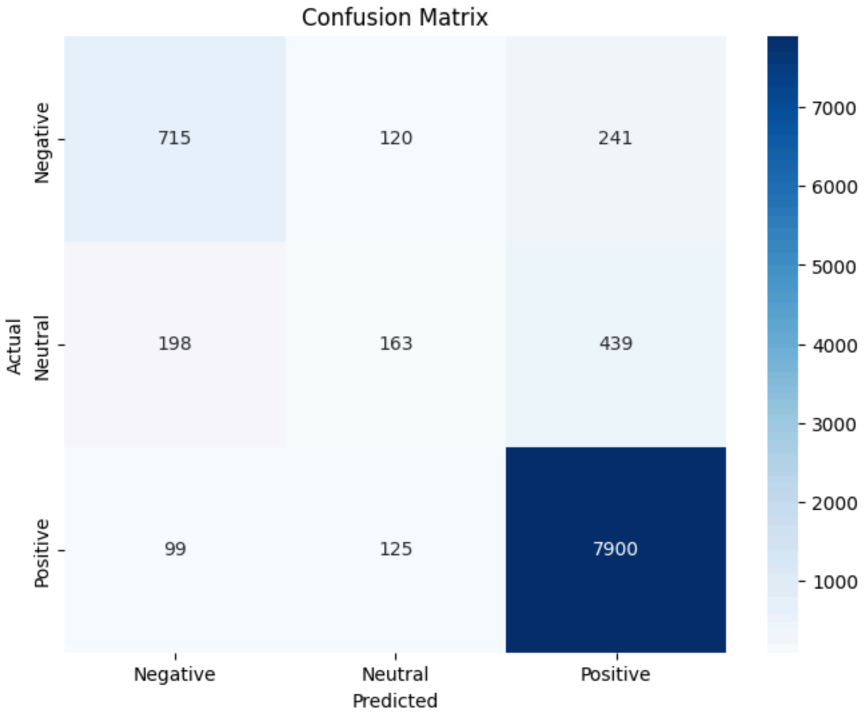
```
print("\nTraining the Model...")
epochs = 100
for epoch in range(epochs):
    model.train()
    epoch_loss = 0
    correct = 0
    total = 0

    for embeddings, labels in train_loader:
        optimizer.zero_grad()
        outputs = model(embeddings)
        loss = criterion(outputs, labels)
        loss.backward()
        optimizer.step()

        epoch_loss += loss.item()
        _, predicted = torch.max(outputs, 1)
        correct += (predicted == labels).sum().item()
        total += labels.size(0)

    print(f"Epoch {epoch + 1}/{epochs}, Loss: {epoch_loss:.4f}, Accuracy: {correct / total:.4f}")
```

Model Evaluation

```
print("\nEvaluating the Model...")
model.eval()
all_preds = []
all_labels = []
with torch.no_grad():
    for embeddings, labels in test_loader:
        outputs = model(embeddings)
        _, predicted = torch.max(outputs, 1)
        all_preds.extend(predicted.tolist())
        all_labels.extend(labels.tolist())

print("\nClassification Report:")
print(classification_report(all_labels, all_preds, target_names=["Negative", "Neutral", "Positive"]))
```

```
Evaluating the Model...

Classification Report:
              precision    recall  f1-score   support

    Negative       0.71      0.66      0.68      1076
     Neutral       0.40      0.20      0.27       800
    Positive       0.92      0.97      0.95      8124

    accuracy                           0.88     10000
   macro avg       0.68      0.61      0.63     10000
weighted avg       0.86      0.88      0.86     10000
```

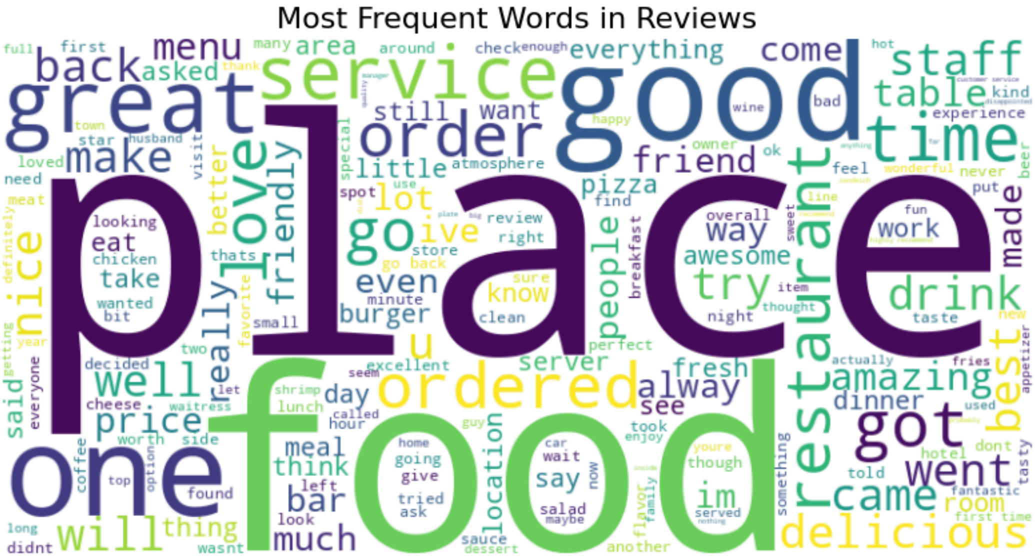
```
conf_matrix = confusion_matrix(all_labels, all_preds)
plt.figure(figsize=(8, 6))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues', xticklabels=["Negative", "Neutral", "Positive"], yticklabels=["N
plt.title('Confusion Matrix')
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.show()
```



Start coding or generate with AI.

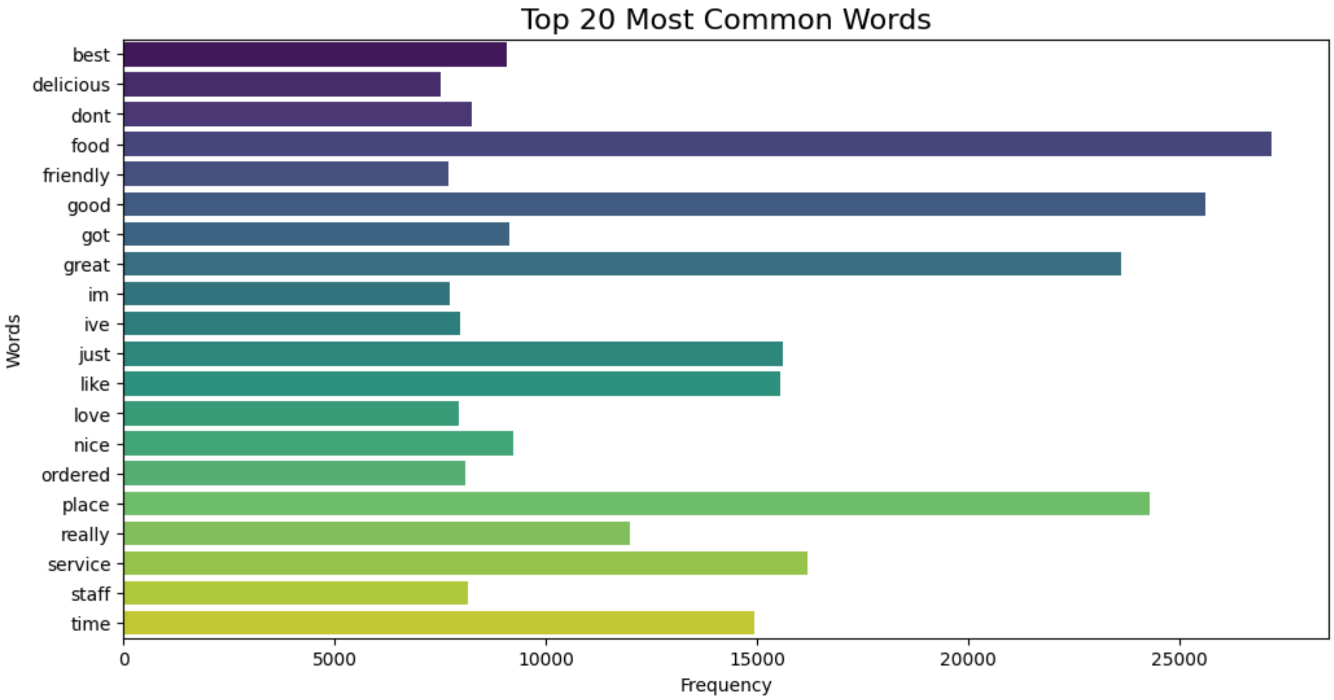
Visualizations

```
from wordcloud import WordCloud
from collections import Counter

# Generate Word Cloud
all_words = ' '.join(data['text_cleaned'])
wordcloud = WordCloud(width=800, height=400, background_color='white', colormap='viridis').generate(all_words)

# Plot Word Cloud
plt.figure(figsize=(10, 6))
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis('off')
plt.title("Most Frequent Words in Reviews", fontsize=16)
plt.show()
```

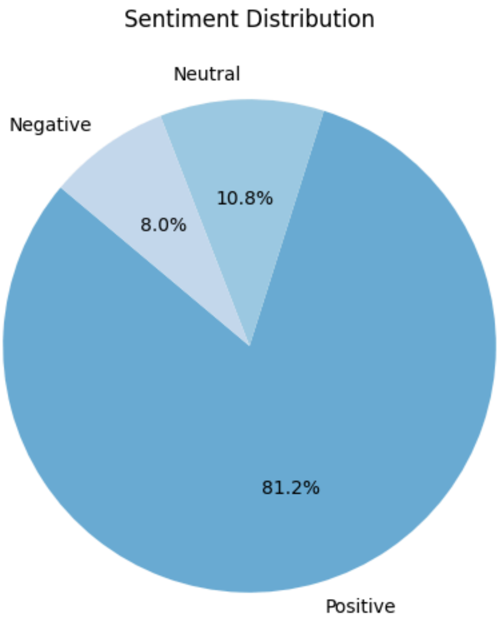


```
from sklearn.feature_extraction.text import CountVectorizer


vectorizer = CountVectorizer(stop_words='english', max_features=20)
word_counts = vectorizer.fit_transform(data['text_cleaned'])
word_freq = dict(zip(vectorizer.get_feature_names_out(), word_counts.toarray().sum(axis=0)))

# Bar Plot
plt.figure(figsize=(12, 6))
sns.barplot(x=list(word_freq.values()), y=list(word_freq.keys()), palette='viridis')
plt.title("Top 20 Most Common Words", fontsize=16)
plt.xlabel("Frequency")
plt.ylabel("Words")
plt.show()
```

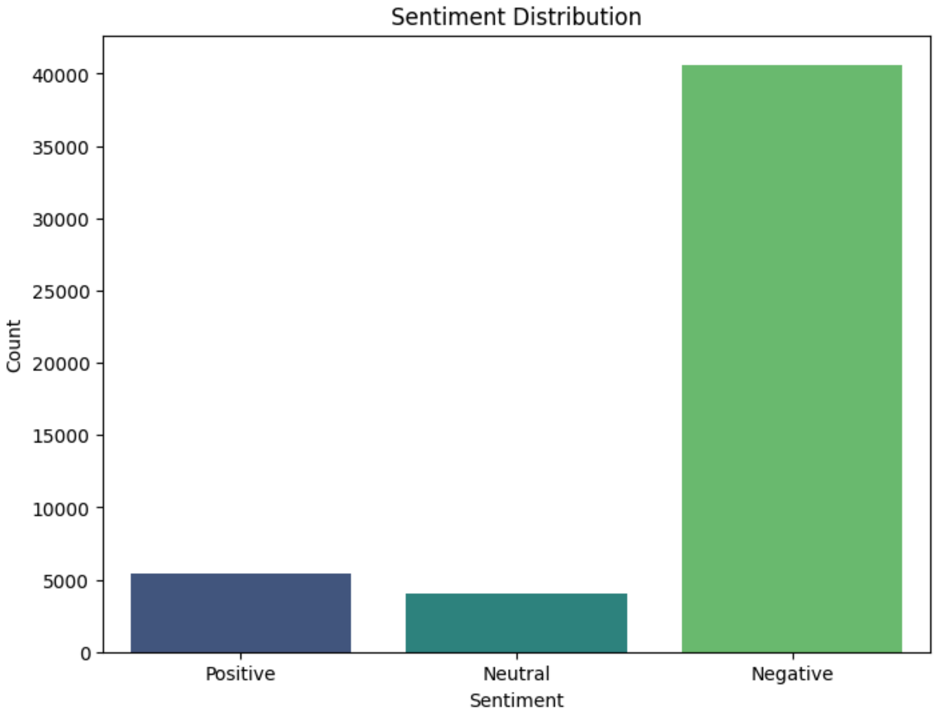
```
/tmp/ipykernel_1703355/357633920.py:10: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v0.14.0. Assign the `y` variable to `hue`

  sns.barplot(x=list(word_freq.values()), y=list(word_freq.keys()), palette='viridis')
```



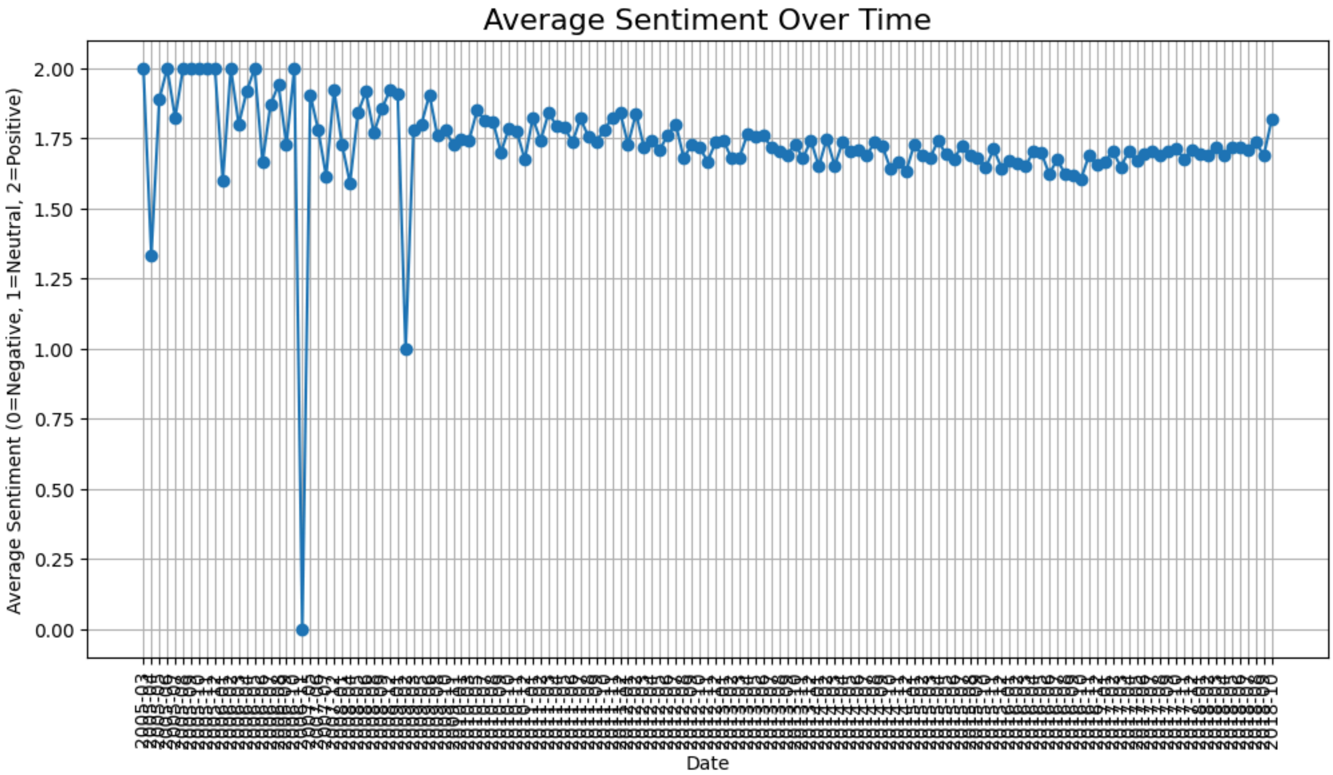
```
# Sentiment Distribution
sentiment_counts = data['sentiment_label'].value_counts()

# Pie Chart
plt.figure(figsize=(8, 6))
plt.pie(sentiment_counts, labels=["Positive", "Neutral", "Negative"], autopct='%1.1f%%', startangle=140, colors=["#6baed6",
plt.title("Sentiment Distribution")
plt.show()

# Bar Plot
plt.figure(figsize=(8, 6))
sns.barplot(x=sentiment_counts.index, y=sentiment_counts.values, palette="viridis")
plt.xticks([0, 1, 2], ["Positive", "Neutral", "Negative"])
plt.title("Sentiment Distribution")
plt.xlabel("Sentiment")
plt.ylabel("Count")
plt.show()
```



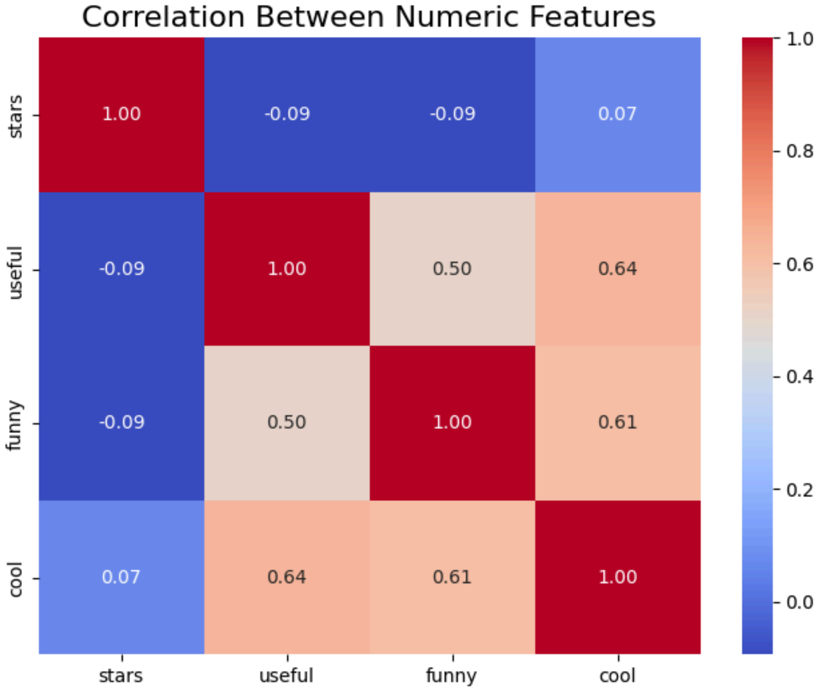
```
/tmp/ipykernel_1703355/969110400.py:12: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v0.14.0. Assign the `x` variable to `hue`

  sns.barplot(x=sentiment_counts.index, y=sentiment_counts.values, palette="viridis")
```



```
data['date'] = pd.to_datetime(data['date'])  # Ensure date is in datetime format
data['month_year'] = data['date'].dt.to_period('M')  # Group by month and year
sentiment_trend = data.groupby('month_year')['sentiment_label'].mean().reset_index()

# Line Plot
plt.figure(figsize=(12, 6))
plt.plot(sentiment_trend['month_year'].astype(str), sentiment_trend['sentiment_label'], marker='o')
plt.title("Average Sentiment Over Time", fontsize=16)
plt.xlabel("Date")
plt.ylabel("Average Sentiment (0=Negative, 1=Neutral, 2=Positive)")
plt.xticks(rotation=90)
plt.grid()
plt.show()
```

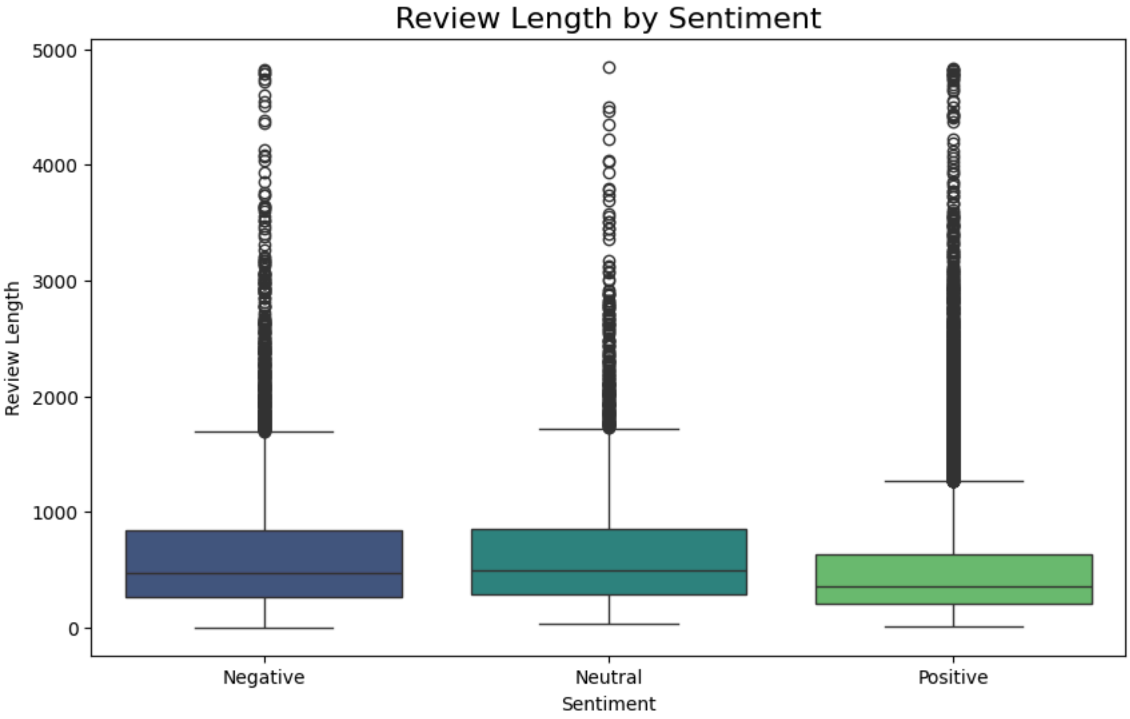


```
# Correlation Heatmap
plt.figure(figsize=(8, 6))
sns.heatmap(data[['stars', 'useful', 'funny', 'cool']].corr(), annot=True, cmap='coolwarm', fmt=".2f")
plt.title("Correlation Between Numeric Features", fontsize=16)
plt.show()
```



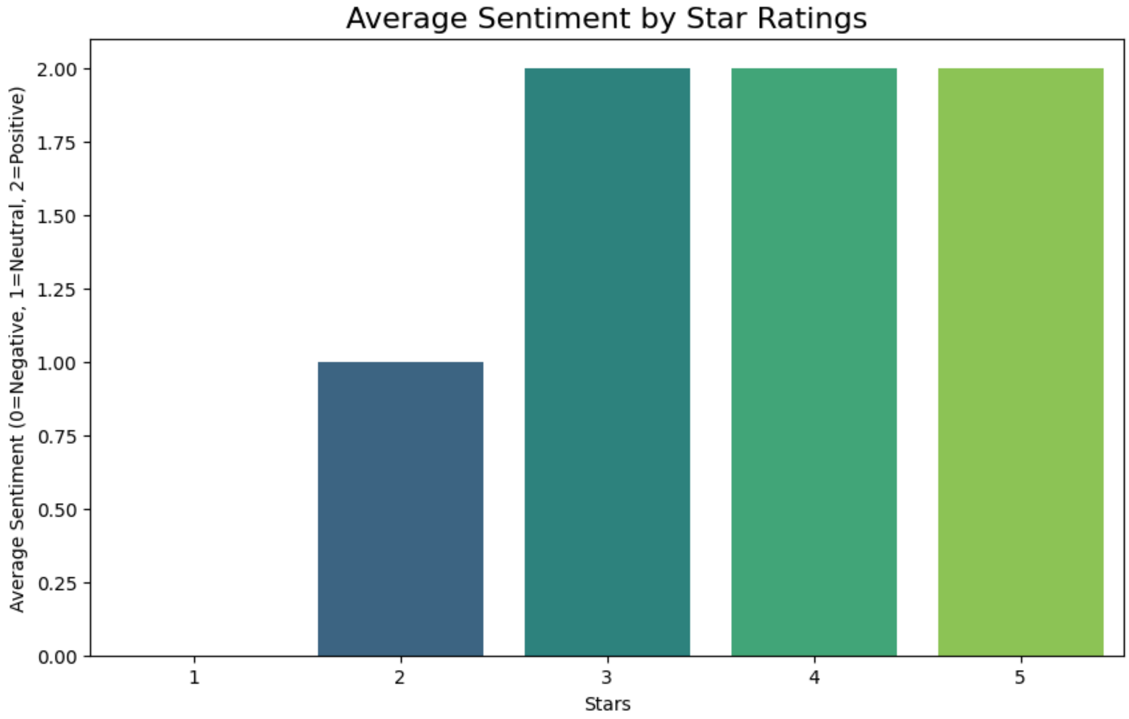
```
data['review_length'] = data['text_cleaned'].apply(len)

# Box Plot
plt.figure(figsize=(10, 6))
sns.boxplot(x='sentiment_label', y='review_length', data=data, palette="viridis")
plt.title("Review Length by Sentiment", fontsize=16)
plt.xlabel("Sentiment")
plt.ylabel("Review Length")
plt.xticks([0, 1, 2], ["Negative", "Neutral", "Positive"])
plt.show()
```

```
/tmp/ipykernel_1703355/835442337.py:5: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v0.14.0. Assign the `x` variable to `hue`

  sns.boxplot(x='sentiment_label', y='review_length', data=data, palette="viridis")
```



```
# Group by Stars
sentiment_by_stars = data.groupby('stars')['sentiment_label'].mean()

# Bar Plot
plt.figure(figsize=(10, 6))
sns.barplot(x=sentiment_by_stars.index, y=sentiment_by_stars.values, palette="viridis")
plt.title("Average Sentiment by Star Ratings", fontsize=16)
plt.xlabel("Stars")
plt.ylabel("Average Sentiment (0=Negative, 1=Neutral, 2=Positive)")
plt.show()
```

```
/tmp/ipykernel_1703355/1853316778.py:6: FutureWarning: 

Passing `palette` without assigning `hue` is deprecated and will be removed in v0.14.0. Assign the `x` variable to `hue`

  sns.barplot(x=sentiment_by_stars.index, y=sentiment_by_stars.values, palette="viridis")
```



```
from wordcloud import WordCloud

# Filter Text Based on Sentiments
positive_text = ' '.join(data[data['sentiment_label'] == 2]['text_cleaned'])
neutral_text = ' '.join(data[data['sentiment_label'] == 1]['text_cleaned'])
negative_text = ' '.join(data[data['sentiment_label'] == 0]['text_cleaned'])

# Generate Word Clouds
positive_wc = WordCloud(width=800, height=400, background_color='white', colormap='Greens').generate(positive_text)
neutral_wc = WordCloud(width=800, height=400, background_color='white', colormap='Blues').generate(neutral_text)
negative_wc = WordCloud(width=800, height=400, background_color='white', colormap='Reds').generate(negative_text)

# Plot Word Clouds
plt.figure(figsize=(16, 8))

plt.subplot(1, 3, 1)
plt.imshow(positive_wc, interpolation='bilinear')
plt.title("Positive Sentiment Word Cloud", fontsize=16)
plt.axis('off')

plt.subplot(1, 3, 2)
plt.imshow(neutral_wc, interpolation='bilinear')
plt.title("Neutral Sentiment Word Cloud", fontsize=16)
plt.axis('off')

plt.subplot(1, 3, 3)
plt.imshow(negative_wc, interpolation='bilinear')
plt.title("Negative Sentiment Word Cloud", fontsize=16)
plt.axis('off')

plt.tight_layout()
plt.show()
```

Positive Sentiment Word Cloud Neutral Sentiment Word Cloud Negative Sentiment Word Cloud

```
from sklearn.feature_extraction.text import CountVectorizer

# Function to Get Most Frequent Words
def get_most_frequent_words(texts, top_n=10):
    vectorizer = CountVectorizer(stop_words='english', max_features=top_n)
    word_counts = vectorizer.fit_transform(texts)
    word_freq = dict(zip(vectorizer.get_feature_names_out(), word_counts.toarray().sum(axis=0)))
    return word_freq

# Get Most Frequent Words
positive_words = get_most_frequent_words(data[data['sentiment_label'] == 2]['text_cleaned'], top_n=10)
neutral_words = get_most_frequent_words(data[data['sentiment_label'] == 1]['text_cleaned'], top_n=10)
negative_words = get_most_frequent_words(data[data['sentiment_label'] == 0]['text_cleaned'], top_n=10)

# Plot Most Frequent Words
```