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_s
from transformers import AutoTokenizer, AutoModel, AutoModelForSequenceClassifi
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", nrow[illegible], li
data_review.head()
```

	review_id	user_id	business_id	st
0	KU_O5udG6zpxOg-VcAEodg	mh_-eMZ6K5RLWhZyISBhwA	XQfwVwDr-v0ZS3_CbbE5Xw	
1	BiTunyQ73aT9WBnpR9DZGw	OyoGAe7OKpv6SyGZT5g77Q	7ATYjTIgM3jUlt4UM3IypQ	
2	saUsX_uimxRlCVr67Z4Jig	8g_iMtfSiwikVnbP2etR0A	YjUWPpI6HXG530lwP-fb2A	
3	AqPFMleE6RsU23_auESxiA	_7bHUi9Uuf5__HHc_Q8guQ	kxX2SOes4o-D3ZQBkiMRfA	
4	Sx8TMOWLNuJBWer-0pcmoA	bcjbaE6dDog4jkNY91ncLQ	e4Vwtrqf-wpJfwesgvdgxQ	

```
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
```

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_down
  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_len
    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
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

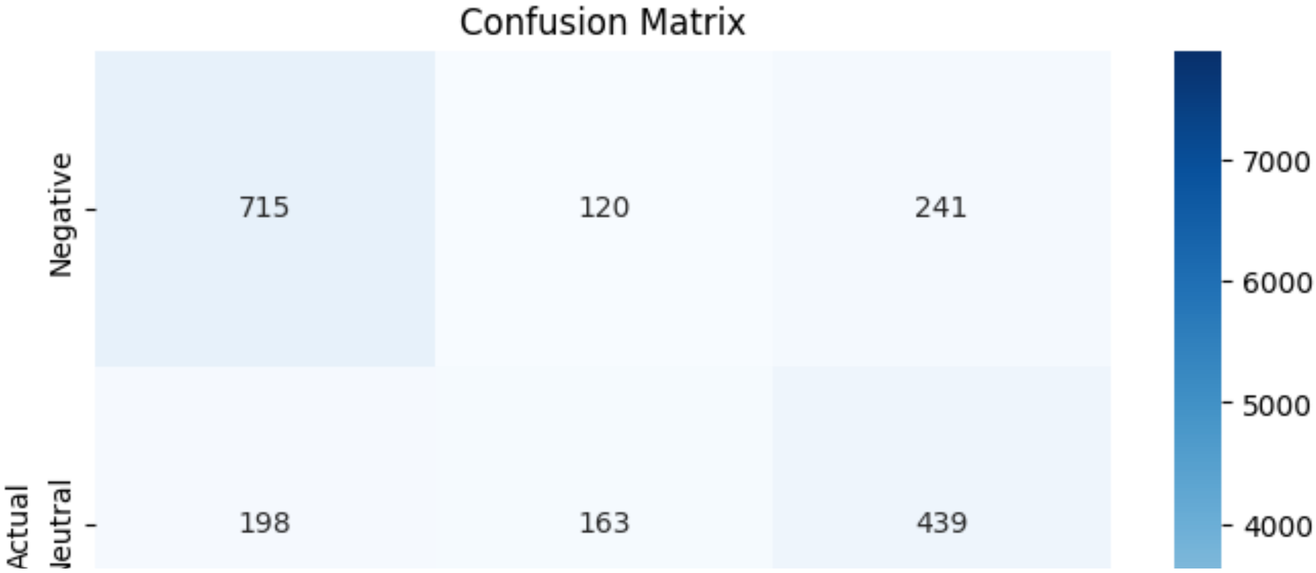
```
print("\nTraining the Model...")
epochs = 100
for epoch in range(epochs):
    model.train()
    epoch_loss = 0
    correct = 0
    total = 0

    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: {corr
```

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", "N
```

```
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
```

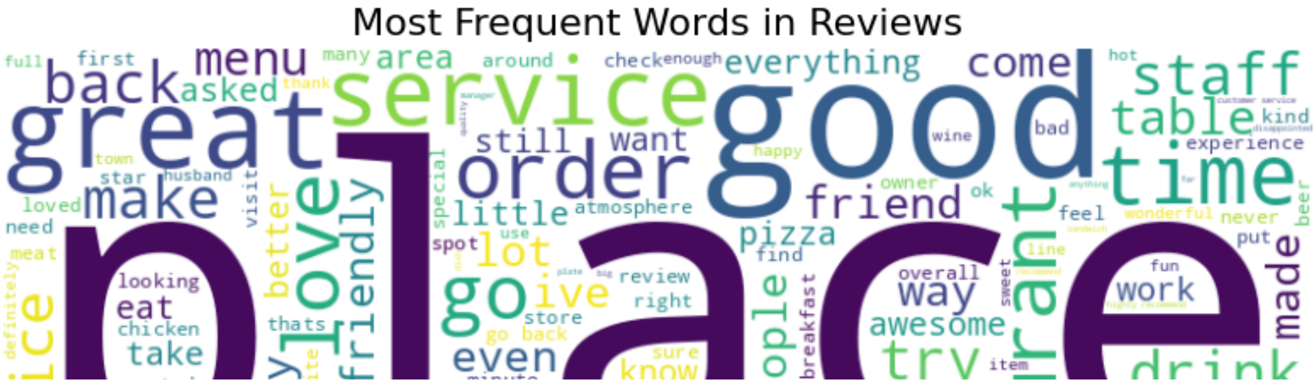
```
conf_matrix = confusion_matrix(all_labels, all_preds)
plt.figure(figsize=(8, 6))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues', xticklabels=["Negat
plt.title('Confusion Matrix')
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.show()
```



Start coding or generate with AI.

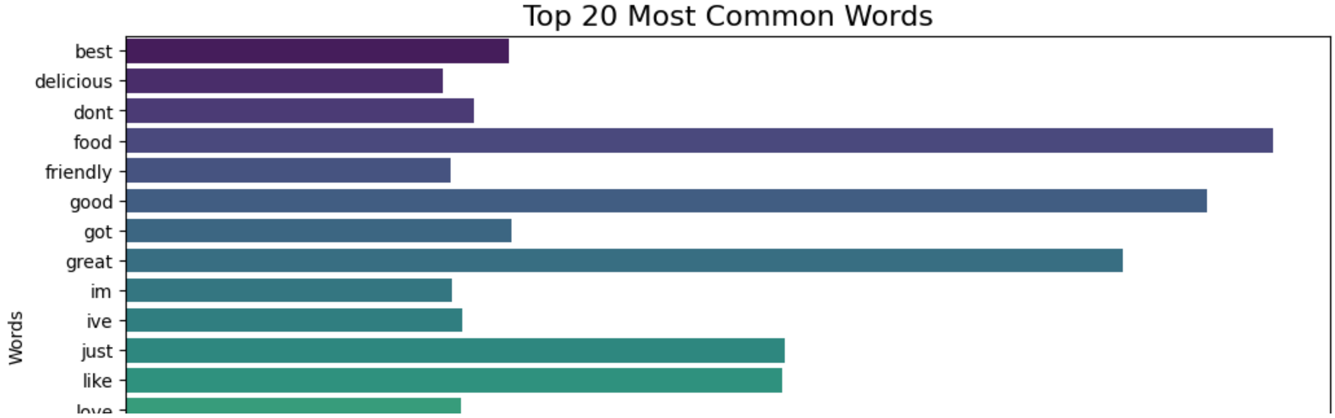
Visualizations

```
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

# 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()
```

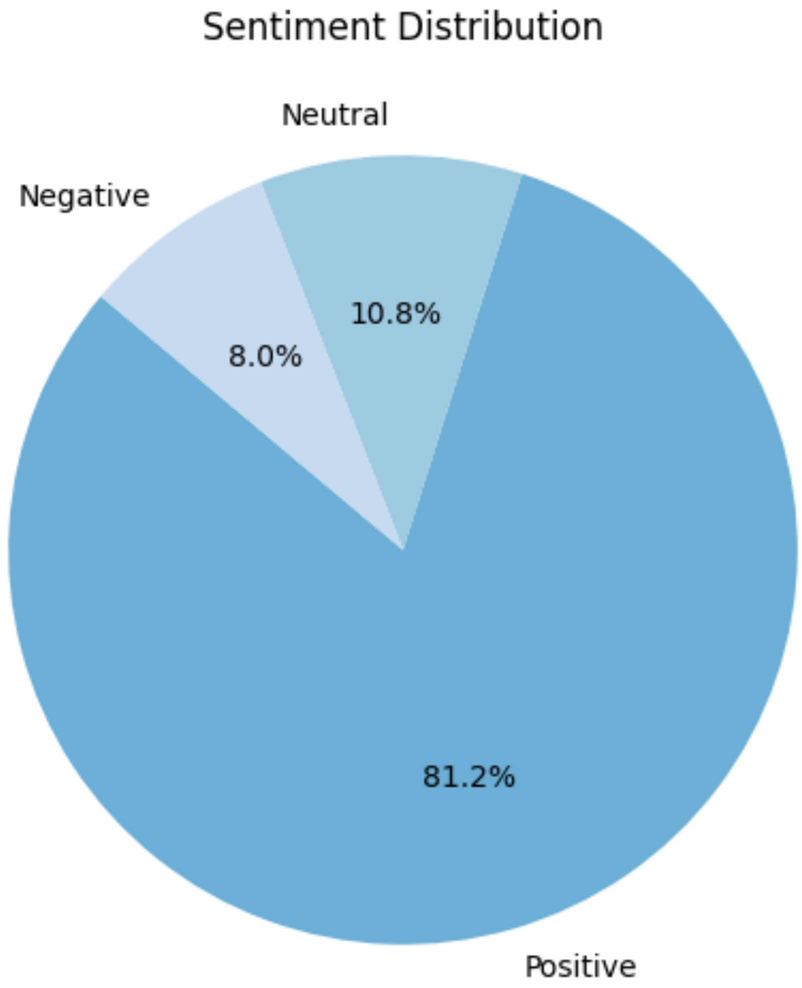


```
from sklearn.feature_extraction.text import CountVectorizer


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().

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

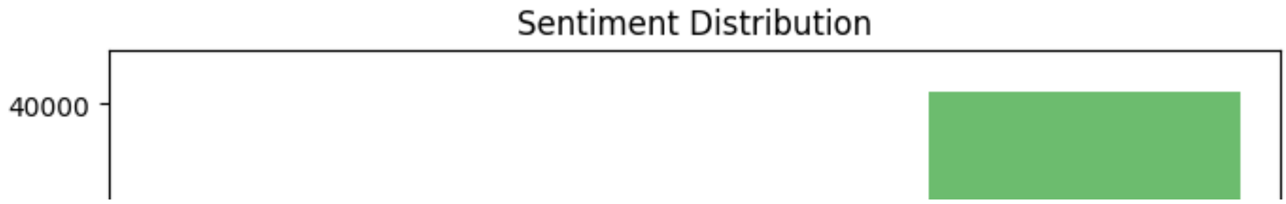
```
/tmp/ipykernel_1703355/357633920.py:10: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed

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



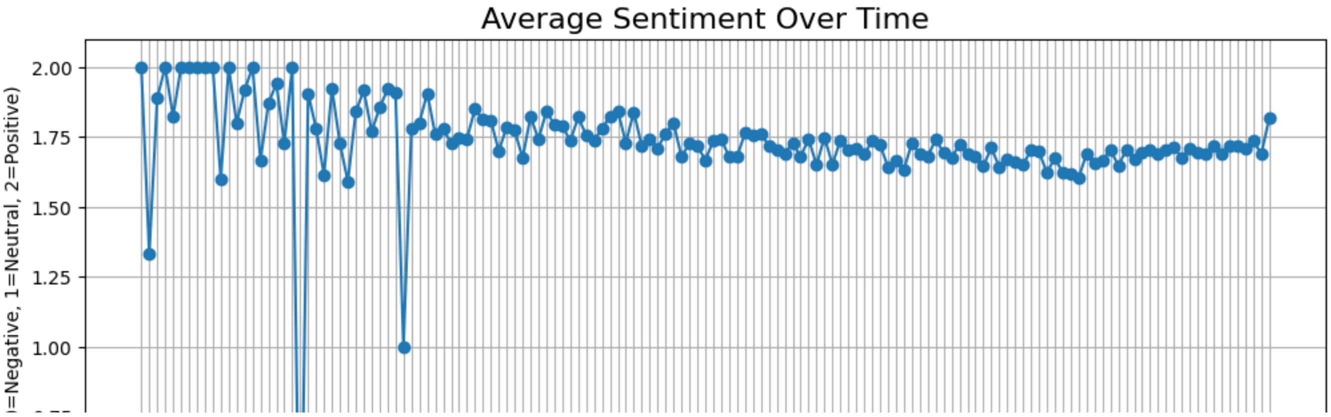
```
# Sentiment Distribution
sentiment_counts = data['sentiment_label'].value_counts()

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

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



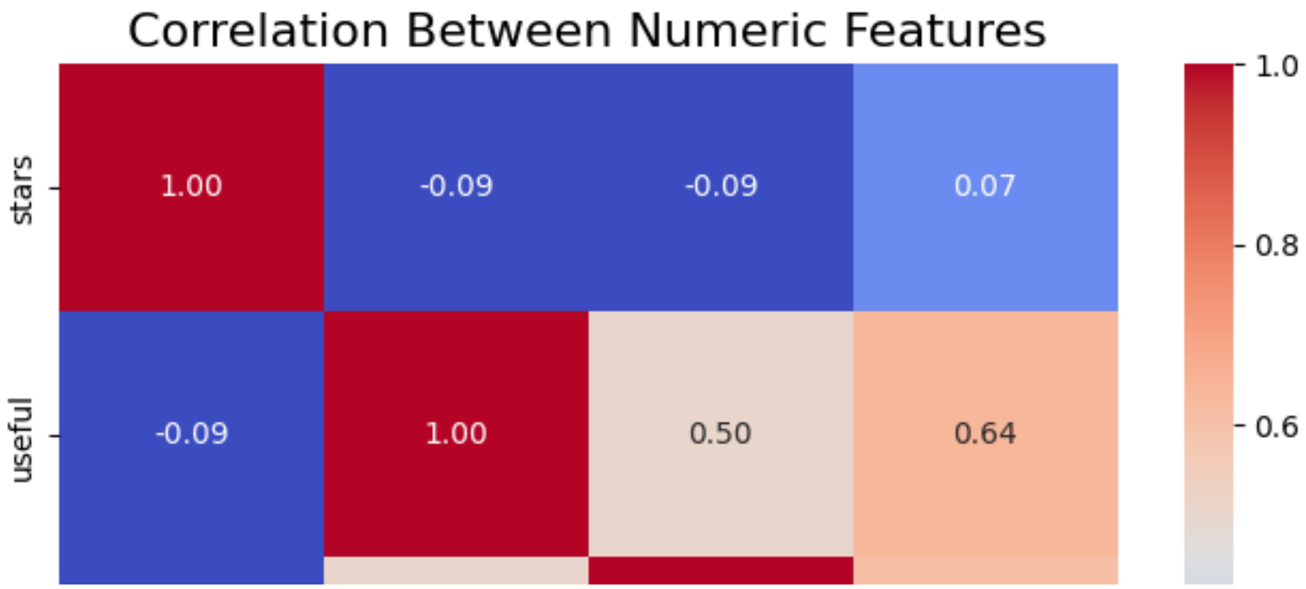
```
/tmp/ipykernel_1703355/969110400.py:12: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed

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



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

# Line Plot
plt.figure(figsize=(12, 6))
plt.plot(sentiment_trend['month_year'].astype(str), sentiment_trend['sentiment_
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()
```

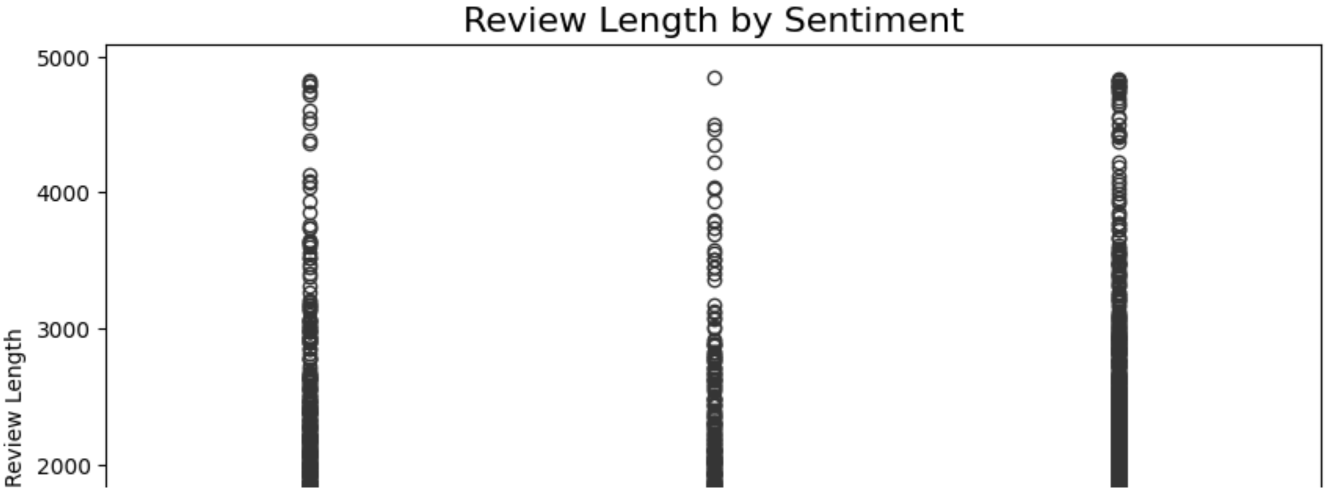


```
# Correlation Heatmap
plt.figure(figsize=(8, 6))
sns.heatmap(data[['stars', 'useful', 'funny', 'cool']].corr(), annot=True, cmap
plt.title("Correlation Between Numeric Features", fontsize=16)
plt.show()
```



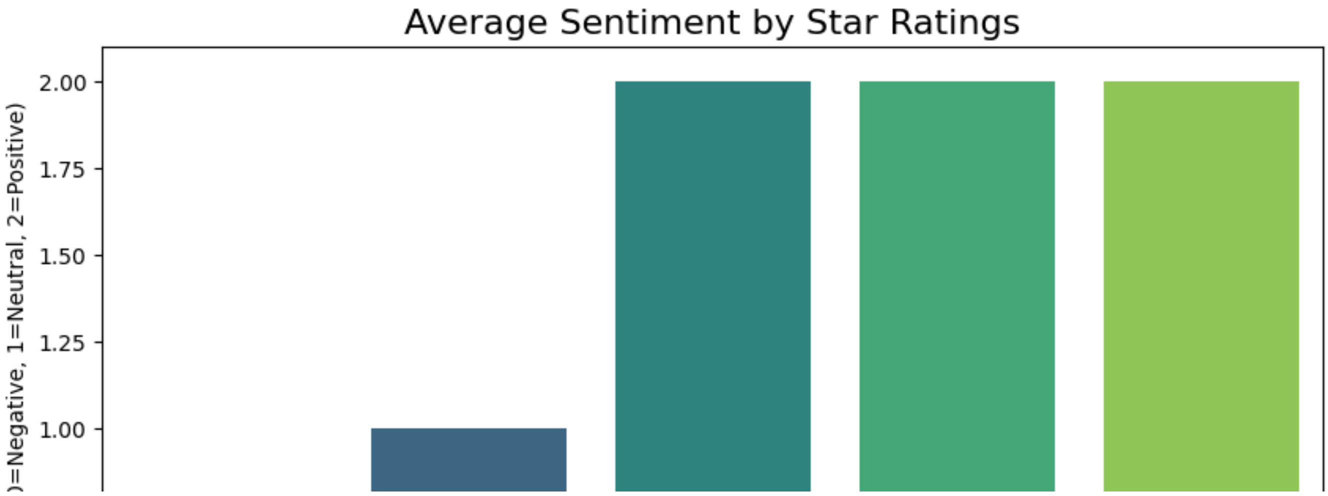
```
data['review_length'] = data['text_cleaned'].apply(len)

# 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

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

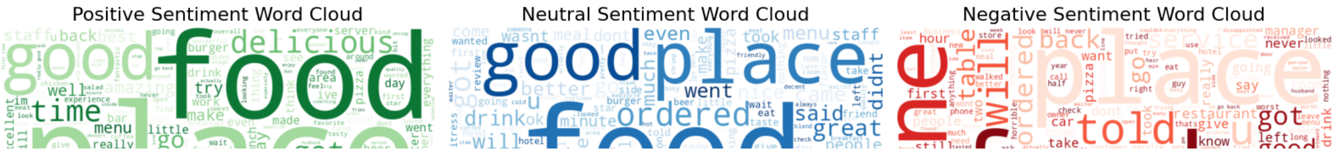


```
# Group by Stars
sentiment_by_stars = data.groupby('stars')['sentiment_label'].mean()

# Bar Plot
plt.figure(figsize=(10, 6))
sns.barplot(x=sentiment_by_stars.index, y=sentiment_by_stars.values, palette="v
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

  sns.barplot(x=sentiment_by_stars.index, y=sentiment_by_stars.values, pale
```

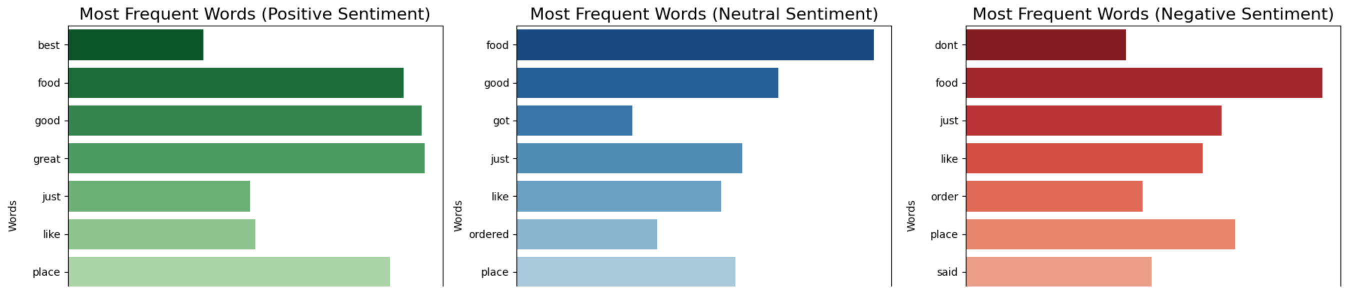


```
from wordcloud import WordCloud

# 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', colorm
neutral_wc = WordCloud(width=800, height=400, background_color='white', colorma
negative_wc = WordCloud(width=800, height=400, background_color='white', colorm

# 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()
```



```
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.toarra
    return word_freq

# Get Most Frequent Words
positive_words = get_most_frequent_words(data[data['sentiment_label'] == 2]['te
neutral_words = get_most_frequent_words(data[data['sentiment_label'] == 1]['tex
negative_words = get_most_frequent_words(data[data['sentiment_label'] == 0]['te

# Plot Most Frequent Words
plt.figure(figsize=(18, 6))

plt.subplot(1, 3, 1)
sns.barplot(x=list(positive_words.values()), y=list(positive_words.keys()), pal
plt.title("Most Frequent Words (Positive Sentiment)", fontsize=16)
plt.xlabel("Frequency")
plt.ylabel("Words")

plt.subplot(1, 3, 2)
sns.barplot(x=list(neutral_words.values()), y=list(neutral_words.keys()), palet
plt.title("Most Frequent Words (Neutral Sentiment)", fontsize=16)
plt.xlabel("Frequency")
plt.ylabel("Words")

plt.subplot(1, 3, 3)
sns.barplot(x=list(negative_words.values()), y=list(negative_words.keys()), pal
plt.title("Most Frequent Words (Negative Sentiment)", fontsize=16)
plt.xlabel("Frequency")
plt.ylabel("Words")

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

```
/tmp/ipykernel_1703355/1829494720.py:19: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed

  sns.barplot(x=list(positive_words.values()), y=list(positive_words.keys()
/tmp/ipykernel_1703355/1829494720.py:25: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed

  sns.barplot(x=list(neutral_words.values()), y=list(neutral_words.keys()),
/tmp/ipykernel_1703355/1829494720.py:31: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed

  sns.barplot(x=list(negative_words.values()), y=list(negative_words.keys()
```



Start coding or generate with AI.

Start coding or generate with AI.

Start coding or generate with AI.

Start coding or generate with AI.