```
!pip install scikit-learn==1.0.2

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from wordcloud import WordCloud
import json
from glob import glob
from imblearn.over_sampling import SMOTE
pd.set_option('display.max_columns', 500)
plt.style.use('ggplot')

import warnings
warnings.filterwarnings('ignore')


# Libraries for Sentiment Analysis
import nltk
from nltk.corpus import stopwords
import re, string
from nltk.stem import WordNetLemmatizer
from sklearn.model_selection import train_test_split

nltk.download('stopwords')
nltk.download('punkt')
nltk.download('wordnet')
nltk.download('omw-1.4')

from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.svm import LinearSVC
from sklearn.metrics import classification_report

from sklearn.naive_bayes import MultinomialNB
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import GridSearchCV

from keras.models import Sequential
from keras.layers import LSTM,GRU, Dense, Dropout, Embedding
from keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Collecting scikit-learn==1.0.2
  Downloading scikit_learn-1.0.2-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (26.5 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 26.5/26.5 MB 24.3 MB/s eta 0:00:00
Requirement already satisfied: numpy>=1.14.6 in /usr/local/lib/python3.10/dist-packages (from scikit-learn==1.0.2) (1.22.4)
Requirement already satisfied: scipy>=1.1.0 in /usr/local/lib/python3.10/dist-packages (from scikit-learn==1.0.2) (1.10.1)
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.10/dist-packages (from scikit-learn==1.0.2) (1.2.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in /usr/local/lib/python3.10/dist-packages (from scikit-learn==1.0.2) (3.1.0)
Installing collected packages: scikit-learn
  Attempting uninstall: scikit-learn
    Found existing installation: scikit-learn 1.2.2
    Uninstalling scikit-learn-1.2.2:
      Successfully uninstalled scikit-learn-1.2.2
Successfully installed scikit-learn-1.0.2
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Unzipping corpora/stopwords.zip.
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Unzipping tokenizers/punkt.zip.
[nltk_data] Downloading package wordnet to /root/nltk_data...
[nltk_data] Downloading package omw-1.4 to /root/nltk_data...
```

```
import sklearn
print(sklearn.__version__)
```

```
1.0.2
```

```
from google.colab import drive

drive.mount('/content/gdrive/', force_remount=True)
%cd /content/gdrive/MyDrive/RTML_Project_Data
```

```
Mounted at /content/gdrive/
/content/gdrive/MyDrive/RTML_Project_Data
```

```
data_file = open("yelp_academic_dataset_business.json")
data = []
```

```
for line in data_file:
    data.append(json.loads(line))
business_df = pd.DataFrame(data)
data_file.close()
```

```
business_df.head()
```

	business_id	name	address	city	state	postal_code	latitude	longitud
0	Pns2l4eNsfO8kk83dixA6A	Abby Rappoport, LAC, CMQ	1616 Chapala St, Ste 2	Santa Barbara	CA	93101	34.426679	-119.7111
1	mpf3x-BjTdTEA3yCZrAYPw	The UPS Store	87 Grasso Plaza Shopping Center	Affton	MO	63123	38.551126	-90.3356
2	tUFrWirKiKi_TAnsVWINQQ	Target	5255 E Broadway Blvd	Tucson	AZ	85711	32.223236	-110.8804
3	MTSW4McQd7CbVtyjqoe9mw	St Honore Pastries	935 Race St	Philadelphia	PA	19107	39.955505	-75.1555
4	mWMc6_wTdE0EUBKIGXDVfA	Perkiomen Valley Brewery	101 Walnut St	Green Lane	PA	18054	40.338183	-75.4716

```
data=[]
for chunk in pd.read_json("yelp_academic_dataset_review.json", lines=True, chunksize=5000):
    data.append(chunk)

# Concatenate the chunks into a single DataFrame
reviews_df = pd.concat(data, ignore_index=True)
```

```
reviews_df.head()
```

	review_id	user_id	business_id	stars	useful	funny	c
0	KU_O5udG6zpxOg-VcAEodg	mh_-eMZ6K5RLWhZyISBhwA	XQfwVwDr-v0ZS3_CbbE5Xw	3	0	0	

```
print('Size of Business DataFrame: ',business_df.shape)
print('Size of Reviews DataFrame: ',reviews_df.shape)
```

```
Size of Business DataFrame:  (150346, 14)
Size of Reviews DataFrame:  (6990280, 9)
```

```
print('Number of Unique Businesses in Review Data: ',reviews_df['business_id'].nunique())
print('Number of Unique Businesses in Business Data: ',business_df['business_id'].nunique())
```

```
Number of Unique Businesses in Review Data:  150346
Number of Unique Businesses in Business Data:  150346
```

Business Categories

```
business_cats=', '.join(business_df['categories'].dropna())
cats=pd.DataFrame(business_cats.split(', '),columns=['category'])
```

```
cats_ser = cats.category.value_counts()
cats_df = pd.DataFrame(cats_ser)
cats_df.reset_index(inplace=True)
```

```
business_df.head(1)
```

	business_id	name	address	city	state	postal_code	latitude	longitude	stars
0	Pns2l4eNsfO8kk83dixA6A	Abby Rappoport, LAC, CMQ	1616 Chapala St, Ste 2	Santa Barbara	CA	93101	34.426679	-119.711197	5.0

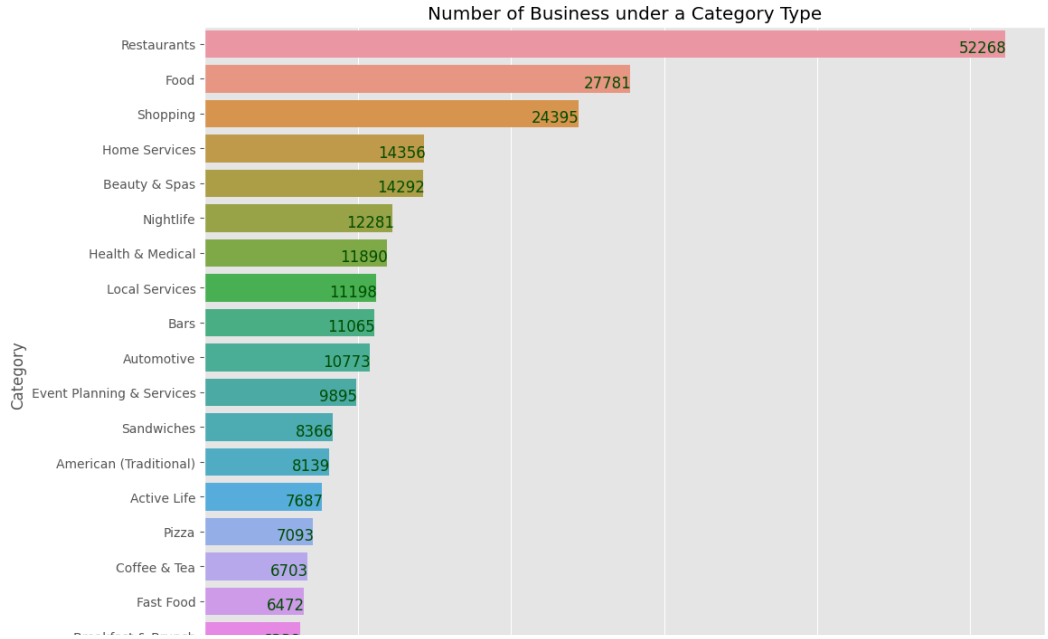
```
cats_df
```

	index	category
0	Restaurants	52268
1	Food	27781
2	Shopping	24395
3	Home Services	14356
4	Beauty & Spas	14292
...	...	...
1306	Beach Bars	1
1307	DUI Schools	1
1308	Patent Law	1
1309	Housing Cooperatives	1
1310	Trade Fairs	1

1311 rows × 2 columns

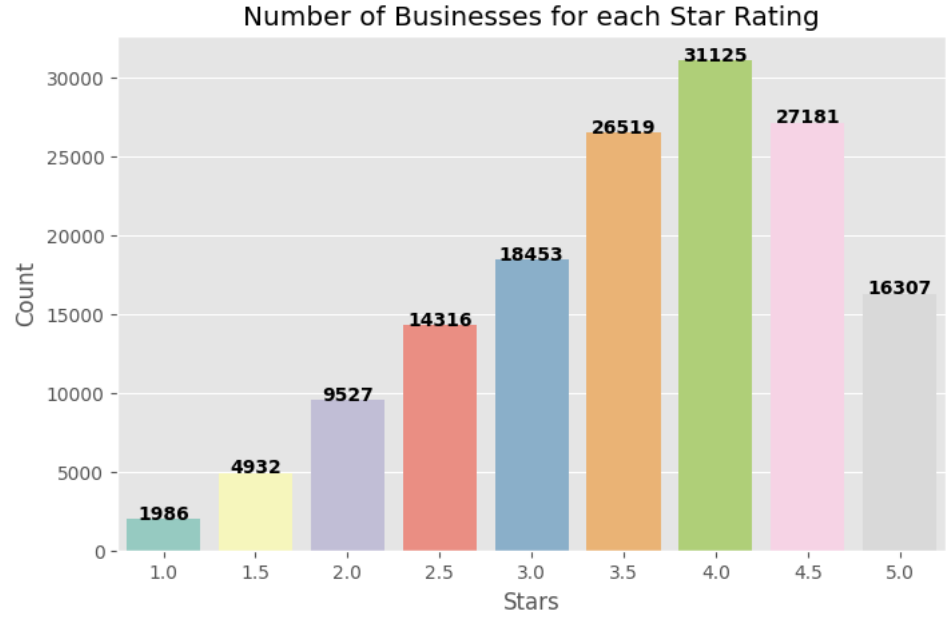
```
plt.figure(figsize=(12,10))
ax = sns.barplot( y= 'index',x = 'category' , data = cats_df.iloc[0:20])
ax.set_ylabel('Category')
ax.set_xlabel('Number of businesses')
ax.set_title('Number of Business under a Category Type')
```

```
for p in ax.patches:
    ax.annotate(int(p.get_width()),
                ((p.get_x() + p.get_width()),
                 p.get_y()),
                 xytext=(1, -18),
                fontsize=12,
                color='#004d00',
                textcoords='offset points',
                horizontalalignment='right')
plt.show()
```



Stars for each Business

```
plt.figure(figsize=(8,5))
ax = sns.countplot( x='stars' , data = business_df, palette='Set3')
ax.set_ylabel('Count')
ax.set_xlabel('Stars')
ax.set_title('Number of Businesses for each Star Rating')

for p in ax.patches:
        width, height = p.get_width(), p.get_height()
        x, y = p.get_xy()
        ax.text(x+width-.4,
                y+height,
                '{:.0f}'.format(height),
                weight='bold',
                horizontalalignment='center')

plt.show()
```

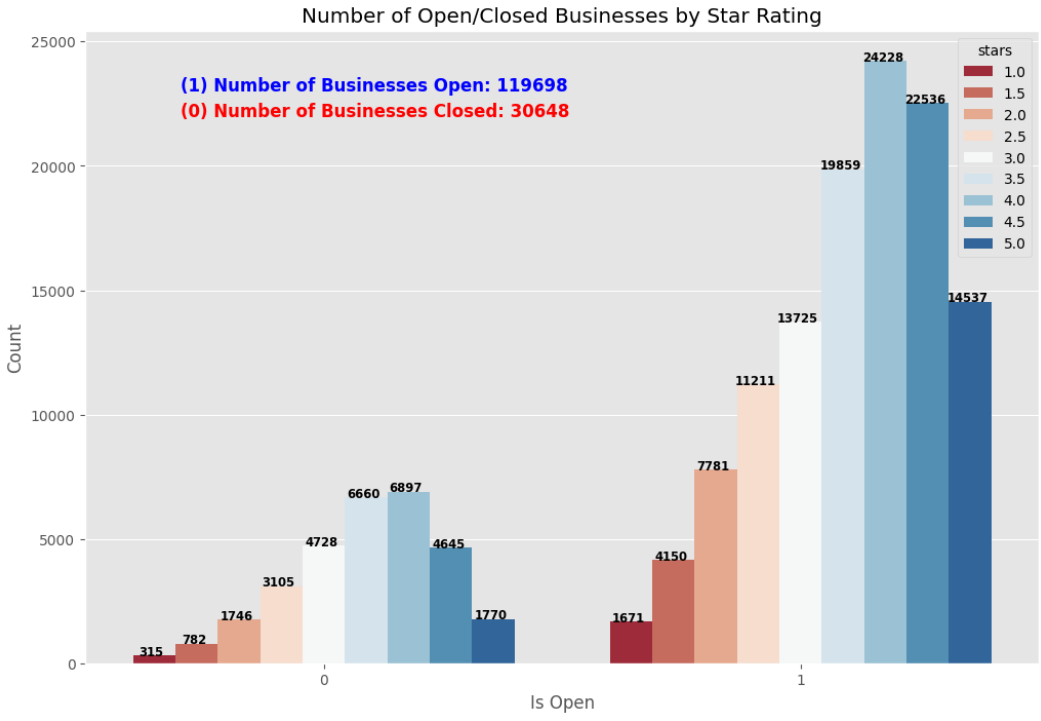


Business Status

```
business_df['is_open'].value_counts()
```

```
1    119698
0     30648
Name: is_open, dtype: int64
```

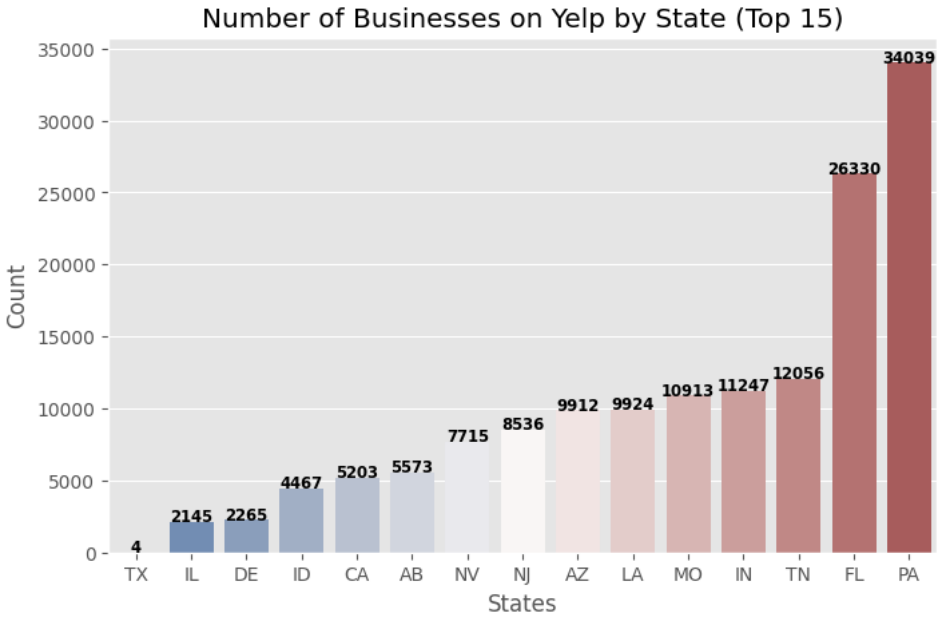
```
plt.figure(figsize=(12,8))
ax = sns.countplot(hue='stars', x='is_open'  , data = business_df, palette='RdBu')
ax.set_ylabel('Count')
ax.set_xlabel('Is Open')
ax.set_title('Number of Open/Closed Businesses by Star Rating')


num_open , num_closed = business_df['is_open'].value_counts()

ax.text(-0.3, 23000,
        '(1) Number of Businesses Open: {:.0f}'.format(num_open),
        weight='bold',
        color='blue',
        size='large')

ax.text(-0.3, 22000,
        '(0) Number of Businesses Closed: {:.0f}'.format(num_closed),
        weight='bold',
        color='red',
        size='large')



for p in ax.patches:
        width, height = p.get_width(), p.get_height()
        x, y = p.get_xy()
        ax.text(x+width-.05,
                y+height,
                '{:.0f}'.format(height),
                weight='bold',
                horizontalalignment='center',
                size='small')

plt.show()
```



Businesses Per State

```
top15 = business_df['state'].value_counts(ascending=True).tail(15).to_frame()

plt.figure(figsize=(8,5))
ax = sns.barplot(x=top15.index,y='state', data=top15, palette='vlag')
ax.set_ylabel('Count')
```

```
ax.set_xlabel('States')
ax.set_title('Number of Businesses on Yelp by State (Top 15)')

for p in ax.patches:
        width, height = p.get_width(), p.get_height()
        x, y = p.get_xy()
        ax.text(x+width-.4,
                y+height+2,
                '{:.0f}'.format(height),
                weight='bold',
                horizontalalignment='center',
               size='small')

plt.show()
```



Build Sentimental Analysis Model

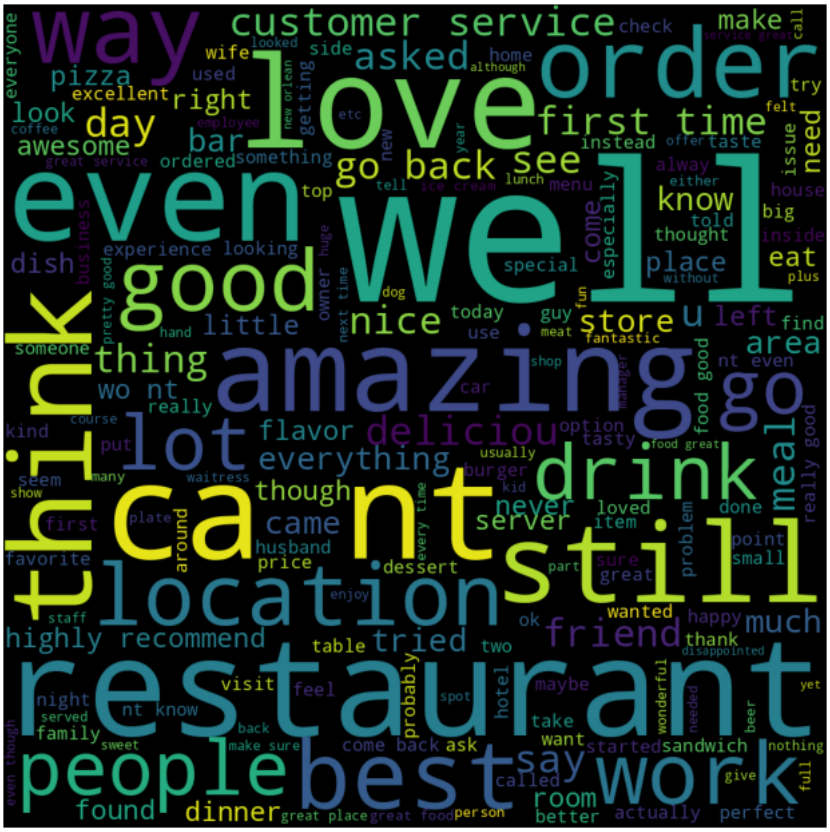
```
# Recode 1,2 stars as 0 (negative review)
# Recode 3,4 and 5 stars as 1 (positive review)

reviews_df['sentiment']=reviews_df['stars'].replace({1:0,2:0,3:1,4:1,5:1})
reviews_df['sentiment'] = reviews_df['sentiment'].astype(int)


# Since this dataset is so large, we will work with a random sample of 100,000 reviews

reviews_subset = reviews_df.sample(100000).reset_index(drop=True)


# Subset of the columns of interest

df = reviews_subset[['text','sentiment']]
df.head()
```

	text	sentiment
0	Very poor customer service. Been to this loca...	0
1	Support Local!\nAfter getting upset at a certa...	1
2	First of all, there was no water at all. They ...	0
3	I cancelled my membership to BJ's years ago. I...	0
4	Expansive collection. Aisles marked for one wa...	1

```
feedbacks = str(' '.join(df['text']).split())
feedbacks = feedbacks.translate(str.maketrans('','',string.punctuation))
feedbacks_wordcloud = WordCloud(background_color='black',max_words=200,width=1000,height=1000,).generate(feedbacks)
plt.figure(figsize=(8,8))
plt.clf()
plt.imshow(feedbacks_wordcloud)
plt.axis('off')
plt.show()
```


```
# Convert strings to lowercase

df['cleaned_text'] = df['text'].apply(lambda x:' '.join(x.lower() for x in str(x).split()))


# Convert contractions into separate words (won't = will not)

def contractions(s):
     s = re.sub(r"won’t", "will not",s)
     s = re.sub(r"would’t", "would not",s)
     s = re.sub(r"could’t", "could not",s)
     s = re.sub(r"\’d",  " would",s)
     s = re.sub(r"can\’t", "can not",s)
     s = re.sub(r"n\’t", " not", s)
     s= re.sub(r"\’re", " are", s)
     s = re.sub(r"\’s", " is", s)
     s = re.sub(r"\’ll", " will", s)
     s = re.sub(r"\’t", " not", s)
     s = re.sub(r"\’ve", " have", s)
     s = re.sub(r"\’m", " am", s)
     return s
df['cleaned_text']=df['cleaned_text'].apply(lambda x:contractions(x))


# Remove non-alpha characters

df['cleaned_text']=df['cleaned_text'].apply(lambda x: ' '.join([re.sub('[^A-Za-z]+','', x) for x in nltk.word_tokenize(x)]))


# Remove extra spaces between words

df['cleaned_text']=df['cleaned_text'].apply(lambda x: re.sub(' +', ' ', x))


# Remove stop words

stop = stopwords.words("english")
stop += ['would','may','one', 'must','upon','might','ought','shall','could','got','went','going','made','said']
df['cleaned_text']=df['cleaned_text'].apply(lambda x: " ".join([x for x in x.split() if x not in stop]))


# Lemmatization

lemmatizer = WordNetLemmatizer()
df['cleaned_text']=df['cleaned_text'].apply(lambda x: " ".join([lemmatizer.lemmatize(w) for w in nltk.word_tokenize(x)]))
```

```
feedbacks = str(' '.join(df['cleaned_text']).split())
feedbacks = feedbacks.translate(str.maketrans('','',string.punctuation))
feedbacks_wordcloud = WordCloud(background_color='black',max_words=200,width=1000,height=1000,).generate(feedbacks)
plt.figure(figsize=(8,8))
plt.clf()
plt.imshow(feedbacks_wordcloud)
plt.axis('off')
plt.show()
```




```
df.sentiment.value_counts()
```

```
1    77038
0    22962
Name: sentiment, dtype: int64
```

```
X = df['cleaned_text']
y = df['sentiment']
```

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

```
print("Train: ",X_train.shape,y_train.shape,"Test: ",(X_test.shape,y_test.shape))
```

```
Train:  (80000,) (80000,) Test:  ((20000,), (20000,))
```

```
vectorizer= TfidfVectorizer()
tf_x_train = vectorizer.fit_transform(X_train)
tf_x_test = vectorizer.transform(X_test)
```

```
word_counts = np.array(np.sum(tf_x_train, axis=0)).reshape((-1,))
words = np.array(vectorizer.get_feature_names())
words_df = pd.DataFrame({"word":words, "count":word_counts})
words_df.sort_values(by="count",ascending=False).head(20)
```

	word	count
22821	food	2516.517719
25868	great	2370.127376
41618	nt	2323.638981
46077	place	2232.490718
25368	good	2197.660330
54399	service	1820.413016
61973	time	1731.910892
4049	back	1400.734324
24750	get	1393.285231
34537	like	1325.328091
25214	go	1318.356427
49377	really	1197.462788
5673	best	1164.584530
57977	staff	1116.760158

```
sm = SMOTE(random_state=1)
X_bal, y_bal = sm.fit_resample(tf_x_train, y_train)
```

```
y_bal.value_counts()
```

```
1    61630
0    61630
Name: sentiment, dtype: int64
```

Linear SVC Model

```
grid_search_clf = LinearSVC()
grid_search_clf.fit(X_bal, y_bal)
```

```
y_test_pred_clf=grid_search_clf.predict(tf_x_test)

report_clf=classification_report(y_test, y_test_pred_clf,output_dict=True)
pd.DataFrame(report_clf)
```

	0	1	accuracy	macro avg	weighted avg
precision	0.787611	0.955017	0.9134	0.871314	0.916581
recall	0.852787	0.931464	0.9134	0.892126	0.913400
f1-score	0.818904	0.943094	0.9134	0.880999	0.914580
support	4592.000000	15408.000000	0.9134	20000.000000	20000.000000

Random Forests Model

```
rf_model = RandomForestClassifier()

param_grid = {'n_estimators': [20,50, 100], 'max_depth': [10, 50, None]}
```

```
grid_search_rf = GridSearchCV(rf_model, param_grid, cv=5)

grid_search_rf.fit(X_bal, y_bal)
```

```
print("Best Hyperparameters: ", grid_search_rf.best_params_)
print("Best Score: ", grid_search_rf.best_score_)

y_test_pred_rf=grid_search_rf.predict(tf_x_test)

report_rf=classification_report(y_test, y_test_pred_rf,output_dict=True)
pd.DataFrame(report_rf)
```

```
Best Hyperparameters:  {'max_depth': None, 'n_estimators': 100}
Best Score:  0.9306019795554112
```

	0	1	accuracy	macro avg	weighted avg
precision	0.757805	0.917476	0.8827	0.837641	0.880816
recall	0.718859	0.931529	0.8827	0.825194	0.882700
f1-score	0.737819	0.924449	0.8827	0.831134	0.881599
support	4592.000000	15408.000000	0.8827	20000.000000	20000.000000

Naive Bayes Model

```
naiv_bay_model = MultinomialNB()

param_grid = {'alpha': [0.1, 0.5, 1.0, 5.0, 10.0]}

grid_search_nb = GridSearchCV(naiv_bay_model, param_grid, cv=5)

grid_search_nb.fit(X_bal, y_bal)


print("Best Hyperparameters: ", grid_search_nb.best_params_)
print("Best Score: ", grid_search_nb.best_score_)

y_test_pred_nb=grid_search_nb.predict(tf_x_test)

report_nb=classification_report(y_test, y_test_pred_nb,output_dict=True)
pd.DataFrame(report_nb)
```

```
Best Hyperparameters:  {'alpha': 0.1}
Best Score:  0.9014765536264806
```

	0	1	accuracy	macro avg	weighted avg
precision	0.692224	0.945482	0.87595	0.818853	0.887334
recall	0.827744	0.890317	0.87595	0.859030	0.875950
f1-score	0.753942	0.917071	0.87595	0.835506	0.879616
support	4592.000000	15408.000000	0.87595	20000.000000	20000.000000

LSTM Model

```
tokenizer = Tokenizer(num_words=10000, oov_token='<OOV>')
tokenizer.fit_on_texts(df['cleaned_text'])

X = tokenizer.texts_to_sequences(df['cleaned_text'])
X = pad_sequences(X, maxlen=100, padding='post', truncating='post')

y = np.array(df['sentiment'])


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



model = Sequential()
model.add(Embedding(input_dim=10000, output_dim=32, input_length=100))
model.add(LSTM(64))
model.add(Dense(1, activation='sigmoid'))

model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy'])



history = model.fit(X_train, y_train, epochs=10, batch_size=32, validation_data=(X_test, y_test))
```

```
Epoch 1/10
2500/2500 [==============================] - 20s 8ms/step - loss: 0.0770 - accuracy: 0.9722 - val_loss: 0.2845 - val_accuracy: 0.91
Epoch 2/10
2500/2500 [==============================] - 20s 8ms/step - loss: 0.0608 - accuracy: 0.9784 - val_loss: 0.3347 - val_accuracy: 0.90
Epoch 3/10
2500/2500 [==============================] - 19s 7ms/step - loss: 0.0497 - accuracy: 0.9831 - val_loss: 0.3553 - val_accuracy: 0.90
Epoch 4/10
2500/2500 [==============================] - 19s 8ms/step - loss: 0.0395 - accuracy: 0.9870 - val_loss: 0.4077 - val_accuracy: 0.90
Epoch 5/10
2500/2500 [==============================] - 20s 8ms/step - loss: 0.0333 - accuracy: 0.9890 - val_loss: 0.4610 - val_accuracy: 0.90
Epoch 6/10
2500/2500 [==============================] - 20s 8ms/step - loss: 0.0274 - accuracy: 0.9917 - val_loss: 0.4321 - val_accuracy: 0.90
Epoch 7/10
```

```
2500/2500 [==============================] - 19s 8ms/step - loss: 0.0227 - accuracy: 0.9934 - val_loss: 0.4562 - val_accuracy: 0.90
Epoch 8/10
2500/2500 [==============================] - 20s 8ms/step - loss: 0.0187 - accuracy: 0.9948 - val_loss: 0.5264 - val_accuracy: 0.90
Epoch 9/10
2500/2500 [==============================] - 20s 8ms/step - loss: 0.0163 - accuracy: 0.9955 - val_loss: 0.4805 - val_accuracy: 0.89
Epoch 10/10
2500/2500 [==============================] - 19s 7ms/step - loss: 0.0150 - accuracy: 0.9960 - val_loss: 0.4812 - val_accuracy: 0.90
```

```
loss, accuracy = model.evaluate(X_test, y_test)
print('Test Accuracy:', accuracy)
```

```
625/625 [==============================] - 3s 4ms/step - loss: 0.4812 - accuracy: 0.9015
Test Accuracy: 0.9014999866485596
```

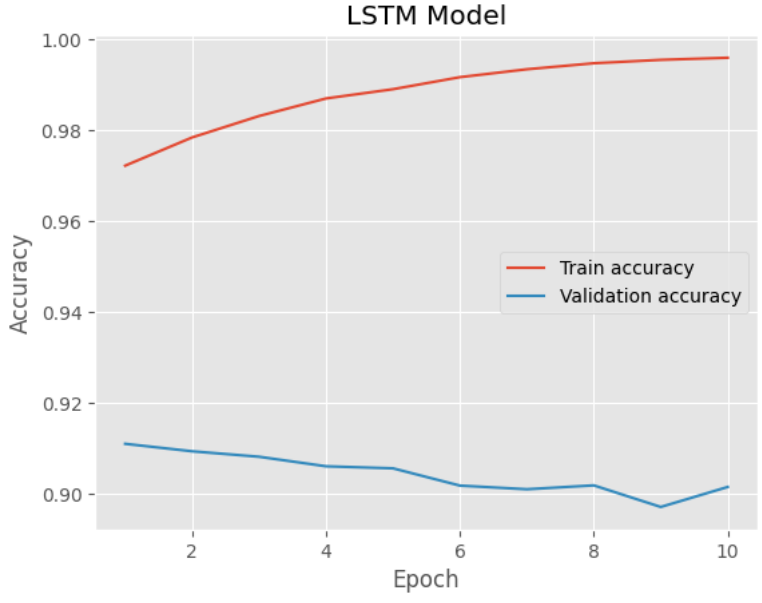
```
y_test_pred_lstm = model.predict(X_test)
y_test_pred_lstm = y_test_pred_lstm.round()
```

```
625/625 [==============================] - 2s 3ms/step
```

```
report_lstm=classification_report(y_test, y_test_pred_lstm,output_dict=True)
pd.DataFrame(report_lstm)
```

	0	1	accuracy	macro avg	weighted avg
precision	0.827983	0.920890	0.9015	0.874436	0.899019
recall	0.734070	0.953047	0.9015	0.843559	0.901500
f1-score	0.778203	0.936693	0.9015	0.857448	0.899384
support	4708.000000	15292.000000	0.9015	20000.000000	20000.000000

```
train_acc = history.history['accuracy']
val_acc = history.history['val_accuracy']
test_acc = accuracy

epochs = np.arange(1, len(train_acc) + 1)

plt.plot(epochs, train_acc, label='Train accuracy')
plt.plot(epochs, val_acc, label='Validation accuracy')
plt.title('LSTM Model')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()
plt.show()
```



GRU Model

```
model = Sequential()
model.add(Embedding(input_dim=10000, output_dim=32, input_length=100))
model.add(GRU(64))
model.add(Dense(1, activation='sigmoid'))

model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy'])
```

```
history = model.fit(X_train, y_train, epochs=10, batch_size=32, validation_data=(X_test, y_test))
```

```
Epoch 1/10
2500/2500 [==============================] - 871s 344ms/step - loss: 0.3205 - accuracy: 0.8678 - val_loss: 0.2071 - val_accuracy: 0
Epoch 2/10
2500/2500 [==============================] - 27s 11ms/step - loss: 0.1697 - accuracy: 0.9328 - val_loss: 0.1952 - val_accuracy: 0.9
Epoch 3/10
2500/2500 [==============================] - 25s 10ms/step - loss: 0.1417 - accuracy: 0.9446 - val_loss: 0.1973 - val_accuracy: 0.9
Epoch 4/10
2500/2500 [==============================] - 22s 9ms/step - loss: 0.1202 - accuracy: 0.9539 - val_loss: 0.2298 - val_accuracy: 0.91
Epoch 5/10
2500/2500 [==============================] - 22s 9ms/step - loss: 0.0967 - accuracy: 0.9633 - val_loss: 0.2414 - val_accuracy: 0.91
Epoch 6/10
2500/2500 [==============================] - 22s 9ms/step - loss: 0.0750 - accuracy: 0.9715 - val_loss: 0.2989 - val_accuracy: 0.90
Epoch 7/10
2500/2500 [==============================] - 21s 9ms/step - loss: 0.0586 - accuracy: 0.9788 - val_loss: 0.3164 - val_accuracy: 0.90
Epoch 8/10
2500/2500 [==============================] - 21s 8ms/step - loss: 0.0449 - accuracy: 0.9840 - val_loss: 0.3890 - val_accuracy: 0.90
Epoch 9/10
2500/2500 [==============================] - 21s 8ms/step - loss: 0.0353 - accuracy: 0.9876 - val_loss: 0.4261 - val_accuracy: 0.90
Epoch 10/10
2500/2500 [==============================] - 20s 8ms/step - loss: 0.0275 - accuracy: 0.9906 - val_loss: 0.4695 - val_accuracy: 0.90
```

```
loss, accuracy = model.evaluate(X_test, y_test)
print('Test Accuracy:', accuracy)
```

```
625/625 [==============================] - 2s 4ms/step - loss: 0.4695 - accuracy: 0.9028
Test Accuracy: 0.9028499722480774
```

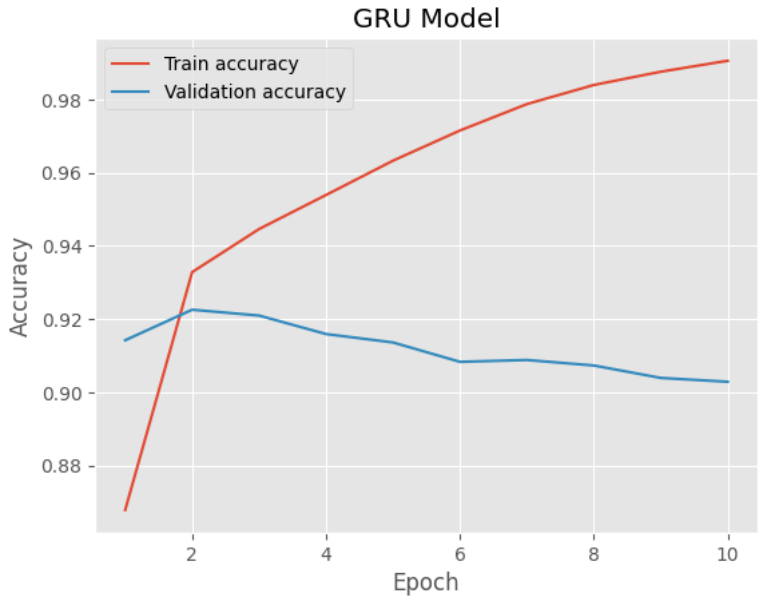
```
y_test_pred_gru = model.predict(X_test)
y_test_pred_gru = y_test_pred_gru.round()
```

```
625/625 [==============================] - 2s 4ms/step
```

```
report_gru=classification_report(y_test, y_test_pred_gru,output_dict=True)
pd.DataFrame(report_gru)
```

	0	1	accuracy	macro avg	weighted avg
precision	0.779210	0.942001	0.90285	0.860606	0.904323
recall	0.809678	0.930909	0.90285	0.870293	0.902850
f1-score	0.794152	0.936422	0.90285	0.865287	0.903494
support	4629.000000	15371.000000	0.90285	20000.000000	20000.000000

```
train_acc = history.history['accuracy']
val_acc = history.history['val_accuracy']
test_acc = accuracy

epochs = np.arange(1, len(train_acc) + 1)

plt.plot(epochs, train_acc, label='Train accuracy')
plt.plot(epochs, val_acc, label='Validation accuracy')
plt.title('GRU Model')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()
plt.show()
```



Testing out the model:

Sample 1

```
df['text'][43]
```

```
'IDK what the deal is with the ceiling..... Oh BBC you are hilarious!! I love that you're making fun o
f me and putting it on a t-shirt. (Except I'm some online chic). \nBut let's get to the real reason
I'm writing this....food and service. \nTo start we walked in and the place was packed. Probably a goo
d sign. The wait wasn't bad at all for Sunday morning. This may seem weird, but the coffee mugs were a
wesome. Big enough to hold plenty, but not so huge that the coffee gets cold before you're done. (I kn
ow, it's an odd observation, but it stood out). \nI had the California omelette. It was huge and came
with hash browns and toast. I thought it was cooked perfectly and had lots of bacon inside. Yay for lo
```

```
df['cleaned_text'][43]
```

```
'idk deal ceiling oh bbc hilarious love making fun putting tshirt except online chic let get real reas
on writing food service start walked place packed probably good sign wait nt bad sunday morning seem w
eird coffee mug awesome big enough hold plenty huge coffee get cold done know odd observation stood ca
lifornia omelette huge came hash brown toast thought cooked perfectly lot bacon inside yay lotsobacon
```

```
sample_review = df['cleaned_text'][43]
sample_review = [sample_review]

#sample_review_transformed = vectorizer.transform(sample_review)

print("Actual Review Sentiment:",df['sentiment'][43])
print("LinearSVC Sentiment Prediction:",grid_search_clf.predict(sample_review_transformed))
print("Naive Bayes Sentiment Prediction:",grid_search_nb.predict(sample_review_transformed))
print("Random Forests Sentiment Prediction:",grid_search_rf.predict(sample_review_transformed))
```

```
Actual Review Sentiment: [0]
LinearSVC Sentiment Prediction: [0]
Naive Bayes Sentiment Prediction: [1]
Random Forests Sentiment Prediction: [0]
LSTM Sentiment Prediction: [0]
```

Sample 2

```
reviews_subset['text'][20]
```

```
'The staff here are just the best. Always eager to help you and on a few occasions have special ordere
d me what I was looking for. I actually drive the extra few miles just to service this location off of
the service alone from the owners here. Large selection of all spirits!'
```

```
df['cleaned_text'][20]
```

```
'staff best always eager help occasion special ordered looking actually drive extra mile service locat
ion service alone owner large selection spirit'
```

```
sample_review = df['cleaned_text'][20]
sample_review = [sample_review]
```

```
sample_review_transformed = vectorizer.transform(sample_review)

print("Actual Review Sentiment:",df['sentiment'][20])
print("LinearSVC Sentiment Prediction:",grid_search_clf.predict(sample_review_transformed))
print("Naive Bayes Sentiment Prediction:",grid_search_nb.predict(sample_review_transformed))
print("Random Forests Sentiment Prediction:",grid_search_rf.predict(sample_review_transformed))
```

```
Actual Review Sentiment: 1
LinearSVC Sentiment Prediction: [1]
Naive Bayes Sentiment Prediction: [1]
Random Forests Sentiment Prediction: [1]
```

Custom Reviews

```
cus_pos_review = 'Blown away by almost every dish. The freshness of the herbs and vegetables, the tenderness of the duck and steak, the c
cus_neg_review = "I have dined in a multitude of culinary institutes and Michelin star restaurants not only in the US but abroad as well.
cus_neu_review = "Great cocktails great vibe, beautiful patio. Very average food for a price. Ok service not super attending. Not family
```

```
cus_pos_review
```

```
'Blown away by almost every dish. The freshness of the herbs and vegetables, the tenderness of the duc
k and steak, the complex spices and of the shan tofu and salads! Not your typical southeast Asian rest
aurant. Definitely a little bit of a twist, but it works well. We tried all the main entrees and a few
appetizers, but the standouts were the shan tofu, ribeye done medium rare (you must dip it in the sauc
e), crispy trout, and beef stir fry. Salads are bright and refreshing. The lighting and decor is sleek
```

```
cus_pos_review = [cus_pos_review]

cus_pos_review_transformed = vectorizer.transform(cus_pos_review)

cus_pos_review_pred = grid_search_clf.predict(cus_pos_review_transformed)

print(cus_pos_review_pred)
```

```
[1]
```

```
cus_neg_review
```

```
'I have dined in a multitude of culinary institutes and Michelin star restaurants not only in the US b
ut abroad as well. I was never treated the way I was treated here with the 2 disgusting hostesses on t
he night of June 17 2022. Who also decided to harass us and say 'well are you guys going to order anyt
hing?!' as we were waiting for our food patiently for 1 AND A HALF HOURS. I did not a receive an apolo
gy for her attitude or assumptions nor an apology for the constant glares I was receiving. Very classl
ess and disgusting. Despite the food being good, I will never come back nor recommend this place to fr
```

```
cus_neg_review = [cus_neg_review]

cus_neg_review_transformed = vectorizer.transform(cus_neg_review)

cus_neg_review_pred = grid_search_clf.predict(cus_neg_review_transformed)

print(cus_neg_review_pred)
```

```
[0]
```

```
cus_neu_review
```

```
'Great cocktails great vibe, beautiful patio. Very average food for a price. Ok service not super atte
nding. Not family friendly or at least our server wasn't accommodating our son in a best way. We won't
be back, but check out on your own'
```

```
cus_neu_review = [cus_neu_review]

cus_neu_review_transformed = vectorizer.transform(cus_neu_review)

cus_neu_review_pred = grid_search_clf.predict(cus_neu_review_transformed)

print(cus_neu_review_pred)
```

```
[1]
```