Restaurant Reviews Sentiment Analysis.

Importing the necessary libraries for reading the tsv data file

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt


#Reading the tsv file.
data = pd.read_csv('Restaurant_Reviews.tsv', delimiter='\t' , quoting=3)
```

:Displaying the count of liked and disliked reviews.

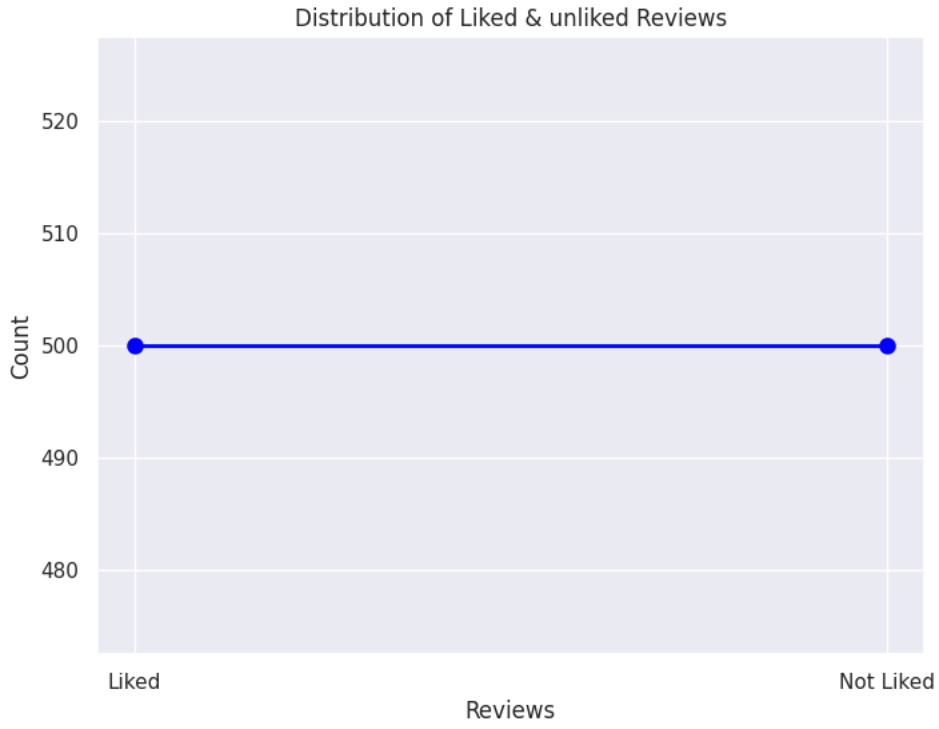
```
liked_count = data[data['Liked'] == 1].shape[0]
not_liked_count = data[data['Liked'] == 0].shape[0]

# Here we are Creating a line plot to display the review count.
plt.figure(figsize=(8, 6))

plt.plot(['Liked', 'Not Liked'], [liked_count, not_liked_count], marker='o', color='blue', linestyle='-', linewidth=2, markersize=8)

# Here we add the title and the labels of the line-graph.
plt.title('Distribution of Liked & unliked Reviews')
plt.xlabel('Reviews')
plt.ylabel('Count')

plt.show()#It will display the line graph for us.
```



As you can see the number liked and disliked in the Restaurant review is 50-50.

```
# Here we are going to count the liked and disliked reviews.
good_reviews_count = len(data.loc[data['Liked'] == 1])
bad_reviews_count=len(data.loc[data['Liked']==0])
(good_reviews_count, good_reviews_count)
```

```
(500, 500)
```

Let us see some features of Restaurant_Reviews dataset.

```
data.shape
```

```
(1000, 2)
```

```
data.head()
```

	Review	Liked
0	Wow... Loved this place.	1
1	Crust is not good.	0
2	Not tasty and the texture was just nasty.	0
3	Stopped by during the late May bank holiday of...	1
4	The selection on the menu was great and so wer...	1

```
data.info
```

```
<bound method DataFrame.info of                                                 Review  Liked
0                             Wow... Loved this place.      1
1                                   Crust is not good.      0
2            Not tasty and the texture was just nasty.      0
3    Stopped by during the late May bank holiday of...      1
4    The selection on the menu was great and so wer...      1
..                                                 ...    ...
995  I think food should have flavor and texture an...      0
996                           Appetite instantly gone.      0
997  Overall I was not impressed and would not go b...      0
998  The whole experience was underwhelming, and I ...      0
999  Then, as if I hadn't wasted enough of my life ...      0

[1000 rows x 2 columns]>
```

```
data.tail()
```

	Review	Liked
995	I think food should have flavor and texture an...	0
996	Appetite instantly gone.	0
997	Overall I was not impressed and would not go b...	0
998	The whole experience was underwhelming, and I ...	0
999	Then, as if I hadn't wasted enough of my life ...	0

As you can see the number of reviews starts from 0 and go upto 999. Total review = 1000

Importing Natural Language Toolkit(nltk)

```
import nltk
import re
nltk.download('stopwords')
nltk.download('wordnet')
from nltk.corpus import stopwords
from nltk.stem.porter import PorterStemmer
from nltk.stem import WordNetLemmatizer

stemmer = PorterStemmer()
lemmatizer = WordNetLemmatizer()
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
[nltk_data] Downloading package wordnet to /root/nltk_data...
[nltk_data]   Package wordnet is already up-to-date!
```

```
corpus = []
for i in range(len(data)):
    review = re.sub('[^a-zA-Z]', ' ', data['Review'][i])#It replaces any character that is not a letter.
```

```
    review = review.lower()#This converts all the text to lowercase
    review = review.split()#This splits the text into a list of words
    all_stopwords = stopwords.words('english')#This creates a list of stopwords from the NLTK corpus.
    all_stopwords.remove('not')
    #remove negative word 'not' as it is closest word to help determine whether the review is good or not
    review = [stemmer.stem(word) for word in review if not word in set(all_stopwords)]
    review = ' '.join(review)
    corpus.append(review)
print(corpus)
```

```
['wow love place', 'crust not good', 'not tasti textur nasti', 'stop late may bank holiday rick steve recommend love', 'select menu gre
```

Text Data Preprocessing and Vectorization for Sentiment Analysis

```
corpus[:1500]
# This slice operation is used to select the first 1500 reviews from the corpus.

from sklearn.feature_extraction.text import CountVectorizer
cv = CountVectorizer(max_features=1500)
X =cv.fit_transform(corpus).toarray()
y = data.iloc[:,1].values
```

Training and testing split up

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.20, random_state = 0)


X_train.shape,X_test.shape, y_train.shape,y_test.shape
```

```
((800, 1500), (200, 1500), (800,), (200,))
```

1.Navie bayes Model

(a) Bernoulli Naive Bayes Classifier.

```
# Bernoulli Naive Bayes Classifier.
# Here we are importing the necessary library's.
from sklearn.model_selection import cross_val_score
from sklearn.naive_bayes import BernoulliNB
from sklearn.model_selection import StratifiedKFold
from sklearn import metrics
from sklearn.metrics import confusion_matrix
from sklearn.metrics import classification_report

# It is the initialization of the Bernoulli NB Classifier.
bnb = BernoulliNB()

# Here we are Performing Stratified K-Fold Cross-Validation.
kfold = StratifiedKFold(n_splits=12)
cv_bnb = cross_val_score(bnb, X_train, y_train, cv=kfold)

# Here we are Printing Cross-Validation Results.
print(cv_bnb)
print(cv_bnb.mean()*100)

# Training the Classifier.
bnb.fit(X_train, y_train)

# Training Accuracy
train_accuracy = bnb.score(X_train, y_train)
print(f'Training Accuracy: {train_accuracy*100:.2f}%')

# Prediction on Test Data.
y_pred_bnb = bnb.predict(X_test)

# test accuracy.
test_accuracy = metrics.accuracy_score(y_pred_bnb, y_test)
print(f'Test Accuracy: {test_accuracy*100:.2f}%')
```

```
# Calculating the Accuracy of Bernoulli NB Classifier.
accuracy_bnb = metrics.accuracy_score(y_pred_bnb, y_test)
print('The accuracy of the Bernoulli Naive Bayes is', accuracy_bnb*100)

# Confusion Matrix.
cm_bnb = confusion_matrix(y_test, y_pred_bnb)
print(cm_bnb)

# Classification Report.
classification_report_bnb = classification_report(y_test, y_pred_bnb)
print(classification_report_bnb)
```

```
[0.71641791 0.79104478 0.73134328 0.76119403 0.7761194  0.71641791
 0.80597015 0.82089552 0.72727273 0.75757576 0.87878788 0.83333333]
77.63643901703604
Training Accuracy: 93.62%
Test Accuracy: 77.50%
The accuracy of the Bernoulli Naive Bayes is 77.5
[[73 24]
 [21 82]]
              precision    recall  f1-score   support

           0       0.78      0.75      0.76        97
           1       0.77      0.80      0.78       103

    accuracy                           0.78       200
   macro avg       0.78      0.77      0.77       200
weighted avg       0.78      0.78      0.77       200
```

(b) Multinomial Naive Bayes Classifier.

```
# Multinomial Naive Bayes Classifier
from sklearn.naive_bayes import MultinomialNB

# Initializing the Multinomial Naive Bayes Classifier.
mnb = MultinomialNB()

# Here we are Performing Stratified K-Fold Cross-Validation.
cv_mnb = cross_val_score(mnb, X_train, y_train, cv=kfold)

# Printing the Cross-Validation Results.
print(cv_mnb)
print(cv_mnb.mean()*100)

# Training the Classifier.
mnb.fit(X_train, y_train)

# Training Accuracy
train_accuracy = mnb.score(X_train, y_train)
print(f'Training Accuracy: {train_accuracy*100:.2f}%')

# Prediction on Test Data.
y_pred_mnb = mnb.predict(X_test)

# test accuracy.
test_accuracy = metrics.accuracy_score(y_pred_mnb, y_test)
print(f'Test Accuracy: {test_accuracy*100:.2f}%')

# Calculate Accuracy of Multinomial NB Classifier.
accuracy_mnb = metrics.accuracy_score(y_pred_mnb, y_test)
print('The accuracy of the Multinomial Naive Bayes is', accuracy_mnb*100)

# Confusion Matrix.
cm_mnb = confusion_matrix(y_test, y_pred_mnb)
print(cm_mnb)

# Classification Report.
classification_report_mnb = classification_report(y_test, y_pred_mnb)
print(classification_report_mnb)
```

```
[0.76119403 0.79104478 0.74626866 0.74626866 0.79104478 0.73134328
 0.80597015 0.80597015 0.77272727 0.77272727 0.87878788 0.84848485]
78.7652645861601
Training Accuracy: 94.00%
Test Accuracy: 77.50%
```

```
The accuracy of the Multinomial Naive Bayes is 77.5
[[74 23]
 [22 81]]
              precision    recall  f1-score   support

           0       0.77      0.76      0.77        97
           1       0.78      0.79      0.78       103

    accuracy                           0.78       200
   macro avg       0.77      0.77      0.77       200
weighted avg       0.77      0.78      0.77       200
```

(c) Complement Naive Bayes Classifier.

```
# Complement Naive Bayes Classifier
from sklearn.naive_bayes import ComplementNB

# Initialize Complement Naive Bayes Classifier
cnb = ComplementNB()

# Performing Stratified K-Fold Cross-Validation
cv_cnb = cross_val_score(cnb, X_train, y_train, cv=kfold)

# Printing Cross-Validation Results
print(cv_cnb)
print(cv_cnb.mean()*100)

# Training the Classifier
cnb.fit(X_train, y_train)

# Training Accuracy
train_accuracy = cnb.score(X_train, y_train)
print(f'Training Accuracy: {train_accuracy*100:.2f}%')

# Prediction on Test Data
y_pred_cnb = cnb.predict(X_test)

test_accuracy = metrics.accuracy_score(y_pred_cnb, y_test)
print(f'Test Accuracy: {test_accuracy*100:.2f}%')

# Calculate Accuracy of Complement Naive Bayes Classifier.
accuracy_cnb = metrics.accuracy_score(y_pred_cnb, y_test)
print('The accuracy of the Complement Naive Bayes is', accuracy_cnb*100)

# Confusion Matrix
cm_cnb = confusion_matrix(y_test, y_pred_cnb)
print(cm_cnb)

# Classification Report
classification_report_cnb = classification_report(y_test, y_pred_cnb)
print(classification_report_cnb)
```

```
[0.76119403 0.79104478 0.74626866 0.74626866 0.79104478 0.73134328
 0.80597015 0.80597015 0.77272727 0.77272727 0.87878788 0.84848485]
78.7652645861601
Training Accuracy: 94.00%
Test Accuracy: 78.00%
The accuracy of the Complement Naive Bayes is 78.0
[[74 23]
 [21 82]]
              precision    recall  f1-score   support

           0       0.78      0.76      0.77        97
           1       0.78      0.80      0.79       103

    accuracy                           0.78       200
   macro avg       0.78      0.78      0.78       200
weighted avg       0.78      0.78      0.78       200
```

2.Logistic Regression.

```
# Logistic Regression Classifier
from sklearn.linear_model import LogisticRegression
from sklearn.preprocessing import StandardScaler
```

```
# Standardize the features for better performance
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)

# Initialize and train Logistic Regression model
lr = LogisticRegression(max_iter=1000, C=1.0, solver='liblinear', class_weight='balanced')
cv_lr = cross_val_score(lr, X_train_scaled, y_train, cv=kfold)

# Print Cross-Validation Results
print(cv_lr)
print(cv_lr.mean()*100)

# Train the Classifier
lr.fit(X_train_scaled, y_train)

# Training Accuracy
train_accuracy = lr.score(X_train_scaled, y_train)
print(f'Training Accuracy: {train_accuracy*100:.2f}%')

# Predict on Test Data
y_pred_lr = lr.predict(X_test_scaled)

# test accuracy.
test_accuracy = metrics.accuracy_score(y_pred_lr, y_test)
print(f'Test Accuracy: {test_accuracy*100:.2f}%')

# Calculate Accuracy of Logistic Regression Classifier.
accuracy_lr = metrics.accuracy_score(y_pred_lr, y_test)
print('The accuracy of Logistic Regression is', accuracy_lr*100)

# Confusion Matrix
cm_lr = confusion_matrix(y_test, y_pred_lr)
print(cm_lr)

# Classification Report
classification_report_lr = classification_report(y_test, y_pred_lr)
print(classification_report_lr)
```

```
[0.70149254 0.7761194  0.71641791 0.70149254 0.74626866 0.79104478
 0.85074627 0.82089552 0.74242424 0.74242424 0.78787879 0.8030303 ]
76.50195989748228
Training Accuracy: 99.25%
Test Accuracy: 80.00%
The accuracy of Logistic Regression is 80.0
[[78 19]
 [21 82]]
              precision    recall  f1-score   support

           0       0.79      0.80      0.80        97
           1       0.81      0.80      0.80       103

    accuracy                           0.80       200
   macro avg       0.80      0.80      0.80       200
weighted avg       0.80      0.80      0.80       200
```

3.Decision Tree Classifier.

```
# Decision Tree Classifier
from sklearn.tree import DecisionTreeClassifier

# Initializing Decision Tree Classifier
dt_classifier = DecisionTreeClassifier(random_state=0, max_depth=10)

# Performing Cross-Validation
cv_dt = cross_val_score(dt_classifier, X_train, y_train, cv=kfold)

# Printing Cross-Validation Results
print(cv_dt)
print(cv_dt.mean()*100)

# Training the Classifier
dt_classifier.fit(X_train, y_train)
```

```
# Training Accuracy
train_accuracy = dt_classifier.score(X_train, y_train)
print(f'Training Accuracy: {train_accuracy*100:.2f}%')

# Prediction on Test Data
y_pred_dt = dt_classifier.predict(X_test)

# Test Accuracy
test_accuracy = metrics.accuracy_score(y_pred_dt, y_test)
print(f'Test Accuracy: {test_accuracy*100:.2f}%')

# Calculate Accuracy of Decision Tree Classifier.
accuracy_dt = metrics.accuracy_score(y_pred_dt, y_test)
print('The accuracy of the Decision Tree Classifier is', accuracy_dt*100)

# Confusion Matrix
cm_dt = confusion_matrix(y_test, y_pred_dt)
print(cm_dt)

# Classification Report
classification_report_dt = classification_report(y_test, y_pred_dt)
print(classification_report_dt)
```

```
[0.70149254 0.67164179 0.71641791 0.76119403 0.74626866 0.74626866
 0.74626866 0.67164179 0.68181818 0.72727273 0.78787879 0.8030303 ]
73.00995024875623
Training Accuracy: 77.25%
Test Accuracy: 68.00%
The accuracy of the Decision Tree Classifier is 68.0
[[93  4]
 [60 43]]
              precision    recall  f1-score   support

           0       0.61      0.96      0.74        97
           1       0.91      0.42      0.57       103

    accuracy                           0.68       200
   macro avg       0.76      0.69      0.66       200
weighted avg       0.77      0.68      0.66       200
```

```
# Improved decision tree.
from sklearn.tree import DecisionTreeClassifier

# Here we made a tuned hyperparameters for the decision tree.
dt_classifier = DecisionTreeClassifier(random_state=0, max_depth=15, min_samples_split=5, min_samples_leaf=4)

# Here we evaluating the Cross-Validation.
cv_dt = cross_val_score(dt_classifier, X_train, y_train, cv=kfold)
print(cv_dt)
print(cv_dt.mean()*100)

# Here we are training the Classifier.
dt_classifier.fit(X_train, y_train)

# Training Accuracy
train_accuracy = dt_classifier.score(X_train, y_train)
print(f'Training Accuracy: {train_accuracy*100:.2f}%')

# Here we are making the Prediction on Test Data.
y_pred_dt = dt_classifier.predict(X_test)

# Test Accuracy
test_accuracy = metrics.accuracy_score(y_pred_dt, y_test)
print(f'Test Accuracy: {test_accuracy*100:.2f}%')

# Calculating the Accuracy.
accuracy_idt = metrics.accuracy_score(y_pred_dt, y_test)
print('The accuracy of the Decision Tree Classifier is', accuracy_idt*100)

# Confusion Matrix
cm_dt = confusion_matrix(y_test, y_pred_dt)
print(cm_dt)

# Classification Report.
classification_report_dt = classification_report(y_test, y_pred_dt)
print(classification_report_dt)
```

```
[0.70149254 0.73134328 0.73134328 0.82089552 0.76119403 0.79104478
 0.7761194  0.71641791 0.8030303  0.75757576 0.77272727 0.8030303 ]
76.38511985526911
Training Accuracy: 78.25%
Test Accuracy: 72.00%
The accuracy of the Decision Tree Classifier is 72.0
[[94  3]
 [53 50]]
              precision    recall  f1-score   support

           0       0.64      0.97      0.77        97
           1       0.94      0.49      0.64       103

    accuracy                           0.72       200
   macro avg       0.79      0.73      0.71       200
weighted avg       0.80      0.72      0.70       200
```

As you can see the accuracy is drastically increased from 68 to 72.

4.Support Vector Classifier.

```
# Support Vector Classifier (SVC)
from sklearn.svm import SVC

# Initializing SVC Classifier
svc_classifier = SVC(kernel='linear', C=1.0, random_state=0)

# Evaluation of Cross-Validation
cv_svc = cross_val_score(svc_classifier, X_train, y_train, cv=kfold)
print(cv_svc)
print(cv_svc.mean()*100)

# Training the Classifier
svc_classifier.fit(X_train, y_train)

# Training Accuracy
train_accuracy = svc_classifier.score(X_train, y_train)
print(f'Training Accuracy: {train_accuracy*100:.2f}%')

# Prediction on Test Data
y_pred_svc = svc_classifier.predict(X_test)

# Test Accuracy
test_accuracy = metrics.accuracy_score(y_pred_svc, y_test)
print(f'Test Accuracy: {test_accuracy*100:.2f}%')

# Calculate Accuracy of Support Vector Classifier.
accuracy_svc = metrics.accuracy_score(y_pred_svc, y_test)
print('The accuracy of the Support Vector Classifier is', accuracy_svc*100)

# Confusion Matrix
cm_svc = confusion_matrix(y_test, y_pred_svc)
print(cm_svc)

# Classification Report
classification_report_svc = classification_report(y_test, y_pred_svc)
print(classification_report_svc)
```

```
[0.7761194  0.82089552 0.74626866 0.79104478 0.7761194  0.76119403
 0.82089552 0.88059701 0.75757576 0.72727273 0.83333333 0.74242424]
78.61450324136891
Training Accuracy: 97.88%
Test Accuracy: 79.00%
The accuracy of the Support Vector Classifier is 79.0
[[79 18]
 [24 79]]
              precision    recall  f1-score   support

           0       0.77      0.81      0.79        97
           1       0.81      0.77      0.79       103

    accuracy                           0.79       200
   macro avg       0.79      0.79      0.79       200
weighted avg       0.79      0.79      0.79       200
```

5.Random Forest Classifier.

```
# Random Forest Classifier
from sklearn.ensemble import RandomForestClassifier

# Initializing Random Forest Classifier
rf_classifier = RandomForestClassifier(n_estimators=100, random_state=0)

# Evaluation of Cross-Validation
cv_rf = cross_val_score(rf_classifier, X_train, y_train, cv=kfold)
print(cv_rf)
print(cv_rf.mean()*100)

# Training the Classifier
rf_classifier.fit(X_train, y_train)

# Training Accuracy
train_accuracy = rf_classifier.score(X_train, y_train)
print(f'Training Accuracy: {train_accuracy*100:.2f}%')

# Prediction on Test Data
y_pred_rf = rf_classifier.predict(X_test)

# Test Accuracy
test_accuracy = metrics.accuracy_score(y_pred_rf, y_test)
print(f'Test Accuracy: {test_accuracy*100:.2f}%')

# Calculate Accuracy of Random Forest Classifier.
accuracy_rf = metrics.accuracy_score(y_pred_rf, y_test)
print('The accuracy of the Random Forest Classifier is', accuracy_rf*100)

# Confusion Matrix
cm_rf = confusion_matrix(y_test, y_pred_rf)
print(cm_rf)

# Classification Report
classification_report_rf = classification_report(y_test, y_pred_rf)
print(classification_report_rf)
```

```
[0.7761194  0.82089552 0.73134328 0.80597015 0.76119403 0.7761194
 0.82089552 0.7761194  0.83333333 0.77272727 0.84848485 0.77272727]
79.13274536408863
Training Accuracy: 99.62%
Test Accuracy: 77.50%
The accuracy of the Random Forest Classifier is 77.5
[[91  6]
 [39 64]]
              precision    recall  f1-score   support

           0       0.70      0.94      0.80        97
           1       0.91      0.62      0.74       103

    accuracy                           0.78       200
   macro avg       0.81      0.78      0.77       200
weighted avg       0.81      0.78      0.77       200
```

```
# Here we are going to print the used algorithms in a order based on its accuracy.
classifiers_accuracy = [
    ('Bernoulli Naive Bayes', accuracy_bnb),
    ('Multinomial Naive Bayes', accuracy_mnb),
    ('Complement Naive Bayes', accuracy_cnb),
    ('Logistic Regression', accuracy_lr),
    ('Decision Tree', accuracy_dt),
    ('Improved Decision Tree', accuracy_idt),
    ('Support Vector Classifier (SVC)', accuracy_svc),
    ('Random Forest Classifier', accuracy_rf)
]

# Sort the list based on accuracy in descending order.
classifiers_accuracy.sort(key=lambda x: x[1], reverse=True)

# Get the best classifier and its accuracy.
best_classifier, best_accuracy = classifiers_accuracy[0]
```

```
# Print the classifiers in order of accuracy.
for classifier, accuracy in classifiers_accuracy:
    print(f'{classifier}: {accuracy*100:.2f}%')

print(f'\nThe {best_classifier} algorithm is best for the Restaurant Reviews dataset.')
```

```
Logistic Regression: 80.00%
Support Vector Classifier (SVC): 79.00%
Complement Naive Bayes: 78.00%
Bernoulli Naive Bayes: 77.50%
Multinomial Naive Bayes: 77.50%
Random Forest Classifier: 77.50%
Improved Decision Tree: 72.00%
Decision Tree: 68.00%

The Logistic Regression algorithm is best for the Restaurant Reviews dataset.
```