```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import nltk
from nltk.stem.porter import PorterStemmer
nltk.download('stopwords')
from nltk.corpus import stopwords
STOPWORDS = set(stopwords.words('english'))

from sklearn.model_selection import train_test_split
from sklearn.preprocessing import MinMaxScaler
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.model_selection import cross_val_score
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
from sklearn.model_selection import GridSearchCV
from sklearn.model_selection import StratifiedKFold
from sklearn.metrics import accuracy_score
from wordcloud import WordCloud
from sklearn.tree import DecisionTreeClassifier
from xgboost import XGBClassifier
import pickle
import re
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Unzipping corpora/stopwords.zip.
```

```
%pip install wordcloud
```

```
Requirement already satisfied: wordcloud in /usr/local/lib/python3.10/dist-packages (1.9.3)
Requirement already satisfied: numpy>=1.6.1 in /usr/local/lib/python3.10/dist-packages (from wordcloud) (1.25.2)
Requirement already satisfied: pillow in /usr/local/lib/python3.10/dist-packages (from wordcloud) (9.4.0)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.10/dist-packages (from wordcloud) (3.7.1)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->wordcloud) (1.2.1)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.10/dist-packages (from matplotlib->wordcloud) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib->wordcloud) (4.51.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->wordcloud) (1.4.5)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib->wordcloud) (24.0)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->wordcloud) (3.1.2)
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.10/dist-packages (from matplotlib->wordcloud) (2.8.2)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.7->matplotlib->wordcloud
```

```
#Load the data

data = pd.read_csv(r"/content/amazon_alexa.tsv", delimiter = '\t', quoting = 3)

print(f"Dataset shape : {data.shape}")
```

```
Dataset shape : (3150, 5)
```

```
data.head()
```

	rating	date	variation	verified_reviews	feedback
0	5	31-Jul-18	Charcoal Fabric	Love my Echo!	1
1	5	31-Jul-18	Charcoal Fabric	Loved it!	1
2	4	31-Jul-18	Walnut Finish	"Sometimes while playing a game, you can answe...	1
3	5	31-Jul-18	Charcoal	"I have had a lot of fun with this thing. My	1

Next steps: Generate code with data View recommended plots

```
#Column names

print(f"Feature names : {data.columns.values}")
```

```
Feature names : ['rating' 'date' 'variation' 'verified_reviews' 'feedback']
```

```
#Check for null values

data.isnull().sum()
```

```
rating             0
date               0
```

```
variation          0
verified_reviews   1
feedback           0
dtype: int64
```

```
#Getting the record where 'verified_reviews' is null

data[data['verified_reviews'].isna() == True]
```

	rating	date	variation	verified_reviews	feedback
473	2	29-Jun-18	White	NaN	0

```
#We will drop the null record

data.dropna(inplace=True)


print(f"Dataset shape after dropping null values : {data.shape}")
```

```
Dataset shape after dropping null values : (3149, 5)
```

```
#Creating a new column 'length' that will contain the length of the string in 'verified_reviews' column

data['length'] = data['verified_reviews'].apply(len)


data.head()
```

	rating	date	variation	verified_reviews	feedback	length
0	5	31-Jul-18	Charcoal Fabric	Love my Echo!	1	13
1	5	31-Jul-18	Charcoal Fabric	Loved it!	1	9
2	4	31-Jul-18	Walnut Finish	"Sometimes while playing a game, you can answe...	1	197
3	5	31-Jul-18	Charcoal Fabric	"I have had a lot of fun with this thing. My 4...	1	174
4	5	31-Jul-18	Charcoal Fabric	Music	1	5

Next steps: Generate code with `data` View recommended plots

```
#Randomly checking for 10th record

print(f"'verified_reviews' column value: {data.iloc[10]['verified_reviews']}") #Original value
print(f"Length of review : {len(data.iloc[10]['verified_reviews'])}") #Length of review using len()
print(f"'length' column value : {data.iloc[10]['length']}") #Value of the column 'length'
```

```
'verified_reviews' column value: "I sent it to my 85 year old Dad, and he talks to it constantly."
Length of review : 65
'length' column value : 65
```

```
data.dtypes
```

```
rating              int64
date               object
variation          object
verified_reviews   object
feedback            int64
length              int64
dtype: object
```

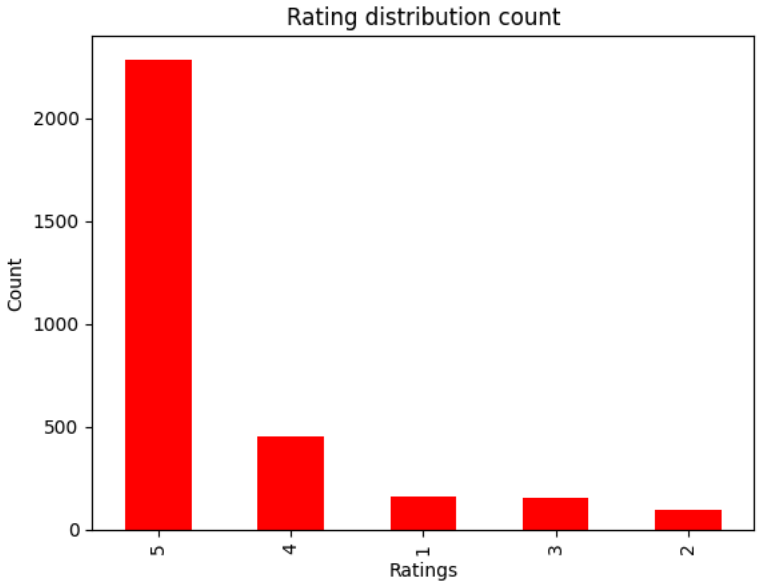
```
len(data)
```

```
3149
```

```
#Distinct values of 'rating' and its count

print(f"Rating value count: \n{data['rating'].value_counts()}")
```

```
Rating value count:
rating
5    2286
4     455
1     161
3     152
2      95
Name: count, dtype: int64
```

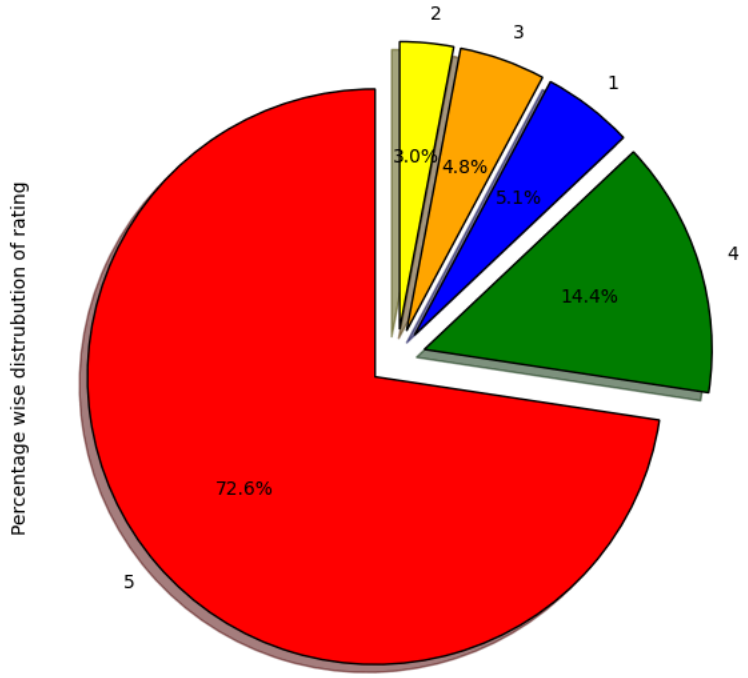
```
#Bar plot to visualize the total counts of each rating

data['rating'].value_counts().plot.bar(color = 'red')
plt.title('Rating distribution count')
plt.xlabel('Ratings')
plt.ylabel('Count')
plt.show()
```




```
#Finding the percentage distribution of each rating - we'll divide the number of records for each rating by total number of records

print(f"Rating value count - percentage distribution: \n{round(data['rating'].value_counts()/data.shape[0]*100,2)}")
```

```
Rating value count - percentage distribution:
rating
5    72.59
4    14.45
1     5.11
3     4.83
2     3.02
Name: count, dtype: float64
```

```
fig = plt.figure(figsize=(7,7))

colors = ('red', 'green', 'blue','orange','yellow')

wp = {'linewidth':1, "edgecolor":'black'}

tags = data['rating'].value_counts()/data.shape[0]

explode=(0.1,0.1,0.1,0.1,0.1)

tags.plot(kind='pie', autopct="%1.1f%%", shadow=True, colors=colors, startangle=90, wedgeprops=wp, explode=explode, label='Percentage w

from io import  BytesIO

graph = BytesIO()

fig.savefig(graph, format="png")
```




```
#Distinct values of 'feedback' and its count

print(f"Feedback value count: \n{data['feedback'].value_counts()}")
```

```
Feedback value count:
feedback
1    2893
0     256
Name: count, dtype: int64
```

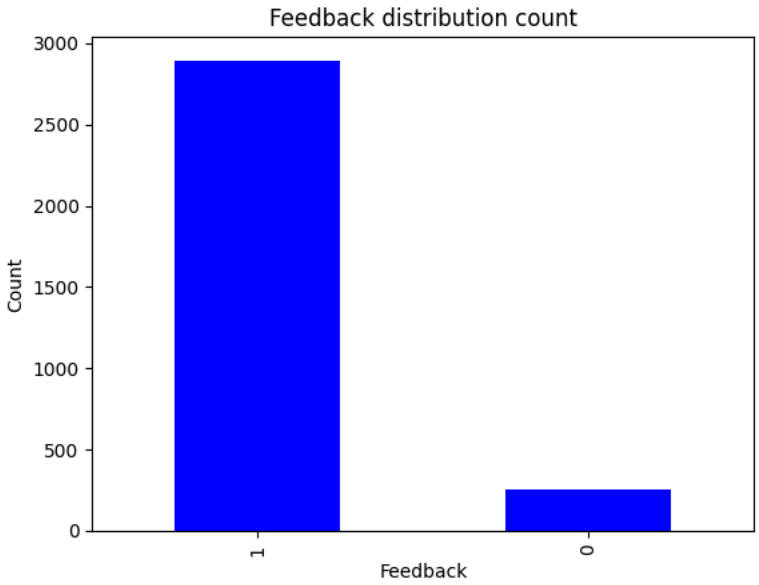
```
#Extracting the 'verified_reviews' value for one record with feedback = 0

review_0 = data[data['feedback'] == 0].iloc[1]['verified_reviews']
print(review_0)
```

```
Sound is terrible if u want good music too get a bose
```

```
#Extracting the 'verified_reviews' value for one record with feedback = 1

review_1 = data[data['feedback'] == 1].iloc[1]['verified_reviews']
print(review_1)
```

```
Loved it!
```

```
#Bar graph to visualize the total counts of each feedback

data['feedback'].value_counts().plot.bar(color = 'blue')
plt.title('Feedback distribution count')
plt.xlabel('Feedback')
plt.ylabel('Count')
plt.show()
```

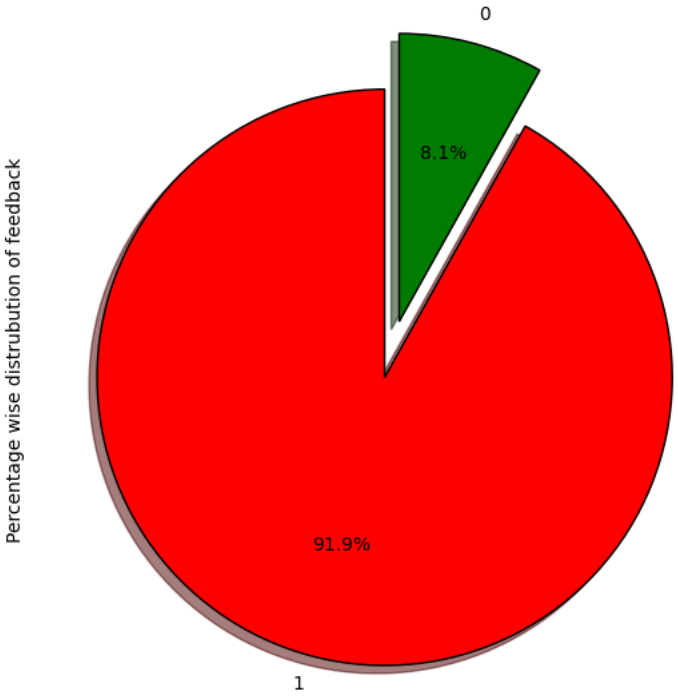



```
#Finding the percentage distribution of each feedback - we'll divide the number of records for each feedback by total number of records

print(f"Feedback value count - percentage distribution: \n{round(data['feedback'].value_counts()/data.shape[0]*100,2)}")
```

```
Feedback value count - percentage distribution:
feedback
1    91.87
0     8.13
Name: count, dtype: float64
```

```
fig = plt.figure(figsize=(7,7))

colors = ('red', 'green')

wp = {'linewidth':1, "edgecolor":'black'}

tags = data['feedback'].value_counts()/data.shape[0]

explode=(0.1,0.1)

tags.plot(kind='pie', autopct="%1.1f%%", shadow=True, colors=colors, startangle=90, wedgeprops=wp, explode=explode, label='Percentage wi
```

```
<Axes: ylabel='Percentage wise distrubution of feedback'>
```




```
#Feedback = 0
data[data['feedback'] == 0]['rating'].value_counts()
```

```
rating
1    161
2     95
Name: count, dtype: int64
```

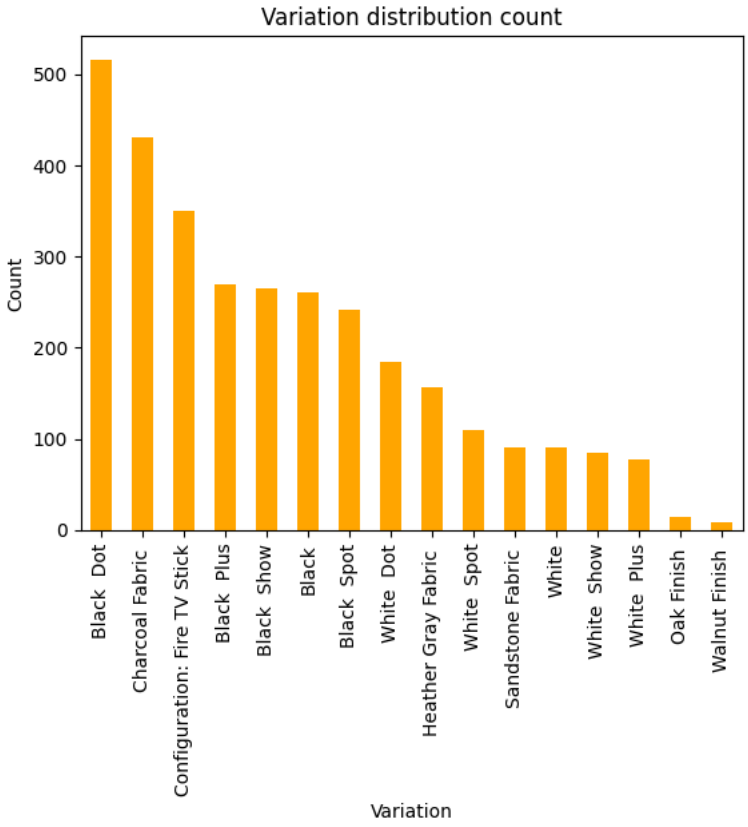
```
#Feedback = 1
data[data['feedback'] == 1]['rating'].value_counts()
```

```
rating
5    2286
4     455
3     152
Name: count, dtype: int64
```

```
#Distinct values of 'variation' and its count

print(f"Variation value count: \n{data['variation'].value_counts()}")
```

```
Variation value count:
variation
Black  Dot                      516
Charcoal Fabric                 430
Configuration: Fire TV Stick    350
Black  Plus                     270
Black  Show                     265
Black                           261
Black  Spot                     241
White  Dot                      184
Heather Gray Fabric             157
White  Spot                     109
Sandstone Fabric                 90
White                            90
White  Show                       85
White  Plus                       78
Oak Finish                        14
Walnut Finish                      9
Name: count, dtype: int64
```

```
#Bar graph to visualize the total counts of each variation

data['variation'].value_counts().plot.bar(color = 'orange')
plt.title('Variation distribution count')
plt.xlabel('Variation')
plt.ylabel('Count')
plt.show()
```




```
#Finding the percentage distribution of each variation - we'll divide the number of records for each variation by total number of records
```

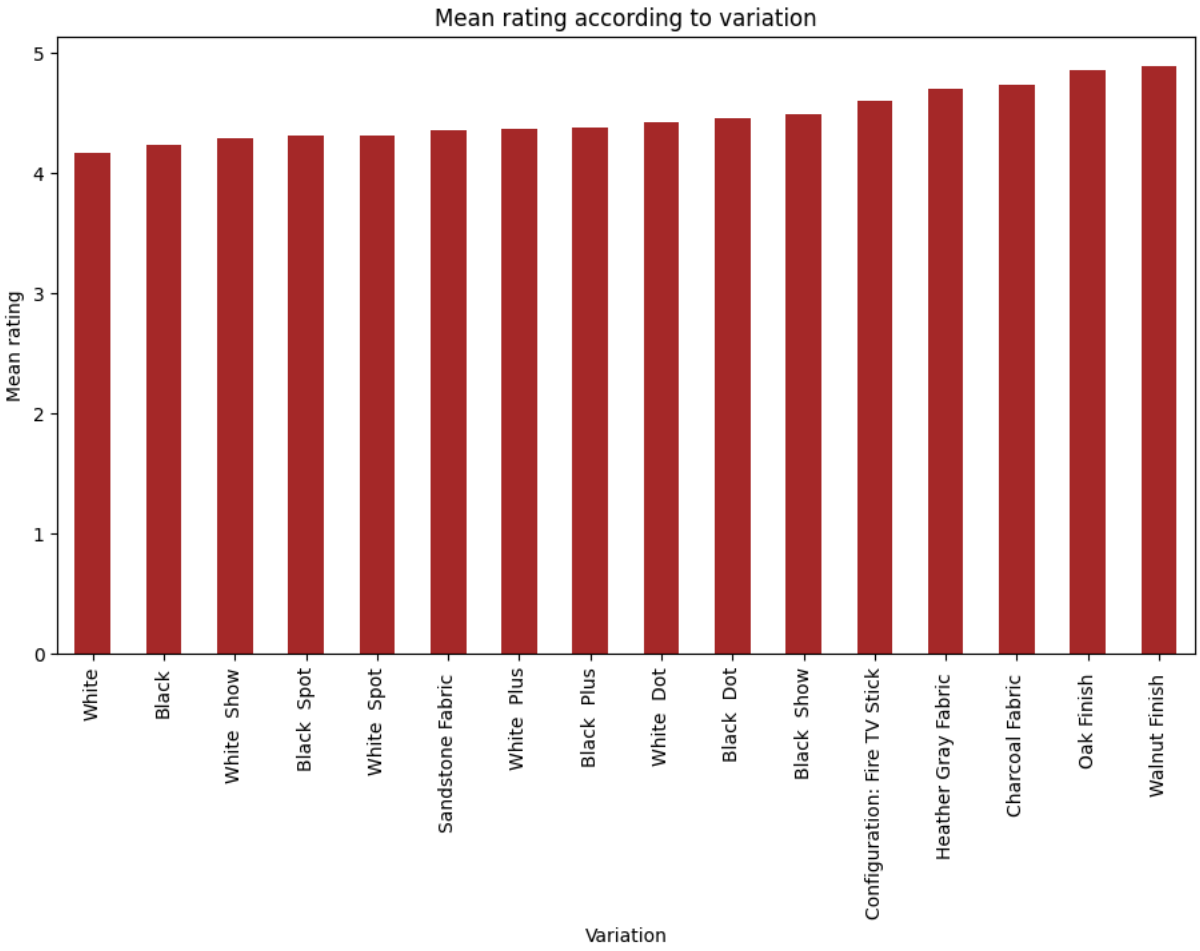
```
print(f"Variation value count - percentage distribution: \n{round(data['variation'].value_counts()/data.shape[0]*100,2)}")
```

```
Variation value count - percentage distribution:
variation
Black  Dot                      16.39
Charcoal Fabric                 13.66
Configuration: Fire TV Stick    11.11
Black  Plus                      8.57
Black  Show                      8.42
Black                            8.29
Black  Spot                      7.65
White  Dot                       5.84
Heather Gray Fabric              4.99
White  Spot                      3.46
Sandstone Fabric                 2.86
White                            2.86
White  Show                      2.70
White  Plus                      2.48
Oak Finish                       0.44
Walnut Finish                    0.29
Name: count, dtype: float64
```

```
data.groupby('variation')['rating'].mean()
```

```
variation
Black                           4.233716
Black  Dot                      4.453488
Black  Plus                     4.370370
Black  Show                     4.490566
Black  Spot                     4.311203
Charcoal Fabric                 4.730233
Configuration: Fire TV Stick    4.591429
Heather Gray Fabric             4.694268
Oak Finish                      4.857143
Sandstone Fabric                4.355556
Walnut Finish                   4.888889
White                           4.166667
White  Dot                      4.423913
White  Plus                     4.358974
White  Show                     4.282353
White  Spot                     4.311927
Name: rating, dtype: float64
```

```
data.groupby('variation')['rating'].mean().sort_values().plot.bar(color = 'brown', figsize=(11, 6))
plt.title("Mean rating according to variation")
plt.xlabel('Variation')
plt.ylabel('Mean rating')
plt.show()
```

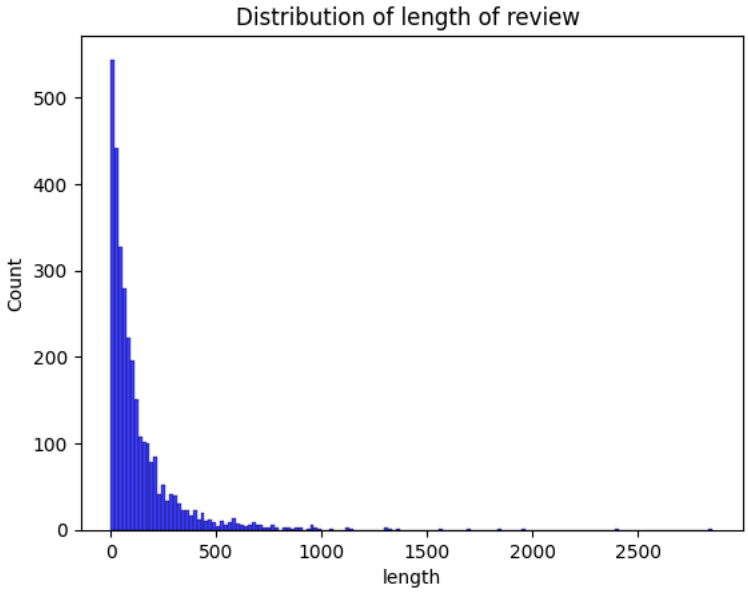



```
data['length'].describe()
```

```
count    3149.000000
mean      132.714513
std       182.541531
min         1.000000
25%        30.000000
50%        74.000000
75%       166.000000
max      2853.000000
Name: length, dtype: float64
```

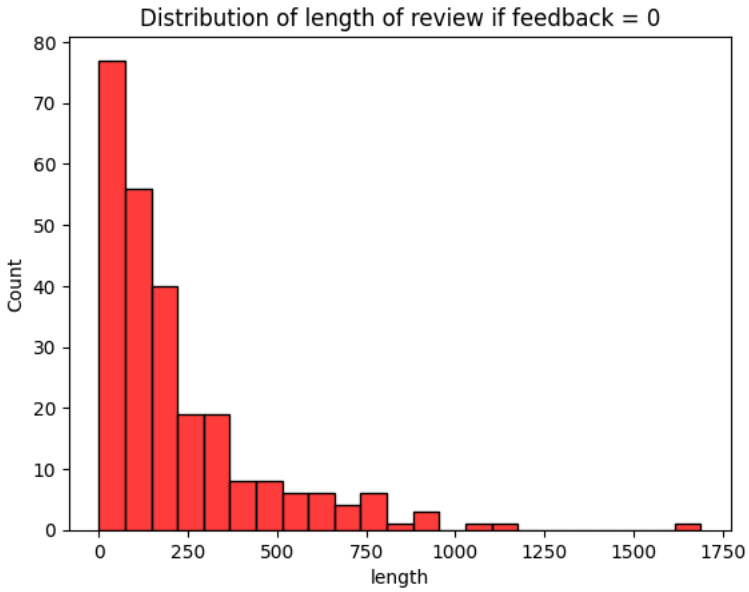
```
sns.histplot(data['length'],color='blue').set(title='Distribution of length of review ')
```

```
[Text(0.5, 1.0, 'Distribution of length of review ')]
```



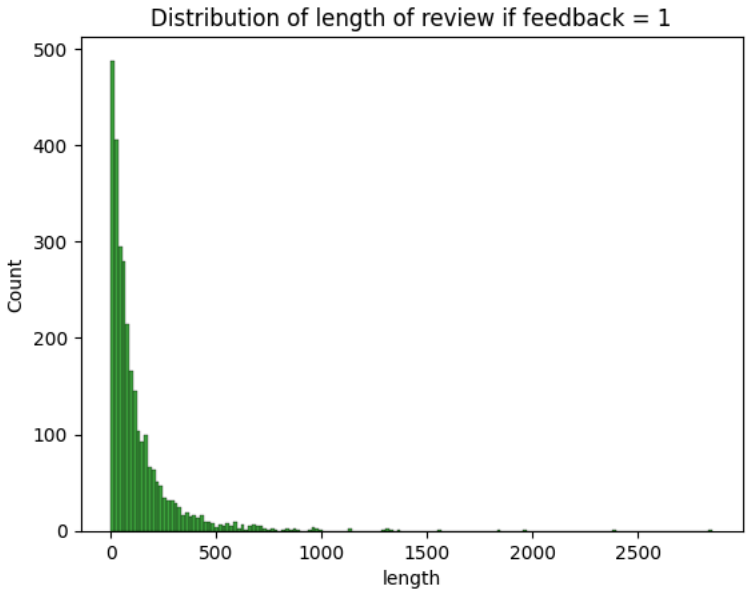

```
sns.histplot(data[data['feedback']==0]['length'],color='red').set(title='Distribution of length of review if feedback = 0')
```

```
[Text(0.5, 1.0, 'Distribution of length of review if feedback = 0')]
```

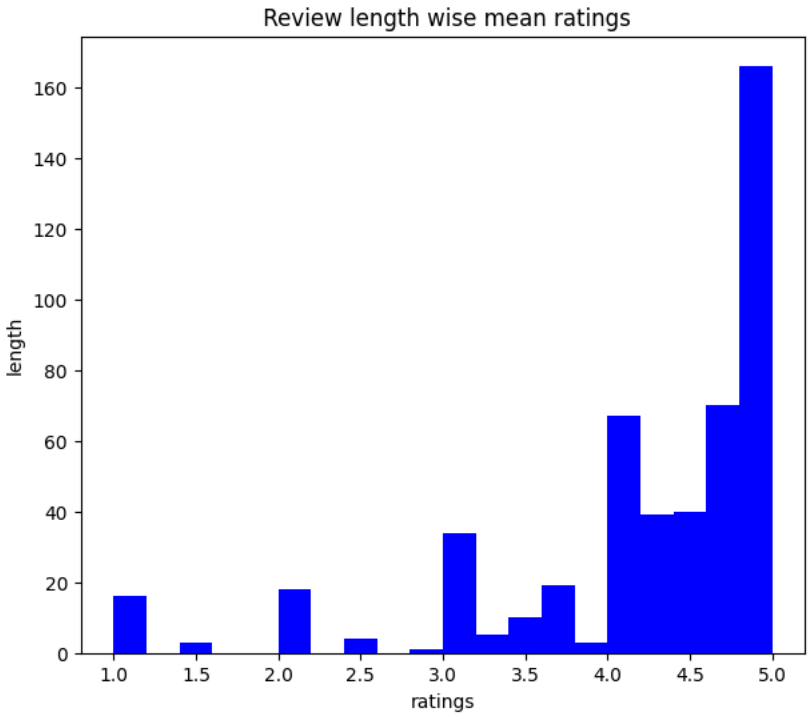



```
sns.histplot(data[data['feedback']==1]['length'],color='green').set(title='Distribution of length of review if feedback = 1')
```

```
[Text(0.5, 1.0, 'Distribution of length of review if feedback = 1')]
```




```
data.groupby('length')['rating'].mean().plot.hist(color = 'blue', figsize=(7, 6), bins = 20)
plt.title(" Review length wise mean ratings")
plt.xlabel('ratings')
plt.ylabel('length')
plt.show()
```




```
cv = CountVectorizer(stop_words='english')
words = cv.fit_transform(data.verified_reviews)
```

```
# Combine all reviews
reviews = " ".join([review for review in data['verified_reviews']])

# Initialize wordcloud object
wc = WordCloud(background_color='white', max_words=50)

# Generate and plot wordcloud
plt.figure(figsize=(10,10))
plt.imshow(wc.generate(reviews))
plt.title('Wordcloud for all reviews', fontsize=10)
plt.axis('off')
plt.show()
```

```
# Combine all reviews for each feedback category and splitting them into individual words
neg_reviews = " ".join([review for review in data[data['feedback'] == 0]['verified_reviews']])
neg_reviews = neg_reviews.lower().split()

pos_reviews = " ".join([review for review in data[data['feedback'] == 1]['verified_reviews']])
pos_reviews = pos_reviews.lower().split()

#Finding words from reviews which are present in that feedback category only
unique_negative = [x for x in neg_reviews if x not in pos_reviews]
unique_negative = " ".join(unique_negative)

unique_positive = [x for x in pos_reviews if x not in neg_reviews]
unique_positive = " ".join(unique_positive)


wc = WordCloud(background_color='white', max_words=50)

# Generate and plot wordcloud
plt.figure(figsize=(10,10))
plt.imshow(wc.generate(unique_negative))
plt.title('Wordcloud for negative reviews', fontsize=10)
plt.axis('off')
plt.show()
```


```
wc = WordCloud(background_color='white', max_words=50)

# Generate and plot wordcloud
plt.figure(figsize=(10,10))
plt.imshow(wc.generate(unique_positive))
plt.title('Wordcloud for positive reviews', fontsize=10)
plt.axis('off')
plt.show()
```

```
corpus = []
stemmer = PorterStemmer()
for i in range(0, data.shape[0]):
  review = re.sub('[^a-zA-Z]', ' ', data.iloc[i]['verified_reviews'])
  review = review.lower().split()
  review = [stemmer.stem(word) for word in review if not word in STOPWORDS]
  review = ' '.join(review)
  corpus.append(review)


cv = CountVectorizer(max_features = 2500)

#Storing independent and dependent variables in X and y
X = cv.fit_transform(corpus).toarray()
y = data['feedback'].values


print(f"X shape: {X.shape}")
print(f"y shape: {y.shape}")
```

```
X shape: (3149, 2500)
y shape: (3149,)
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.3, random_state = 15)

print(f"X train: {X_train.shape}")
print(f"y train: {y_train.shape}")
print(f"X test: {X_test.shape}")
print(f"y test: {y_test.shape}")
```

```
X train: (2204, 2500)
y train: (2204,)
X test: (945, 2500)
y test: (945,)
```

```
print(f"X train max value: {X_train.max()}")
print(f"X test max value: {X_test.max()}")
```

```
X train max value: 12
X test max value: 10
```

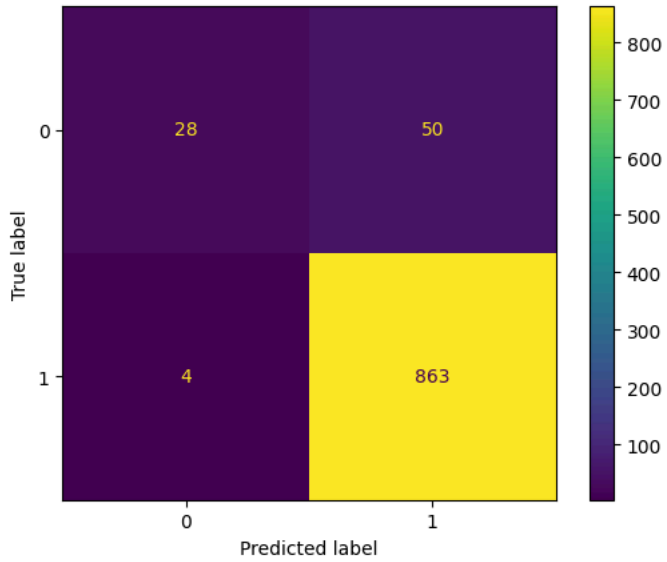
```
scaler = MinMaxScaler()

X_train_scl = scaler.fit_transform(X_train)
X_test_scl = scaler.transform(X_test)


#Fitting scaled X_train and y_train on Random Forest Classifier
model_rf = RandomForestClassifier()
model_rf.fit(X_train_scl, y_train)
```

```
▾ RandomForestClassifier
RandomForestClassifier()
```

```
#Accuracy of the model on training and testing data

print("Training Accuracy :", model_rf.score(X_train_scl, y_train))
print("Testing Accuracy :", model_rf.score(X_test_scl, y_test))
```

```
Training Accuracy : 0.9945553539019963
Testing Accuracy : 0.9428571428571428
```

```
#Predicting on the test set
y_preds = model_rf.predict(X_test_scl)


#Confusion Matrix
cm = confusion_matrix(y_test, y_preds)


cm_display = ConfusionMatrixDisplay(confusion_matrix=cm,display_labels=model_rf.classes_)
cm_display.plot()
plt.show()
```




```
accuracies = cross_val_score(estimator = model_rf, X = X_train_scl, y = y_train, cv = 10)

print("Accuracy :", accuracies.mean())
print("Standard Variance :", accuracies.std())
```

```
Accuracy : 0.9314932126696833
Standard Variance : 0.010210854999266212
```

```
params = {
    'bootstrap': [True],
    'max_depth': [80, 100],
    'min_samples_split': [8, 12],
    'n_estimators': [100, 300]
}
```

```
cv_object = StratifiedKFold(n_splits = 2)

grid_search = GridSearchCV(estimator = model_rf, param_grid = params, cv = cv_object, verbose = 0, return_train_score = True)
grid_search.fit(X_train_scl, y_train.ravel())
```

```
GridSearchCV
estimator: RandomForestClassifier
RandomForestClassifier
```

```
#Getting the best parameters from the grid search


print("Best Parameter Combination : {}".format(grid_search.best_params_))
```

```
Best Parameter Combination : {'bootstrap': True, 'max_depth': 100, 'min_samples_split': 8, 'n_estimators': 100}
```

```
print("Cross validation mean accuracy on train set : {}".format(grid_search.cv_results_['mean_train_score'].mean()*100))
print("Cross validation mean accuracy on test set : {}".format(grid_search.cv_results_['mean_test_score'].mean()*100))
print("Accuracy score for test set :", accuracy_score(y_test, y_preds))
```

```
Cross validation mean accuracy on train set : 96.84097096188748
Cross validation mean accuracy on test set : 92.17332123411978
Accuracy score for test set : 0.9428571428571428
```

```
model_xgb = XGBClassifier()
model_xgb.fit(X_train_scl, y_train)
```

```
XGBClassifier
XGBClassifier(base_score=None, booster=None, callbacks=None
```

```
#Accuracy of the model on training and testing data

print("Training Accuracy :", model_xgb.score(X_train_scl, y_train))
print("Testing Accuracy :", model_xgb.score(X_test_scl, y_test))
```

```
Training Accuracy : 0.971415607985481
```