Decision Trees: Comparision between ID3 and CART

Download the dataset

In [39]:

```
!rm -rf iris.csv
!wget https://gist.githubusercontent.com/netj/8836201/raw/6f9306ad21398ea43cba4f7d537619d0e
```

```
--2021-11-21 14:09:35--  https://gist.githubusercontent.com/netj/8836201/ra
w/6f9306ad21398ea43cba4f7d537619d0e07d5ae3/iris.csv (https://gist.githubuser
content.com/netj/8836201/raw/6f9306ad21398ea43cba4f7d537619d0e07d5ae3/iris.c
sv)
Resolving gist.githubusercontent.com (gist.githubusercontent.com)... 185.19
9.110.133, 185.199.109.133, 185.199.111.133, ...
Connecting to gist.githubusercontent.com (gist.githubusercontent.com)|185.19
9.110.133|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 3975 (3.9K) [text/plain]
Saving to: ‘iris.csv’

iris.csv            100%[===================>]   3.88K  --.-KB/s    in 0s

2021-11-21 14:09:35 (55.5 MB/s) - ‘iris.csv’ saved [3975/3975]
```

Importing libraries

1. Pandas : For data manipulation and storage
2. Train test split : for splitting the dataset into training data and testing data
3. DecisionTreeClassifier : The machine learning algorithm for decision tree
4. Metrics : Accuracy, Recall, Precision, F1 Score

In [40]:

```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score, recall_score, precision_score, f1_score
```

Load the dataset

In [41]:

```
df = pd.read_csv('iris.csv')
df.head()
```

Out[41]:

	sepal.length	sepal.width	petal.length	petal.width	variety
0	5.1	3.5	1.4	0.2	Setosa
1	4.9	3.0	1.4	0.2	Setosa
2	4.7	3.2	1.3	0.2	Setosa
3	4.6	3.1	1.5	0.2	Setosa
4	5.0	3.6	1.4	0.2	Setosa

Add a column 'class' representing the 'variety' as discrete values

In [42]:

```
df['class'] = df['variety'].map(
    {
        'Setosa': 0,
        'Versicolor': 1,
        'Virginica': 2
    }
)
```

Get the independent (X) data

In [43]:

```
X = df[['sepal.length', 'sepal.width', 'petal.length', 'petal.width']]
X
```

Out[43]:

	sepal.length	sepal.width	petal.length	petal.width
0	5.1	3.5	1.4	0.2
1	4.9	3.0	1.4	0.2
2	4.7	3.2	1.3	0.2
3	4.6	3.1	1.5	0.2
4	5.0	3.6	1.4	0.2
...	...	...	...	...
145	6.7	3.0	5.2	2.3
146	6.3	2.5	5.0	1.9
147	6.5	3.0	5.2	2.0
148	6.2	3.4	5.4	2.3
149	5.9	3.0	5.1	1.8

150 rows × 4 columns

Get the dependent (Y) data

In [44]:

```
Y = df[['class']]
Y
```

Out[44]:

	class
0	0
1	0
2	0
3	0
4	0
...	...
145	2
146	2
147	2
148	2
149	2

150 rows × 1 columns

Split the dataset into training and testing data

In [45]:

```
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size=0.3, random_state=1)
```

Create ID3 and CART classifiers

In [46]:

```
id3 = DecisionTreeClassifier(criterion='entropy')
cart = DecisionTreeClassifier(criterion='gini')
```

Create the ID3 and CART models and test them

In [47]:

```
id3_model = id3.fit(X_train, Y_train)
cart_model = cart.fit(X_train, Y_train)
Y_id3 = id3_model.predict(X_test)
Y_cart = cart_model.predict(X_test)
```

ID3 Metrics

In [48]:

```
accuracy = accuracy_score(Y_test, Y_id3)
recall = recall_score(Y_test, Y_id3, average='micro')
precision = precision_score(Y_test, Y_id3, average='micro')
f1 = f1_score(Y_test, Y_id3, average='micro')
print("Accuracy:", accuracy)
print("Error Rate:", 1.0-accuracy)
print("Recall:", recall)
print("Precision:", precision)
print("F1 Score:", f1)
```

```
Accuracy: 0.9555555555555556
Error Rate: 0.0444444444444444
Recall: 0.9555555555555556
Precision: 0.9555555555555556
F1 Score: 0.9555555555555556
```

CART Metrics

In [49]:

```
accuracy = accuracy_score(Y_test, Y_cart)
recall = recall_score(Y_test, Y_cart, average='micro')
precision = precision_score(Y_test, Y_cart, average='micro')
f1 = f1_score(Y_test, Y_cart, average='micro')
print("Accuracy:", accuracy)
print("Error Rate:", 1.0-accuracy)
print("Recall:", recall)
print("Precision:", precision)
print("F1 Score:", f1)
```

```
Accuracy: 0.9555555555555556
Error Rate: 0.0444444444444444
Recall: 0.9555555555555556
Precision: 0.9555555555555556
F1 Score: 0.9555555555555556
```

Association Analysis

In [50]:

```
import pandas as pd
import numpy as np
from mlxtend.frequent_patterns import apriori, association_rules
import matplotlib.pyplot as plt
```

In [51]:

```
## Use this to read data directly from github
df = pd.read_csv('https://gist.githubusercontent.com/Harsh-Git-Hub/2979ec48043928ad9033d846
## Print first 10 rows
df.head(10)
```

Out[51]:

	0	1	2	3	4	5	6
0	Bread	Wine	Eggs	Meat	Cheese	Pencil	Diaper
1	Bread	Cheese	Meat	Diaper	Wine	Milk	Pencil
2	Cheese	Meat	Eggs	Milk	Wine	NaN	NaN
3	Cheese	Meat	Eggs	Milk	Wine	NaN	NaN
4	Meat	Pencil	Wine	NaN	NaN	NaN	NaN
5	Eggs	Bread	Wine	Pencil	Milk	Diaper	Bagel
6	Wine	Pencil	Eggs	Cheese	NaN	NaN	NaN
7	Bagel	Bread	Milk	Pencil	Diaper	NaN	NaN
8	Bread	Diaper	Cheese	Milk	Wine	Eggs	NaN
9	Bagel	Wine	Diaper	Meat	Pencil	Eggs	Cheese

In [52]:

```
items = set()
for col in df:
    items.update(df[col].unique())
print(items)
```

```
{nan, 'Diaper', 'Bread', 'Pencil', 'Cheese', 'Wine', 'Eggs', 'Bagel', 'Mil
k', 'Meat'}
```

In [53]:

```
# Data Preprocessing
itemset = set(items)
encoded_vals = []
for index, row in df.iterrows():
    rowset = set(row)
    labels = {}
    uncommons = list(itemset - rowset)
    commons = list(itemset.intersection(rowset))
    for uc in uncommons:
        labels[uc] = 0
    for com in commons:
        labels[com] = 1
    encoded_vals.append(labels)
encoded_vals[0]
ohe_df = pd.DataFrame(encoded_vals)
```

In [54]:

```
freq_items = apriori(ohe_df, min_support=0.2, use_colnames=True)
freq_items.head(7)
```

Out[54]:

	support	itemsets
0	0.869841	(nan)
1	0.425397	(Bagel)
2	0.501587	(Milk)
3	0.406349	(Diaper)
4	0.504762	(Bread)
5	0.361905	(Pencil)
6	0.501587	(Cheese)

In [55]:

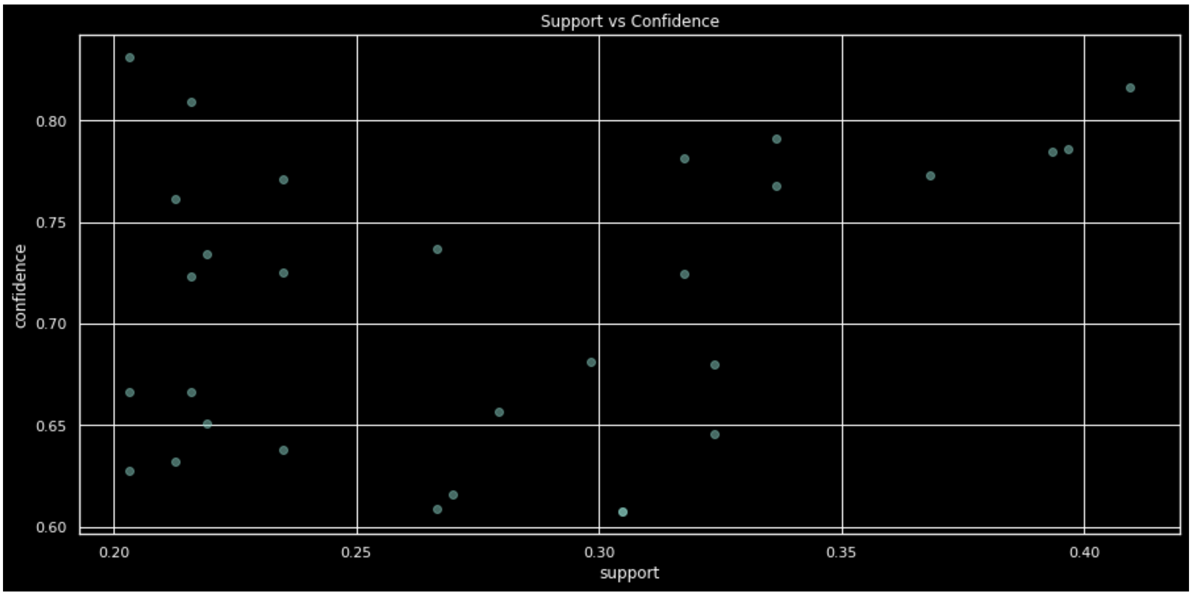
```
rules = association_rules(freq_items, metric="confidence", min_threshold=0.6)
rules.head()
```

Out[55]:

	antecedents	consequents	antecedent support	consequent support	support	confidence	lift	leverag
0	(Bagel)	(nan)	0.425397	0.869841	0.336508	0.791045	0.909413	-0.03352
1	(Milk)	(nan)	0.501587	0.869841	0.409524	0.816456	0.938626	-0.02677
2	(Diaper)	(nan)	0.406349	0.869841	0.317460	0.781250	0.898152	-0.03599
3	(Bread)	(nan)	0.504762	0.869841	0.396825	0.786164	0.903801	-0.04223
4	(Pencil)	(nan)	0.361905	0.869841	0.266667	0.736842	0.847100	-0.04813

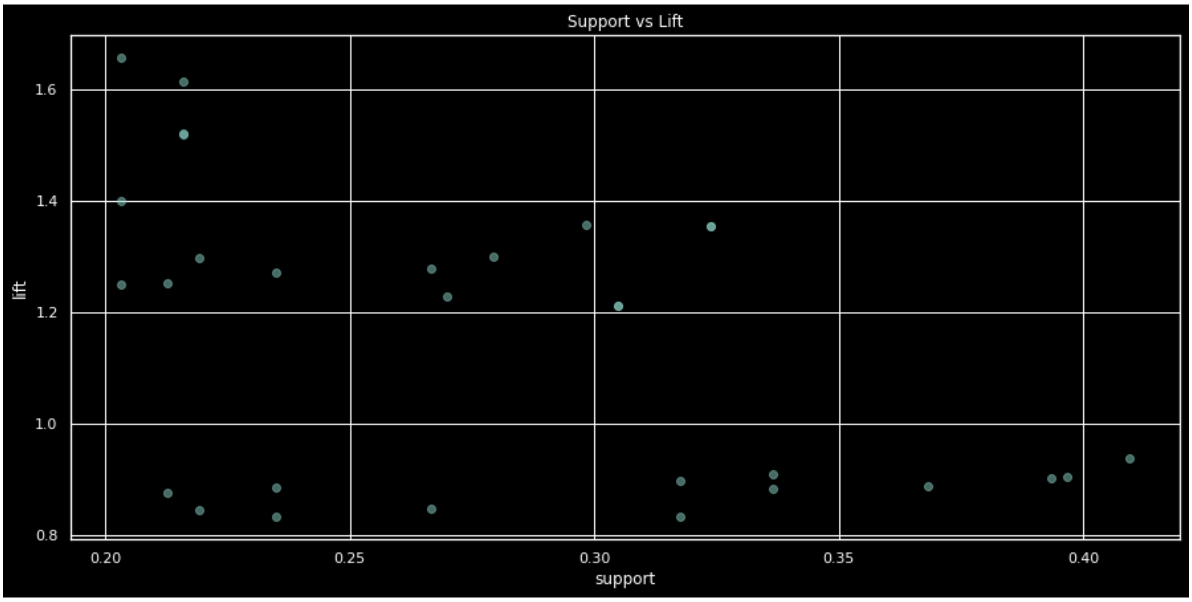
In [56]:

```
# Rules vs Confidence
plt.scatter(rules['support'], rules['confidence'], alpha=0.5)
plt.xlabel('support')
plt.ylabel('confidence')
plt.title('Support vs Confidence')
plt.show()
```



In [57]:

```
# Support vs Lift
plt.scatter(rules['support'], rules['lift'], alpha=0.5)
plt.xlabel('support')
plt.ylabel('lift')
plt.title('Support vs Lift')
plt.show()
```

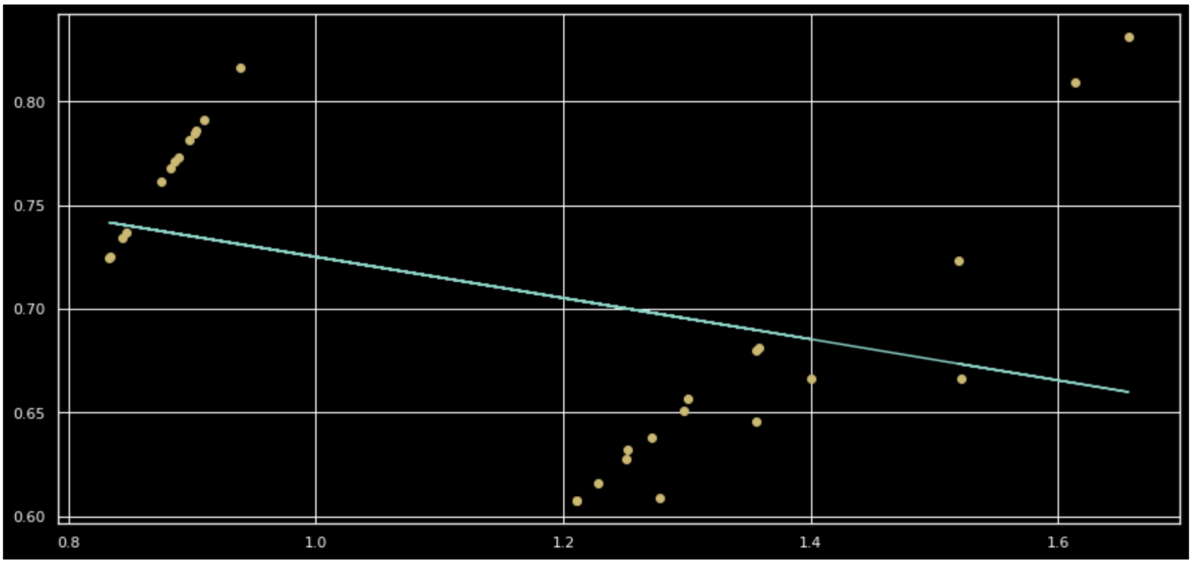


In [58]:

```
# Lift vs Confidence
fit = np.polyfit(rules['lift'], rules['confidence'], 1)
fit_fn = np.poly1d(fit)
plt.plot(rules['lift'], rules['confidence'], 'yo', rules['lift'], fit_fn(rules['lift']))
```

Out[58]:

```
[<matplotlib.lines.Line2D at 0x7fdbe4966a10>,
 <matplotlib.lines.Line2D at 0x7fdbe49666d0>]
```



KMeans Clustering

In [59]:

```
from sklearn.cluster import KMeans
```

In [60]:

```
kmeans = KMeans(n_clusters=3)
# Using dataset from Decision Tree program
model = kmeans.fit(X_train, Y_train)
Y_pred = kmeans.predict(X_test)
```

In [61]:

```
print("Accuracy:", accuracy_score(Y_test['class'], Y_pred))
print("Recall:", recall_score(Y_test['class'], Y_pred, average='weighted'))
print("Precision:", precision_score(Y_test['class'], Y_pred, average='weighted'))
print("F1 Score:", f1_score(Y_test['class'], Y_pred, average='weighted'))
```

```
Accuracy: 0.2222222222222222
Recall: 0.2222222222222222
Precision: 0.26262626262626265
F1 Score: 0.24074074074074073
```

Linear and Logistic Regression

In [62]:

```
!rm-rf Advertising.csv
!wget https://raw.githubusercontent.com/justmarkham/scikit-learn-videos/master/data/Adverti
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error,r2_score
from sklearn.model_selection import train_test_split

data = pd.read_csv("Advertising.csv")
print(data.head())
print('\n')

print(data.columns)
print('\n')

print(data.drop(['Unnamed: 0'], axis=1))


plt.figure(figsize=(16, 8))
plt.scatter(
 data['TV'],
 data['Sales'],
 c='black'
)


plt.xlabel("Money spent on TV ads ($)")
plt.ylabel("Sales ($)")
plt.show()

X = data['TV'].values.reshape(-1,1)
y = data['Sales'].values.reshape(-1,1)
x_train, x_test, y_train, y_test = train_test_split(X,y,test_size = 0.3)
reg = LinearRegression()
reg.fit(x_train, y_train)

print("Slope: ",reg.coef_[0][0])
print("Intercept: ",reg.intercept_[0])
print("The linear model is: Y = {:.5} + {:.5}X".format(reg.intercept_[0], reg.coef_[0][0]))

predictions = reg.predict(x_test)
plt.figure(figsize=(16, 8))
plt.scatter(
 x_test,
 y_test,
 c='black'
)
plt.plot(
 x_test,
 predictions,
 c='blue',
 linewidth=2
)
plt.xlabel("Money spent on TV ads ($)")
plt.ylabel("Sales ($)")
plt.show()

rmse = np.sqrt(mean_squared_error(y_test,predictions))
```

```
print("Root Mean Squared Error = ",rmse)

r2 = r2_score(y_test,predictions)
print("R2 = ",r2)


import matplotlib.pyplot as plt
import numpy as np
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import classification_report, confusion_matrix

x = np.arange(10).reshape(-1, 1)
y = np.array([0, 0, 0, 0, 1, 1, 1, 1, 1, 1])

print(x)
print('\n')

print(y)
print('\n')

model = LogisticRegression(solver='liblinear', random_state=0)

print(model.fit(x, y))
print('\n')

print(model.classes_)
print('\n')

print(model.intercept_)
print('\n')

print(model.coef_)
print('\n')

print(model.predict_proba(x))
print('\n')

print(model.predict(x))
print('\n')

print(model.score(x, y))
print('\n')

confusion_matrix(y, model.predict(x))

cm = confusion_matrix(y, model.predict(x))

fig, ax = plt.subplots(figsize=(8, 8))
ax.imshow(cm)
ax.grid(False)
ax.xaxis.set(ticks=(0, 1), ticklabels=('Predicted 0s', 'Predicted 1s'))
ax.yaxis.set(ticks=(0, 1), ticklabels=('Actual 0s', 'Actual 1s'))
ax.set_ylim(1.5, -0.5)
for i in range(2):
    for j in range(2):
        ax.text(j, i, cm[i, j], ha='center', va='center', color='red')
plt.show()

print(classification_report(y, model.predict(x)))
```

```
/bin/bash: rm-rf: command not found
--2021-11-21 14:09:39--  https://raw.githubusercontent.com/justmarkham/sci
kit-learn-videos/master/data/Advertising.csv (https://raw.githubuserconten
t.com/justmarkham/scikit-learn-videos/master/data/Advertising.csv)
Resolving raw.githubusercontent.com (raw.githubusercontent.com)... 185.19
9.111.133, 185.199.110.133, 185.199.109.133, ...
Connecting to raw.githubusercontent.com (raw.githubusercontent.com)|185.19
9.111.133|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 4555 (4.4K) [text/plain]
Saving to: ‘Advertising.csv.3’

Advertising.csv.3   100%[===================>]   4.45K  --.-KB/s    in 0s

2021-11-21 14:09:39 (43.5 MB/s) - ‘Advertising.csv.3’ saved [4555/4555]

   Unnamed: 0     TV  Radio  Newspaper  Sales
0           1  230.1   37.8       69.2   22.1
1           2   44.5   39.3       45.1   10.4
```

Map Reduce

In [63]:

```
# FOR HADOOP
"""
wget -drc --accept-regex=REGEX -P data ftp://ftp.ncdc.noaa.gov/pub/data/noaa/2015/6*

export PATH=$PATH:/usr/local/hbase/bin:/usr/local/hadoop/sbin:/usr/local/hadoop/bin
export HADOOP_HOME=/usr/local/hadoop
export STREAM=$HADOOP_HOME/share/hadoop/tools/lib/hadoop-streaming-*.jar

start-dfs.sh
hdfs dfs -mkdir weather_data
hdfs dfs -put weather.txt weather_data/
"""
"""
# mapper.py
import sys

for line in sys.stdin:
    line = line.strip()
    print('%s\t%d' % (line[15:23], int(line[87:92])))
# reducer.py
from operator import itemgetter
import sys

current_date = None
current_temperature = 0
date = None

for line in sys.stdin:
    line = line.strip()
    date, temperature = line.split('\t', 1)
    try:
        temperature = int(temperature)
    except ValueError:
        continue

    if current_date == date:
        if current_temperature < temperature:
            current_temperature = temperature
    else:
        if current_date:
            print('%s\t%d' % (current_date, current_temperature))
        current_temperature = temperature
        current_date = date

if current_date == date:
    print('%s\t%d' % (current_date, current_temperature))
"""
"""
chmod a+x mapper.py
chmod a+x reducer.py
cat test.txt | python mapper.py | python reducer.py
"""
```

Out[63]:

```
'\nchmod a+x mapper.py \nchmod a+x reducer.py \ncat test.txt | python mappe
r.py | python reducer.py \n'
```

Program 6

In [64]:

```
import numpy as np
import pandas as pd
import re
import warnings
warnings.filterwarnings('ignore')
import matplotlib.pyplot as plt
%matplotlib inline
from plotly.offline import download_plotlyjs, init_notebook_mode, plot, iplot
import plotly.express as px
import plotly.graph_objects as go
import plotly.figure_factory as ff
from plotly.colors import n_colors
from plotly.subplots import make_subplots
init_notebook_mode(connected= True)
import cufflinks as cf
cf.go_offline()
from wordcloud import WordCloud, ImageColorGenerator
import nltk
from nltk.corpus import stopwords
```

In [65]:

```
!rm -rf amazon_vfl_reviews.csv
!wget https://raw.githubusercontent.com/tezz-io/_data/master/amazon_vfl_reviews.csv
from textblob import TextBlob
df= pd.read_csv('amazon_vfl_reviews.csv')
df.head()
```

```
--2021-11-21 14:09:40--  https://raw.githubusercontent.com/tezz-io/_data/mas
ter/amazon_vfl_reviews.csv (https://raw.githubusercontent.com/tezz-io/_data/
master/amazon_vfl_reviews.csv)
Resolving raw.githubusercontent.com (raw.githubusercontent.com)... 185.199.1
08.133, 185.199.110.133, 185.199.109.133, ...
Connecting to raw.githubusercontent.com (raw.githubusercontent.com)|185.199.
108.133|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 797308 (779K) [text/plain]
Saving to: ‘amazon_vfl_reviews.csv’

amazon_vfl_reviews. 100%[===================>] 778.62K  --.-KB/s    in 0.04s

2021-11-21 14:09:40 (17.5 MB/s) - ‘amazon_vfl_reviews.csv’ saved [797308/797
308]
```

Out[65]:

	asin	name	date	rating	review
0	B07W7CTLD1	Mamaearth-Onion-Growth-Control-Redensyl	2019-09-06	1	I bought this hair oil after viewing so many g...
1	B07W7CTLD1	Mamaearth-Onion-Growth-Control-Redensyl	2019-08-14	5	Used This Mama Earth Newly Launched Onion Oil ...
2	B07W7CTLD1	Mamaearth-Onion-Growth-Control-Redensyl	2019-10-19	1	So bad product...My hair falling increase too ...
3	B07W7CTLD1	Mamaearth-Onion-Growth-Control-Redensyl	2019-09-16	1	Product just smells similar to navarathna hair...
4	B07W7CTLD1	Mamaearth-Onion-Growth-Control-Redensyl	2019-08-18	5	I have been trying different onion oil for my ...

In [66]:

```
df.isnull().sum()
df.shape
```

Out[66]:

```
(2782, 5)
```

In [67]:

```
df.dropna(inplace= True)
df = df.reset_index()
df.drop(['index'], axis = 1, inplace= True)
df.shape
```

Out[67]:

```
(2778, 5)
```

In [68]:

```
def get_brand(x):
    return x.split('-')[0]

df['brand']= df['name'].apply(get_brand)
df['brand'].unique()
```

Out[68]:

```
array(['Mamaearth', 'Godrej', 'Titan', 'Maaza', 'Paper', 'Indiana',
       'Coca', 'Natural', 'Maggi', 'Glucon', 'Amul', 'Patanjali',
       'PATANJALI', 'Dettol', 'Savlon', 'Cinthol', 'Britannia',
       'NutriChoice', 'Streax', 'Himalaya', 'Society', 'Tata', 'Fastrack',
       'Reflex', 'MYSORE', 'Mysore'], dtype=object)
```

In [69]:

```
df['brand'] = df['brand'].str.replace('PATANJALI', 'Patanjali')
df['brand'] = df['brand'].str.replace('MYSORE', 'Mysore')

#number of unique brands
len(df['brand'].unique())
```

Out[69]:

```
24
```

In [70]:

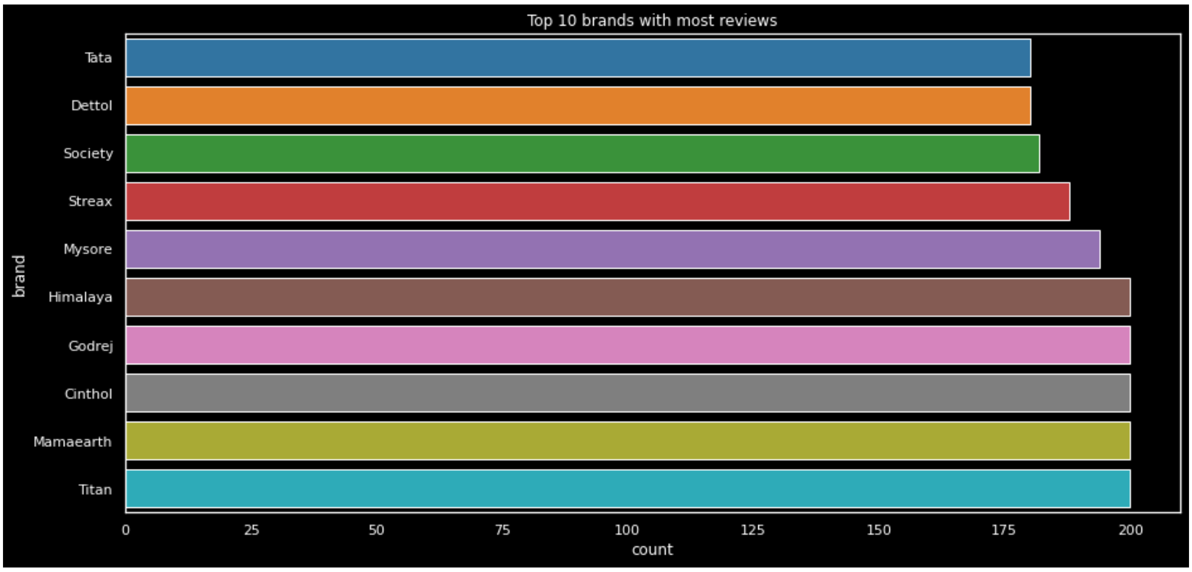
```
df1= pd.DataFrame(df.groupby('brand')['asin'].count().reset_index())
df1.columns= ['brand', 'count']

sort_df= df1.sort_values(['count'], ascending= True)

fig= px.bar(sort_df.iloc[:5, :], y= 'brand', x= 'count', orientation= 'h', color= 'count')
fig.update_layout(title_text= 'Top 5 brands with least number of reviews', title_x= .5, tem
fig.show()
```

In [71]:

```
import seaborn as sns
sns.set(rc={'figure.figsize':(15,7)})
sns.set_theme(style="darkgrid")
plt.style.use("dark_background")
plt.title('Top 10 brands with most reviews')
sns.barplot(x= sort_df['count'].tail(10) , y= sort_df['brand'].tail(10), palette= 'tab10' )
```



In [72]:

```
brand= sort_df.iloc[-10: , :]['brand'].to_list()
count= sort_df.iloc[-10: , :]['count'].to_list()

fig= go.Figure(data= [go.Table(header= dict(values= ['Brand', 'Number of reviews'], fill_co
                              cells= dict(values=[brand, count], height= 20))])
fig.update_layout(title_text='Top 5 Names of brands with most number of reviews',title_x=0.
                  template='plotly_dark')

fig.show()
```

In [73]:

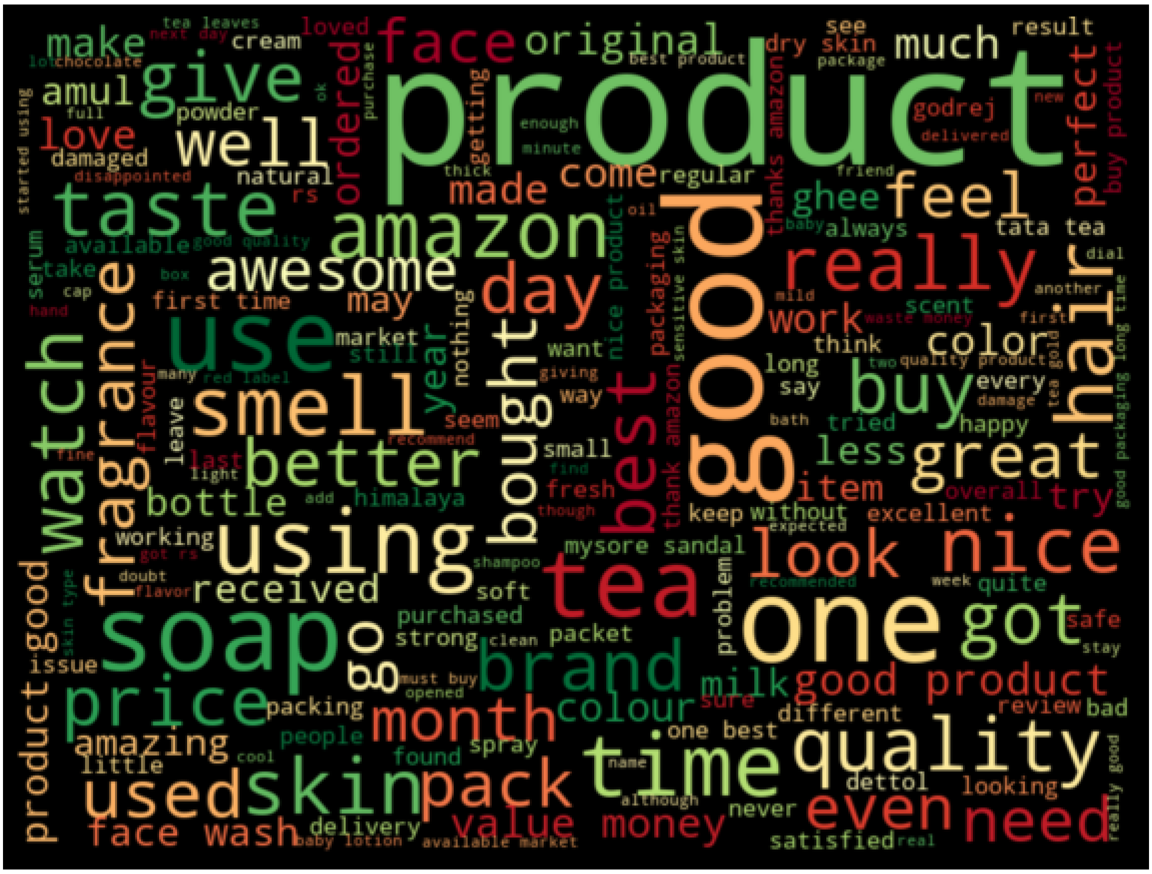
```
import nltk
nltk.download('stopwords')
stop_words = stopwords.words('english')

corpus = []
for i in range(0,len(df)):
    text= re.sub('[^a-zA-Z]', ' ', df['review'][i])
    text= text.lower()
    text= text.split()
    text= [word for word in text if not word in stop_words]
    text= ' '.join(text)
    corpus.append(text)

word_cloud = WordCloud(width = 800,
                       height = 600,
                       colormap = 'RdYlGn',
                       margin = 0,
                       max_words = 200,
                       max_font_size = 120,
                       background_color = 'black').generate(' '.join(corpus))


plt.figure(figsize = (10, 10))
plt.imshow(word_cloud, interpolation = 'gaussian')
plt.axis('off')
plt.show()
```

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



In [74]:

```
rating= pd.DataFrame(df['rating'].value_counts().reset_index())
rating.columns= ['rating', 'count']

rating.sort_values('rating', ascending= False, inplace= True)
rating
```

Out[74]:

	rating	count
0	5	1444
2	4	460
3	3	198
4	2	130
1	1	546

In [75]:

```
fig= px.bar(rating, x= 'rating', y= 'count')
fig.update_layout(title_text= 'Distribution of ratings', title_x= 0.5, template= 'plotly_da
fig.show()
```

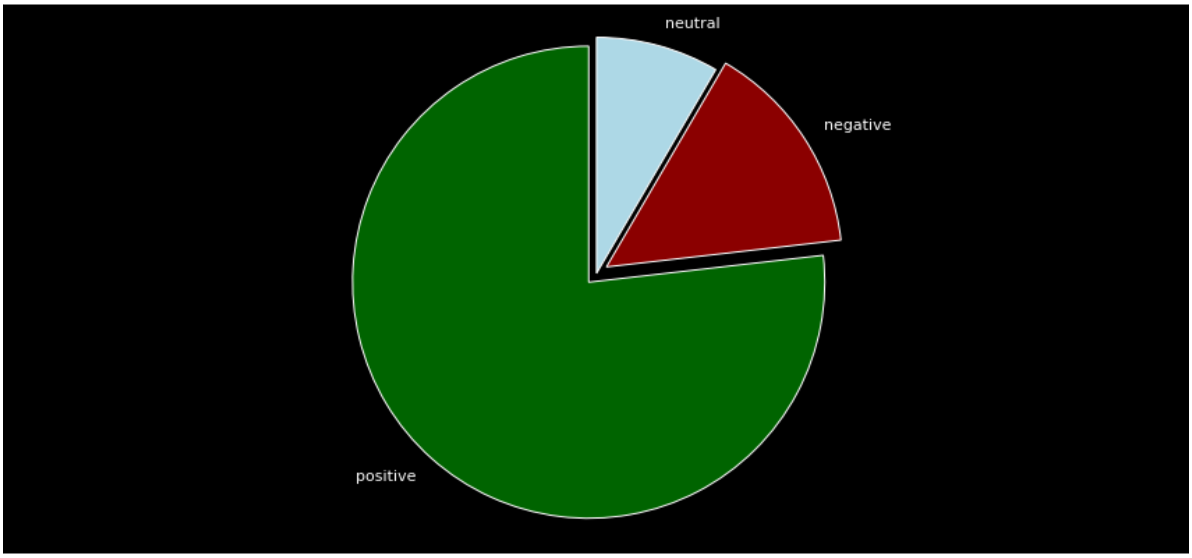
In [76]:

```
def polarity(text):
    return TextBlob(text).sentiment.polarity

df['polarity_score']= df['review'].apply(lambda x : polarity(x))

def sentiment(x):
    if x<0:
        return 'negative'
    elif x==0:
        return 'neutral'
    else:
        return 'positive'

df['polarity'] = df['polarity_score'].\
   map(lambda x: sentiment(x))
values = df['polarity'].value_counts()
labels= df['polarity'].value_counts().index
plt.pie(values , labels= labels ,explode= (.05,.05,0),
          colors=['#006400','#8B0000','#add8e6'],startangle= 90)
plt.axis('equal')
plt.show()
```



In [76]: