In [1]:
```
import pandas as pd
import numpy as np
import pickle
import seaborn as sns
import spacy
import csv
import nltk
import matplotlib.pyplot as plt
import warnings
import re
import string
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import CountVectorizer,TfidfVectorizer
from sklearn.metrics import accuracy_score, confusion_matrix
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import DBSCAN, SpectralClustering, MeanShift
from sklearn.decomposition import PCA,TruncatedSVD,NMF
from sklearn import svm
from sklearn.feature_extraction import text
from sklearn.metrics.pairwise import cosine_similarity
from nltk.tokenize import word_tokenize
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import BernoulliNB
from sklearn.metrics import precision_score, recall_score, accuracy_score, r
from nltk.corpus import stopwords
from autocorrect import Speller
from matplotlib import pyplot as plt
from corextopic import corextopic as ct
from corextopic import vis_topic as vt
from collections import Counter,Counter,defaultdict
from scipy.linalg import svd
from sklearn.tree import DecisionTreeClassifier
spell = Speller(lang='en')
%matplotlib inline
warnings.filterwarnings('ignore')
sns.set_style("whitegrid")
```

Importing data and EDA:

In [2]:
```
df_original_data = pd.read_csv('Hotel_Reviews.csv')
df_all_data = df_original_data.copy()
```

feature engineering: getting Countries Column from hotel address columns:

In [3]:
```
def get_contries():
    df_all_data['Country'] = df_all_data.Hotel_Address.apply(lambda x: str(x
    df_all_data['Country'] = df_all_data['Country'].str.replace('Kingdom','U
get_contries()
```

In [4]:
```
df_all_data
```

Out[4]:

	Hotel_Address	Additional_Number_of_Scoring	Review_Date	Average_Score	Hotel_I
0	s Gravesandestraat 55 Oost 1092 AA Amsterdam ...	194	8/3/2017	7.7	Hotel A
1	s Gravesandestraat 55 Oost 1092 AA Amsterdam ...	194	8/3/2017	7.7	Hotel A
2	s Gravesandestraat 55 Oost 1092 AA Amsterdam ...	194	7/31/2017	7.7	Hotel A
3	s Gravesandestraat 55 Oost 1092 AA Amsterdam ...	194	7/31/2017	7.7	Hotel A
4	s Gravesandestraat 55 Oost 1092 AA Amsterdam ...	194	7/24/2017	7.7	Hotel A
...	...	...	...	...	
515733	Wurzbachgasse 21 15 Rudolfsheim F nfhaus 1150 ...	168	8/30/2015	8.1	At Hotel V
515734	Wurzbachgasse 21 15 Rudolfsheim F nfhaus 1150 ...	168	8/22/2015	8.1	At Hotel V
515735	Wurzbachgasse 21 15 Rudolfsheim F nfhaus 1150 ...	168	8/19/2015	8.1	At Hotel V
515736	Wurzbachgasse 21 15 Rudolfsheim F nfhaus 1150 ...	168	8/17/2015	8.1	At Hotel V
515737	Wurzbachgasse 21 15 Rudolfsheim F nfhaus 1150 ...	168	8/9/2015	8.1	At Hotel V

515738 rows × 18 columns

In [5]:
```
df_all_data['Country'].unique()
```

Out[5]:
```
array(['Netherlands', 'United Kingdom', 'France', 'Spain', 'Italy',
       'Austria'], dtype=object)
```

In [6]:
```
df_all_data['Country'].value_counts()
```

Out[6]:
```
United Kingdom    262301
Spain              60149
France             59928
Netherlands        57214
Austria            38939
Italy              37207
Name: Country, dtype: int64
```

Dividing Data into two parts, positive reviews and negative reviews:

In [7]:
```
df_pos = df_all_data[['Positive_Review','Hotel_Name','Country','Reviewer_Sc
df_neg = df_all_data[['Negative_Review','Hotel_Name','Country','Reviewer_Sc
df_recom = df_all_data[['Reviewer_Nationality','Hotel_Name','Reviewer_Score'
```

Renaming columns from ('Positive_Review"Negative_Review') to Review

In [8]:
```
df_pos.rename(columns = {'Positive_Review':'Review'},inplace= True)
df_neg.rename(columns = {'Negative_Review':'Review'},inplace= True)
```

Making new Column named Sentiment and assigning 1 to positive review and 0 to negative review

In [9]:
```
df_pos['Sentiment'] = 1
df_neg['Sentiment'] = 0
df_all = pd.concat([df_pos,df_neg],ignore_index=True)
df_drop = df_all.drop_duplicates()
```

data contain non english letters. code below removes all non english reviews

In [10]:
```
df_drop = df_drop[df_drop['Review'].map(lambda x: x.isascii())]
```

Extra Data cleaning such as removing punctuation, repeated_chars etc...

In [11]:
```
alphanumeric = lambda x: re.sub('\w*\d\w*', ' ', x)
punc_lower = lambda x: re.sub('[%s]' % re.escape(string.punctuation), ' ', x
repeated_chars = lambda x: re.sub('(.)\\1{2,}', '\\1', x)
df_drop['Review'] = df_drop.Review.map(alphanumeric).map(punc_lower).map(rep
df_drop
```

Out[11]:

	Review	Hotel_Name	Country	Reviewer_Score	Reviewer_Nationality	Sentim
0	only the park outside of the hotel was beauti...	Hotel Arena	Netherlands	2.9	Russia	
1	no real complaints the hotel was great great ...	Hotel Arena	Netherlands	7.5	Ireland	
2	location was good and staff were ok it is cut...	Hotel Arena	Netherlands	7.1	Australia	
3	great location in nice surroundings the bar a...	Hotel Arena	Netherlands	3.8	United Kingdom	
4	amazing location and building romantic setting	Hotel Arena	Netherlands	6.7	New Zealand	
...	...	...	...	...	...	
1031471	no trolly or staff to help you take the lugga...	Atlantis Hotel Vienna	Austria	7.0	Kuwait	
1031472	the hotel looks like but surely not	Atlantis Hotel Vienna	Austria	5.8	Estonia	
1031473	the ac was useless it was a hot week in vienn...	Atlantis Hotel Vienna	Austria	2.5	Egypt	
1031474	no negative	Atlantis Hotel Vienna	Austria	8.8	Mexico	
1031475	i was in floor it didn t work free wife	Atlantis Hotel Vienna	Austria	8.3	Hungary	

939223 rows × 6 columns

Data contain over 700,000. taking data sample is necessary. We started from 5000 sample till 100,000. After 100,000 we noticed that the model is not improving nor changing. So, 100,000 is enough to work on

In [13]:
```
data_sample = df_drop.sample(100000,random_state=2021)
```

In [ ]:
```
data_sample['Review'] = data_sample['Review'].map(lambda x: spell(x))
```

In [15]:
```
file = open('data100000', 'rb')
data_sample = pickle.load(file)
file.close()
```

In [17]:
```
df_drop
```

Out[17]:

	Review	Hotel_Name	Country	Reviewer_Score	Reviewer_Nationality	Sentim
0	only the park outside of the hotel was beauti...	Hotel Arena	Netherlands	2.9	Russia	
1	no real complaints the hotel was great great ...	Hotel Arena	Netherlands	7.5	Ireland	
2	location was good and staff were ok it is cut...	Hotel Arena	Netherlands	7.1	Australia	
3	great location in nice surroundings the bar a...	Hotel Arena	Netherlands	3.8	United Kingdom	
4	amazing location and building romantic setting	Hotel Arena	Netherlands	6.7	New Zealand	
...	...	...	...	...	...	
1031471	no trolly or staff to help you take the lugga...	Atlantis Hotel Vienna	Austria	7.0	Kuwait	
1031472	the hotel looks like but surely not	Atlantis Hotel Vienna	Austria	5.8	Estonia	
1031473	the ac was useless it was a hot week in vienn...	Atlantis Hotel Vienna	Austria	2.5	Egypt	
1031474	no negative	Atlantis Hotel Vienna	Austria	8.8	Mexico	
1031475	i was in floor it didn t work free wife	Atlantis Hotel Vienna	Austria	8.3	Hungary	

939223 rows × 6 columns

In [20]:
```
data_sample
```

Out[20]:

	Review	Hotel_Name	Country	Reviewer_Score	Reviewer_Nationality	Senti
198260	friendly staff good service overall clean rooms	Radisson Blu Edwardian New Providence Wharf	United Kingdom	9.6	United Kingdom	
378853	no positive	Leonardo Hotel Vienna	Austria	8.3	Romania	
602911	very iverpriced	First Hotel Paris Tour Eiffel	France	5.0	Australia	
746579	room was very dated and cramped not exactly r...	Radisson Blu Edwardian Vanderbilt	United Kingdom	9.6	United Kingdom	

Tokenizing and lemmatizing reviews

In [21]:
```
w_tokenizer = nltk.tokenize.WhitespaceTokenizer()
lemmatizer = nltk.stem.WordNetLemmatizer()

def lemmatize_text(text):
    return [lemmatizer.lemmatize(w) for w in w_tokenizer.tokenize(text)]

data_sample['text_lemmatized'] = data_sample.Review.apply(lemmatize_text)
```

In [22]:
```
data_sample['Joined_text_lemmatize'] =  data_sample['text_lemmatized'].apply
```

In [23]:
```
nlp = spacy.load('en_core_web_sm')
data_sample['spacy_doc'] = list(nlp.pipe(data_sample.Joined_text_lemmatize))
data_sample
```

Out[23]:

	Review	Hotel_Name	Country	Reviewer_Score	Reviewer_Nationality	Senti
198260	friendly staff good service overall clean rooms	Radisson Blu Edwardian New Providence Wharf	United Kingdom	9.6	United Kingdom	
378853	no positive	Leonardo Hotel Vienna	Austria	8.3	Romania	
602911	very iverpriced	First Hotel Paris Tour Eiffel	France	5.0	Australia	
746579	room was very dated and cramped not exactly r...	Radisson Blu Edwardian Vanderbilt	United Kingdom	9.6	United Kingdom	

Topicing

In [28]:
```
Positive = open('wordpo', 'rb')
Negative = open('wordne', 'rb')
wordss = pickle.load(Positive)
words_neg = pickle.load(Negative)
Positive.close()
Negative.close()
```

In [25]:
```
positive_reviews = data_sample[data_sample.Sentiment==1]
negative_reviews = data_sample[data_sample.Sentiment==0]
```

In [26]:
```
sam_pos_df = positive_reviews.copy()
sam_neg_df = negative_reviews.copy()
```

In [27]:
```
sam_pos_df['Review'] = sam_pos_df['Review'].str.replace("hotel" , "")
sam_neg_df['Review'] = sam_neg_df['Review'].str.replace("hotel" , "")
```

WordCloud for Positive Reviews:

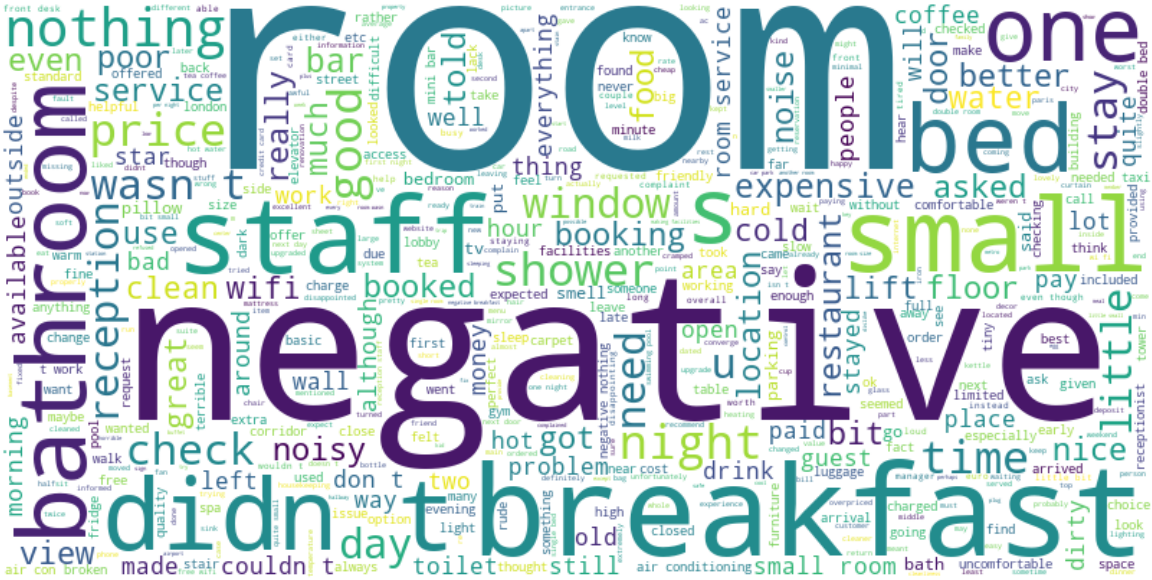
In [29]:
```
from wordcloud import WordCloud

long_string = ','.join(list(sam_pos_df['Review'].values))
wordcloud = WordCloud(background_color="white", max_words=500, contour_width
wordcloud.generate(long_string)
wordcloud.to_image()
```

Out[29]:

WordCloud for Negative Reviews:

In [31]:
```
long_string = ','.join(list(sam_neg_df['Review'].values))
wordcloud = WordCloud(background_color="white", max_words=500, contour_width
wordcloud.generate(long_string)
wordcloud.to_image()
```

Out[31]:



In [32]:
```
pos_adj = [token.text.lower() for doc in positive_reviews.spacy_doc for toke
neg_adj = [token.text.lower() for doc in negative_reviews.spacy_doc for toke

pos_noun = [token.text.lower() for doc in positive_reviews.spacy_doc for tok
neg_noun = [token.text.lower() for doc in negative_reviews.spacy_doc for tok
```

In [33]:
```
print('Positive Adjective: ',Counter(pos_adj).most_common(5))
print('Negative Adjective: ',Counter(neg_adj).most_common(5))
print('Positive Noun: ',Counter(pos_noun).most_common(5))
print('Negative Noun: ',Counter(neg_noun).most_common(5))
```

```
Positive Adjective:  [('good', 11569), ('great', 11182), ('friendly', 947
4), ('helpful', 8437), ('nice', 7277)]
Negative Adjective:  [('negative', 6378), ('small', 5228), ('little', 235
1), ('good', 2078), ('expensive', 1738)]
Positive Noun:  [('staff', 20879), ('location', 20624), ('room', 19406),
('hotel', 13632), ('breakfast', 9273)]
Negative Noun:  [('room', 22061), ('hotel', 8428), ('breakfast', 6269),
('staff', 4218), ('bed', 4006)]
```

In [34]:
```
ENGLISH_STOP_WORDS = stopwords.words('english')
```

taking stop words from stopwords library and adding extra stop words:

In [35]:
```
stop_words = text.ENGLISH_STOP_WORDS.union(['didnt','did','havent', 'week',
                                            'go', 'us', 'dont', 'got', 'im',
                                           'get','try', 'would', 'time','goo
                                            'check','told','asked','like','c
                                           'loved','com','night','birthday',
                                           'feel','days','differ','thier','c
```

In [36]:
```
vectorizer = CountVectorizer(stop_words=wordss)
doc_word = vectorizer.fit_transform(positive_reviews['Joined_text_lemmatize'
doc_word.shape
```

Out[36]: (53634, 10120)

In [37]:
```
def display_topics(model, feature_names, no_top_words, topic_names=None):
    for ix, topic in enumerate(model.components_):
        if not topic_names or not topic_names[ix]:
            print("\nTopic ", ix)
        else:
            print("\nTopic: '",topic_names[ix],"'")
        print(", ".join([feature_names[i]
                         for i in topic.argsort()[:-no_top_words - 1:-1]]))
```

In [38]:
```
example = positive_reviews['Joined_text_lemmatize']
```

LSA Topicing

In [39]:
```
lsa = TruncatedSVD(3)
doc_topic = lsa.fit_transform(doc_word)
lsa.explained_variance_ratio_
```

Out[39]: array([0.05824249, 0.04503644, 0.0364302])

In [40]:
```
display_topics(lsa, vectorizer.get_feature_names(),10)
```

```
Topic  0
room, staff, location, helpful, clean, nice, comfortable, excellent, bed,
lovely

Topic  1
room, bed, comfortable, clean, nice, bathroom, spacious, view, big, small

Topic  2
location, room, station, perfect, close, central, walk, excellent, near, t
ube
```

NMF Topicing

In [41]:
```
nmf_model = NMF(4)
doc_topic = nmf_model.fit_transform(doc_word)
```

In [42]:
```
display_topics(nmf_model, vectorizer.get_feature_names(), 10)
```

```
Topic  0
room, comfortable, clean, bed, lovely, bathroom, spacious, view, quiet, sm
all

Topic  1
staff, helpful, excellent, lovely, clean, reception, extremely, restauran
t, bar, comfortable

Topic  2
location, excellent, perfect, station, close, central, walk, near, tube, l
ondon

Topic  3
nice, station, close, bed, restaurant, walk, metro, area, minute, clean
```

In [43]:
```
Vt = pd.DataFrame(doc_topic.round(5),
             index = example,
             columns = ["Room_Condition","Staff",'Station','Area'])
Vt
```

Out[43]:

Joined_text_lemmatize	Room_Condition	Staff	Station	Area
friendly staff good service overall clean room	0.07506	0.08137	0.00000	0.00000
no positive	0.00004	0.00007	0.00006	0.00005
the design are beautiful staff are friendly atmosphere is comfortable good location	0.01102	0.08344	0.08419	0.00000
the bed wa super pillow were fab great night s sleep	0.01292	0.00301	0.00000	0.01293
everything wa perfect	0.00173	0.00113	0.00659	0.00000
...	...	...	...	...
no positive	0.00004	0.00007	0.00006	0.00005
very pleasant surprised with this hotel room are so comfortable clean and modern we felt a if we got a lot for the price despite being in a busy area gothic quarter we were never disturbed by street noise we were literally facing barcelona cathedral a soon a we stepped outside the hotel what a beautiful view every morning the pool area on the top floor is also a lovely little outdoor space with nice view loved our stay here	0.11478	0.01526	0.00196	0.14125
a modern hotel in a very central location with wonderful stuff	0.00224	0.00000	0.08957	0.00117
bed wa large and comfortable room were basic but contained everything we needed	0.09294	0.00000	0.00000	0.00627
bed location	0.00905	0.00000	0.08352	0.00527

53634 rows × 4 columns

Corecx Topicing

Topicing on Positive Reviews

In [44]:
```
vectorizer = CountVectorizer(ngram_range=(1,2),max_features=2000,
                             stop_words=wordss,token_pattern='\\b[a-z][a-z]+\
                             binary=True)
doc_word = vectorizer.fit_transform(positive_reviews['Review'])
words = list(np.asarray(vectorizer.get_feature_names()))
```

In [45]:
```
topic_model = ct.Corex(n_hidden=3, words=words, seed=1)
topic_model.fit(doc_word, words=words, docs=positive_reviews)
topics = topic_model.get_topics()
for n,topic in enumerate(topics):
    topic_words,_,_ = zip(*topic)
    print('{}: '.format(n) + ','.join(topic_words))
```

```
0: station,close,walk,metro,walking,tube,distance,near,walking distance,ea
sy
1: room,comfortable,clean,bed,rooms,spacious,positive,bathroom,nice,staff
2: bar,coffee,tea,reception,water,restaurant,pool,complimentary,park,arriv
al
```

Topicing on Negative Reviews

In [46]:
```
vectorizer = CountVectorizer(ngram_range=(1,3),max_features=2000,
                             stop_words=words_neg,token_pattern='\\b[a-z][a-z
                             binary=True)
doc_word = vectorizer.fit_transform(negative_reviews['Review'])
words = list(np.asarray(vectorizer.get_feature_names()))
```

In [47]:
```
topic_model = ct.Corex(n_hidden=5, words=words, seed=1)
topic_model.fit(doc_word, words=words, docs=negative_reviews)
topics = topic_model.get_topics()
for n,topic in enumerate(topics):
    topic_words,_,_ = zip(*topic)
    print('{}: '.format(n) + ','.join(topic_words))
```

```
0: staff,reception,rude,morning,arrived,pay,early,paid,desk,checked
1: bathroom,negative,shower,floor,hot,water,old,rooms,bath,cold
2: air,door,conditioning,air conditioning,far,walk,outside,city,station,sl
eep
3: breakfast,coffee,tea,bar,price,expensive,tea coffee,money,restaurant,po
or
4: room,small,bed,room small,double,small room,size,beds,tiny,single
```

Clustring

In [48]:
```
def cluster(df):
    for i in df:
        lat = i['lat'].unique()
        lng = i['lng'].unique()
        loc = []
        for f, b in zip(lat, lng):
            loc.append([f,b])
        confert =pd.DataFrame(loc)
        confert.dropna(inplace=True)
        lat = confert[0].tolist()
        lng = confert[1].tolist()
        loc = []
        for f, b in zip(lat,lng):
            loc.append([f,b])

        X = StandardScaler().fit_transform(loc)
        db = DBSCAN(eps=0.15, min_samples=3).fit(X)

        # Let's find the observations DBSCAN called "core"
        core_samples_mask = np.zeros_like(db.labels_, dtype=bool)
        core_samples_mask[db.core_sample_indices_] = True
        labels = db.labels_

        # Number of clusters in labels, ignoring noise if present.
        n_clusters_ = len(set(labels)) - (1 if -1 in labels else 0)

        unique_labels = set(labels)
        colors = plt.cm.rainbow(np.linspace(0, 1, len(unique_labels)))
        plt.figure(dpi=200)
        show_core = True
        show_non_core = True
        for k, col in zip(unique_labels, colors):
            if k == -1:
                # Black used for noise.
                col = 'k'

            class_member_mask = (labels == k)
            if show_core:
                xy = X[class_member_mask & core_samples_mask]
                x, y = xy[:,0], xy[:,1]
                plt.scatter(x, y, c=col, edgecolors='k',  s=20, linewidths=1

            if show_non_core:
                xy = X[class_member_mask & ~core_samples_mask]
                x, y = xy[:,0], xy[:,1]
                plt.scatter(x, y, c=col, s=20, linewidths=1.1)

        plt.title('Estimated number of clusters: %d' % n_clusters_);
```

In [49]:
```
list_of_country_df = []
for i in range(len(df_all_data['Country'].value_counts().index)):
    list_of_country_df.append(df_all_data[(df_all_data["Country"] == df_all_
```

In [50]:
```
cluster([df_all_data])
```

```
*c* argument looks like a single numeric RGB or RGBA sequence, which shoul
d be avoided as value-mapping will have precedence in case its length matc
hes with *x* & *y*.  Please use the *color* keyword-argument or provide a
2-D array with a single row if you intend to specify the same RGB or RGBA
value for all points.
*c* argument looks like a single numeric RGB or RGBA sequence, which shoul
d be avoided as value-mapping will have precedence in case its length matc
hes with *x* & *y*.  Please use the *color* keyword-argument or provide a
2-D array with a single row if you intend to specify the same RGB or RGBA
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2-D array with a single row if you intend to specify the same RGB or RGBA
value for all points.
*c* argument looks like a single numeric RGB or RGBA sequence, which shoul
d be avoided as value-mapping will have precedence in case its length matc
hes with *x* & *y*.  Please use the *color* keyword-argument or provide a
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2-D array with a single row if you intend to specify the same RGB or RGBA
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hes with *x* & *y*.  Please use the *color* keyword-argument or provide a
2-D array with a single row if you intend to specify the same RGB or RGBA
value for all points.
*c* argument looks like a single numeric RGB or RGBA sequence, which shoul
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hes with *x* & *y*.  Please use the *color* keyword-argument or provide a
2-D array with a single row if you intend to specify the same RGB or RGBA
value for all points.
*c* argument looks like a single numeric RGB or RGBA sequence, which shoul
d be avoided as value-mapping will have precedence in case its length matc
hes with *x* & *y*.  Please use the *color* keyword-argument or provide a
2-D array with a single row if you intend to specify the same RGB or RGBA
value for all points.
*c* argument looks like a single numeric RGB or RGBA sequence, which shoul
d be avoided as value-mapping will have precedence in case its length matc
hes with *x* & *y*.  Please use the *color* keyword-argument or provide a
2-D array with a single row if you intend to specify the same RGB or RGBA
value for all points.
```

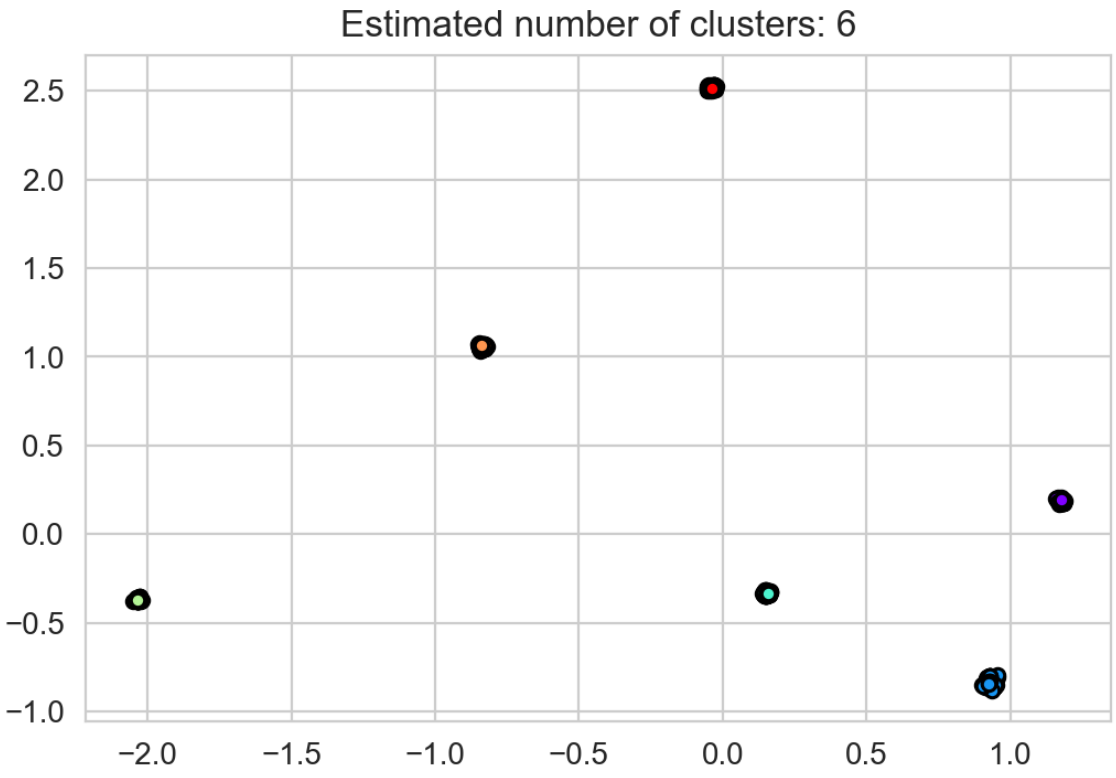
Estimated number of clusters: 6
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0

Cluster for hotels location in each country

In [51]:
```
cluster(list_of_country_df)
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```
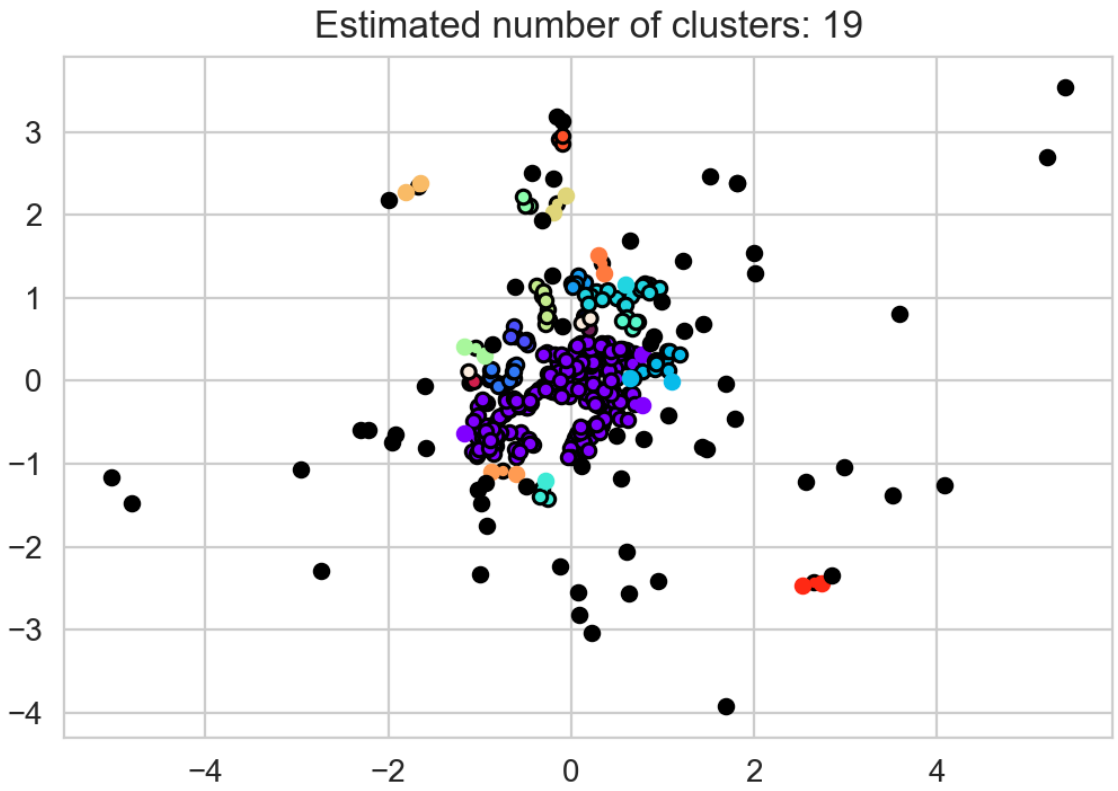
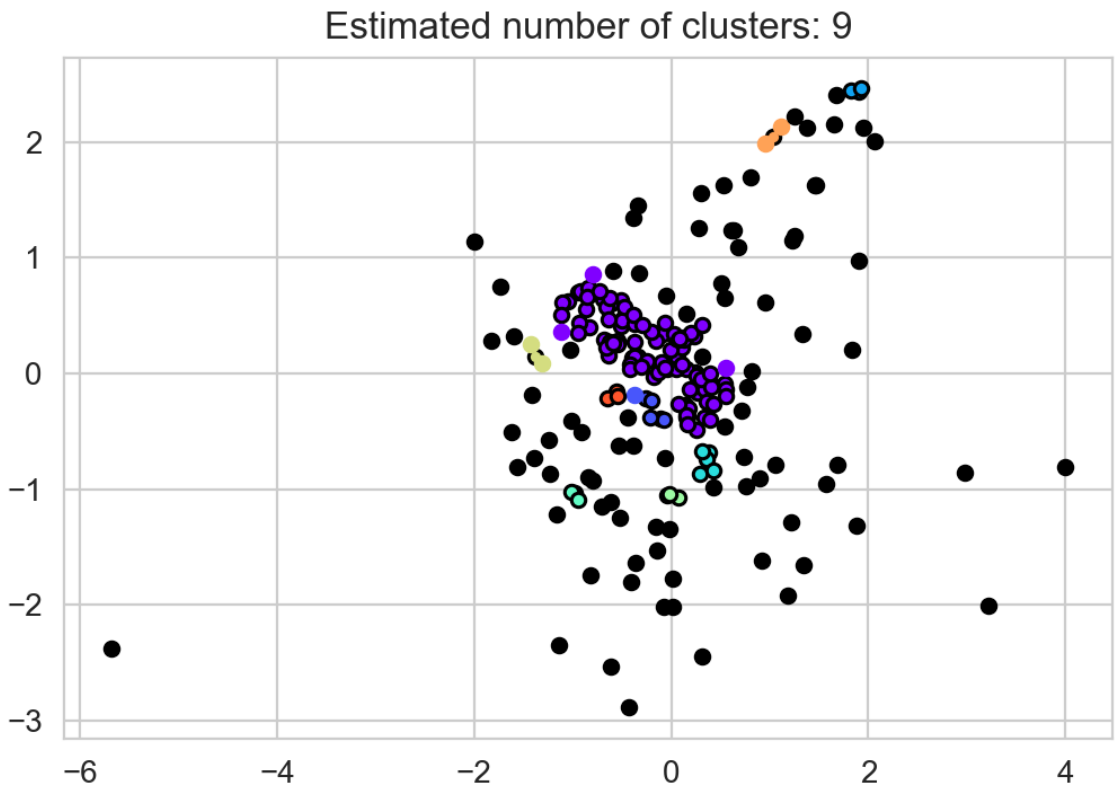
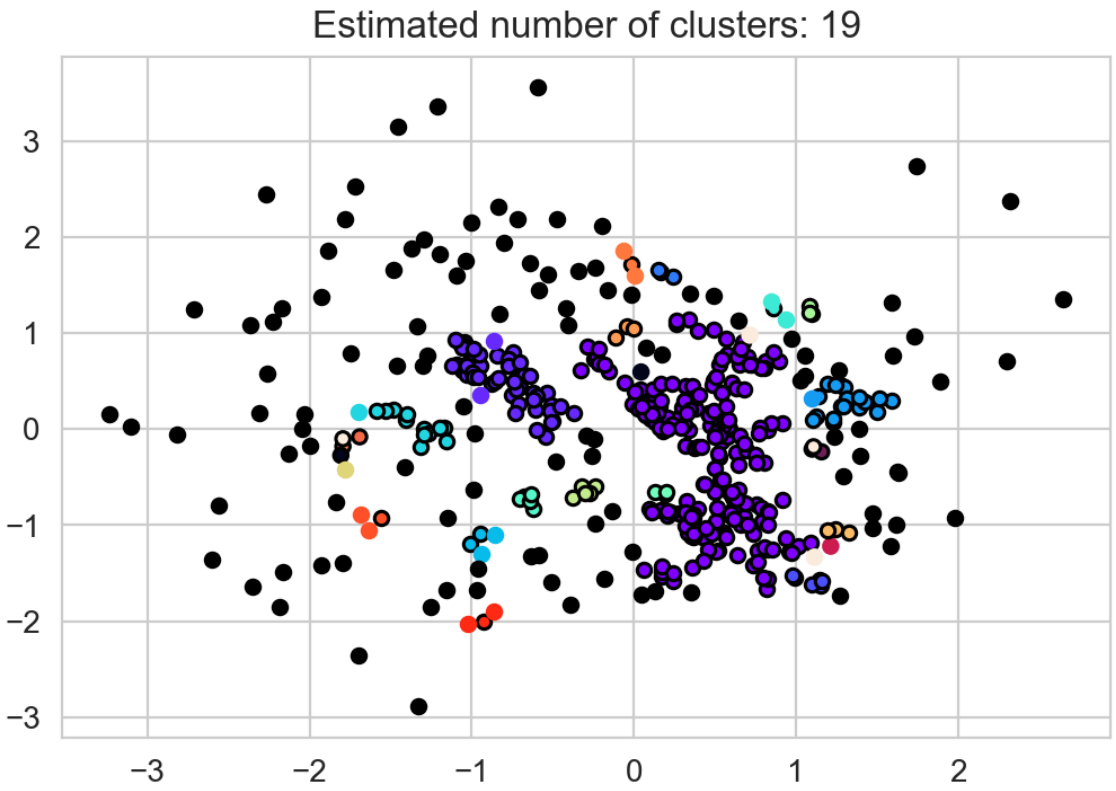
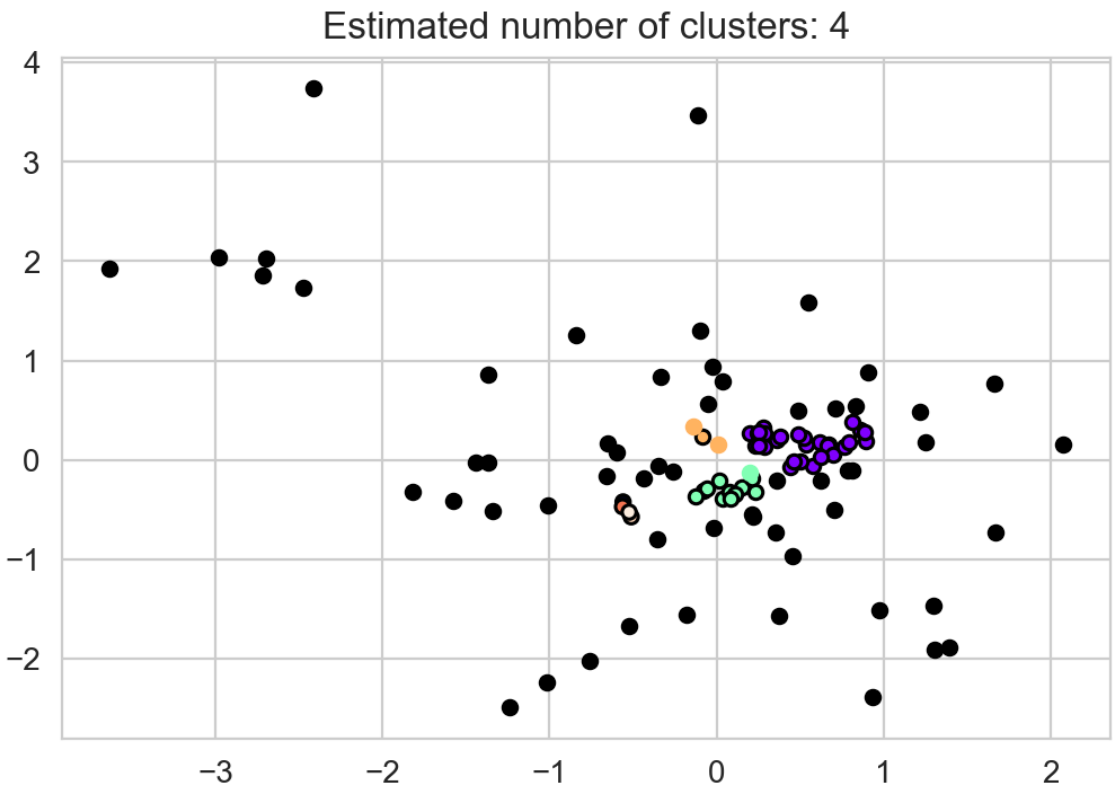
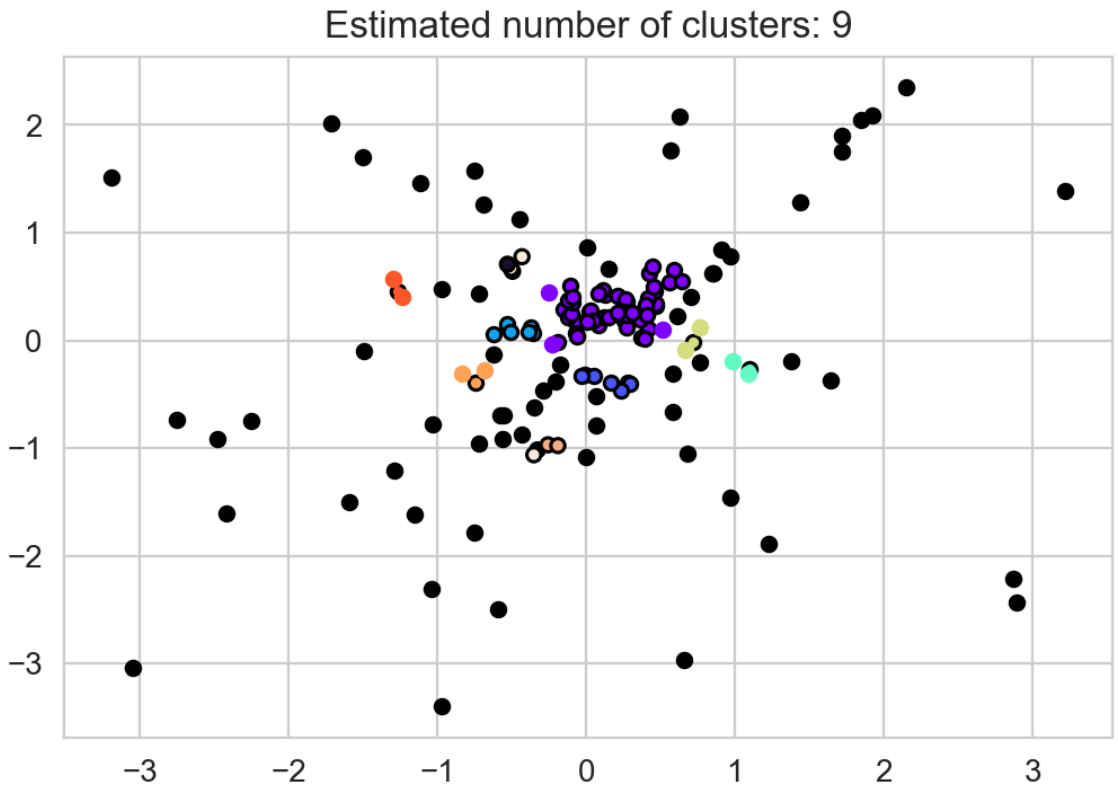
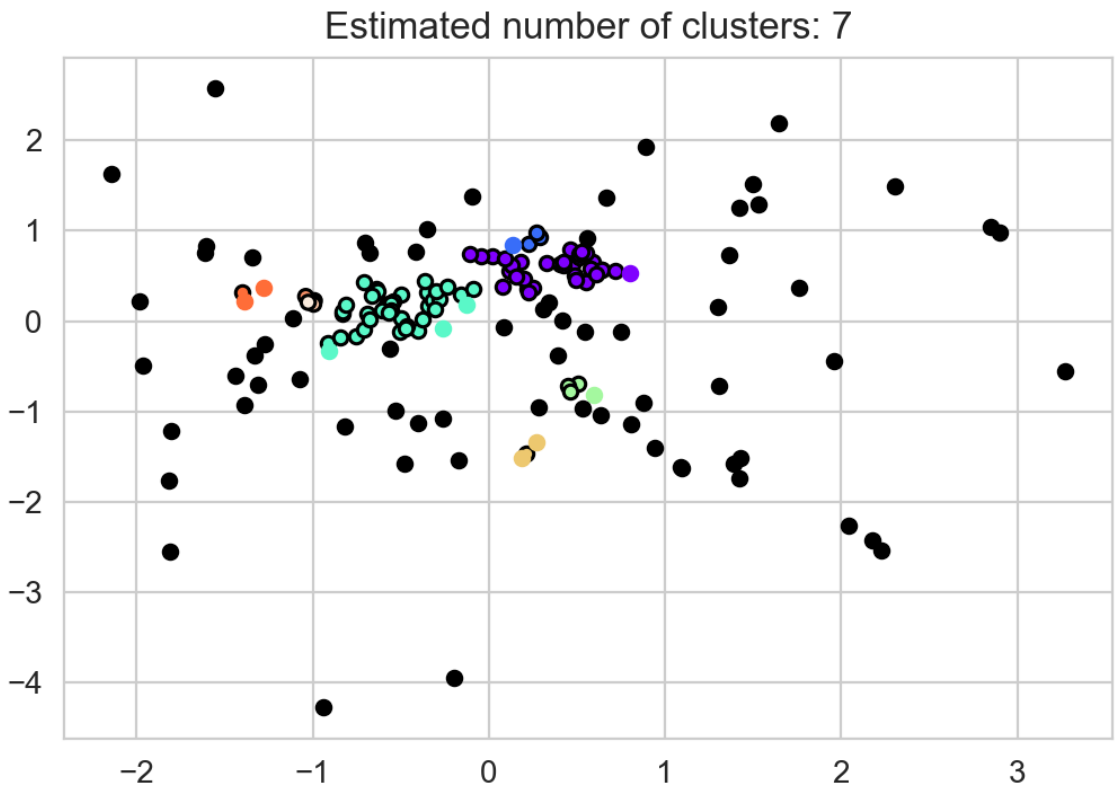


Estimated number of clusters: 19
3
2
1
0
−1
−2
−3
−4
−4
−2
0
2
4


Estimated number of clusters: 9
2
1
0
−1
−2
−3
−6
−4
−2
0
2
4


Estimated number of clusters: 19
3
2
1
0
−1
−2
−3
−3
−2
−1
0
1
2


Estimated number of clusters: 4
4
3
2
1
0
−1
−2
−3
−2
−1
0
1
2





SVD Recommndation System

In [52]:
```
df_recommand = data_sample
```

In [53]:
```
df_reco = df_all_data[["Reviewer_Nationality" , "Hotel_Name" , "Reviewer_Sc
df_reco
```

Out[53]:

	Reviewer_Nationality	Hotel_Name	Reviewer_Score	Country
0	Russia	Hotel Arena	2.9	Netherlands
1	Ireland	Hotel Arena	7.5	Netherlands
2	Australia	Hotel Arena	7.1	Netherlands
3	United Kingdom	Hotel Arena	3.8	Netherlands
4	New Zealand	Hotel Arena	6.7	Netherlands
...	...	...	...	...
515733	Kuwait	Atlantis Hotel Vienna	7.0	Austria
515734	Estonia	Atlantis Hotel Vienna	5.8	Austria
515735	Egypt	Atlantis Hotel Vienna	2.5	Austria
515736	Mexico	Atlantis Hotel Vienna	8.8	Austria
515737	Hungary	Atlantis Hotel Vienna	8.3	Austria

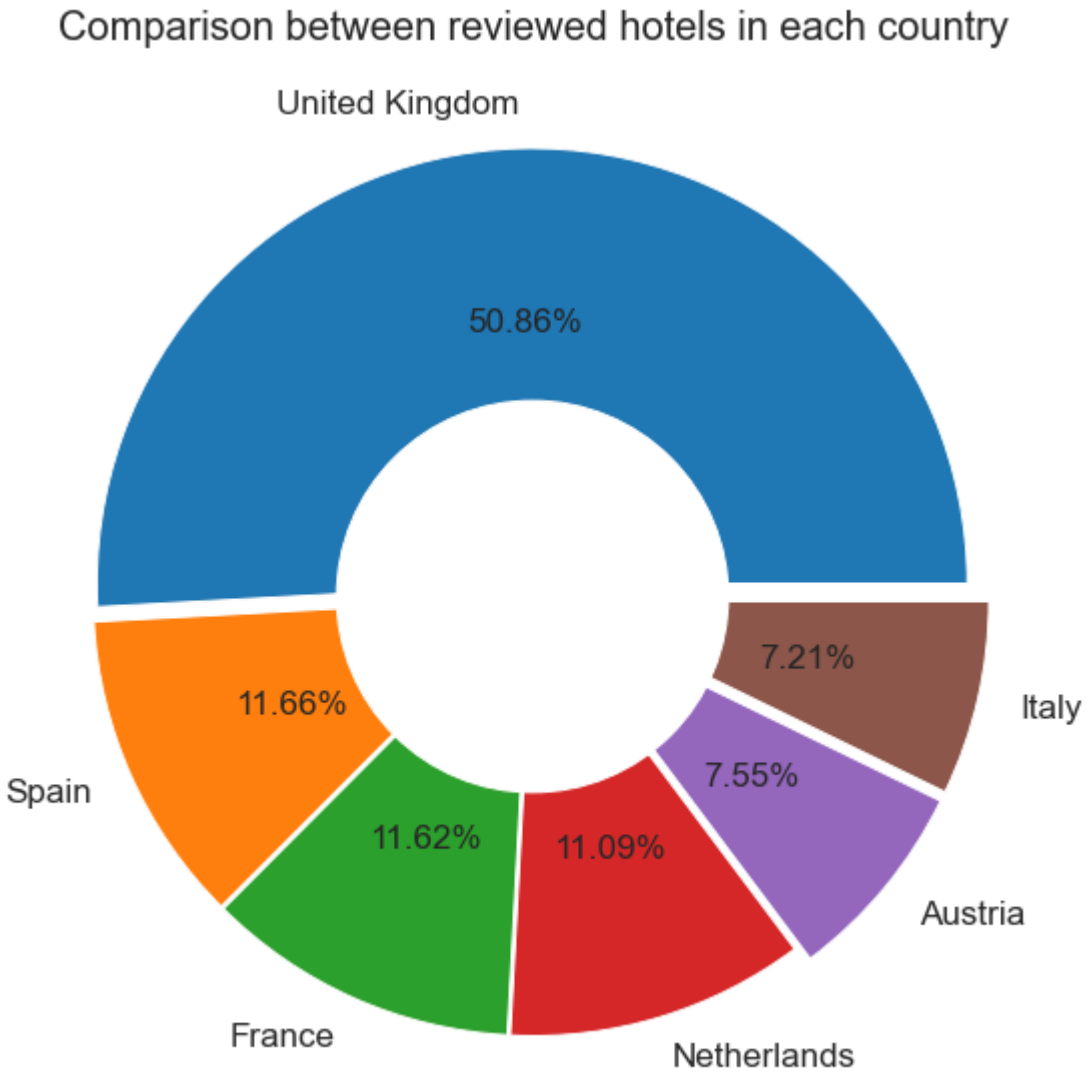
515738 rows × 4 columns

In [54]:
```
df_reco = df_reco[df_reco["Reviewer_Nationality"] != " "]
df_reco.Reviewer_Nationality = df_reco.Reviewer_Nationality.str.strip()
```

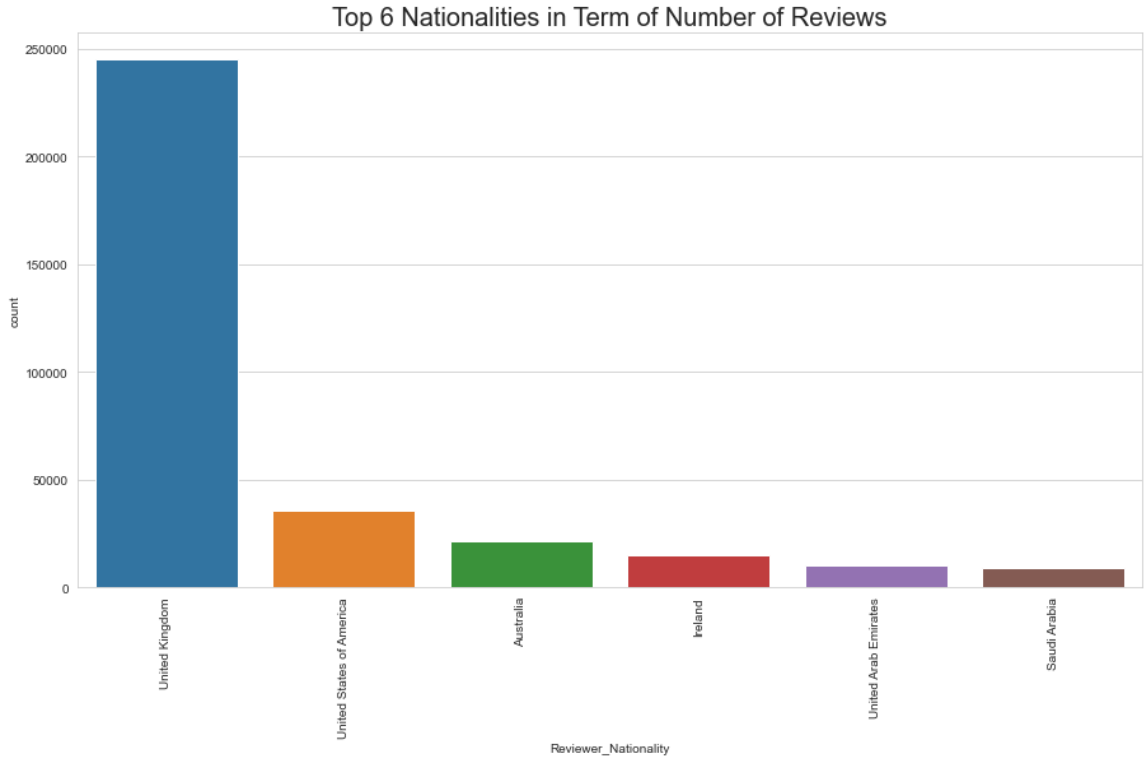
In [55]:
```
df_reco['Country'].value_counts().index
```

Out[55]:
```
Index(['United Kingdom', 'Spain', 'France', 'Netherlands', 'Austria', 'Ita
ly'], dtype='object')
```

In [56]:
```
plt.figure(figsize=(10,10))
plt.pie(x=df_reco['Country'].value_counts(),labels=list(df_reco['Country'].v
        ,autopct='%.2f%%',textprops={'fontsize': 17},explode=[0.03,0.01,0.01
plt.title('Comparison between reviewed hotels in each country',fontdict={'fc

centre_circle = plt.Circle((0,0),0.45,fc='white')
fig = plt.gcf()
fig.gca().add_artist(centre_circle)



plt.show()
```



In [57]:
```
df_top_6 = df_reco[(df_reco['Reviewer_Nationality'] == "United Kingdom") | (
plt.figure(figsize=(15,8))
sns.countplot(x='Reviewer_Nationality',data=df_top_6 ,order = df_top_6['Revi
plt.title('Top 6 Nationalities in Term of Number of Reviews',fontdict={'font
plt.xticks(rotation=90);
```



In [58]:
```
df_high_all = df_reco[(df_reco["Reviewer_Score"] >= 8)]
df_high_all
```

Out[58]:

	Reviewer_Nationality	Hotel_Name	Reviewer_Score	Country
7	United Kingdom	Hotel Arena	10.0	Netherlands
10	United Kingdom	Hotel Arena	10.0	Netherlands
13	Italy	Hotel Arena	9.2	Netherlands
14	Canada	Hotel Arena	8.8	Netherlands
15	Italy	Hotel Arena	10.0	Netherlands
...	...	...	...	...
515724	India	Atlantis Hotel Vienna	8.3	Austria
515729	Brazil	Atlantis Hotel Vienna	10.0	Austria
515732	Kuwait	Atlantis Hotel Vienna	10.0	Austria
515736	Mexico	Atlantis Hotel Vienna	8.8	Austria
515737	Hungary	Atlantis Hotel Vienna	8.3	Austria

335366 rows × 4 columns

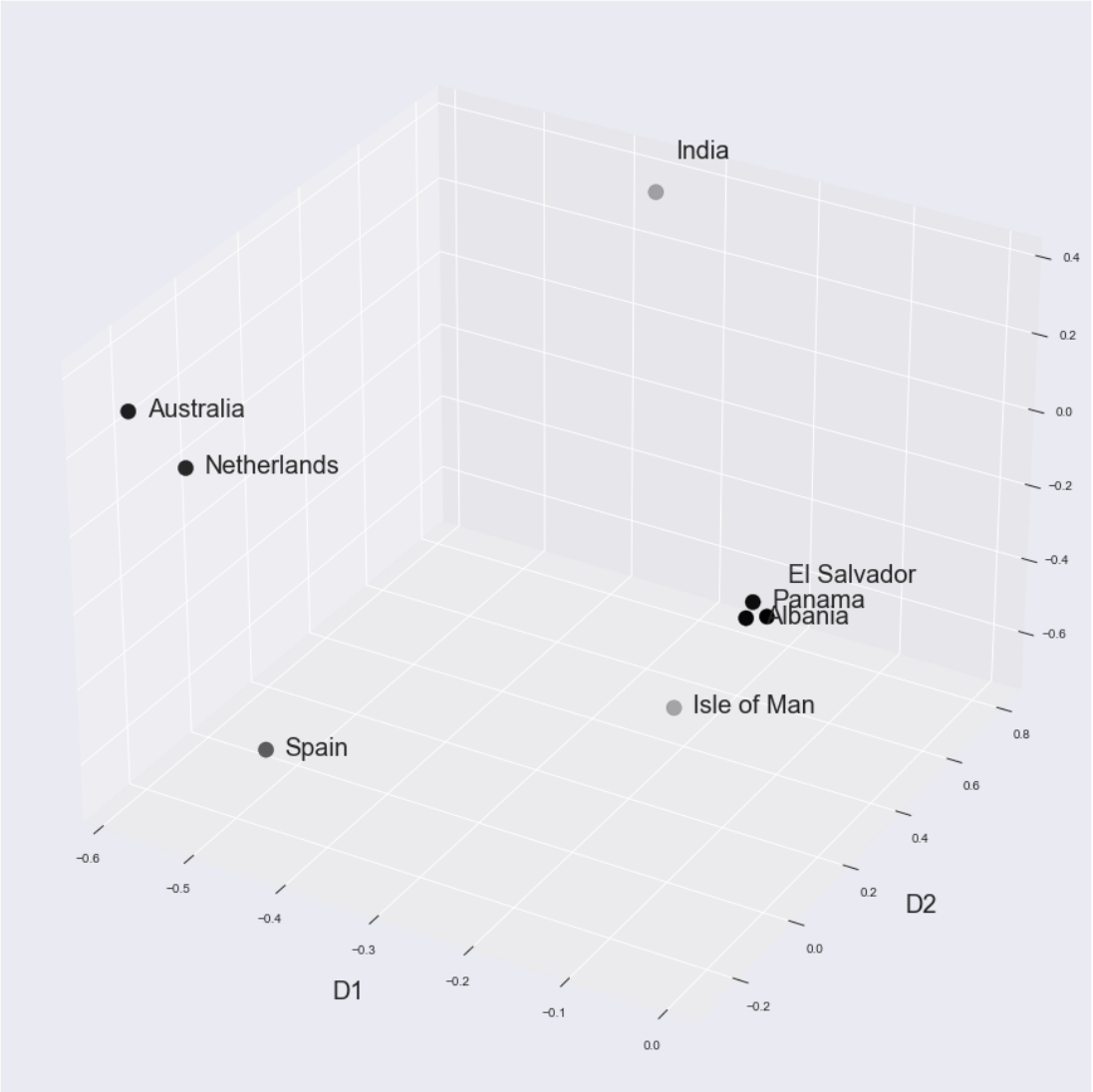
In [59]:
```
df_reco['Country'].value_counts().index
```

Out[59]:
```
Index(['United Kingdom', 'Spain', 'France', 'Netherlands', 'Austria', 'Ita
ly'], dtype='object')
```

In [60]:
```
list_of_country_df = []
for i in range(len(df_reco['Country'].value_counts().index)):
    list_of_country_df.append(df_high_all[(df_high_all["Country"] == df_recc
    list_of_country_df[i] = list_of_country_df[i][["Reviewer_Nationality" ,
    list_of_country_df[i] = pd.get_dummies(list_of_country_df[i] , columns =
    list_of_country_df[i] = list_of_country_df[i].drop_duplicates()
    list_of_country_df[i] = list_of_country_df[i].groupby("Reviewer_National
```

In [61]:
```
def plot_3D_reco(df):
    U, Sigma, VT = svd(df)
    plt.style.use('seaborn')

    fig = plt.figure(figsize=(20,16))
    ax = fig.gca(projection='3d')
    ax.scatter(U[:,0],U[:,1],U[:,2],c='k',s=150);
    ax.set_xlabel("D1", fontsize=20, labelpad=20)
    ax.set_ylabel("D2", fontsize=20, labelpad=20)
    ax.set_zlabel("D3", fontsize=20, labelpad=20);

    lbls = df.index
    offset = 0.02
    for i, txt in enumerate(lbls):
        if i not in [6,7]:
            ax.text(U[i,0]+offset,U[i,1],U[i,2],txt, fontsize=20)
        else:
            ax.text(U[i,0]+offset,U[i,1],U[i,2]+5*offset,txt, fontsize=20)
```

In [64]:
```
plot_3D_reco(list_of_country_df[0].sample(8))
```



In [65]:
```
def get_recommends_user(userID, df ,Nationalities , Hotels):
    U, Sigma, VT = svd(df)
    userrecs = []
    for user in range(U.shape[0]):
        if user!= userID:
            userrecs.append([user,np.dot(U[userID],U[user])])
    final_rec = [i[0] for i in sorted(userrecs,key=lambda x: x[1],reverse=Tr
    comp_user = final_rec[0]
    print("Users from %s are most similar to users from %s."% (User_National
    rec_likes = df.iloc[comp_user]
    current = df.iloc[userID]
    recs = []
    for i,item in enumerate(current):
        if item != rec_likes[i] and rec_likes[i]!=0:
            recs.append(i)
    return recs
```

In [79]:
```
user_nation = 'Saudi Arabia'
#user_nation = input("Enter Country Name ")
print("=========People from %s========= "%user_nation )

i = 0
for df in list_of_country_df:
    print("\n\n===Recommended hotels in %s==="%df_reco['Country'].value_cour
    User_Nationality_list = df.index
    Hotel_names_list = df.columns.str.replace("Hotel_Name_", "")
    user_nation_index = list(df.index).index(user_nation)
    recommended_hotels = get_recommends_user(user_nation_index,df,
                                             User_Nationality_list,Hotel_nam


    if len(recommended_hotels) > 10:
        recommended_hotels_first_10 = recommended_hotels[0:10]
    else:
        recommended_hotels_first_10 = recommended_hotels

    print("There are %s hotels that people from %s did not visit, they might

    print("\n%s Hotels for people from %s to check out:\n "% (len(recommende
                                                             User_Nationali
                                                           list(Hotel_names

    i+=1
```

```
=========People from Saudi Arabia=========


===Recommended hotels in United Kingdom===
Users from Saudi Arabia are most similar to users from Singapore.
There are 50 hotels that people from Saudi Arabia did not visit, they migh
t like

10 Hotels for people from Saudi Arabia to check out:
  ['Andaz London Liverpool Street', 'Bermondsey Square Hotel A Bespoke Hot
el', 'Best Western Seraphine Kensington Olympia', 'Blakes Hotel', 'Caesar
Hotel', 'Charlotte Street Hotel', 'Comfort Inn Suites Kings Cross St Pancr
as', 'Covent Garden Hotel', 'De Vere Devonport House', 'DoubleTree By Hilt
on London Excel']


===Recommended hotels in Spain===
Users from Saudi Arabia are most similar to users from Gibraltar.
There are 9 hotels that people from Saudi Arabia did not visit, they might
like

9 Hotels for people from Saudi Arabia to check out:
  ['AC Hotel Sants a Marriott Lifestyle Hotel', 'Aparthotel Atenea Barcelo
na', 'Attica 21 Barcelona Mar', 'Catalonia Diagonal Centro', 'Catalonia Ei
xample 1864', 'Hotel Omm', 'Hotel Spa Villa Olimpica Suites', 'Mercure Bar
celona Condor', 'NH Sants Barcelona']


===Recommended hotels in France===
Users from Saudi Arabia are most similar to users from Luxembourg.
There are 35 hotels that people from Saudi Arabia did not visit, they migh
t like

10 Hotels for people from Saudi Arabia to check out:
  ['Au Manoir Saint Germain', 'Best Western Mercedes Arc de Triomphe', 'Be
st Western Plus 61 Paris Nation Hotel', 'Best Western Premier Op ra Faubou
rg Ex Hotel Jules ', 'BoB Hotel by Elegancia', 'Grand Pigalle Hotel', 'H t
el Arvor Saint Georges', 'H tel Chaplain Paris Rive Gauche', 'H tel Diva O
pera', 'H tel Duc De St Simon']


===Recommended hotels in Netherlands===
Users from Saudi Arabia are most similar to users from Jersey.
There are 1 hotels that people from Saudi Arabia did not visit, they might
like

1 Hotels for people from Saudi Arabia to check out:
  ['Dutch Design Hotel Artemis']


===Recommended hotels in Austria===
Users from Saudi Arabia are most similar to users from Portugal.
There are 19 hotels that people from Saudi Arabia did not visit, they migh
t like

10 Hotels for people from Saudi Arabia to check out:
  ['ARCOTEL Wimberger', 'Alma Boutique Hotel', 'Arthotel ANA Prime', 'Aust
ria Trend Hotel Ananas Wien', 'Austria Trend Hotel Anatol Wien', 'Eurostar
s Embassy', 'FourSide Hotel Vienna City Center', 'Hotel Kavalier', 'Hotel
Pension Baron am Schottentor', 'Hotel Regina']
```

```
===Recommended hotels in Italy===
Users from Saudi Arabia are most similar to users from Belgium.
There are 26 hotels that people from Saudi Arabia did not visit, they migh
t like

10 Hotels for people from Saudi Arabia to check out:
  ['AC Hotel Milano a Marriott Lifestyle Hotel', 'ADI Hotel Poliziano Fier
a', 'Barcel Milan', 'Best Western Atlantic Hotel', 'Best Western Plus Hote
l Felice Casati', 'Ca Bianca Hotel Corte Del Naviglio', 'Colombia', 'Hotel
Auriga', 'Hotel Manin', 'Hotel Mercure Milano Centro']
```

Recommndation System

In [67]:
```
recom_data = df_recommand[df_recommand['Reviewer_Score'] >= 8]
recom_data = recom_data[['Reviewer_Nationality','Hotel_Name']]
recom_data.drop_duplicates(inplace=True)
recom_data.Reviewer_Nationality = recom_data.Reviewer_Nationality.str.strip(
```

In [68]:
```
recom_data = recom_data[recom_data['Reviewer_Nationality'] != 'United Kingdo
recom_data = recom_data[recom_data['Reviewer_Nationality'] != 'United States
recom_data = recom_data[recom_data['Reviewer_Nationality'] != 'Australia']
recom_data = recom_data[recom_data['Reviewer_Nationality'] != 'Ireland']
```

In [69]:
```
user_hotel_map = defaultdict(list)
hotel_user_map = defaultdict(list)
```

In [70]:
```
data_recom = pd.DataFrame(recom_data)
data_recom.to_csv(r'data_rec.csv', index=False)
```

In [71]:
```
with open('data_rec.csv', 'r') as csvfile:
    w = csv.reader(csvfile)
    for row in w:
        user_hotel_map[row[0]].append(row[1])
        hotel_user_map[row[1]].append(row[0])
```

In [72]:
```
def get_similar_hotel(user_hotel_map,hotel_user_map,m):
    biglist = []
    for u in hotel_user_map[m]:
        biglist.extend(user_hotel_map[u])
    return Counter(biglist).most_common(4)[1:]
```

In [73]:
```
def get_hotel_recommendation(user_hotel_map,hotel_user_map,u1):
    biglist = []
    for m in user_hotel_map[u1]:
        for u in hotel_user_map[m]:
            biglist.extend(user_hotel_map[u])
    return Counter(biglist).most_common(3)
```

In [74]:
```
def get_similar_users(user_hotel_map,hotel_user_map,m):
    hotel_user_map
    user_hotel_map
    biglist = []
    for u in user_hotel_map[m]:
        biglist.extend(hotel_user_map[u])
    return Counter(biglist).most_common(4)[1:]
```

In [75]:
```
get_similar_hotel(user_hotel_map,hotel_user_map,'The Kensington Hotel')
```

Out[75]:
```
[('Park Grand Paddington Court', 12),
 ('Park Plaza Westminster Bridge London', 11),
 ('Best Western Premier Hotel Couture', 11)]
```

In [76]:
```
get_hotel_recommendation(user_hotel_map,hotel_user_map,'Saudi Arabia')
```

Out[76]:
```
[('Park Plaza Westminster Bridge London', 6784),
 ('The Student Hotel Amsterdam City', 6662),
 ('Best Western Premier Hotel Couture', 6582)]
```

In [78]:
```
country = 'Kuwait'
get_similar_users(user_hotel_map,hotel_user_map,country)
```

Out[78]:
```
[('United Arab Emirates', 217), ('Saudi Arabia', 207), ('Canada', 176)]
```

Modeling

In [80]:
```
def get_scores(model,X_train,X_val):
    model.fit(X_train,y_train)
    print(f'Traing score: {model.score(X_train,y_train)}')
    print(f'Val score:    {model.score(X_val,y_val)}')
    print( f"F1 score:    {f1_score(model.predict(X_val),y_val)}")
    print(f'Precision score: {precision_score(y_val,model.predict(X_val))}')
    print(f'Recall score: {recall_score(y_val,model.predict(X_val))}')
    print(f'accuracy score: {accuracy_score(y_val, model.predict(X_val))}')
```

In [81]:
```
X = data_sample.Review
y = data_sample.Sentiment
```

In [82]:
```
from sklearn.model_selection import train_test_split
X_train_val, X_test, y_train_val, y_test = train_test_split(X, y, test_size=
X_train, X_val, y_train, y_val = train_test_split(X_train_val, y_train_val,
```

In [91]:
```
from sklearn.feature_extraction.text import CountVectorizer

cv1 = CountVectorizer()

X_train_cv1 = cv1.fit_transform(X_train)
X_val_cv1  = cv1.transform(X_val)
```

In [92]:
```
lr = LogisticRegression()
get_scores(lr,X_train_cv1,X_val_cv1)
```

```
Traing score: 0.9525948825158184
Val score:    0.9414547604967475
F1 score:    0.9462443438914028
Precision score: 0.9477882523567803
Recall score: 0.9447054571738345
accuracy score: 0.9414547604967475
```

In [93]:
```
bnb = BernoulliNB()
get_scores(bnb,X_train_cv1,X_val_cv1)
```

```
Traing score: 0.8894770202497582
Val score:    0.8771929824561403
F1 score:    0.8933036478849118
Precision score: 0.8489583333333334
Recall score: 0.9425370437296712
accuracy score: 0.8771929824561403
```

In [94]:
```
DTC = DecisionTreeClassifier()
get_scores(DTC,X_train_cv1,X_val_cv1)
```

```
Traing score: 0.9910149343356278
Val score:    0.9034102109205598
F1 score:    0.9112318840579711
Precision score: 0.9135488557936796
Recall score: 0.9089266353451392
accuracy score: 0.9034102109205598
```

In [96]:
```
tfidf1 = TfidfVectorizer()

X_train_tfidf1 = tfidf1.fit_transform(X_train)
X_val_tfidf1  = tfidf1.transform(X_val)
get_scores(lr,X_train_tfidf1,X_val_tfidf1)
```

```
Traing score: 0.9487806776607693
Val score:    0.9428346146264538
F1 score:    0.9471766848816029
Precision score: 0.9548292324641939
Recall score: 0.93964582580412
accuracy score: 0.9428346146264538
```

In [97]:
```
bnb = BernoulliNB()
get_scores(bnb,X_train_tfidf1,X_val_tfidf1)
```

```
Traing score: 0.8894770202497582
Val score:    0.8771929824561403
F1 score:    0.8933036478849118
Precision score: 0.8489583333333334
Recall score: 0.9425370437296712
accuracy score: 0.8771929824561403
```

In [90]:
```
DTC = DecisionTreeClassifier()
get_scores(DTC,X_train_tfidf1,X_val_tfidf1)
```

```
Traing score: 0.9822300310251648
Val score:    0.8817267888823181
F1 score:    0.891304347826087
Precision score: 0.8935706501997821
Recall score: 0.889049512106975
accuracy score: 0.8817267888823181
```

Final model

In [98]:
```
model = LogisticRegression()
tfidf1 = TfidfVectorizer()
X_train_val_tfidf1 = tfidf1.fit_transform(X_train_val)
X_test_tfidf1  = tfidf1.transform(X_test)
model.fit(X_train_val_tfidf1 ,y_train_val)
print(f'Traing score: {model.score(X_train_val_tfidf1,y_train_val)}')
print(f'Val score:    {model.score(X_test_tfidf1,y_test)}')
print( f"F1 score:    {f1_score(model.predict(X_test_tfidf1),y_test)}")
print(f'Precision score: {precision_score(y_test,model.predict(X_test_tfidf1
print(f'Recall score: {recall_score(y_test,model.predict(X_test_tfidf1))}')
print(f'accuracy score: {accuracy_score(y_test, model.predict(X_test_tfidf1)
```

```
Traing score: 0.9486736842105263
Val score:    0.9426
F1 score:    0.9469990766389659
Precision score: 0.9574309185959672
Recall score: 0.9367921081476068
accuracy score: 0.9426
```

In [ ]:
```
```