

Problem: Lead Scoring Model

You have to build a ML model that predicts the lead score as an OUTPUT on the basis of the INPUT set of features. This lead score will range from 0-100, so more the lead score means more chances of conversion of lead to WON. Steps should be: 1.Data Cleaning (including Feature Selection) 2. Training (on Y percent of data) 3. Testing (on (100-Y) percent of data) 4. Evaluate the performance using metrics such as accuracy, precision, recall and F1-score.

Importing required Libraries

```
In [1]: import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings('ignore')
```

Reading the data

```
In [2]: data=pd.read_csv(r"C:\Users\goura\Downloads\Data_Science_Internship - Dump.csv")
data.shape
```

```
Out[2]: (46608, 16)
```

```
In [3]: data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 46608 entries, 0 to 46607
Data columns (total 16 columns):
#   Column                Non-Null Count  Dtype
---  -
0   Unnamed: 0            46608 non-null  int64
1   Agent_id              46608 non-null  object
2   status                46608 non-null  object
3   lost_reason           43244 non-null  object
4   budget                42908 non-null  object
5   lease                 44267 non-null  object
6   movein                32970 non-null  object
7   source                46608 non-null  object
8   source_city           46608 non-null  object
9   source_country        46608 non-null  object
10  utm_source             46608 non-null  object
11  utm_medium             46608 non-null  object
12  des_city               46608 non-null  object
13  des_country            46608 non-null  object
14  room_type              23061 non-null  object
15  lead_id                46608 non-null  object
dtypes: int64(1), object(15)
memory usage: 5.7+ MB
```

```
In [4]: data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 46608 entries, 0 to 46607
Data columns (total 16 columns):
#   Column                Non-Null Count  Dtype
---  -
0   Unnamed: 0            46608 non-null  int64
1   Agent_id              46608 non-null  object
2   status                46608 non-null  object
```

```

3   lost_reason      43244 non-null object
4   budget           42908 non-null object
5   lease            44267 non-null object
6   movein           32970 non-null object
7   source            46608 non-null object
8   source_city      46608 non-null object
9   source_country   46608 non-null object
10  utm_source        46608 non-null object
11  utm_medium        46608 non-null object
12  des_city          46608 non-null object
13  des_country       46608 non-null object
14  room_type         23061 non-null object
15  lead_id           46608 non-null object
dtypes: int64(1), object(15)
memory usage: 5.7+ MB

```

Data Preprocessing and Handling Missing Values

```
In [6]: data["movein"].value_counts()
```

```

Out[6]: 10/09/22      2453
        31/08/22      2191
        01/09/22      2123
        09/09/22      1565
        17/09/22      1424
        ...
        20/10/23         1
        24/06/24         1
        12/04/23         1
        19/10/23         1
        06/06/23         1
Name: movein, Length: 477, dtype: int64

```

```
In [7]: data.isnull().sum()
```

```

Out[7]: Unnamed: 0      0
        Agent_id      0
        status        0
        lost_reason    3364
        budget         3700
        lease          2341
        movein         13638
        source         0
        source_city    0
        source_country  0
        utm_source     0
        utm_medium     0
        des_city       0
        des_country    0
        room_type      23547
        lead_id        0
dtype: int64

```

Feature Engineering

Removing the NaN data features Separating the Label data to handle missing values

Dropping the leads with status other than WON or LOST

```
In [8]: data=data[(data['status'] == 'LOST') | (data['status'] == 'WON')]
```

```
In [9]: data=data[["status","lost_reason","budget","lease","movein","room_type"]]
```

```
In [10]: data
```

```
Out[10]:
```

	status	lost_reason	budget	lease	movein	room_type
0	LOST	Not responding	NaN	NaN	NaN	NaN
1	LOST	Low budget	NaN	NaN	NaN	NaN
2	LOST	Not responding	£121 - £180 Per Week	Full Year Course Stay 40 - 44 weeks	31/08/22	Ensuite
3	LOST	Low budget	0-0	0	NaN	NaN
4	LOST	Junk lead	NaN	NaN	NaN	NaN
...
46603	LOST	Low availability	£60 - £120 Per week	Complete Education Year Stay 50 - 52 weeks	01/09/22	Studio
46604	LOST	Semester stay	£60 - £120 Per week	Summer/Short Stay 8 - 12 weeks	29/09/22	Studio
46605	LOST	Low availability	£241 - £300 Per week	Full Year Course Stay 40 - 44 weeks	20/09/22	Studio
46606	LOST	Low availability	1108	294	30/08/22	NaN
46607	LOST	Low availability	£181 - £240 Per Week	Full Year Course Stay 40 - 44 weeks	01/09/22	Studio

46317 rows × 6 columns

```
In [11]: null_pertanage=[]
def null_per(x):
    for i in x.columns:
        a=x[i].isnull().sum()/len(x[i]) * 100
        print(i,a)
        if a>=5:
            null_pertanage.append(i)
null_per(data)
```

```
status 0.0
lost_reason 6.634712956365914
budget 7.975473368309692
lease 5.04350454476758
movein 29.38445926981454
room_type 50.71787896452706
```

```
In [12]: data["status"].value_counts()
```

```
Out[12]: LOST    43244
WON        3073
Name: status, dtype: int64
```

```
In [13]: #Extracting WON label
a=data["status"] == 'WON'
```

```
In [14]: data1=data[a]
```

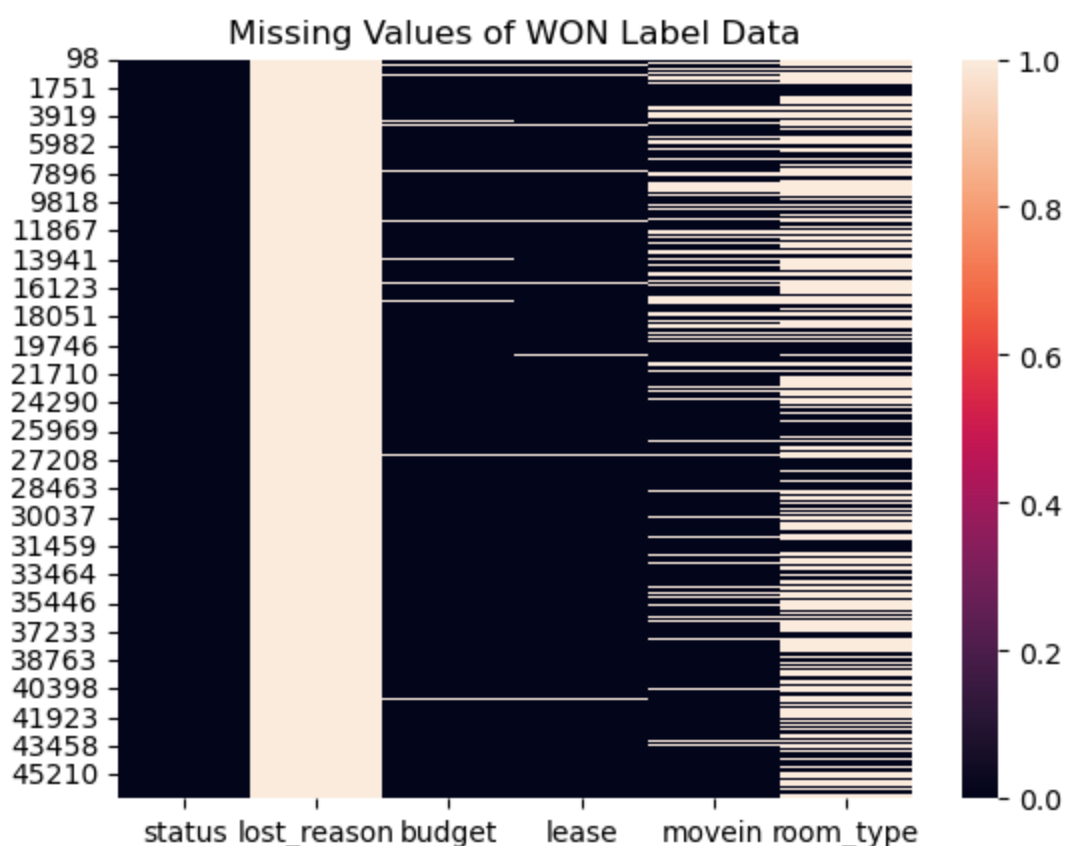
```
In [15]: data1.info()

<class 'pandas.core.frame.DataFrame'>
Int64Index: 3073 entries, 98 to 46592
Data columns (total 6 columns):
 #   Column      Non-Null Count  Dtype  
---  -
 0   status      3073 non-null   object 
 1   lost_reason  0 non-null      object 
 2   budget      2994 non-null   object 
 3   lease       3017 non-null   object 
 4   movein      2442 non-null   object 
 5   room_type   1461 non-null   object 
dtypes: object(6)
memory usage: 168.1+ KB
```

```
In [16]: missing_data=data1.isnull().sum()
missing_data
```

```
Out[16]: status      0
lost_reason  3073
budget      79
lease       56
movein     631
room_type   1612
dtype: int64
```

```
In [17]: #Representation of null values for WON label data
sns.heatmap(data1.isnull())
plt.title('Missing Values of WON Label Data')
plt.show()
```



Key Takeaways from the WON Label Dataset Heatmap:

1. There was no information found for lost reason.

2. Approximately half of the data for roomtype is missing, followed by movein.

3. Some data points for both budget and lease features are missing.

```
In [18]: data1['room_type'].value_counts()
```

```
Out[18]: Ensuite          855
Studio          449
Entire Place    157
Name: room_type, dtype: int64
```

```
In [19]: # Encoding room_type data
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
data1.loc[:, 'room_type'] = le.fit_transform(data1['room_type'])
```

```
In [21]: #To handle missing/null values for room_type data using knn imputer
from sklearn.impute import KNNImputer
knn=KNNImputer(n_neighbors=5)
num=[col for col in data1.columns if data1[col].dtypes != 'O']
knn.fit(data1[num])
```

```
Out[21]: ▼ KNNImputer
KNNImputer()
```

```
In [24]: data1.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 3073 entries, 98 to 46592
Data columns (total 6 columns):
 #   Column      Non-Null Count  Dtype
---  -
 0   status      3073 non-null   object
 1   lost_reason  0 non-null      object
 2   budget      2994 non-null   object
 3   lease       3017 non-null   object
 4   movein      2442 non-null   object
 5   room_type   3073 non-null   int32
dtypes: int32(1), object(5)
memory usage: 156.1+ KB
```

```
In [25]: data1["lease"].value_counts().sum() #fill with zero #to fill this use knn imputer
data1['lease'].isnull().sum()
```

```
Out[25]: 56
```

```
In [26]: #Filling missing values with mode for lease
mode_val = data1['lease'].mode()[0]
data1['lease'].fillna(mode_val, inplace=True)
data1.isnull().sum()
```

```
Out[26]: status          0
lost_reason      3073
budget           79
lease            0
movein           631
room_type        0
dtype: int64
```

```
In [27]: #Converting the categorical data for lease feature
```

```
data1.loc[:, 'lease']=le.fit_transform(data1['lease'])
```

```
In [28]: data1.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 3073 entries, 98 to 46592
Data columns (total 6 columns):
 #   Column          Non-Null Count  Dtype
---  -
 0   status          3073 non-null   object
 1   lost_reason     0 non-null      object
 2   budget          2994 non-null   object
 3   lease           3073 non-null   int32
 4   movein          2442 non-null   object
 5   room_type       3073 non-null   int32
dtypes: int32(2), object(4)
memory usage: 144.0+ KB
```

```
In [29]: data1['budget'].value_counts()
```

```
Out[29]: £121 - £180 Per Week      637
£60 - £120 Per week             522
0-0                             212
£181 - £240 Per Week           135
0-100                           86
...
319                             1
0-70 to 100                     1
150-180/week                    1
308                             1
£135 Per week                   1
Name: budget, Length: 346, dtype: int64
```

```
In [30]: data1['budget'].isnull().sum()
```

```
Out[30]: 79
```

```
In [31]: #Filling missing values with mode for budget
mode_budget = data1['budget'].mode()[0]
data1['budget'].fillna(mode_budget, inplace=True)
data1.isnull().sum()
```

```
Out[31]: status          0
lost_reason    3073
budget         0
lease          0
movein         631
room_type      0
dtype: int64
```

```
In [32]: # Converting Categorical variable budget by using LabelEncoder
data1.loc[:, 'budget']=le.fit_transform(data1['budget'])
```

```
In [33]: null_per(data1)
```

```
status 0.0
lost_reason 100.0
budget 0.0
lease 0.0
movein 20.53368044256427
room_type 0.0
```

```
In [34]: #using Simple Imputer to impute missing values with most frequent strategy
from sklearn.impute import SimpleImputer
import numpy as np
```

```

imputer = SimpleImputer(strategy='most_frequent')
imputed_data = imputer.fit_transform(data1[['movein']])
data1['movein'] = np.squeeze(imputed_data)

```

In [35]: data1.info()

```

<class 'pandas.core.frame.DataFrame'>
Int64Index: 3073 entries, 98 to 46592
Data columns (total 6 columns):
 #   Column          Non-Null Count  Dtype
---  -
 0   status          3073 non-null   object
 1   lost_reason     0 non-null      object
 2   budget          3073 non-null   int32
 3   lease           3073 non-null   int32
 4   movein          3073 non-null   object
 5   room_type       3073 non-null   int32
dtypes: int32(3), object(3)
memory usage: 132.0+ KB

```

In [36]: data1.head()

```

Out[36]:
   status lost_reason budget lease movein room_type
98  WON          NaN    85    51 10/09/22         3
111 WON          NaN   326    62 09/09/22         2
139 WON          NaN   336    62 29/09/22         1
141 WON          NaN   306    61 07/09/22         0
152 WON          NaN   326    62 31/08/22         1

```

In [37]: b=data["status"] == 'LOST'
data2=data[b]
data2.isnull().sum()

```

Out[37]:
status          0
lost_reason      0
budget         3615
lease           2280
movein         12979
room_type       21879
dtype: int64

```

In [38]: data2.info()

```

<class 'pandas.core.frame.DataFrame'>
Int64Index: 43244 entries, 0 to 46607
Data columns (total 6 columns):
 #   Column          Non-Null Count  Dtype
---  -
 0   status          43244 non-null  object
 1   lost_reason     43244 non-null  object
 2   budget          39629 non-null  object
 3   lease           40964 non-null  object
 4   movein          30265 non-null  object
 5   room_type       21365 non-null  object
dtypes: object(6)
memory usage: 2.3+ MB

```

In [39]: # Imputing budget column
data2.head()

```

Out[39]:
   status lost_reason budget lease movein room_type

```

0	LOST	Not responding	NaN	NaN	NaN	NaN
1	LOST	Low budget	NaN	NaN	NaN	NaN
2	LOST	Not responding	£121 - £180 Per Week	Full Year Course Stay 40 - 44 weeks	31/08/22	Ensuite
3	LOST	Low budget	0-0	0	NaN	NaN
4	LOST	Junk lead	NaN	NaN	NaN	NaN

```
In [40]: data2['lost_reason'].value_counts()
```

```
Out[40]: Low availability      8892
Not responding      7827
Not interested      6449
Low budget          5505
Wants private accommodation  2781
Short stay          2264
Not a student       1518
Just Enquiring      1263
Inadequate details   827
Semester stay        817
Booked with manager  676
Junk lead            629
Booked on campus accommodation  613
Supply issue         538
No supply            534
Not serving in that region  411
Repeat lead          394
Booked with competitor  356
Not going to university  329
Distance issue       219
Junk lead/ Just Enquiring  147
Lead issue           127
Looking for admission   41
Didn't respond in time   35
Visa/admission denied    17
Guarantor issue        17
Looking for Scholarship    8
Looking for loan         5
Underage student        4
Cross sell              1
Name: lost_reason, dtype: int64
```

```
In [41]: data2['budget'].value_counts()
```

```
Out[41]: £60 - £120 Per week      9228
£121 - £180 Per Week      8241
0-0                        5507
£181 - £240 Per Week      2008
100                        1453
...
90-100£                    1
0-Max 425                  1
250 Per Week               1
0-80-100$                  1
0-500 PCM                  1
Name: budget, Length: 1769, dtype: int64
```

```
In [42]: # Using Simple imputer to handle the missing values for budget feature
imputed_data2 = imputer.fit_transform(data2[['budget']])
data2['budget'] = np.squeeze(imputed_data2)
null_per(data2)
```

```
status 0.0
lost_reason 0.0
```



```
budget 0.0
lease 5.272407732864675
movein 30.013412265285353
room_type 50.59430209971325
```

```
In [43]: # Using Simple imputer to handle the missing values for lease data
imputed_lease = imputer.fit_transform(data2[['lease']])
data2['lease'] = np.squeeze(imputed_lease)

# Using Simple imputer to handle the missing values for movein data
imputed_movein = imputer.fit_transform(data2[['movein']])
data2['movein'] = np.squeeze(imputed_movein)

# Encoding room_type data and handling missing values by using KNN imputer
data2.loc[:, 'room_type'] = le.fit_transform(data2['room_type'])
num=[col for col in data2.columns if data2[col].dtypes !='O']
knn.fit(data2[num])
```

```
Out[43]: ▼ KNNImputer
KNNImputer()
```

```
In [44]: data2.isnull().sum()
```

```
Out[44]: status      0
lost_reason  0
budget      0
lease       0
movein      0
room_type   0
dtype: int64
```

```
In [45]: data2.lost_reason.value_counts()
```

Out[45]:	Low availability	8892
	Not responding	7827
	Not interested	6449
	Low budget	5505
	Wants private accommodation	2781
	Short stay	2264
	Not a student	1518
	Just Enquiring	1263
	Inadequate details	827
	Semester stay	817
	Booked with manager	676
	Junk lead	629
	Booked on campus accommodation	613
	Supply issue	538
	No supply	534
	Not serving in that region	411
	Repeat lead	394
	Booked with competitor	356
	Not going to university	329
	Distance issue	219
	Junk lead/ Just Enquiring	147
	Lead issue	127
	Looking for admission	41
	Didn't respond in time	35
	Visa/admission denied	17
	Guarantor issue	17
	Looking for Scholarship	8
	Looking for loan	5
	Underage student	4

Cross sell
Name: lost_reason, dtype: int64

1

```
In [46]: df=pd.concat([data1,data2])  
df.head()
```

```
Out[46]:
```

	status	lost_reason	budget	lease	movein	room_type
98	WON	NaN	85	51	10/09/22	3
111	WON	NaN	326	62	09/09/22	2
139	WON	NaN	336	62	29/09/22	1
141	WON	NaN	306	61	07/09/22	0
152	WON	NaN	326	62	31/08/22	1

```
In [47]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>  
Int64Index: 46317 entries, 98 to 46607  
Data columns (total 6 columns):  
#   Column          Non-Null Count  Dtype  
---  ---  
0   status          46317 non-null  object  
1   lost_reason     43244 non-null  object  
2   budget          46317 non-null  object  
3   lease           46317 non-null  object  
4   movein          46317 non-null  object  
5   room_type       46317 non-null  int32  
dtypes: int32(1), object(5)  
memory usage: 2.3+ MB
```

```
In [48]: # Assigning 0 for Null value of lost_reason  
df['lost_reason'].fillna(0, inplace=True)  
df['lost_reason'].isnull().sum()
```

```
Out[48]: 0
```

```
In [49]: df.info()
```

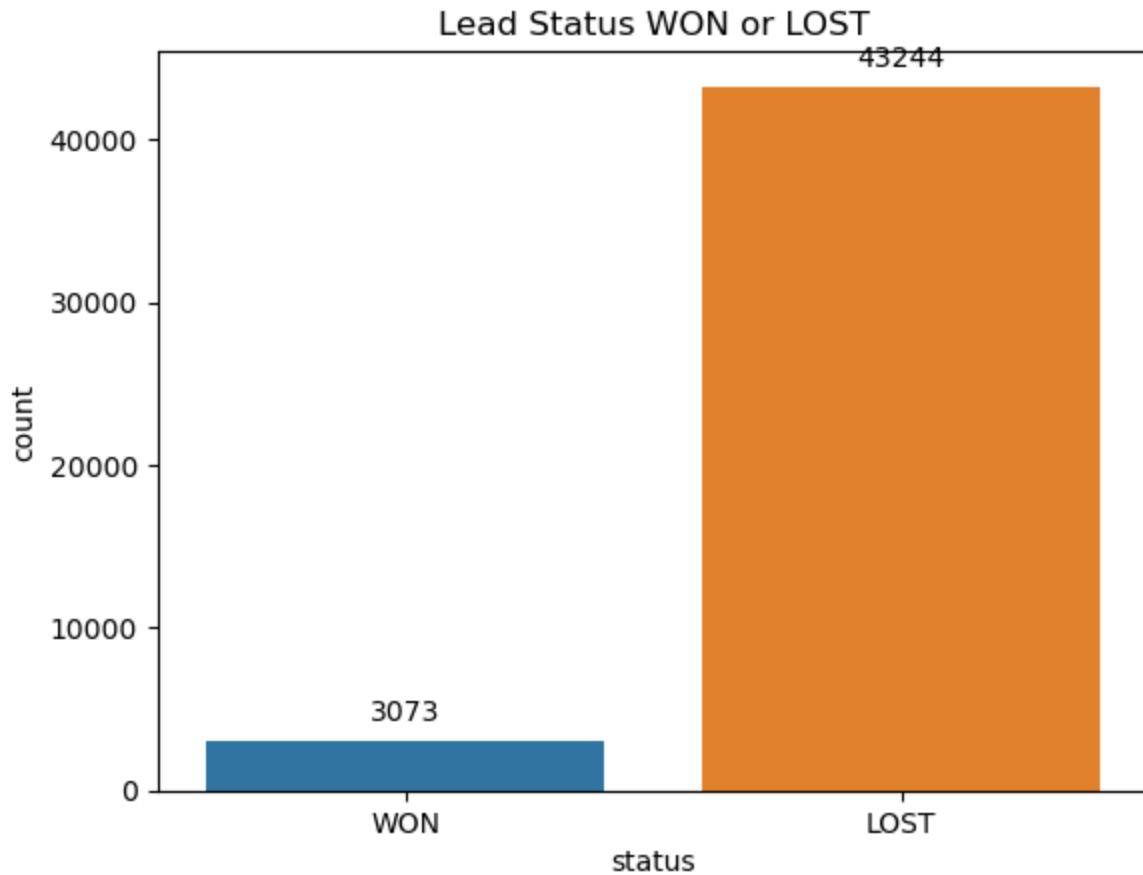
```
<class 'pandas.core.frame.DataFrame'>  
Int64Index: 46317 entries, 98 to 46607  
Data columns (total 6 columns):  
#   Column          Non-Null Count  Dtype  
---  ---  
0   status          46317 non-null  object  
1   lost_reason     46317 non-null  object  
2   budget          46317 non-null  object  
3   lease           46317 non-null  object  
4   movein          46317 non-null  object  
5   room_type       46317 non-null  int32  
dtypes: int32(1), object(5)  
memory usage: 2.3+ MB
```

```
In [50]: df.isnull().sum()
```

```
Out[50]: status          0  
lost_reason          0  
budget              0  
lease               0  
movein              0  
room_type           0  
dtype: int64
```

EDA for Status feature

```
In [51]: # Exploring Status data
ax=sns.countplot(x='status',data=df)
for p in ax.patches:
    ax.annotate(format(p.get_height()), (p.get_x() + p.get_width() / 2., p.get_height()),
                ha = 'center', va = 'center', xytext = (0, 10), textcoords = 'offset poi
plt.title('Lead Status WON or LOST')
plt.show()
```



Key Observations from Above Countplot:

Because the status has two classes, WON has 3073 data points and LOST has 43244 data points, the data is completely imbalanced, so we must choose under sampling.

```
In [52]: #Identifying the minority class
minority_class = df['status'].value_counts().idxmin()
minority_class
```

```
Out[52]: 'WON'
```

```
In [53]: # Randomly selecting samples from the majority class
majority_class = df[df['status'] != minority_class]
undersampled_majority = majority_class.sample(n=len(df[df['status'] == minority_class]),

# Combining the minority class with the undersampled majority class
undersampled_data = pd.concat([undersampled_majority, df[df['status'] == minority_class])

# Shuffle the data
undersampled_data = undersampled_data.sample(frac=1, random_state=42)
```

```
#Final dataset after undersampling
undersampled_data
```

Out[53]:

	status	lost_reason	budget	lease	movein	room_type
39682	WON	0	326	61	31/08/22	0
41431	LOST	Not interested	£121 - £180 Per Week	Full Year Course Stay 40 - 44 weeks	15/09/22	1
2387	WON	0	302	2	03/09/22	3
44680	LOST	Wants private accommodation	£60 - £120 Per week	0	31/08/22	5
32359	WON	0	342	62	23/09/22	0
...
11642	WON	0	342	65	02/09/22	0
32988	WON	0	300	35	07/09/22	3
33686	WON	0	342	62	10/09/22	0
36088	WON	0	326	62	12/09/22	0
16156	LOST	Not responding	£121 - £180 Per Week	Full Year Course Stay 40 - 44 weeks	14/09/22	5

6146 rows × 6 columns

```
In [54]: undersampled_data['lost_reason'].isnull().sum()
```

Out[54]: 0

Because the data set contains a feedback column in text form, we must perform text preprocessing and feature extraction from the lost reason feature.

Text Data Analysis and Text Data Feature Extraction (lost reason)

```
In [55]: import pandas as pd
from sklearn.feature_extraction.text import TfidfVectorizer
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize
from nltk.stem import PorterStemmer, WordNetLemmatizer

book = undersampled_data[['lost_reason']]
book
```

Out[55]:

	lost_reason
39682	0
41431	Not interested
2387	0

44680	Wants private accommodation
32359	0
...	...
11642	0
32988	0
33686	0
36088	0
16156	Not responding

6146 rows × 1 columns

```
In [56]: #Converting the data type to string
book['lost_reason'] = book['lost_reason'].astype(str).str.strip()
book = book[book['lost_reason'] != '']
# Removing space and empty strings from the list
book = [lost_reason.strip() for lost_reason in book.lost_reason]
book = [lost_reason for lost_reason in book if lost_reason]
book
```

```
Out[56]: ['0',
'Not interested',
'0',
'Wants private accommodation',
'0',
'0',
'0',
'0',
'0',
'0',
'Not responding',
'0',
'Booked with competitor',
'0',
'Low budget',
'0',
'0',
'Not responding',
'0',
'0',
'0',
'Low availability',
'Low availability',
'Not interested',
'0',
'Short stay',
'0',
'Not interested',
'0',
'0',
'0',
'Short stay',
'Not responding',
'Low budget',
'0',
'Not a student',
'Semester stay',
'Not interested',
'0',
'Not interested',
'Low availability',
```

'0',
'Not responding',
'0',
'Not responding',
'0',
'0',
'0',
'0',
'0',
'0',
'0',
'Short stay',
'Inadequate details',
'Low availability',
'Semester stay',
'Wants private accommodation',
'0',
'0',
'Inadequate details',
'0',
'Low availability',
'Short stay',
'Booked with manager',
'0',
'Supply issue',
'Booked with competitor',
'0',
'0',
'0',
'Short stay',
'0',
'Not interested',
'Not interested',
'Low availability',
'0',
'Wants private accommodation',
'0',
'Not interested',
'Not interested',
'Not responding',
'0',
'0',
'Repeat lead',
'0',
'0',
'0',
'Not responding',
'0',
'Junk lead',
'Semester stay',
'0',
'Low availability',
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In [57]: # Joining the list into one string/text
text = ' '.join(book)
text
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Out[57]: "0 Not interested 0 Wants private accommodation 0 0 0 0 0 Not responding 0 Booked with c
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In [58]: #Removing all Punctuation marks
import string
no_punc_text = text.translate(str.maketrans('', '', string.punctuation))
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```
In [59]: import nltk
nltk.download('punkt')
```

```
[nltk_data] Downloading package punkt to
[nltk_data] C:\Users\goura\AppData\Roaming\nltk_data...
[nltk_data] Package punkt is already up-to-date!
```

```
Out[59]: True
```

```
In [60]: #Tokenization
import nltk
from nltk.tokenize import word_tokenize
# nltk.download('punkt')
text_tokens = word_tokenize(no_punc_text)
print(text_tokens[0:50])
```

```
['0', 'Not', 'interested', '0', 'Wants', 'private', 'accommodation', '0', '0', '0', '0', '0', 'Not', 'responding', '0', 'Booked', 'with', 'competitor', '0', 'Low', 'budget', '0', '0', 'Not', 'responding', '0', '0', '0', 'Low', 'availability', 'Low', 'availability', 'Not', 'interested', '0', 'Short', 'stay', '0', 'Not', 'interested', '0', '0', '0', 'Short', 'stay', 'Not', 'responding', 'Low', 'budget', '0']
```

```
In [61]: len(text_tokens)
```

```
Out[61]: 9839
```

```
In [62]: #Removing stopwords
from nltk.corpus import stopwords
# nltk.download('punkt')
nltk.download('stopwords')
my_stop_words = stopwords.words('english')
my_stop_words.append('the')
```

```
[nltk_data] Downloading package stopwords to
[nltk_data] C:\Users\goura\AppData\Roaming\nltk_data...
[nltk_data] Package stopwords is already up-to-date!
```

```
In [63]: my_stop_words
#my_stop_words.append('Its')

# Simplified look of the no_stop_tokens for loop
""" final_words = []
    for word in text_tokens:
        if word in my_stop_words:
            'do nothing'
        else:
            final_words.append(word) """

no_stop_tokens = [word for word in text_tokens if not word in my_stop_words]
print(no_stop_tokens[0:40])
```

```
['0', 'Not', 'interested', '0', 'Wants', 'private', 'accommodation', '0', '0', '0', '0', '0', 'Not', 'responding', '0', 'Booked', 'competitor', '0', 'Low', 'budget', '0', '0', 'Not', 'responding', '0', '0', '0', 'Low', 'availability', 'Low', 'availability', 'Not', 'interested', '0', 'Short', 'stay', '0', 'Not', 'interested', '0']
```

```
In [64]: #Normalize the data
lower_words = [x.lower() for x in no_stop_tokens]
print(lower_words[0:25])
```

```
['0', 'not', 'interested', '0', 'wants', 'private', 'accommodation', '0', '0', '0', '0', '0', 'not', 'responding', '0', 'booked', 'competitor', '0', 'low', 'budget', '0', '0', 'not', 'responding', '0']
```

```
In [65]: #Stemming
from nltk.stem import PorterStemmer
ps = PorterStemmer()
stemmed_tokens = [ps.stem(word) for word in lower_words]
print(stemmed_tokens[0:40])
```

```
['0', 'not', 'interest', '0', 'want', 'privat', 'accommod', '0', '0', '0', '0', '0', 'not', 'respond', '0', 'book', 'competitor', '0', 'low', 'budget', '0', '0', 'not', 'respond', '0', '0', '0', 'low', 'avail', 'low', 'avail', 'not', 'interest', '0', 'short', 'stay', '0', 'not', 'interest', '0']
```

```
In [67]: import spacy
!pip install -U spacy

import spacy
```



```
!pip install pydantic==1.10.2
```

```
Requirement already satisfied: spacy in c:\users\goura\anaconda3\lib\site-packages (3.5.1)
Requirement already satisfied: thinc<8.2.0,>=8.1.8 in c:\users\goura\anaconda3\lib\site-packages (from spacy) (8.1.9)
Requirement already satisfied: langcodes<4.0.0,>=3.2.0 in c:\users\goura\anaconda3\lib\site-packages (from spacy) (3.3.0)
Requirement already satisfied: wasabi<1.2.0,>=0.9.1 in c:\users\goura\anaconda3\lib\site-packages (from spacy) (1.1.1)
Requirement already satisfied: catalogue<2.1.0,>=2.0.6 in c:\users\goura\anaconda3\lib\site-packages (from spacy) (2.0.8)
Requirement already satisfied: jinja2 in c:\users\goura\anaconda3\lib\site-packages (from spacy) (2.11.3)
Requirement already satisfied: pydantic!=1.8,!1.8.1,<1.11.0,>=1.7.4 in c:\users\goura\anaconda3\lib\site-packages (from spacy) (1.10.6)
Requirement already satisfied: srsly<3.0.0,>=2.4.3 in c:\users\goura\anaconda3\lib\site-packages (from spacy) (2.4.6)
Requirement already satisfied: requests<3.0.0,>=2.13.0 in c:\users\goura\anaconda3\lib\site-packages (from spacy) (2.28.1)
Requirement already satisfied: murmurhash<1.1.0,>=0.28.0 in c:\users\goura\anaconda3\lib\site-packages (from spacy) (1.0.9)
Requirement already satisfied: setuptools in c:\users\goura\anaconda3\lib\site-packages (from spacy) (63.4.1)
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Requirement already satisfied: typing-extensions>=4.2.0 in c:\users\goura\anaconda3\lib\site-packages (from pydantic!=1.8,!1.8.1,<1.11.0,>=1.7.4->spacy) (4.3.0)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\goura\anaconda3\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy) (1.26.11)
Requirement already satisfied: idna<4,>=2.5 in c:\users\goura\anaconda3\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy) (3.3)
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Requirement already satisfied: click<9.0.0,>=7.1.1 in c:\users\goura\anaconda3\lib\site-packages (from typer<0.8.0,>=0.3.0->spacy) (8.0.4)
Requirement already satisfied: MarkupSafe>=0.23 in c:\users\goura\anaconda3\lib\site-packages (from jinja2->spacy) (2.1.1)
```

```
kages (from jinja2->spacy) (2.0.1)
Collecting pydantic==1.10.2
```

```
ERROR: Could not install packages due to an OSError: [WinError 5] Access is denied:
'C:\Users\goura\anaconda3\lib\site-packages\~\pydantic\annotated_types.cp39-win_amd64.pyd'
Consider using the '--user' option or check the permissions.
```

```
Downloading pydantic-1.10.2-cp39-cp39-win_amd64.whl (2.1 MB)
----- 2.1/2.1 MB 5.0 MB/s eta 0:00:00
Requirement already satisfied: typing-extensions>=4.1.0 in c:\users\goura\anaconda3\lib\site-packages (from pydantic==1.10.2) (4.3.0)
Installing collected packages: pydantic
  Attempting uninstall: pydantic
    Found existing installation: pydantic 1.10.6
    Uninstalling pydantic-1.10.6:
      Successfully uninstalled pydantic-1.10.6
```

```
In [68]: !python -m spacy download en_core_web_sm
!python -m spacy download en_core_web_md
!python -m spacy download en_core_web_lg
```

```
Collecting en-core-web-sm==3.5.0
  Downloading https://github.com/explosion/spacy-models/releases/download/en_core_web_sm-3.5.0/en_core_web_sm-3.5.0-py3-none-any.whl (12.8 MB)
----- 12.8/12.8 MB 4.8 MB/s eta 0:00:00
Requirement already satisfied: spacy<3.6.0,>=3.5.0 in c:\users\goura\anaconda3\lib\site-packages (from en-core-web-sm==3.5.0) (3.5.1)
Requirement already satisfied: setuptools in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (63.4.1)
Requirement already satisfied: spacy-legacy<3.1.0,>=3.0.11 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (3.0.12)
Requirement already satisfied: spacy-loggers<2.0.0,>=1.0.0 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (1.0.4)
Requirement already satisfied: cymem<2.1.0,>=2.0.2 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (2.0.7)
Requirement already satisfied: tqdm<5.0.0,>=4.38.0 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (4.64.1)
Requirement already satisfied: wasabi<1.2.0,>=0.9.1 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (1.1.1)
Requirement already satisfied: requests<3.0.0,>=2.13.0 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (2.28.1)
Requirement already satisfied: jinja2 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (2.11.3)
Requirement already satisfied: typer<0.8.0,>=0.3.0 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (0.7.0)
Requirement already satisfied: smart-open<7.0.0,>=5.2.1 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (5.2.1)
Requirement already satisfied: catalogue<2.1.0,>=2.0.6 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (2.0.8)
Requirement already satisfied: pathy>=0.10.0 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (0.10.1)
Requirement already satisfied: pydantic!=1.8,!<1.8.1,<1.11.0,>=1.7.4 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (1.10.2)
Requirement already satisfied: packaging>=20.0 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (21.3)
Requirement already satisfied: langcodes<4.0.0,>=3.2.0 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (3.3.0)
Requirement already satisfied: srsly<3.0.0,>=2.4.3 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (2.4.6)
Requirement already satisfied: thinc<8.2.0,>=8.1.8 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (8.1.9)
Requirement already satisfied: preshed<3.1.0,>=3.0.2 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (3.0.8)
Requirement already satisfied: numpy>=1.15.0 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (1.21.5)
```

Requirement already satisfied: murmurhash<1.1.0,>=0.28.0 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (1.0.9)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in c:\users\goura\anaconda3\lib\site-packages (from packaging>=20.0->spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (3.0.9)
Requirement already satisfied: typing-extensions>=4.1.0 in c:\users\goura\anaconda3\lib\site-packages (from pydantic!=1.8,!1.8.1,<1.11.0,>=1.7.4->spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (4.3.0)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\goura\anaconda3\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (2022.9.14)
Requirement already satisfied: charset-normalizer<3,>=2 in c:\users\goura\anaconda3\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (2.0.4)
Requirement already satisfied: idna<4,>=2.5 in c:\users\goura\anaconda3\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (3.3)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\goura\anaconda3\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (1.26.11)
Requirement already satisfied: confection<1.0.0,>=0.0.1 in c:\users\goura\anaconda3\lib\site-packages (from thinc<8.2.0,>=8.1.8->spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (0.0.4)
Requirement already satisfied: blis<0.8.0,>=0.7.8 in c:\users\goura\anaconda3\lib\site-packages (from thinc<8.2.0,>=8.1.8->spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (0.7.9)
Requirement already satisfied: colorama in c:\users\goura\anaconda3\lib\site-packages (from tqdm<5.0.0,>=4.38.0->spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (0.4.6)
Requirement already satisfied: click<9.0.0,>=7.1.1 in c:\users\goura\anaconda3\lib\site-packages (from typer<0.8.0,>=0.3.0->spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (8.0.4)
Requirement already satisfied: MarkupSafe>=0.23 in c:\users\goura\anaconda3\lib\site-packages (from jinja2->spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (2.0.1)
Installing collected packages: en-core-web-sm
Successfully installed en-core-web-sm-3.5.0
[+] Download and installation successful
You can now load the package via spacy.load('en_core_web_sm')
Collecting en-core-web-md==3.5.0
 Downloading https://github.com/explosion/spacy-models/releases/download/en_core_web_md-3.5.0/en_core_web_md-3.5.0-py3-none-any.whl (42.8 MB)
----- 42.8/42.8 MB 4.5 MB/s eta 0:00:00
Requirement already satisfied: spacy<3.6.0,>=3.5.0 in c:\users\goura\anaconda3\lib\site-packages (from en-core-web-md==3.5.0) (3.5.1)
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Requirement already satisfied: jinja2 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-md==3.5.0) (2.11.3)

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Requirement already satisfied: smart-open<7.0.0,>=5.2.1 in c:\users\goura\anaconda3\lib\
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\site-packages (from packaging>=20.0->spacy<3.6.0,>=3.5.0->en-core-web-md==3.5.0) (3.0.
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Requirement already satisfied: typing-extensions>=4.1.0 in c:\users\goura\anaconda3\lib
\site-packages (from pydantic!=1.8,!1.8.1,<1.11.0,>=1.7.4->spacy<3.6.0,>=3.5.0->en-core
-web-md==3.5.0) (4.3.0)
Requirement already satisfied: charset-normalizer<3,>=2 in c:\users\goura\anaconda3\lib
\site-packages (from requests<3.0.0,>=2.13.0->spacy<3.6.0,>=3.5.0->en-core-web-md==3.5.
0) (2.0.4)
Requirement already satisfied: idna<4,>=2.5 in c:\users\goura\anaconda3\lib\site-package
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(1.26.11)
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Requirement already satisfied: colorama in c:\users\goura\anaconda3\lib\site-packages (f
rom tqdm<5.0.0,>=4.38.0->spacy<3.6.0,>=3.5.0->en-core-web-md==3.5.0) (0.4.6)
Requirement already satisfied: click<9.0.0,>=7.1.1 in c:\users\goura\anaconda3\lib\site-
packages (from typer<0.8.0,>=0.3.0->spacy<3.6.0,>=3.5.0->en-core-web-md==3.5.0) (8.0.4)
Requirement already satisfied: MarkupSafe>=0.23 in c:\users\goura\anaconda3\lib\site-pac
kages (from jinja2->spacy<3.6.0,>=3.5.0->en-core-web-md==3.5.0) (2.0.1)
Installing collected packages: en-core-web-md
Successfully installed en-core-web-md-3.5.0
[+] Download and installation successful
You can now load the package via spacy.load('en_core_web_md')
Collecting en-core-web-lg==3.5.0
  Downloading https://github.com/explosion/spacy-models/releases/download/en_core_web_lg
-3.5.0/en_core_web_lg-3.5.0-py3-none-any.whl (587.7 MB)
----- 587.7/587.7 MB 795.2 kB/s eta 0:00:00
Requirement already satisfied: spacy<3.6.0,>=3.5.0 in c:\users\goura\anaconda3\lib\site-
packages (from en-core-web-lg==3.5.0) (3.5.1)
Requirement already satisfied: pathy>=0.10.0 in c:\users\goura\anaconda3\lib\site-packag
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Requirement already satisfied: langcodes<4.0.0,>=3.2.0 in c:\users\goura\anaconda3\lib\s
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Requirement already satisfied: wasabi<1.2.0,>=0.9.1 in c:\users\goura\anaconda3\lib\site
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Requirement already satisfied: catalogue<2.1.0,>=2.0.6 in c:\users\goura\anaconda3\lib\s
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Requirement already satisfied: packaging>=20.0 in c:\users\goura\anaconda3\lib\site-pack
ages (from spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (21.3)

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Requirement already satisfied: preshed<3.1.0,>=3.0.2 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (3.0.8)
Requirement already satisfied: pydantic!=1.8,!1.8.1,<1.11.0,>=1.7.4 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (1.10.2)
Requirement already satisfied: smart-open<7.0.0,>=5.2.1 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (5.2.1)
Requirement already satisfied: thinc<8.2.0,>=8.1.8 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (8.1.9)
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Requirement already satisfied: spacy-loggers<2.0.0,>=1.0.0 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (1.0.4)
Requirement already satisfied: Jinja2 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (2.11.3)
Requirement already satisfied: cymem<2.1.0,>=2.0.2 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (2.0.7)
Requirement already satisfied: tqdm<5.0.0,>=4.38.0 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (4.64.1)
Requirement already satisfied: requests<3.0.0,>=2.13.0 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (2.28.1)
Requirement already satisfied: setuptools in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (63.4.1)
Requirement already satisfied: srsly<3.0.0,>=2.4.3 in c:\users\goura\anaconda3\lib\site-packages (from spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (2.4.6)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in c:\users\goura\anaconda3\lib\site-packages (from packaging>=20.0->spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (3.0.9)
Requirement already satisfied: typing-extensions>=4.1.0 in c:\users\goura\anaconda3\lib\site-packages (from pydantic!=1.8,!1.8.1,<1.11.0,>=1.7.4->spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (4.3.0)
Requirement already satisfied: idna<4,>=2.5 in c:\users\goura\anaconda3\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (3.3)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\goura\anaconda3\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (2022.9.14)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\goura\anaconda3\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (1.26.11)
Requirement already satisfied: charset-normalizer<3,>=2 in c:\users\goura\anaconda3\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (2.0.4)
Requirement already satisfied: blis<0.8.0,>=0.7.8 in c:\users\goura\anaconda3\lib\site-packages (from thinc<8.2.0,>=8.1.8->spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (0.7.9)
Requirement already satisfied: confection<1.0.0,>=0.0.1 in c:\users\goura\anaconda3\lib\site-packages (from thinc<8.2.0,>=8.1.8->spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (0.0.4)
Requirement already satisfied: colorama in c:\users\goura\anaconda3\lib\site-packages (from tqdm<5.0.0,>=4.38.0->spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (0.4.6)
Requirement already satisfied: click<9.0.0,>=7.1.1 in c:\users\goura\anaconda3\lib\site-packages (from typer<0.8.0,>=0.3.0->spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (8.0.4)
Requirement already satisfied: MarkupSafe>=0.23 in c:\users\goura\anaconda3\lib\site-packages (from Jinja2->spacy<3.6.0,>=3.5.0->en-core-web-lg==3.5.0) (2.0.1)
Installing collected packages: en-core-web-lg
Successfully installed en-core-web-lg-3.5.0
[+] Download and installation successful
You can now load the package via spacy.load('en_core_web-lg')

```

```

In [69]: # NLP english language model of spacy library
nlp = spacy.load("en_core_web-lg")

# joining the tokens after removing stop words
doc=nlp(' '.join(no_stop_tokens))
print(doc[0:40])

```

0 Not interested 0 Wants private accommodation 0 0 0 0 0 Not responding 0 Booked competitor 0 Low budget 0 0 Not responding 0 0 0 Low availability Low availability Not interested 0 Short stay 0 Not interested 0

```
In [70]: lemmas = [token.lemma_ for token in doc]
print(lemmas[0:25])

['0', 'not', 'interested', '0', 'want', 'private', 'accommodation', '0', '0', '0', '0', '0', '0', 'not', 'respond', '0', 'book', 'competitor', '0', 'low', 'budget', '0', '0', '0', 'not', 'respond', '0']
```

Extracting Features from the text data using tfidf vectorizer

```
In [71]: from sklearn.feature_extraction.text import TfidfVectorizer
vectorizer_n_gram_max_features = TfidfVectorizer(norm="l2", analyzer='word', ngram_range=
tf_idf_matrix_n_gram_max_features = vectorizer_n_gram_max_features.fit_transform(book)
print(vectorizer_n_gram_max_features.get_feature_names())

print(tf_idf_matrix_n_gram_max_features.toarray())

['availability', 'budget', 'interested', 'low', 'low availability', 'low budget', 'not', 'not interested', 'not responding', 'responding']
[[0.         0.         0.         ... 0.         0.         0.         ]
 [0.         0.         0.62529835 ... 0.62529835 0.         0.         ]
 [0.         0.         0.         ... 0.         0.         0.         ]
 ...
 [0.         0.         0.         ... 0.         0.         0.         ]
 [0.         0.         0.         ... 0.         0.         0.         ]
 [0.         0.         0.         ... 0.         0.61935183 0.61935183]]
```

```
In [72]: tfidf=tf_idf_matrix_n_gram_max_features.toarray()
tfidf.shape
```

Out[72]: (6146, 10)

```
In [73]: text_data=pd.DataFrame(tfidf, columns=['availability', 'budget', 'interested', 'low', 'low
text_data.head(2)
```

Out[73]:

	availability	budget	interested	low	low availability	low budget	not	not interested	not responding	responding
0	0.0	0.0	0.000000	0.0	0.0	0.0	0.000000	0.000000	0.0	0.0
1	0.0	0.0	0.625298	0.0	0.0	0.0	0.466909	0.625298	0.0	0.0

```
In [74]: undersampled_data.head(2)
```

Out[74]:

	status	lost_reason	budget	lease	movein	room_type
39682	WON	0	326	61	31/08/22	0
41431	LOST	Not interested	£121 - £180 Per Week	Full Year Course Stay 40 - 44 weeks	15/09/22	1

```
In [81]: #Label Encoding for Status
undersampled_data['status'] = undersampled_data['status'].replace({'WON': 1, 'LOST':0})
```

```
In [80]: # Converting budget to string data type
undersampled_data['budget'] = undersampled_data['budget'].astype(str)
```

```
# Label Encoding for budget
undersampled_data.loc[:, 'budget']=le.fit_transform(undersampled_data['budget'])
```

```
In [82]: # Converting lease to string data type
undersampled_data['lease']=undersampled_data['lease'].astype(str)

# Label Encoding for lease
undersampled_data.loc[:, 'lease']=le.fit_transform(undersampled_data['lease'])

# set index of undersampled data to text data so that we can combine the data
text_data = text_data.set_index(undersampled_data.index)

# Concatenating both data sets
combined_df = pd.concat([undersampled_data, text_data], axis=1)
```

```
In [83]: combined_df.head()
```

```
Out[83]:
```

	status	budget	lease	movein	room_type	availability	budget	interested	low	low availability	low budget
39682	1	293	120	31/08/22	0	0.0	0.0	0.000000	0.0	0.0	0.0
41431	0	447	19	15/09/22	1	0.0	0.0	0.625298	0.0	0.0	0.0
2387	1	264	42	03/09/22	3	0.0	0.0	0.000000	0.0	0.0	0.0
44680	0	455	0	31/08/22	5	0.0	0.0	0.000000	0.0	0.0	0.0
32359	1	313	121	23/09/22	0	0.0	0.0	0.000000	0.0	0.0	0.0

```
In [84]: # Converting Date column to datetime type
combined_df['movein'] = pd.to_datetime(combined_df['movein'])
combined_df.head()
```

```
Out[84]:
```

	status	budget	lease	movein	room_type	availability	budget	interested	low	low availability	low budget
39682	1	293	120	2022-08-31	0	0.0	0.0	0.000000	0.0	0.0	0.0
41431	0	447	19	2022-09-15	1	0.0	0.0	0.625298	0.0	0.0	0.0
2387	1	264	42	2022-03-09	3	0.0	0.0	0.000000	0.0	0.0	0.0
44680	0	455	0	2022-08-31	5	0.0	0.0	0.000000	0.0	0.0	0.0
32359	1	313	121	2022-09-23	0	0.0	0.0	0.000000	0.0	0.0	0.0

```
In [85]: # Converting date column to month, year, day, and weekday
combined_df['month'] = combined_df['movein'].dt.month
combined_df['year'] = combined_df['movein'].dt.year
combined_df['day'] = combined_df['movein'].dt.day
combined_df['weekday'] = combined_df['movein'].dt.day_name()
combined_df.head()
```

```
Out[85]:
```

	status	budget	lease	movein	room_type	availability	budget	interested	low	low availability	low budget
39682	1	293	120	2022-08-31	0	0.0	0.0	0.000000	0.0	0.0	0.0

41431	0	447	19	2022-09-15	1	0.0	0.0	0.625298	0.0	0.0	0.0	0.466909
2387	1	264	42	2022-03-09	3	0.0	0.0	0.000000	0.0	0.0	0.0	0.000000
44680	0	455	0	2022-08-31	5	0.0	0.0	0.000000	0.0	0.0	0.0	0.000000
32359	1	313	121	2022-09-23	0	0.0	0.0	0.000000	0.0	0.0	0.0	0.000000

```
In [86]: # Removing movein from dataset
combined_df=combined_df.drop('movein', axis=1)

#Converting weekday to numerical
weekday_series = combined_df['weekday']

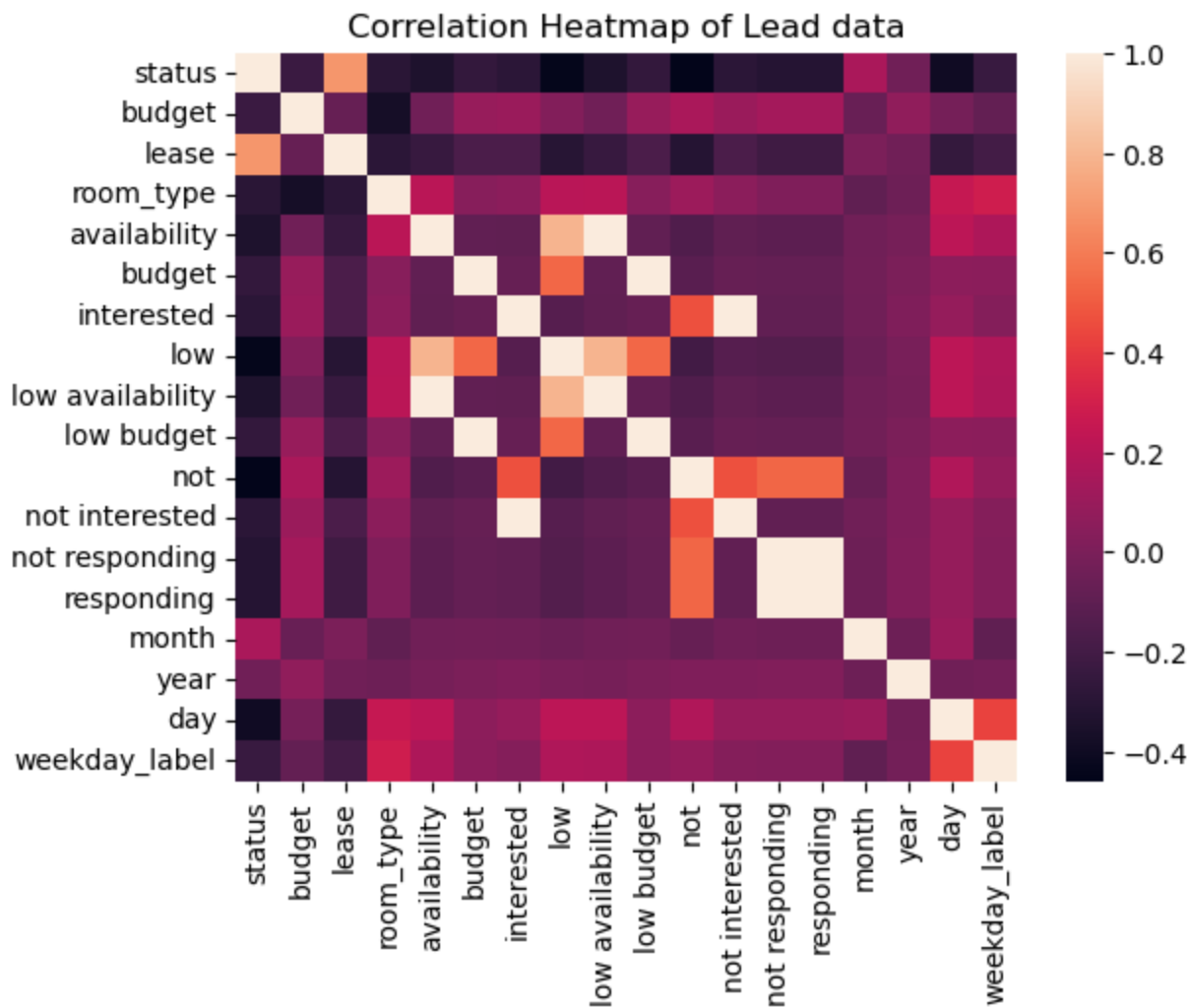
combined_df['weekday_label'] = LabelEncoder().fit_transform(weekday_series)
combined_df.head(2)
combined_df=combined_df.drop('weekday', axis=1)
combined_df
```

```
Out[86]:
```

	status	budget	lease	room_type	availability	budget	interested	low	low availability	low budget	not in
39682	1	293	120	0	0.0	0.0	0.000000	0.0	0.0	0.0	0.000000
41431	0	447	19	1	0.0	0.0	0.625298	0.0	0.0	0.0	0.466909
2387	1	264	42	3	0.0	0.0	0.000000	0.0	0.0	0.0	0.000000
44680	0	455	0	5	0.0	0.0	0.000000	0.0	0.0	0.0	0.000000
32359	1	313	121	0	0.0	0.0	0.000000	0.0	0.0	0.0	0.000000
...
11642	1	313	124	0	0.0	0.0	0.000000	0.0	0.0	0.0	0.000000
32988	1	258	67	3	0.0	0.0	0.000000	0.0	0.0	0.0	0.000000
33686	1	313	121	0	0.0	0.0	0.000000	0.0	0.0	0.0	0.000000
36088	1	293	121	0	0.0	0.0	0.000000	0.0	0.0	0.0	0.000000
16156	0	447	19	5	0.0	0.0	0.000000	0.0	0.0	0.0	0.482500

6146 rows × 18 columns

```
In [87]: # Correlation representaiton using Heatmap
sns.heatmap(combined_df.corr())
plt.title('Correlation Heatmap of Lead data')
plt.show()
```

Key Insights from the Lead Data Correlation Heatmap:

Budget vs low budget and availability vs low availability are highly correlated features.

In [88]: `combined_df.corr()`

Out[88]:

	status	budget	lease	room_type	availability	budget	interested	low	low availability
status	1.000000	-0.234550	0.683268	-0.295073	-0.338850	-0.259585	-0.290072	-0.445657	-0.338850
budget	-0.234550	1.000000	-0.072826	-0.374788	-0.040360	0.091083	0.104141	0.021374	-0.040360
lease	0.683268	-0.072826	1.000000	-0.289602	-0.242651	-0.170143	-0.172119	-0.309526	-0.242651
room_type	-0.295073	-0.374788	-0.289602	1.000000	0.212600	0.041222	0.052248	0.205374	0.212600
availability	-0.338850	-0.040360	-0.242651	0.212600	1.000000	-0.087961	-0.098291	0.794001	1.000000
budget	-0.259585	0.091083	-0.170143	0.041222	-0.087961	1.000000	-0.075298	0.535720	-0.087961
interested	-0.290072	0.104141	-0.172119	0.052248	-0.098291	-0.075298	1.000000	-0.129273	-0.098291
low	-0.445657	0.021374	-0.309526	0.205374	0.794001	0.535720	-0.129273	1.000000	0.794001
low availability	-0.338850	-0.040360	-0.242651	0.212600	1.000000	-0.087961	-0.098291	0.794001	1.000000
low budget	-0.259585	0.091083	-0.170143	0.041222	-0.087961	1.000000	-0.075298	0.535720	-0.087961
not	-0.458071	0.151785	-0.312334	0.110143	-0.155218	-0.118908	0.468031	-0.204143	-0.155218
not interested	-0.290072	0.104141	-0.172119	0.052248	-0.098291	-0.075298	1.000000	-0.129273	-0.098291

not responding	-0.314442	0.134379	-0.214803	0.012382	-0.106549	-0.081624	-0.091211	-0.140133	-0.10654
responding	-0.314442	0.134379	-0.214803	0.012382	-0.106549	-0.081624	-0.091211	-0.140133	-0.10654
month	0.154807	-0.068809	0.000796	-0.098135	-0.038930	-0.035942	-0.039316	-0.054935	-0.03893
year	-0.041215	0.070631	-0.036812	-0.051878	-0.014701	-0.001963	0.009535	-0.013660	-0.01470
day	-0.397082	-0.023933	-0.253840	0.248301	0.215743	0.055964	0.084512	0.217035	0.21574
weekday_label	-0.240360	-0.086280	-0.198568	0.286428	0.166230	0.050973	0.030335	0.172018	0.16623

```
In [89]: combined_df.columns
```

```
Out[89]: Index(['status', 'budget', 'lease', 'room_type', 'availability', 'budget',
        'interested', 'low', 'low availability', 'low budget', 'not',
        'not interested', 'not responding', 'responding', 'month', 'year',
        'day', 'weekday_label'],
        dtype='object')
```

Building a Logistics Regression Model

```
In [90]: from sklearn.model_selection import train_test_split
        from sklearn.linear_model import LogisticRegression
        from sklearn.metrics import accuracy_score

        # Defining Independent and dependent variables
        x=combined_df.drop('status', axis=1)
        y=combined_df['status']

        # Split the data into training and testing sets
        x_train, x_test, y_train, y_test = train_test_split(x,y , test_size=0.2, random_state=42)

        # Building a logisticRegression machine learning algorithm
        model = LogisticRegression()

        # Train the model on the training set
        model.fit(x_train, y_train)

        # Evaluate the performance of the model on the testing set
        y_pred = model.predict(x_test)
        accuracy_lr = accuracy_score(y_test, y_pred)
        print('Logistic Regression model Accuracy is :', accuracy_lr*100,'%')

        Logistic Regression model Accuracy is : 92.35772357723577 %
```

```
In [91]: proba_score=model.predict_proba(x_test)
        proba_score=proba_score*100
        proba_score
```

```
Out[91]: array([[9.90564967e+00, 9.00943503e+01],
        [1.42767985e+00, 9.85723202e+01],
        [4.06686792e-01, 9.95933132e+01],
        ...,
        [9.99537470e+01, 4.62529967e-02],
        [9.36931323e-01, 9.90630687e+01],
        [1.92165692e+01, 8.07834308e+01]])
```

```
In [92]: x_test.columns
```

```
Out[92]: Index(['budget', 'lease', 'room_type', 'availability', 'budget', 'interested',
        'low', 'low availability', 'low budget', 'not', 'not interested',
        'not responding', 'responding', 'month', 'year', 'day',
```

```
'weekday_label'],  
dtype='object')
```

Combining the x_test data with its lead scoring for both 0(LOST) class and 1(WON) class

```
In [93]: combined_data = np.concatenate((x_test, proba_score), axis=1)  
combined_data  
Lead_score_data=pd.DataFrame(combined_data, columns=['budget', 'lease', 'room_type', 'av  
          'low', 'low availability', 'low budget', 'not', 'not interested',  
          'not responding', 'responding', 'month', 'year', 'day',  
          'weekday_label', 'Lead_Score for 0(LOST) class','Lead_Score for 1(WON) class'])  
Lead_score_data
```

Out[93]:

	budget	lease	room_type	availability	budget	interested	low	low availability	low budget	not	no interest
0	266.0	67.0	3.0	0.000000	0.0	0.0	0.000000	0.000000	0.0	0.0000	0.
1	308.0	121.0	2.0	0.000000	0.0	0.0	0.000000	0.000000	0.0	0.0000	0.
2	293.0	121.0	0.0	0.000000	0.0	0.0	0.000000	0.000000	0.0	0.0000	0.
3	1.0	0.0	5.0	0.000000	0.0	0.0	0.000000	0.000000	0.0	0.0000	0.
4	450.0	23.0	0.0	0.000000	0.0	0.0	0.000000	0.000000	0.0	0.4825	0.
...
1225	0.0	0.0	3.0	0.000000	0.0	0.0	0.000000	0.000000	0.0	0.0000	0.
1226	32.0	100.0	3.0	0.000000	0.0	0.0	0.000000	0.000000	0.0	0.0000	0.
1227	146.0	0.0	5.0	0.605292	0.0	0.0	0.516956	0.605292	0.0	0.0000	0.
1228	313.0	121.0	0.0	0.000000	0.0	0.0	0.000000	0.000000	0.0	0.0000	0.
1229	293.0	121.0	2.0	0.000000	0.0	0.0	0.000000	0.000000	0.0	0.0000	0.

1230 rows × 19 columns

```
In [94]: # Confusion matrix  
from sklearn.metrics import confusion_matrix  
print(confusion_matrix(y_test,y_pred))  
  
[[549  65]  
 [ 29 587]]
```

Calculation of Precision, Recall,F1 score from Classification report

Classification report

```
In [96]: from sklearn.metrics import classification_report  
print(classification_report(y_test,y_pred))  
  
precision    recall  f1-score   support
```

	0	0.95	0.89	0.92	614
	1	0.90	0.95	0.93	616
accuracy				0.92	1230
macro avg		0.93	0.92	0.92	1230
weighted avg		0.93	0.92	0.92	1230

Conclusion: For class 0, the precision, recall, and F1-score are 82%, 79%, and 81%, respectively, while for class 1, they are 80%, 83%, and 82%. The model's overall accuracy is 0.81, indicating that it correctly predicted 81% of the total number of instances. It also calculated probability scores for the test data for both WON and LOST classes using predict_proba () The model's overall accuracy was 81.21%. I built the model successfully and accurately.