leads-scoring-assignment-analysis

May 2, 2023

[1]:

```
# Suppressing Warnings
import warnings
warnings.filterwarnings('ignore')
# Importing Pandas and NumPy
import pandas as pd, numpy as np

import matplotlib.pyplot as plt
import seaborn as sns
```

[2]:

```
# Importing data
lead_data = pd.read_csv(r"E:\LIBA_BA\Machine_Learning\Lead Scoring Assignment␣
 ↪Answers\Leads.csv")
lead_data.head()
```

[2]:

```
                            Prospect ID  Lead Number              Lead Origin  \
0  7927b2df-8bba-4d29-b9a2-b6e0beafe620       660737                      API
1  2a272436-5132-4136-86fa-dcc88c88f482       660728                      API
2  8cc8c611-a219-4f35-ad23-fdfd2656bd8a       660727  Landing Page Submission
3  0cc2df48-7cf4-4e39-9de9-19797f9b38cc       660719  Landing Page Submission
4  3256f628-e534-4826-9d63-4a8b88782852       660681  Landing Page Submission

      Lead Source Do Not Email Do Not Call  Converted  TotalVisits  \
0      Olark Chat           No          No          0          0.0
1  Organic Search           No          No          0          5.0
2  Direct Traffic           No          No          1          2.0
3  Direct Traffic           No          No          0          1.0
4          Google           No          No          1          2.0

   Total Time Spent on Website  Page Views Per Visit  …  \
0                            0                   0.0  …
1                          674                   2.5  …
2                         1532                   2.0  …
3                          305                   1.0  …
4                         1428                   1.0  …

  Get updates on DM Content    Lead Profile    City  \
0                        No          Select  Select
```

```
1                        No          Select  Select
2                        No  Potential Lead  Mumbai
3                        No          Select  Mumbai
4                        No          Select  Mumbai

  Asymmetrique Activity Index Asymmetrique Profile Index  \
0                   02.Medium                  02.Medium
1                   02.Medium                  02.Medium
2                   02.Medium                    01.High
3                   02.Medium                    01.High
4                   02.Medium                    01.High

  Asymmetrique Activity Score Asymmetrique Profile Score  \
0                        15.0                       15.0
1                        15.0                       15.0
2                        14.0                       20.0
3                        13.0                       17.0
4                        15.0                       18.0

  I agree to pay the amount through cheque  \
0                                        No
1                                        No
2                                        No
3                                        No
4                                        No

  A free copy of Mastering The Interview Last Notable Activity
0                                     No              Modified
1                                     No          Email Opened
2                                    Yes          Email Opened
3                                     No              Modified
4                                     No              Modified

[5 rows x 37 columns]
```

[3]:

```
# checking the shape of the data
lead_data.shape
```

[3]:

```
(9240, 37)
```

[4]:

```
# checking non null count and datatype of the variables
lead_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 9240 entries, 0 to 9239
Data columns (total 37 columns):
 #   Column                                         Non-Null Count  Dtype
```

```
---  ------                                         --------------  -----
 0   Prospect ID                                    9240 non-null   object
 1   Lead Number                                    9240 non-null   int64
 2   Lead Origin                                    9240 non-null   object
 3   Lead Source                                    9204 non-null   object
 4   Do Not Email                                   9240 non-null   object
 5   Do Not Call                                    9240 non-null   object
 6   Converted                                      9240 non-null   int64
 7   TotalVisits                                    9103 non-null   float64
 8   Total Time Spent on Website                    9240 non-null   int64
 9   Page Views Per Visit                           9103 non-null   float64
 10  Last Activity                                  9137 non-null   object
 11  Country                                        6779 non-null   object
 12  Specialization                                 7802 non-null   object
 13  How did you hear about X Education             7033 non-null   object
 14  What is your current occupation                6550 non-null   object
 15  What matters most to you in choosing a course  6531 non-null   object
 16  Search                                         9240 non-null   object
 17  Magazine                                       9240 non-null   object
 18  Newspaper Article                              9240 non-null   object
 19  X Education Forums                             9240 non-null   object
 20  Newspaper                                      9240 non-null   object
 21  Digital Advertisement                          9240 non-null   object
 22  Through Recommendations                        9240 non-null   object
 23  Receive More Updates About Our Courses         9240 non-null   object
 24  Tags                                           5887 non-null   object
 25  Lead Quality                                   4473 non-null   object
 26  Update me on Supply Chain Content              9240 non-null   object
 27  Get updates on DM Content                      9240 non-null   object
 28  Lead Profile                                   6531 non-null   object
 29  City                                           7820 non-null   object
 30  Asymmetrique Activity Index                    5022 non-null   object
 31  Asymmetrique Profile Index                     5022 non-null   object
 32  Asymmetrique Activity Score                    5022 non-null   float64
 33  Asymmetrique Profile Score                     5022 non-null   float64
 34  I agree to pay the amount through cheque       9240 non-null   object
 35  A free copy of Mastering The Interview         9240 non-null   object
 36  Last Notable Activity                          9240 non-null   object
dtypes: float64(4), int64(3), object(30)
memory usage: 2.6+ MB
```

[5]:

```
# Describing data
lead_data.describe()
```

[5]:

```
        Lead Number    Converted  TotalVisits  Total Time Spent on Website  \
count   9240.000000  9240.000000  9103.000000                  9240.000000
mean  617188.435606     0.385390     3.445238                   487.698268
```

```
std     23405.995698     0.486714     4.854853                   548.021466
min    579533.000000     0.000000     0.000000                     0.000000
25%    596484.500000     0.000000     1.000000                    12.000000
50%    615479.000000     0.000000     3.000000                   248.000000
75%    637387.250000     1.000000     5.000000                   936.000000
max    660737.000000     1.000000   251.000000                  2272.000000

       Page Views Per Visit  Asymmetrique Activity Score  \
count           9103.000000                  5022.000000
mean               2.362820                    14.306252
std                2.161418                     1.386694
min                0.000000                     7.000000
25%                1.000000                    14.000000
50%                2.000000                    14.000000
75%                3.000000                    15.000000
max               55.000000                    18.000000

       Asymmetrique Profile Score
count                 5022.000000
mean                    16.344883
std                      1.811395
min                     11.000000
25%                     15.000000
50%                     16.000000
75%                     18.000000
max                     20.000000
```

1 Data Cleaning

[6]:

```
# Converting 'Select' values to NaN.
lead_data = lead_data.replace('Select', np.nan)
```

[7]:

```
# checking the columns for null values
lead_data.isnull().sum()
```

[7]:

```
Prospect ID                                         0
Lead Number                                         0
Lead Origin                                         0
Lead Source                                        36
Do Not Email                                        0
Do Not Call                                         0
Converted                                           0
TotalVisits                                       137
Total Time Spent on Website                         0
Page Views Per Visit                              137
Last Activity                                     103
```

```
Country                                          2461
Specialization                                   3380
How did you hear about X Education               7250
What is your current occupation                  2690
What matters most to you in choosing a course    2709
Search                                              0
Magazine                                            0
Newspaper Article                                   0
X Education Forums                                  0
Newspaper                                           0
Digital Advertisement                               0
Through Recommendations                             0
Receive More Updates About Our Courses              0
Tags                                             3353
Lead Quality                                     4767
Update me on Supply Chain Content                   0
Get updates on DM Content                           0
Lead Profile                                     6855
City                                             3669
Asymmetrique Activity Index                      4218
Asymmetrique Profile Index                       4218
Asymmetrique Activity Score                      4218
Asymmetrique Profile Score                       4218
I agree to pay the amount through cheque            0
A free copy of Mastering The Interview              0
Last Notable Activity                               0
dtype: int64
```

[8]:

```
# Finding the null percentages across columns
round(lead_data.isnull().sum()/len(lead_data.index),2)*100
```

[8]:

```
Prospect ID                                       0.0
Lead Number                                       0.0
Lead Origin                                       0.0
Lead Source                                       0.0
Do Not Email                                      0.0
Do Not Call                                       0.0
Converted                                         0.0
TotalVisits                                       1.0
Total Time Spent on Website                       0.0
Page Views Per Visit                              1.0
Last Activity                                     1.0
Country                                          27.0
Specialization                                   37.0
How did you hear about X Education               78.0
What is your current occupation                  29.0
What matters most to you in choosing a course    29.0
```

```
Search                                            0.0
Magazine                                          0.0
Newspaper Article                                 0.0
X Education Forums                                0.0
Newspaper                                         0.0
Digital Advertisement                             0.0
Through Recommendations                           0.0
Receive More Updates About Our Courses            0.0
Tags                                             36.0
Lead Quality                                     52.0
Update me on Supply Chain Content                 0.0
Get updates on DM Content                         0.0
Lead Profile                                     74.0
City                                             40.0
Asymmetrique Activity Index                      46.0
Asymmetrique Profile Index                       46.0
Asymmetrique Activity Score                      46.0
Asymmetrique Profile Score                       46.0
I agree to pay the amount through cheque          0.0
A free copy of Mastering The Interview            0.0
Last Notable Activity                             0.0
dtype: float64
```

[9]:

```
# dropping the columns with missing values greater than or equal to 40% .
lead_data=lead_data.drop(columns=['How did you hear about X Education','Lead␣
 ↪Quality','Lead Profile',
                                  'Asymmetrique Activity Index','Asymmetrique␣
 ↪Profile Index','Asymmetrique Activity Score',
                                 'Asymmetrique Profile Score'])
```

[10]:

```
# Finding the null percentages across columns after removing the above columns
round(lead_data.isnull().sum()/len(lead_data.index),2)*100
```

[10]:

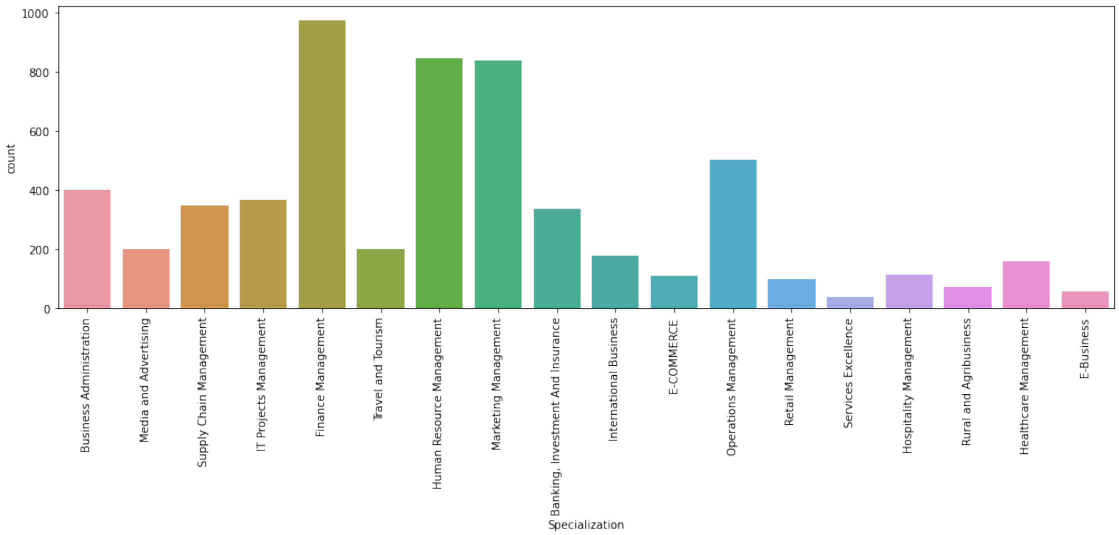
```
Prospect ID                                       0.0
Lead Number                                       0.0
Lead Origin                                       0.0
Lead Source                                       0.0
Do Not Email                                      0.0
Do Not Call                                       0.0
Converted                                         0.0
TotalVisits                                       1.0
Total Time Spent on Website                       0.0
Page Views Per Visit                              1.0
Last Activity                                     1.0
Country                                          27.0
Specialization                                   37.0
What is your current occupation                  29.0
What matters most to you in choosing a course    29.0
Search                                            0.0
Magazine                                          0.0
Newspaper Article                                 0.0
X Education Forums                                0.0
Newspaper                                         0.0
Digital Advertisement                             0.0
Through Recommendations                           0.0
Receive More Updates About Our Courses            0.0
Tags                                             36.0
Update me on Supply Chain Content                 0.0
Get updates on DM Content                         0.0
City                                             40.0
I agree to pay the amount through cheque          0.0
A free copy of Mastering The Interview            0.0
Last Notable Activity                             0.0
dtype: float64
```

[11]:

```
plt.figure(figsize=(17,5))
sns.countplot(lead_data['Specialization'])
plt.xticks(rotation=90)
```

[11]:

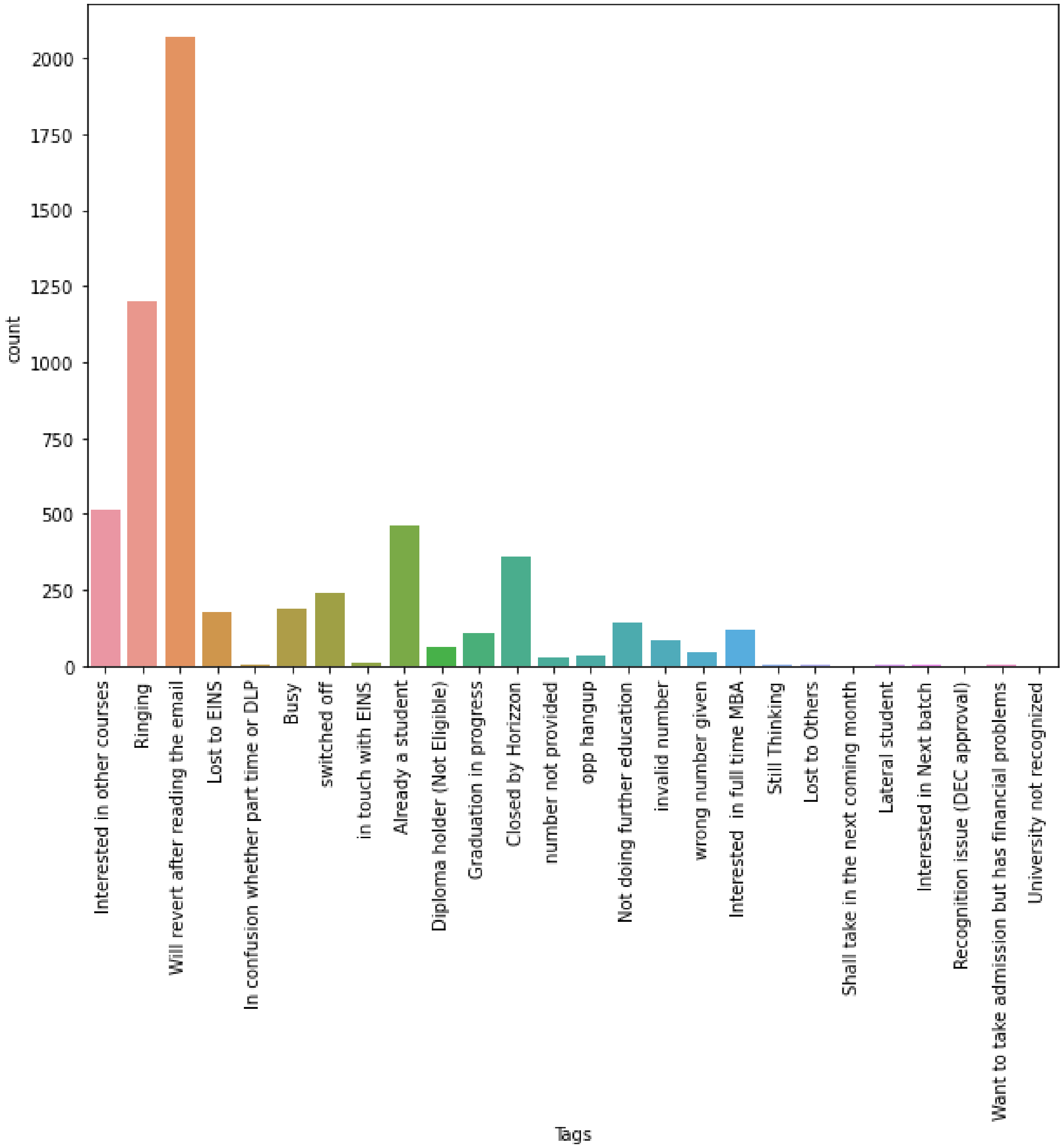
```
(array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16,
        17]),
 [Text(0, 0, 'Business Administration'),
  Text(1, 0, 'Media and Advertising'),
  Text(2, 0, 'Supply Chain Management'),
  Text(3, 0, 'IT Projects Management'),
  Text(4, 0, 'Finance Management'),
  Text(5, 0, 'Travel and Tourism'),
  Text(6, 0, 'Human Resource Management'),
  Text(7, 0, 'Marketing Management'),
  Text(8, 0, 'Banking, Investment And Insurance'),
  Text(9, 0, 'International Business'),
  Text(10, 0, 'E-COMMERCE'),
  Text(11, 0, 'Operations Management'),
  Text(12, 0, 'Retail Management'),
  Text(13, 0, 'Services Excellence'),
  Text(14, 0, 'Hospitality Management'),
  Text(15, 0, 'Rural and Agribusiness'),
  Text(16, 0, 'Healthcare Management'),
  Text(17, 0, 'E-Business')])
```



[12]:
```
# Creating a separate category called 'Others' for this
lead_data['Specialization'] = lead_data['Specialization'].replace(np.nan,␣
 ↪'Others')
```

[13]:
```
# Visualizing Tags column
plt.figure(figsize=(10,7))
sns.countplot(lead_data['Tags'])
plt.xticks(rotation=90)
```

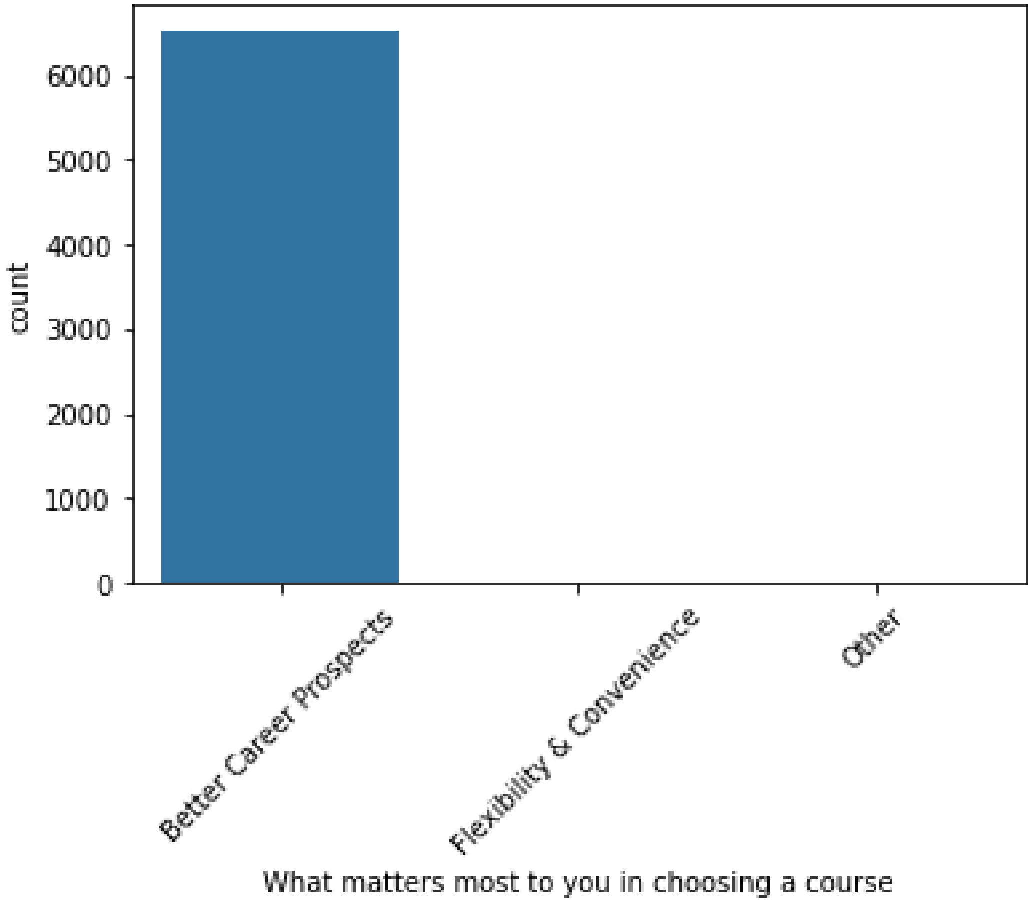
[13]:
```
(array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16,
        17, 18, 19, 20, 21, 22, 23, 24, 25]),
 [Text(0, 0, 'Interested in other courses'),
  Text(1, 0, 'Ringing'),
  Text(2, 0, 'Will revert after reading the email'),
  Text(3, 0, 'Lost to EINS'),
  Text(4, 0, 'In confusion whether part time or DLP'),
  Text(5, 0, 'Busy'),
  Text(6, 0, 'switched off'),
  Text(7, 0, 'in touch with EINS'),
  Text(8, 0, 'Already a student'),
  Text(9, 0, 'Diploma holder (Not Eligible)'),
  Text(10, 0, 'Graduation in progress'),
  Text(11, 0, 'Closed by Horizzon'),
  Text(12, 0, 'number not provided'),
  Text(13, 0, 'opp hangup'),
  Text(14, 0, 'Not doing further education'),
  Text(15, 0, 'invalid number'),
  Text(16, 0, 'wrong number given'),
  Text(17, 0, 'Interested  in full time MBA'),
  Text(18, 0, 'Still Thinking'),
  Text(19, 0, 'Lost to Others'),
  Text(20, 0, 'Shall take in the next coming month'),
  Text(21, 0, 'Lateral student'),
  Text(22, 0, 'Interested in Next batch'),
  Text(23, 0, 'Recognition issue (DEC approval)'),
  Text(24, 0, 'Want to take admission but has financial problems'),
  Text(25, 0, 'University not recognized')])
```



```
[14]: # Imputing the missing data in the tags column with 'Will revert after reading␣
       ↪the email'
      lead_data['Tags']=lead_data['Tags'].replace(np.nan,'Will revert after reading␣
       ↪the email')
```

```
[15]: # Visualizing this column
      sns.countplot(lead_data['What matters most to you in choosing a course'])
      plt.xticks(rotation=45)
```

```
[15]: (array([0, 1, 2]),
       [Text(0, 0, 'Better Career Prospects'),
        Text(1, 0, 'Flexibility & Convenience'),
        Text(2, 0, 'Other')])
```



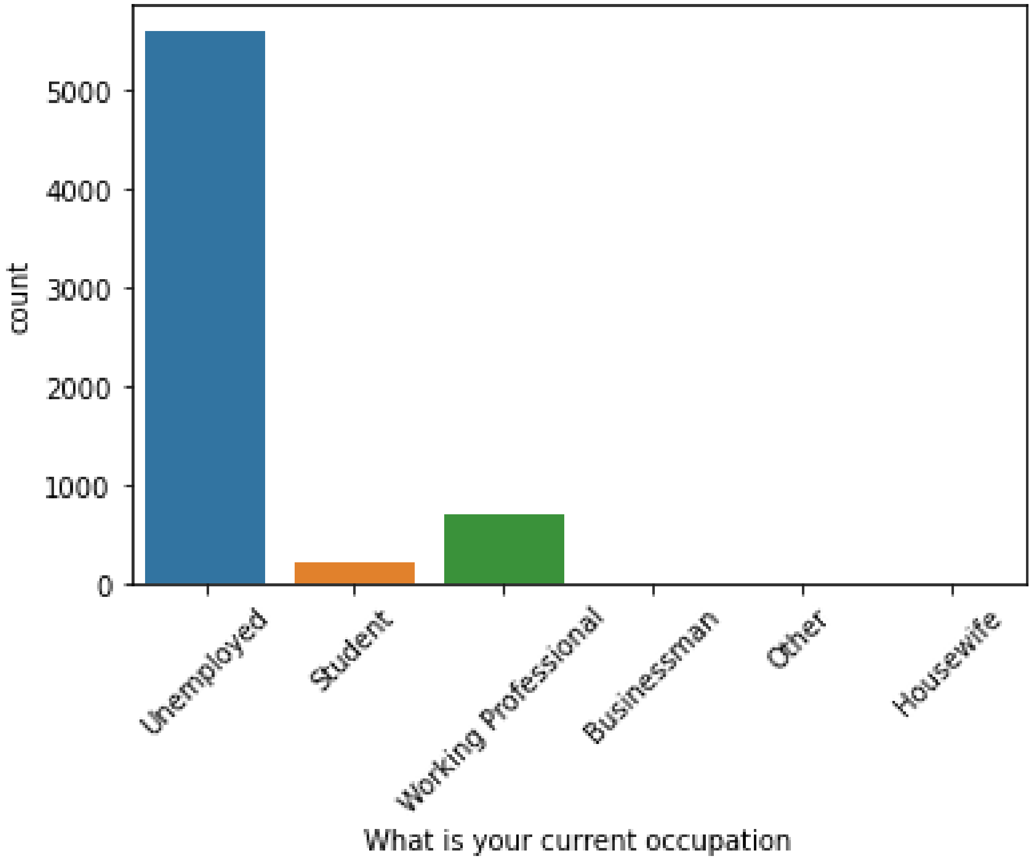
```
[16]: # Finding the percentage of the different categories of this column:
      round(lead_data['What matters most to you in choosing a course'].
       ↪value_counts(normalize=True),2)*100
```

```
[16]: Better Career Prospects      100.0
      Flexibility & Convenience      0.0
      Other                          0.0
      Name: What matters most to you in choosing a course, dtype: float64
```

```
[17]: # Dropping this column
      lead_data=lead_data.drop('What matters most to you in choosing a course',axis=1)
```

```
[18]: #4) Column: 'What is your current occupation'
      sns.countplot(lead_data['What is your current occupation'])
      plt.xticks(rotation=45)
```

```
[18]: (array([0, 1, 2, 3, 4, 5]),
       [Text(0, 0, 'Unemployed'),
        Text(1, 0, 'Student'),
        Text(2, 0, 'Working Professional'),
        Text(3, 0, 'Businessman'),
        Text(4, 0, 'Other'),
        Text(5, 0, 'Housewife')])
```



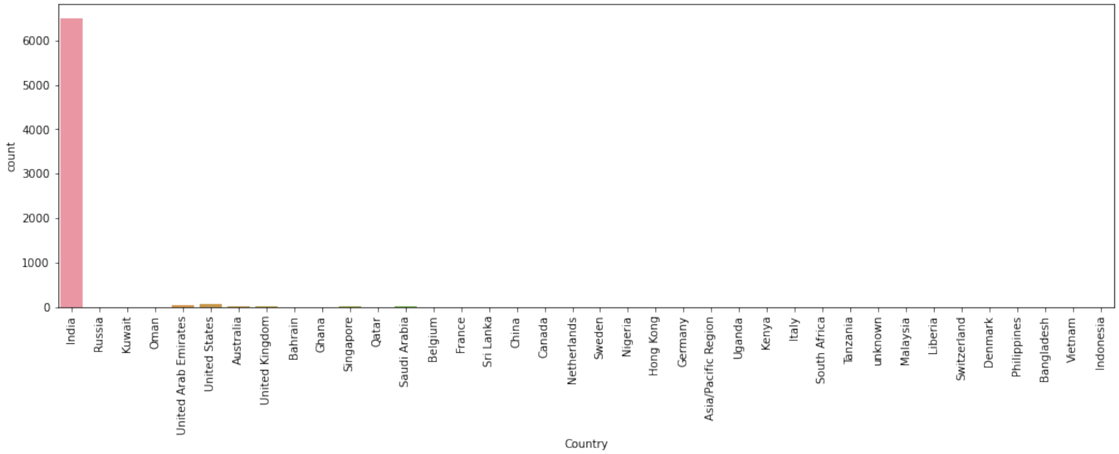
```
[19]: # Finding the percentage of the different categories of this column:
      round(lead_data['What is your current occupation'].
       ↪value_counts(normalize=True),2)*100
```

```
[19]: Unemployed              85.0
      Working Professional    11.0
      Student                  3.0
      Other                    0.0
      Housewife                0.0
      Businessman              0.0
      Name: What is your current occupation, dtype: float64
```

```
[20]: # Imputing the missing data in the 'What is your current occupation' column␣
       ↪with 'Unemployed'
      lead_data['What is your current occupation']=lead_data['What is your current␣
       ↪occupation'].replace(np.nan,'Unemployed')
```

```
[21]: #Country
      plt.figure(figsize=(17,5))
      sns.countplot(lead_data['Country'])
      plt.xticks(rotation=90)
```

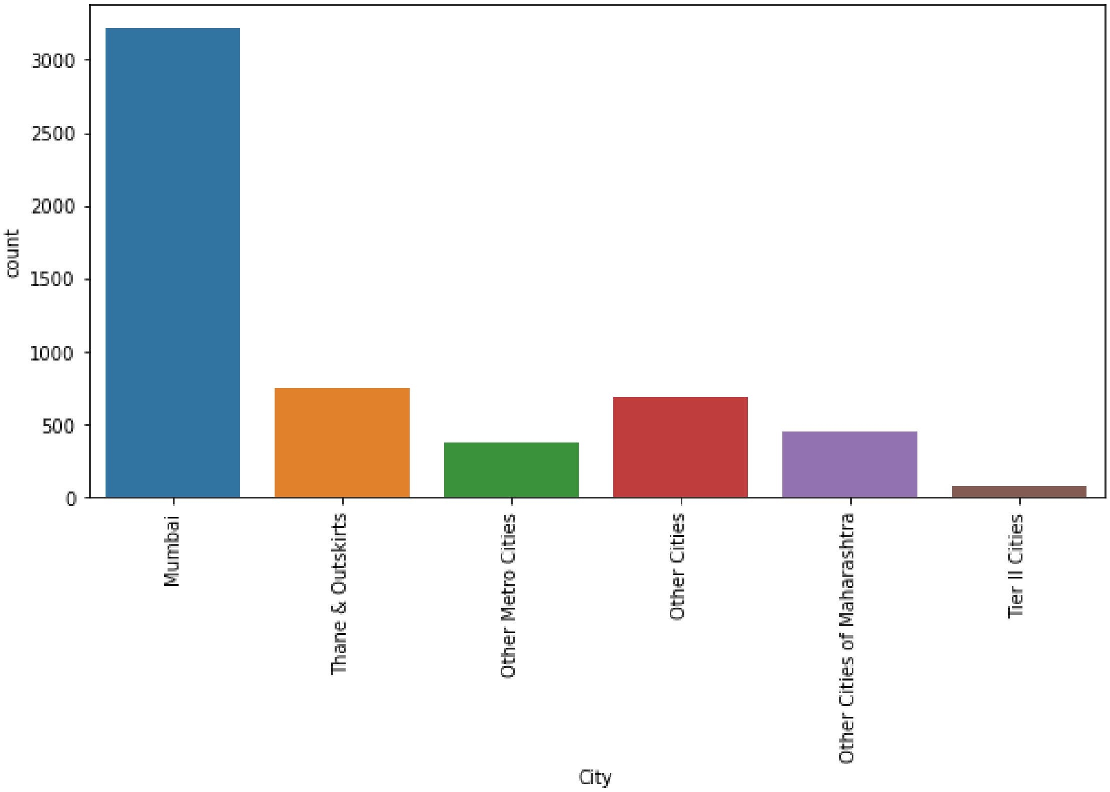
```
[21]: (array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16,
              17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33,
              34, 35, 36, 37]),
       [Text(0, 0, 'India'),
        Text(1, 0, 'Russia'),
        Text(2, 0, 'Kuwait'),
        Text(3, 0, 'Oman'),
        Text(4, 0, 'United Arab Emirates'),
        Text(5, 0, 'United States'),
        Text(6, 0, 'Australia'),
        Text(7, 0, 'United Kingdom'),
        Text(8, 0, 'Bahrain'),
        Text(9, 0, 'Ghana'),
        Text(10, 0, 'Singapore'),
        Text(11, 0, 'Qatar'),
        Text(12, 0, 'Saudi Arabia'),
        Text(13, 0, 'Belgium'),
        Text(14, 0, 'France'),
        Text(15, 0, 'Sri Lanka'),
        Text(16, 0, 'China'),
        Text(17, 0, 'Canada'),
        Text(18, 0, 'Netherlands'),
        Text(19, 0, 'Sweden'),
        Text(20, 0, 'Nigeria'),
        Text(21, 0, 'Hong Kong'),
        Text(22, 0, 'Germany'),
        Text(23, 0, 'Asia/Pacific Region'),
        Text(24, 0, 'Uganda'),
        Text(25, 0, 'Kenya'),
        Text(26, 0, 'Italy'),
        Text(27, 0, 'South Africa'),
        Text(28, 0, 'Tanzania'),
        Text(29, 0, 'unknown'),
        Text(30, 0, 'Malaysia'),
        Text(31, 0, 'Liberia'),
        Text(32, 0, 'Switzerland'),
        Text(33, 0, 'Denmark'),
        Text(34, 0, 'Philippines'),
        Text(35, 0, 'Bangladesh'),
        Text(36, 0, 'Vietnam'),
        Text(37, 0, 'Indonesia')])
```



[22]:
```
# Imputing the missing data in the 'Country' column with 'India'
lead_data['Country']=lead_data['Country'].replace(np.nan,'India')
```

[23]:
```
#City
plt.figure(figsize=(10,5))
sns.countplot(lead_data['City'])
plt.xticks(rotation=90)
```

[23]:
```
(array([0, 1, 2, 3, 4, 5]),
 [Text(0, 0, 'Mumbai'),
  Text(1, 0, 'Thane & Outskirts'),
  Text(2, 0, 'Other Metro Cities'),
  Text(3, 0, 'Other Cities'),
  Text(4, 0, 'Other Cities of Maharashtra'),
 Text(5, 0, 'Tier II Cities')])
```



```
[24]: # Finding the percentage of the different categories of this column:
      round(lead_data['City'].value_counts(normalize=True),2)*100
```

```
[24]: Mumbai                         58.0
      Thane & Outskirts              13.0
      Other Cities                   12.0
      Other Cities of Maharashtra     8.0
      Other Metro Cities              7.0
      Tier II Cities                  1.0
      Name: City, dtype: float64
```

```
[25]: # Imputing the missing data in the 'City' column with 'Mumbai'
      lead_data['City']=lead_data['City'].replace(np.nan,'Mumbai')
```

```
[26]: # Finding the null percentages across columns after removing the above columns
      round(lead_data.isnull().sum()/len(lead_data.index),2)*100
```

```
[26]: Prospect ID                                 0.0
      Lead Number                                 0.0
      Lead Origin                                 0.0
      Lead Source                                 0.0
      Do Not Email                                0.0
      Do Not Call                                 0.0
      Converted                                   0.0
      TotalVisits                                 1.0
      Total Time Spent on Website                 0.0
      Page Views Per Visit                        1.0
      Last Activity                               1.0
      Country                                     0.0
      Specialization                              0.0
      What is your current occupation             0.0
      Search                                      0.0
      Magazine                                    0.0
      Newspaper Article                           0.0
      X Education Forums                          0.0
      Newspaper                                   0.0
      Digital Advertisement                       0.0
      Through Recommendations                     0.0
      Receive More Updates About Our Courses      0.0
      Tags                                        0.0
      Update me on Supply Chain Content           0.0
      Get updates on DM Content                   0.0
      City                                        0.0
      I agree to pay the amount through cheque    0.0
      A free copy of Mastering The Interview      0.0
      Last Notable Activity                       0.0
      dtype: float64
```

[27]:

```
# Dropping the rows with null values
lead_data.dropna(inplace = True)
```

[28]:

```
# Finding the null percentages across columns after removing the above columns
round(lead_data.isnull().sum()/len(lead_data.index),2)*100
```

[28]:

```
Prospect ID                                 0.0
Lead Number                                 0.0
Lead Origin                                 0.0
Lead Source                                 0.0
Do Not Email                                0.0
Do Not Call                                 0.0
Converted                                   0.0
TotalVisits                                 0.0
Total Time Spent on Website                 0.0
Page Views Per Visit                        0.0
Last Activity                               0.0
Country                                     0.0
```

```
Specialization                                0.0
What is your current occupation               0.0
Search                                        0.0
Magazine                                      0.0
Newspaper Article                             0.0
X Education Forums                            0.0
Newspaper                                     0.0
Digital Advertisement                         0.0
Through Recommendations                       0.0
Receive More Updates About Our Courses        0.0
Tags                                          0.0
Update me on Supply Chain Content             0.0
Get updates on DM Content                     0.0
City                                          0.0
I agree to pay the amount through cheque      0.0
A free copy of Mastering The Interview        0.0
Last Notable Activity                         0.0
dtype: float64
```

[29]:

```
# Percentage of rows retained
(len(lead_data.index)/9240)*100
```

[29]:

```
98.2034632034632
```

2 Exploratory Data Anaysis

[30]:

```
lead_data[lead_data.duplicated()]
```

[30]:

```
Empty DataFrame
Columns: [Prospect ID, Lead Number, Lead Origin, Lead Source, Do Not Email, Do
Not Call, Converted, TotalVisits, Total Time Spent on Website, Page Views Per
Visit, Last Activity, Country, Specialization, What is your current occupation,
Search, Magazine, Newspaper Article, X Education Forums, Newspaper, Digital
Advertisement, Through Recommendations, Receive More Updates About Our Courses,
Tags, Update me on Supply Chain Content, Get updates on DM Content, City, I
agree to pay the amount through cheque, A free copy of Mastering The Interview,
Last Notable Activity]
Index: []

[0 rows x 29 columns]
```

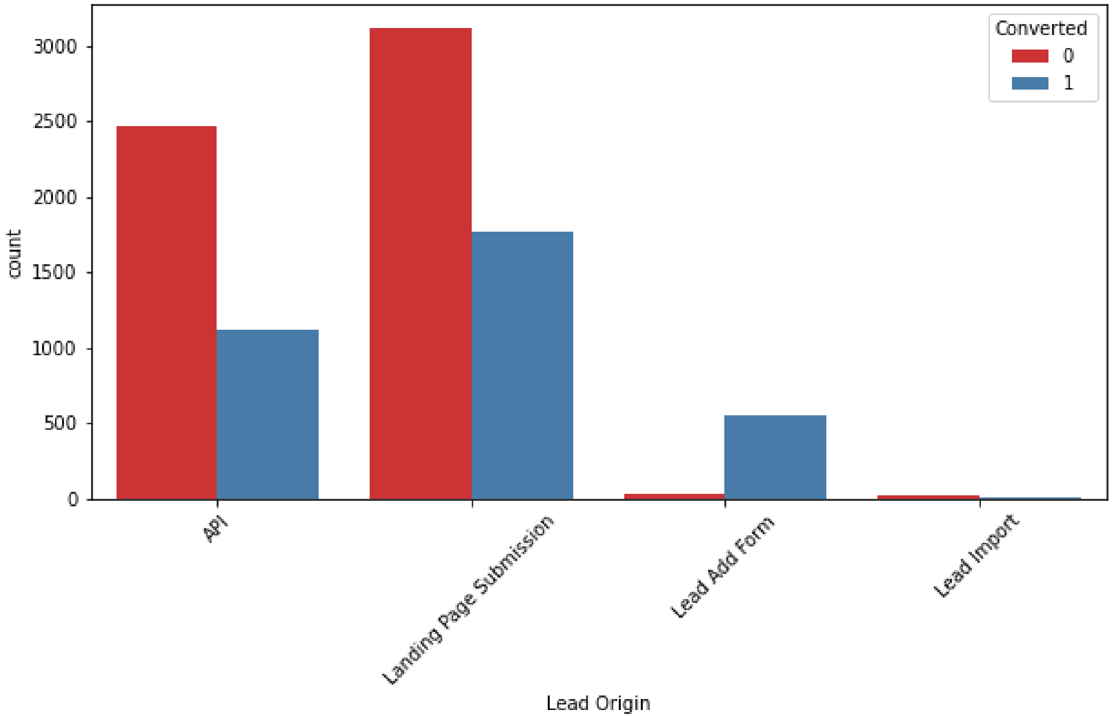
3 Univariate Analysis and Bivariate Analysis

```
[31]: #Converted
      Converted = (sum(lead_data['Converted'])/len(lead_data['Converted'].index))*100
      Converted
```

```
[31]: 37.85541106458012
```

```
[32]: #Lead Origin
      plt.figure(figsize=(10,5))
      sns.countplot(x = "Lead Origin", hue = "Converted", data =␣
       ↪lead_data,palette='Set1')
      plt.xticks(rotation = 45)
```

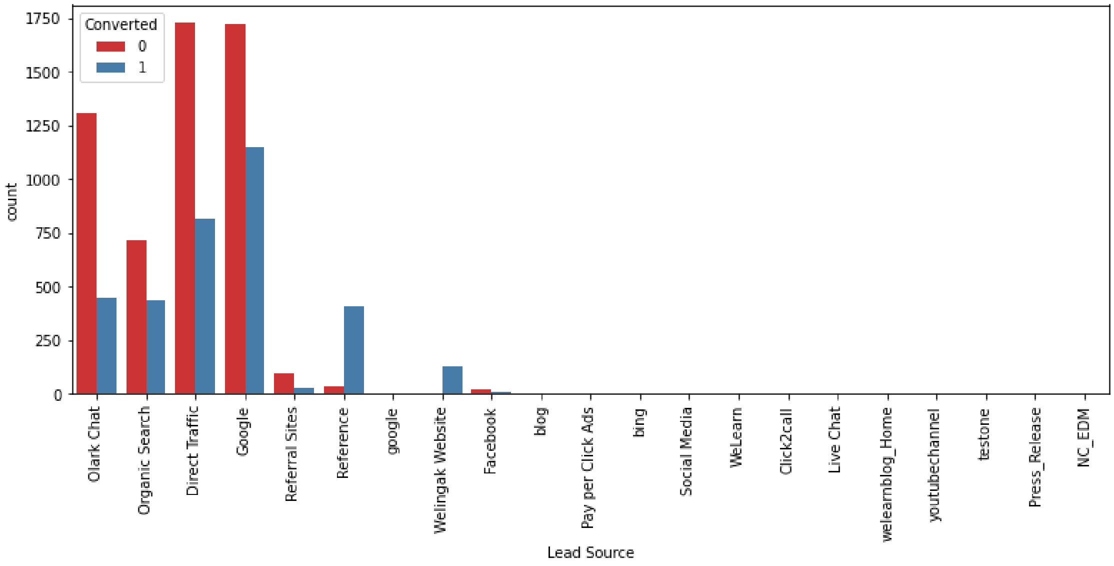
```
[32]: (array([0, 1, 2, 3]),
       [Text(0, 0, 'API'),
        Text(1, 0, 'Landing Page Submission'),
        Text(2, 0, 'Lead Add Form'),
        Text(3, 0, 'Lead Import')])
```



```
[33]: #Lead Score
      plt.figure(figsize=(13,5))
      sns.countplot(x = "Lead Source", hue = "Converted", data = lead_data,␣
       ↪palette='Set1')
```

```
plt.xticks(rotation = 90)
```

```
[33]: (array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16,
              17, 18, 19, 20]),
       [Text(0, 0, 'Olark Chat'),
        Text(1, 0, 'Organic Search'),
        Text(2, 0, 'Direct Traffic'),
        Text(3, 0, 'Google'),
        Text(4, 0, 'Referral Sites'),
        Text(5, 0, 'Reference'),
        Text(6, 0, 'google'),
        Text(7, 0, 'Welingak Website'),
        Text(8, 0, 'Facebook'),
        Text(9, 0, 'blog'),
        Text(10, 0, 'Pay per Click Ads'),
        Text(11, 0, 'bing'),
        Text(12, 0, 'Social Media'),
        Text(13, 0, 'WeLearn'),
        Text(14, 0, 'Click2call'),
        Text(15, 0, 'Live Chat'),
        Text(16, 0, 'welearnblog_Home'),
        Text(17, 0, 'youtubechannel'),
        Text(18, 0, 'testone'),
        Text(19, 0, 'Press_Release'),
        Text(20, 0, 'NC_EDM')])
```



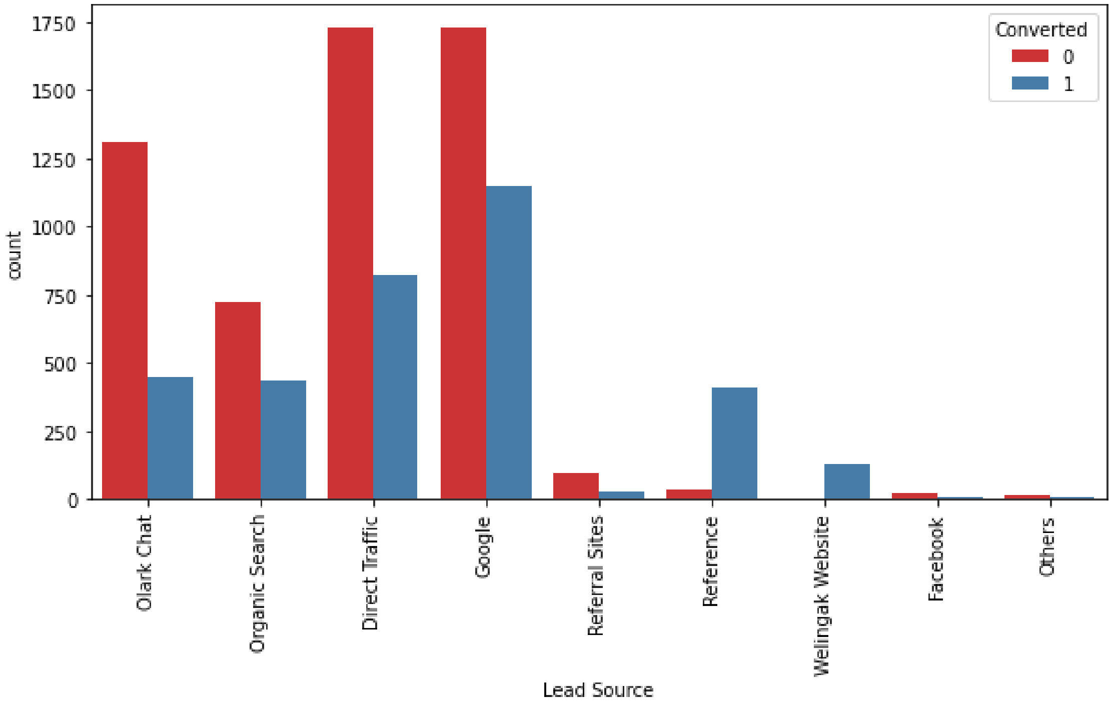
```
[34]: # Need to replace 'google' with 'Google'
```

```
lead_data['Lead Source'] = lead_data['Lead Source'].replace(['google'],␣
  ↪'Google')
```

```
[35]: # Creating a new category 'Others' for some of the Lead Sources which do not␣
  ↪have much values.
lead_data['Lead Source'] = lead_data['Lead Source'].replace(['Click2call',␣
  ↪'Live Chat', 'NC_EDM', 'Pay per Click Ads', 'Press_Release',
  'Social Media', 'WeLearn', 'bing', 'blog', 'testone', 'welearnblog_Home',␣
  ↪'youtubechannel'], 'Others')
```

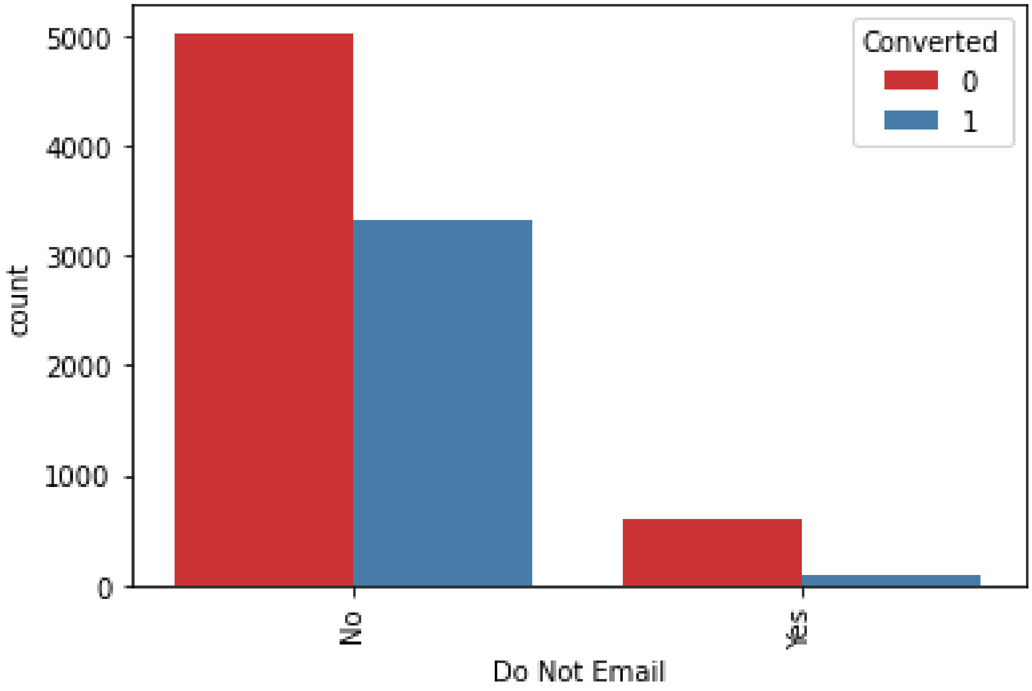
```
[36]: # Visualizing again
plt.figure(figsize=(10,5))
sns.countplot(x = "Lead Source", hue = "Converted", data =␣
  ↪lead_data,palette='Set1')
plt.xticks(rotation = 90)
```

```
[36]: (array([0, 1, 2, 3, 4, 5, 6, 7, 8]),
       [Text(0, 0, 'Olark Chat'),
        Text(1, 0, 'Organic Search'),
        Text(2, 0, 'Direct Traffic'),
        Text(3, 0, 'Google'),
        Text(4, 0, 'Referral Sites'),
        Text(5, 0, 'Reference'),
        Text(6, 0, 'Welingak Website'),
        Text(7, 0, 'Facebook'),
        Text(8, 0, 'Others')])
```



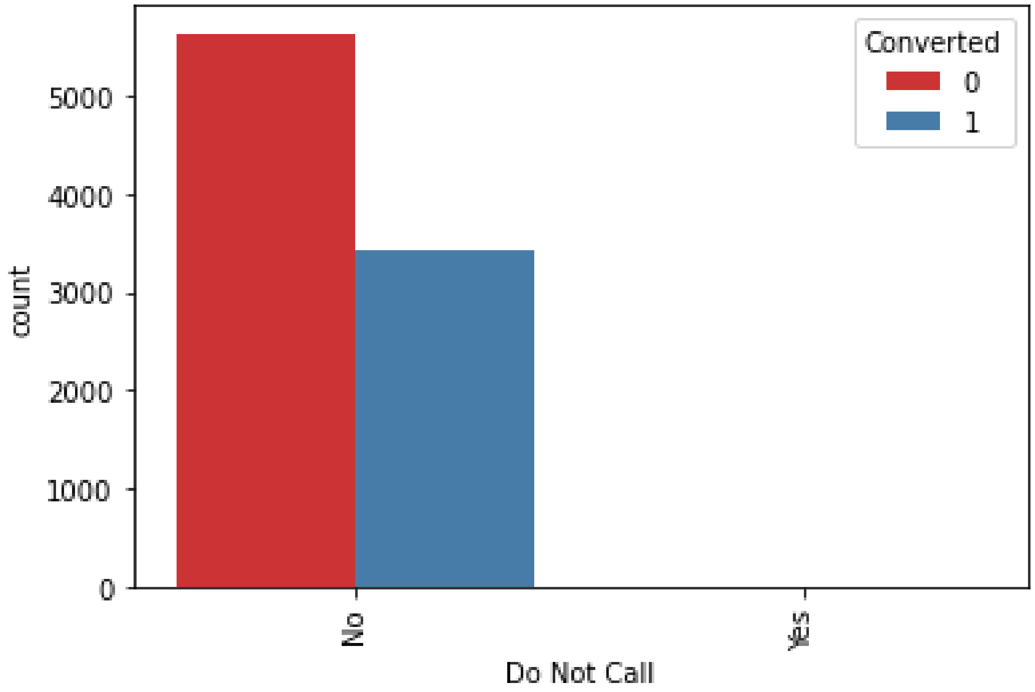
```
[37]: sns.countplot(x = "Do Not Email", hue = "Converted", data =␣
       ↪lead_data,palette='Set1')
      plt.xticks(rotation = 90)
```

```
[37]: (array([0, 1]), [Text(0, 0, 'No'), Text(1, 0, 'Yes')])
```



```
[38]: sns.countplot(x = "Do Not Call", hue = "Converted", data =␣
       ↪lead_data,palette='Set1')
      plt.xticks(rotation = 90)
```

```
[38]: (array([0, 1]), [Text(0, 0, 'No'), Text(1, 0, 'Yes')])
```

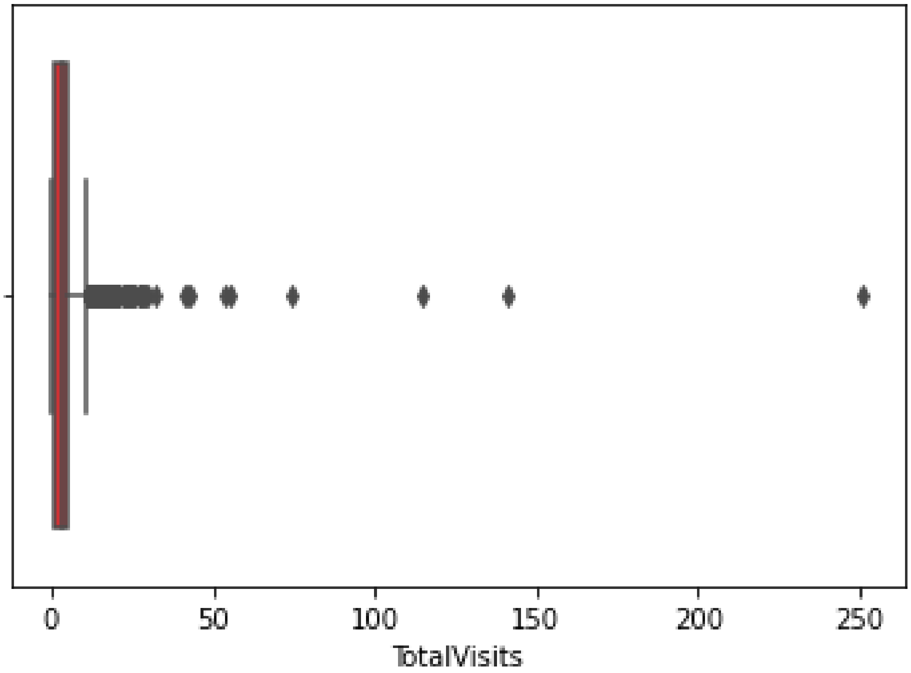


[39]:
```
lead_data['TotalVisits'].describe(percentiles=[0.05,.25, .5, .75, .90, .95, .99])
```

[39]:
```
count    9074.000000
mean        3.456028
std         4.858802
min         0.000000
5%          0.000000
25%         1.000000
50%         3.000000
75%         5.000000
90%         7.000000
95%        10.000000
99%        17.000000
max       251.000000
Name: TotalVisits, dtype: float64
```

[40]:
```
sns.boxplot(lead_data['TotalVisits'],orient='vert',palette='Set1')
```

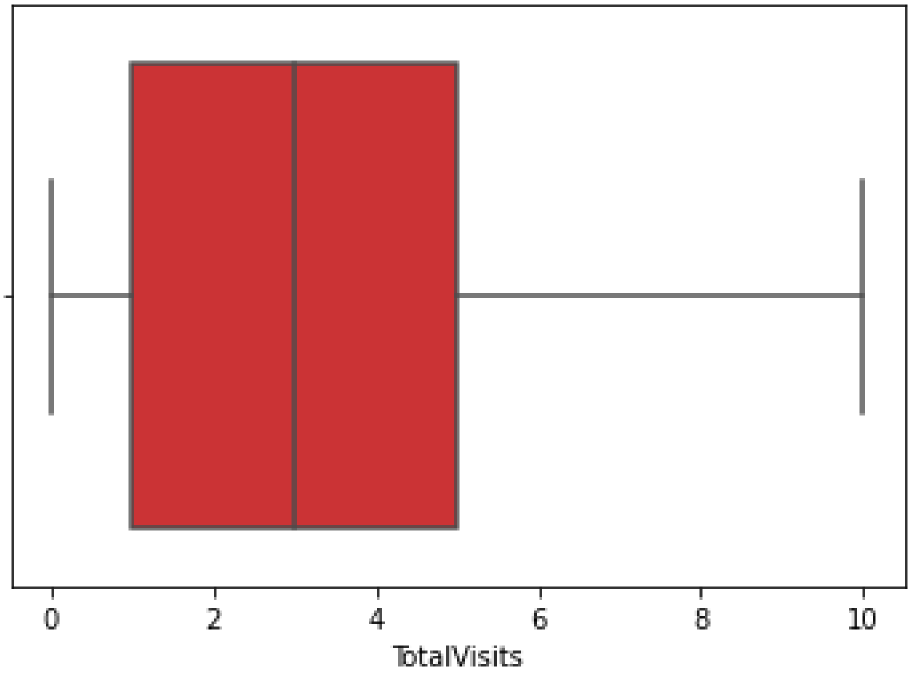
[40]:
```
<AxesSubplot:xlabel='TotalVisits'>
```



[41]:
```
percentiles = lead_data['TotalVisits'].quantile([0.05,0.95]).values
lead_data['TotalVisits'][lead_data['TotalVisits'] <= percentiles[0]] =␣
 ↪percentiles[0]
lead_data['TotalVisits'][lead_data['TotalVisits'] >= percentiles[1]] =␣
 ↪percentiles[1]
```

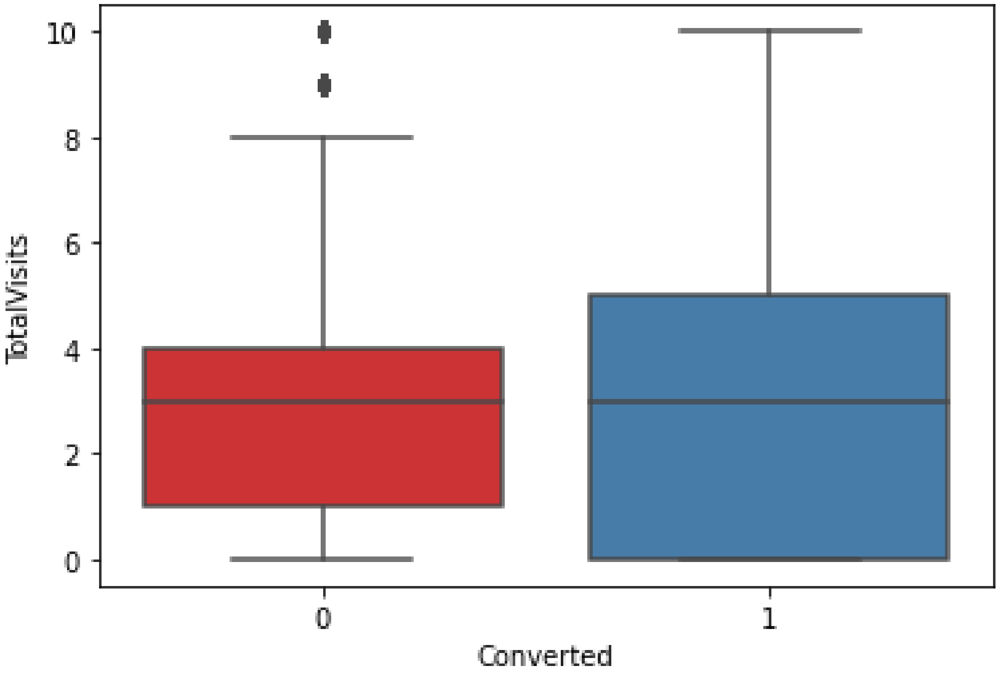
[42]:
```
# Visualizing again
sns.boxplot(lead_data['TotalVisits'],orient='vert',palette='Set1')
```

[42]:
```
<AxesSubplot:xlabel='TotalVisits'>
```



```
[43]: sns.boxplot(y = 'TotalVisits', x = 'Converted', data = lead_data,palette='Set1')
```

```
[43]: <AxesSubplot:xlabel='Converted', ylabel='TotalVisits'>
```

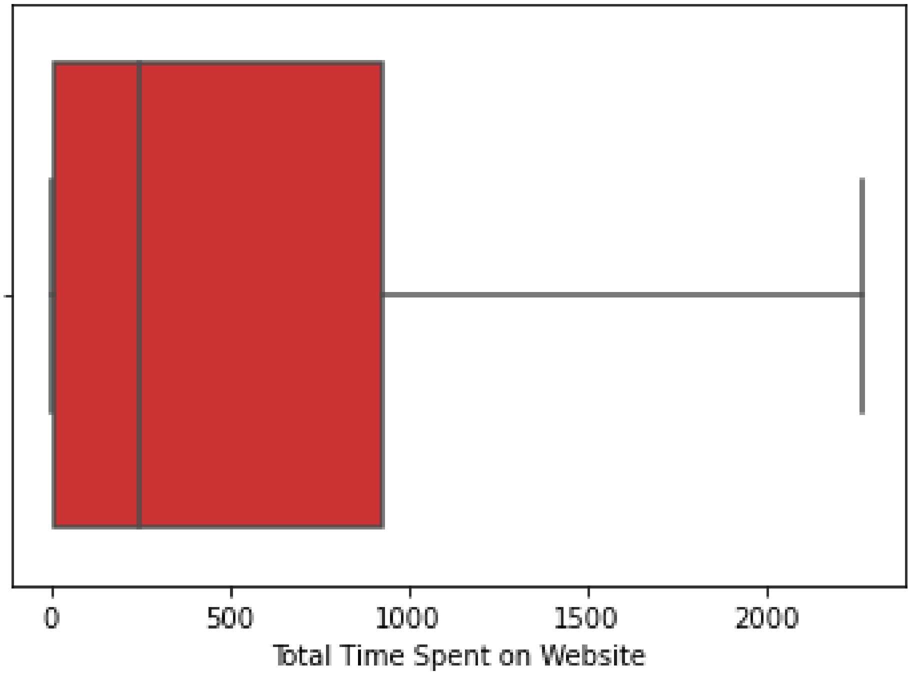


[44]:
```
lead_data['Total Time Spent on Website'].describe()
```

[44]:
```
count    9074.000000
mean      482.887481
std       545.256560
min         0.000000
25%        11.000000
50%       246.000000
75%       922.750000
max      2272.000000
Name: Total Time Spent on Website, dtype: float64
```

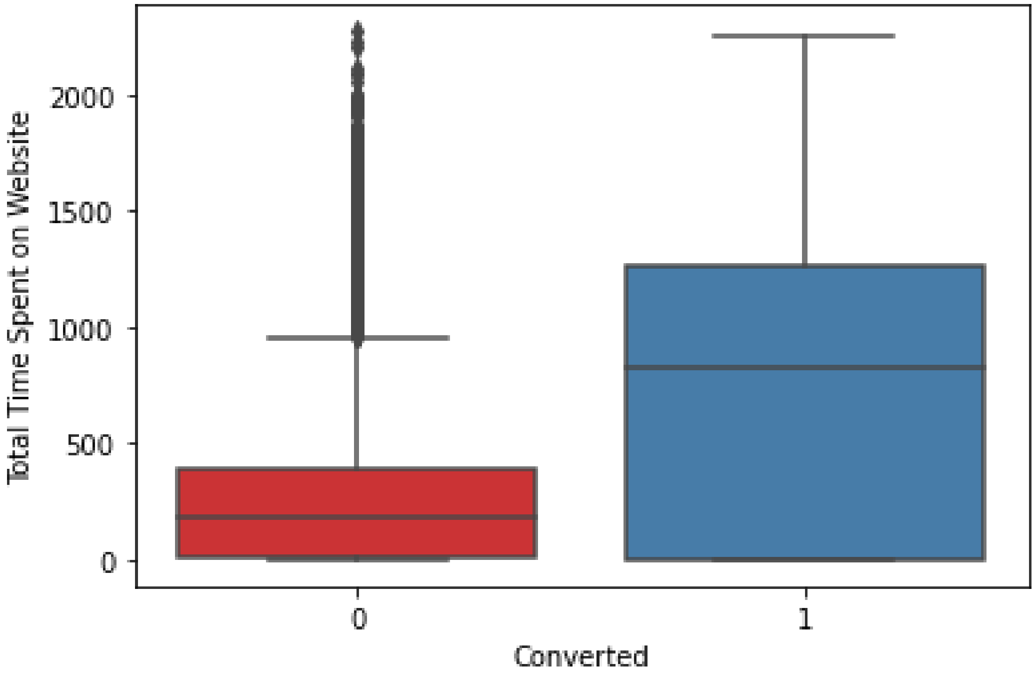
[45]:
```
sns.boxplot(lead_data['Total Time Spent on␣
↪Website'],orient='vert',palette='Set1')
```

[45]:
```
<AxesSubplot:xlabel='Total Time Spent on Website'>
```



[46]:
```
sns.boxplot(y = 'Total Time Spent on Website', x = 'Converted', data =␣
↪lead_data,palette='Set1')
```

[46]:
```
<AxesSubplot:xlabel='Converted', ylabel='Total Time Spent on Website'>
```

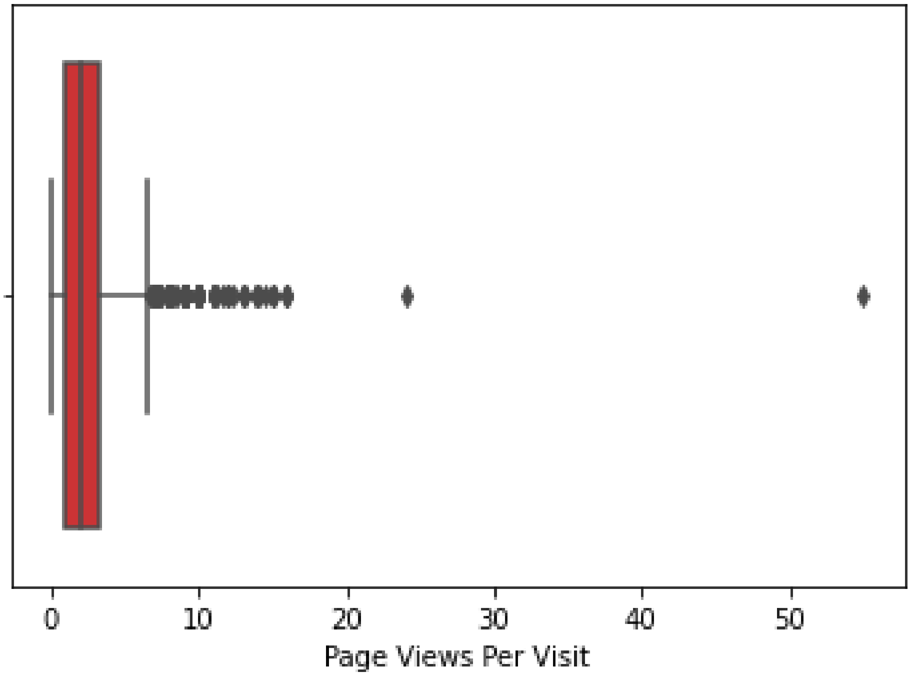


```
[47]: lead_data['Page Views Per Visit'].describe()
```

```
[47]: count    9074.000000
      mean        2.370151
      std         2.160871
      min         0.000000
      25%         1.000000
      50%         2.000000
      75%         3.200000
      max        55.000000
      Name: Page Views Per Visit, dtype: float64
```

```
[48]: sns.boxplot(lead_data['Page Views Per Visit'],orient='vert',palette='Set1')
```

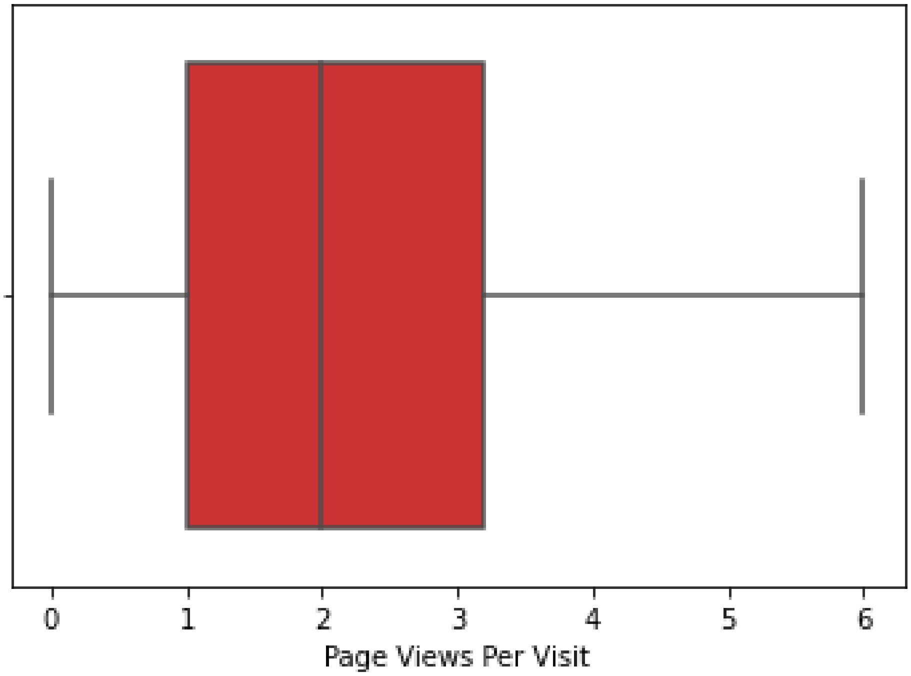
```
[48]: <AxesSubplot:xlabel='Page Views Per Visit'>
```



[49]:
```
percentiles = lead_data['Page Views Per Visit'].quantile([0.05,0.95]).values
lead_data['Page Views Per Visit'][lead_data['Page Views Per Visit'] <=␣
  ↪percentiles[0]] = percentiles[0]
lead_data['Page Views Per Visit'][lead_data['Page Views Per Visit'] >=␣
  ↪percentiles[1]] = percentiles[1]
```

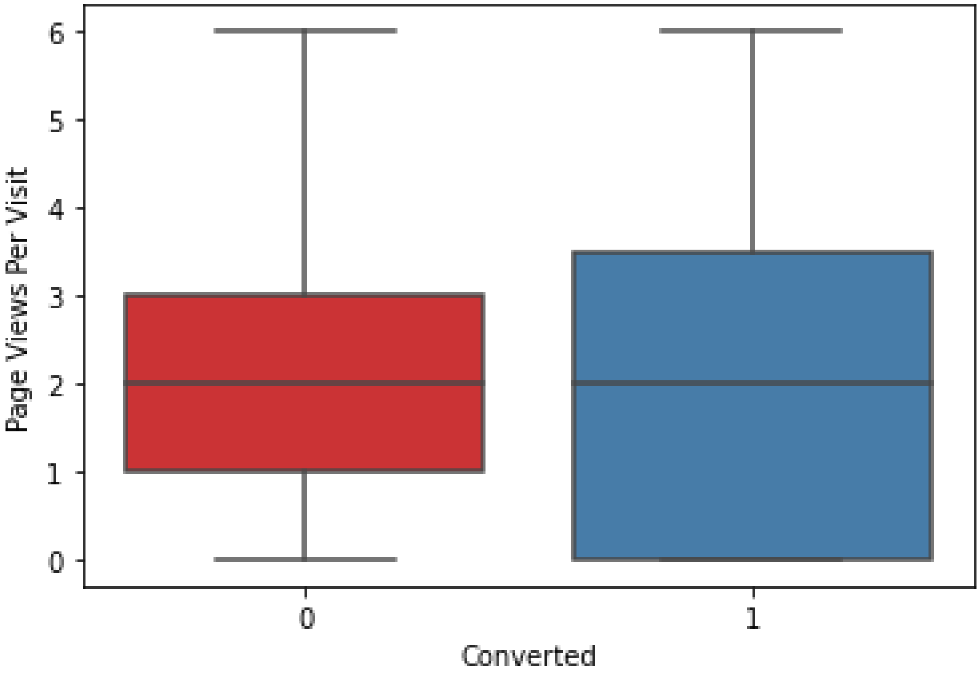
[50]:
```
# Visualizing again
sns.boxplot(lead_data['Page Views Per Visit'],palette='Set1',orient='vert')
```

[50]:
```
<AxesSubplot:xlabel='Page Views Per Visit'>
```



```
[51]: sns.boxplot(y = 'Page Views Per Visit', x = 'Converted', data␣
       ↪=lead_data,palette='Set1')
```

```
[51]: <AxesSubplot:xlabel='Converted', ylabel='Page Views Per Visit'>
```



[52]:

```
lead_data['Last Activity'].describe()
```

[52]:

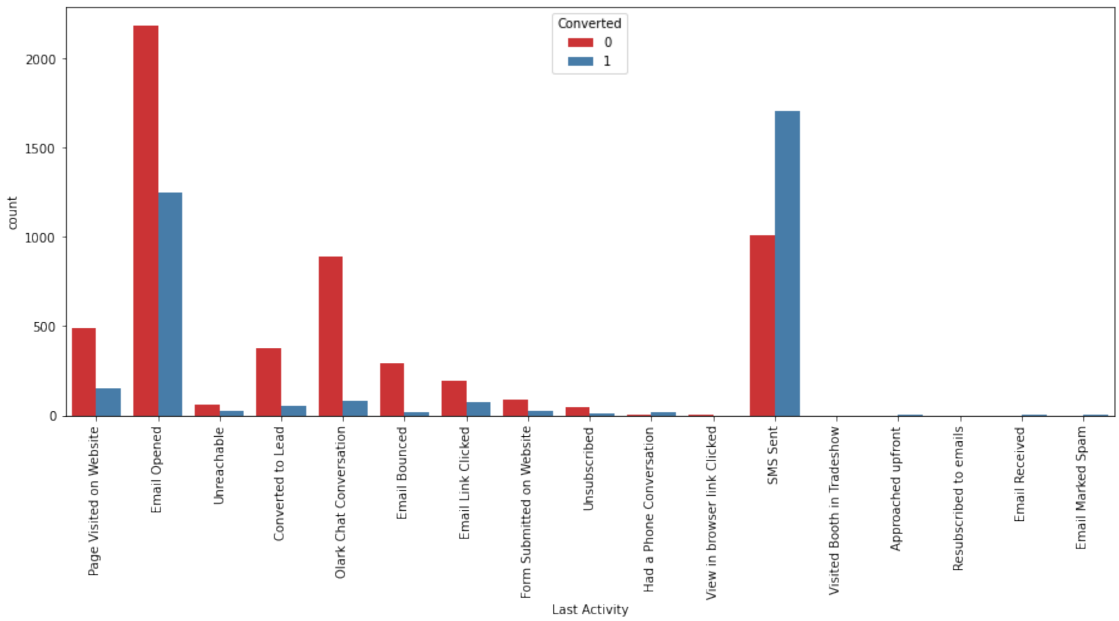
```
count              9074
unique               17
top        Email Opened
freq               3432
Name: Last Activity, dtype: object
```

[53]:

```
plt.figure(figsize=(15,6))
sns.countplot(x = "Last Activity", hue = "Converted", data =␣
 ↪lead_data,palette='Set1')
plt.xticks(rotation = 90)
```

[53]:

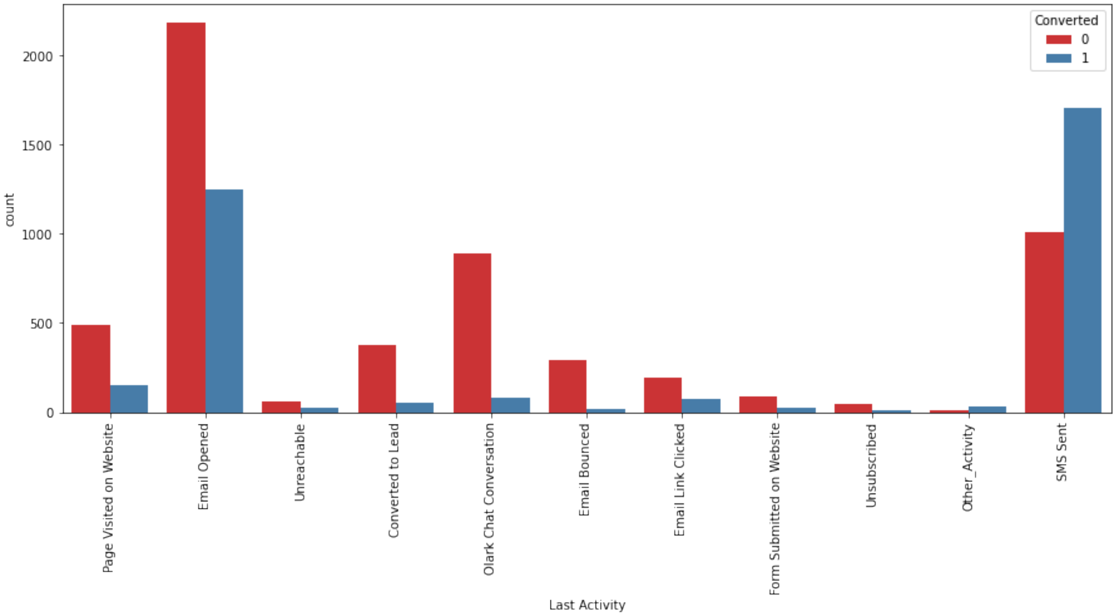
```
(array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16]),
 [Text(0, 0, 'Page Visited on Website'),
  Text(1, 0, 'Email Opened'),
  Text(2, 0, 'Unreachable'),
  Text(3, 0, 'Converted to Lead'),
  Text(4, 0, 'Olark Chat Conversation'),
  Text(5, 0, 'Email Bounced'),
  Text(6, 0, 'Email Link Clicked'),
  Text(7, 0, 'Form Submitted on Website'),
  Text(8, 0, 'Unsubscribed'),
  Text(9, 0, 'Had a Phone Conversation'),
  Text(10, 0, 'View in browser link Clicked'),
  Text(11, 0, 'SMS Sent'),
  Text(12, 0, 'Visited Booth in Tradeshow'),
  Text(13, 0, 'Approached upfront'),
  Text(14, 0, 'Resubscribed to emails'),
  Text(15, 0, 'Email Received'),
  Text(16, 0, 'Email Marked Spam')])
```



```
[54]: # We can club the last activities to "Other_Activity" which are having less␣
       ↪data.
      lead_data['Last Activity'] = lead_data['Last Activity'].replace(['Had a Phone␣
       ↪Conversation', 'View in browser link Clicked',
                                                                  'Visited Booth in␣
       ↪Tradeshow', 'Approached upfront',
                                                                  'Resubscribed to␣
       ↪emails','Email Received', 'Email Marked Spam'], 'Other_Activity')
```

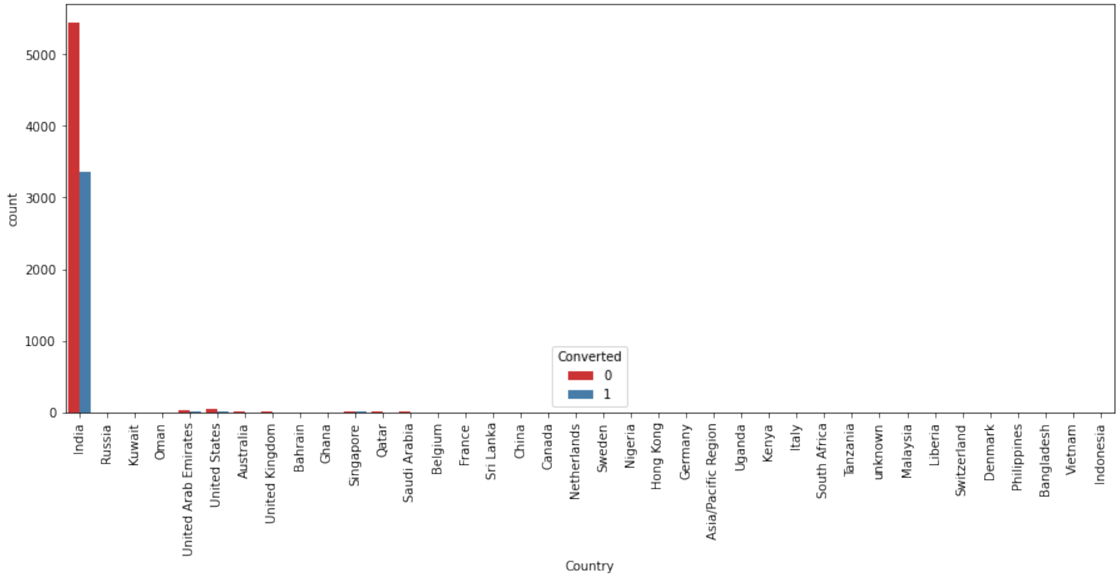
```
[55]: # Visualizing again
      plt.figure(figsize=(15,6))
      sns.countplot(x = "Last Activity", hue = "Converted", data =␣
       ↪lead_data,palette='Set1')
      plt.xticks(rotation = 90)
```

```
[55]: (array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10]),
       [Text(0, 0, 'Page Visited on Website'),
        Text(1, 0, 'Email Opened'),
        Text(2, 0, 'Unreachable'),
        Text(3, 0, 'Converted to Lead'),
        Text(4, 0, 'Olark Chat Conversation'),
        Text(5, 0, 'Email Bounced'),
        Text(6, 0, 'Email Link Clicked'),
        Text(7, 0, 'Form Submitted on Website'),
        Text(8, 0, 'Unsubscribed'),
        Text(9, 0, 'Other_Activity'),
Text(10, 0, 'SMS Sent')])
```



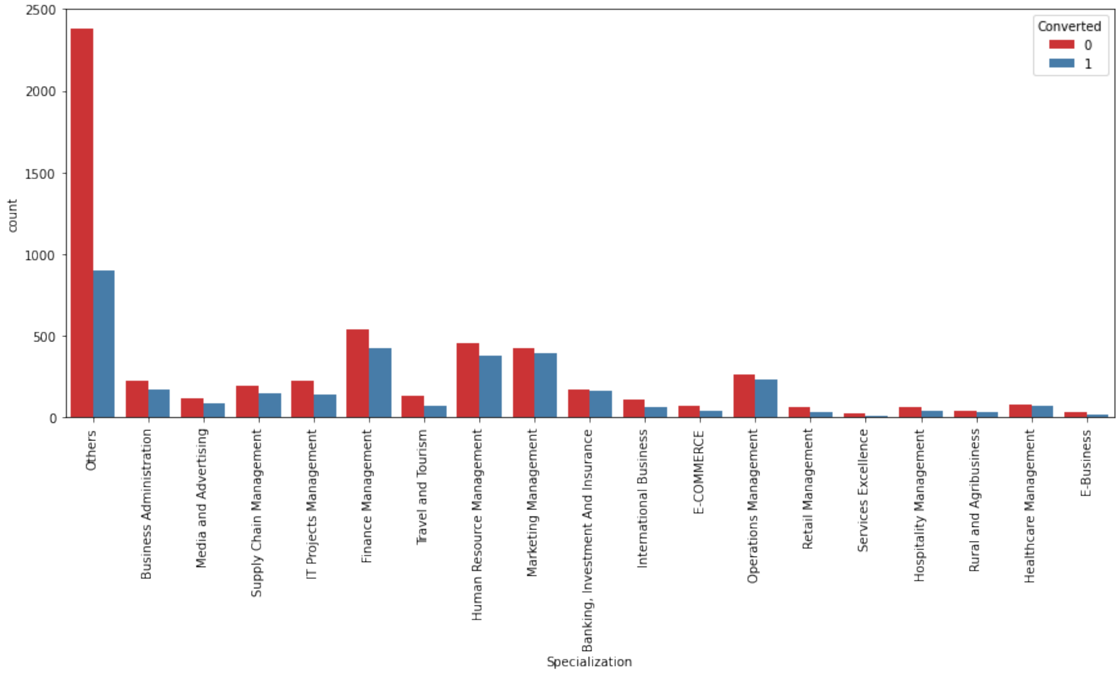
```
[56]: plt.figure(figsize=(15,6))
      sns.countplot(x = "Country", hue = "Converted", data = lead_data,palette='Set1')
      plt.xticks(rotation = 90)
```

```
[56]: (array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16,
              17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33,
              34, 35, 36, 37]),
       [Text(0, 0, 'India'),
        Text(1, 0, 'Russia'),
        Text(2, 0, 'Kuwait'),
        Text(3, 0, 'Oman'),
        Text(4, 0, 'United Arab Emirates'),
        Text(5, 0, 'United States'),
        Text(6, 0, 'Australia'),
        Text(7, 0, 'United Kingdom'),
        Text(8, 0, 'Bahrain'),
        Text(9, 0, 'Ghana'),
        Text(10, 0, 'Singapore'),
        Text(11, 0, 'Qatar'),
        Text(12, 0, 'Saudi Arabia'),
        Text(13, 0, 'Belgium'),
        Text(14, 0, 'France'),
        Text(15, 0, 'Sri Lanka'),
        Text(16, 0, 'China'),
        Text(17, 0, 'Canada'),
        Text(18, 0, 'Netherlands'),
        Text(19, 0, 'Sweden'),
        Text(20, 0, 'Nigeria'),
        Text(21, 0, 'Hong Kong'),
        Text(22, 0, 'Germany'),
        Text(23, 0, 'Asia/Pacific Region'),
        Text(24, 0, 'Uganda'),
        Text(25, 0, 'Kenya'),
        Text(26, 0, 'Italy'),
        Text(27, 0, 'South Africa'),
        Text(28, 0, 'Tanzania'),
        Text(29, 0, 'unknown'),
        Text(30, 0, 'Malaysia'),
        Text(31, 0, 'Liberia'),
        Text(32, 0, 'Switzerland'),
        Text(33, 0, 'Denmark'),
        Text(34, 0, 'Philippines'),
        Text(35, 0, 'Bangladesh'),
        Text(36, 0, 'Vietnam'),
        Text(37, 0, 'Indonesia')])
```



[57]:
```
plt.figure(figsize=(15,6))
sns.countplot(x = "Specialization", hue = "Converted", data =␣
 ↪lead_data,palette='Set1')
plt.xticks(rotation = 90)
```

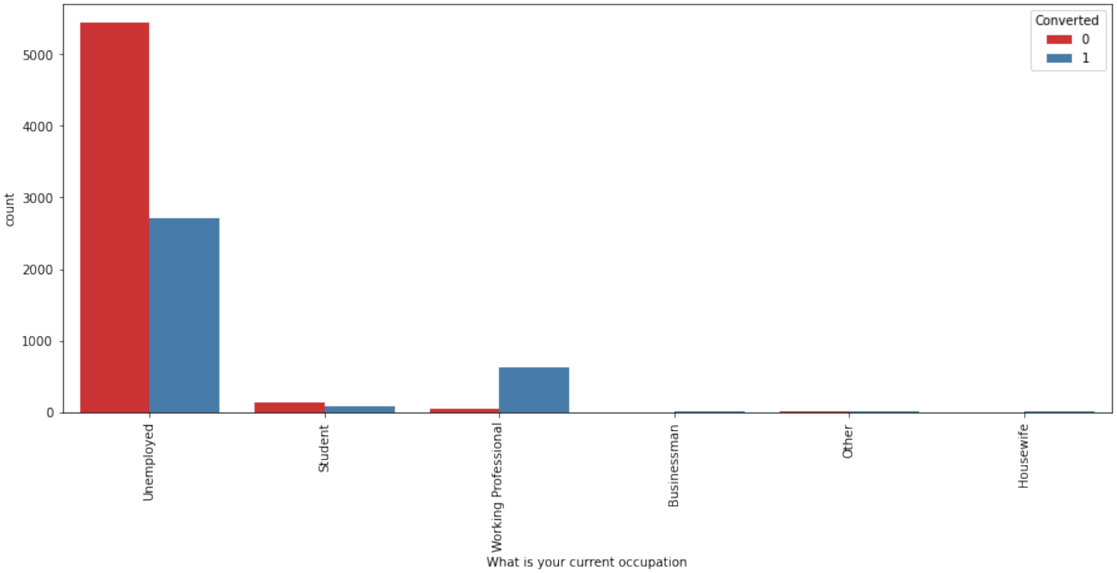
```
[57]: (array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16,
        17, 18]),
  [Text(0, 0, 'Others'),
   Text(1, 0, 'Business Administration'),
   Text(2, 0, 'Media and Advertising'),
   Text(3, 0, 'Supply Chain Management'),
   Text(4, 0, 'IT Projects Management'),
   Text(5, 0, 'Finance Management'),
   Text(6, 0, 'Travel and Tourism'),
   Text(7, 0, 'Human Resource Management'),
   Text(8, 0, 'Marketing Management'),
   Text(9, 0, 'Banking, Investment And Insurance'),
   Text(10, 0, 'International Business'),
   Text(11, 0, 'E-COMMERCE'),
   Text(12, 0, 'Operations Management'),
   Text(13, 0, 'Retail Management'),
   Text(14, 0, 'Services Excellence'),
   Text(15, 0, 'Hospitality Management'),
   Text(16, 0, 'Rural and Agribusiness'),
   Text(17, 0, 'Healthcare Management'),
   Text(18, 0, 'E-Business')])
```



```
[58]: plt.figure(figsize=(15,6))
      sns.countplot(x = "What is your current occupation", hue = "Converted", data =␣
       ↪lead_data,palette='Set1')
```

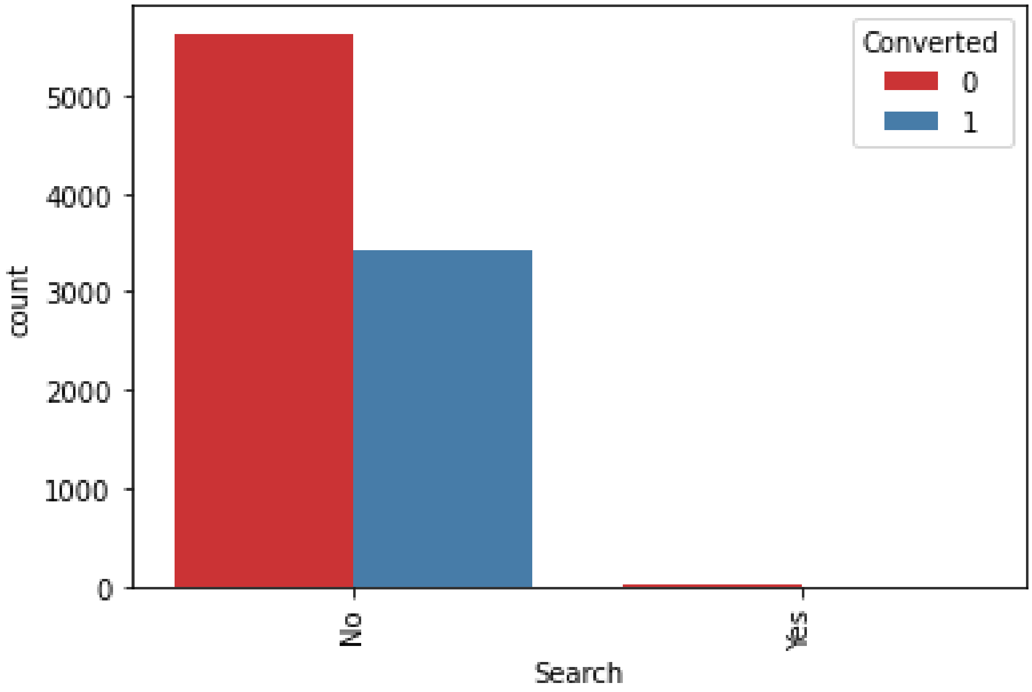
```
plt.xticks(rotation = 90)
```

```
[58]: (array([0, 1, 2, 3, 4, 5]),
       [Text(0, 0, 'Unemployed'),
        Text(1, 0, 'Student'),
        Text(2, 0, 'Working Professional'),
        Text(3, 0, 'Businessman'),
        Text(4, 0, 'Other'),
        Text(5, 0, 'Housewife')])
```



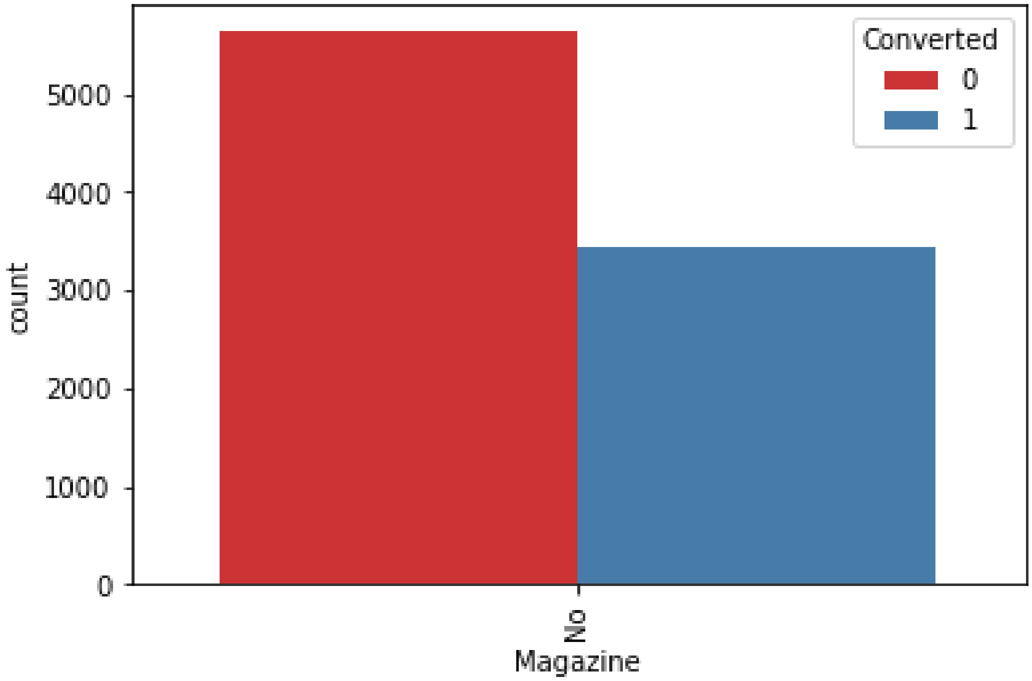
```
[59]: sns.countplot(x = "Search", hue = "Converted", data = lead_data,palette='Set1')
      plt.xticks(rotation = 90)
```

```
[59]: (array([0, 1]), [Text(0, 0, 'No'), Text(1, 0, 'Yes')])
```



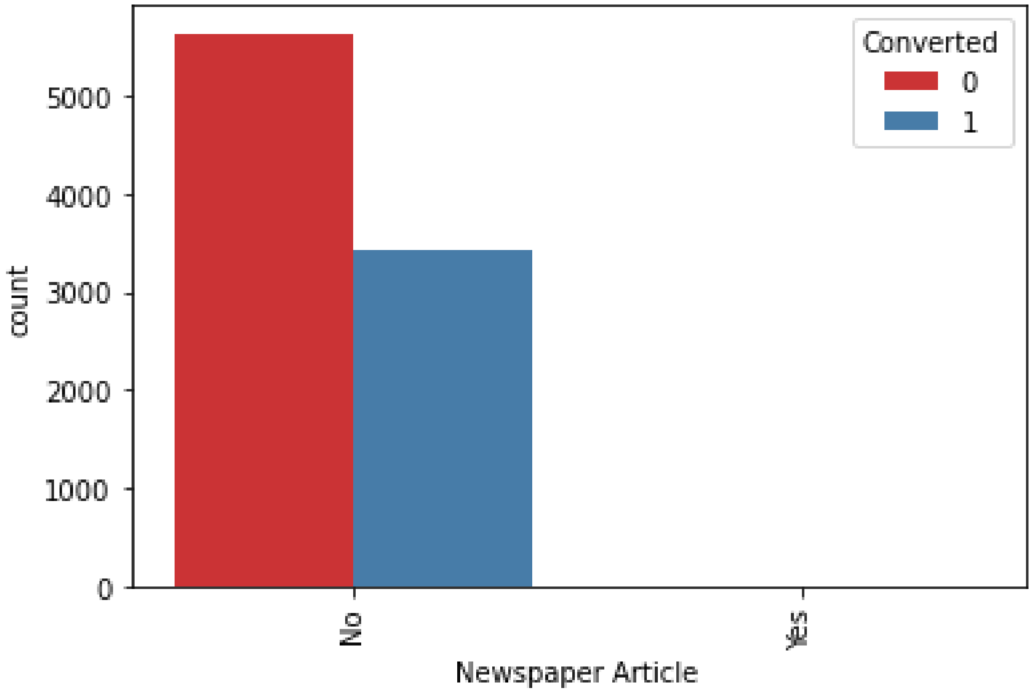
[60]:
```
sns.countplot(x = "Magazine", hue = "Converted", data =␣
 ↪lead_data,palette='Set1')
plt.xticks(rotation = 90)
```

[60]:
```
(array([0]), [Text(0, 0, 'No')])
```



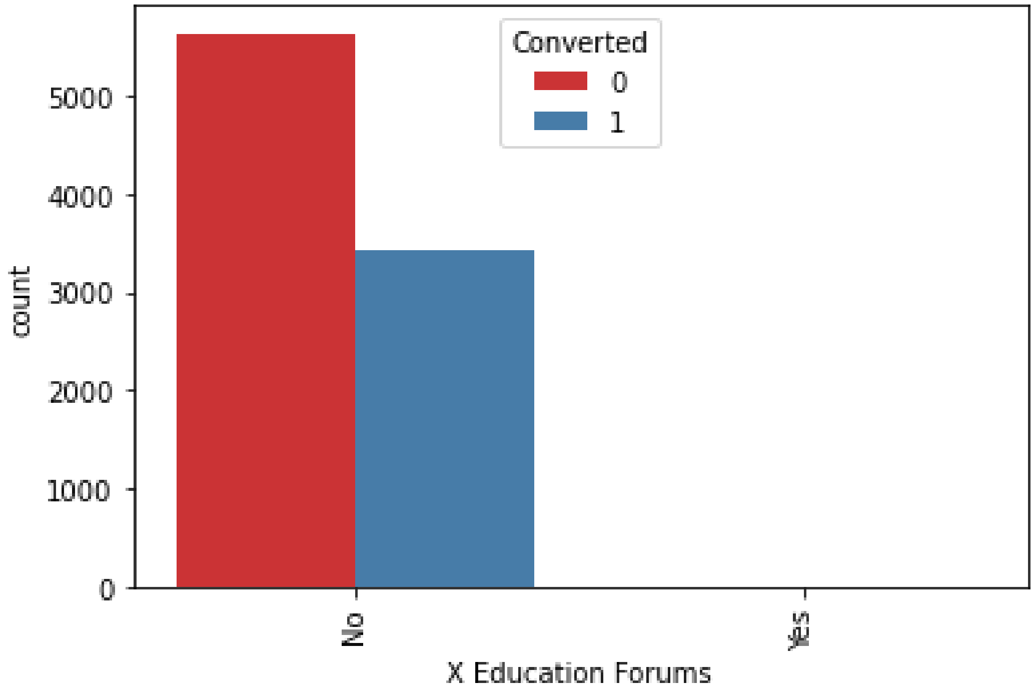
```
[61]: sns.countplot(x = "Newspaper Article", hue = "Converted", data =␣
      ↪lead_data,palette='Set1')
      plt.xticks(rotation = 90)
```

```
[61]: (array([0, 1]), [Text(0, 0, 'No'), Text(1, 0, 'Yes')])
```



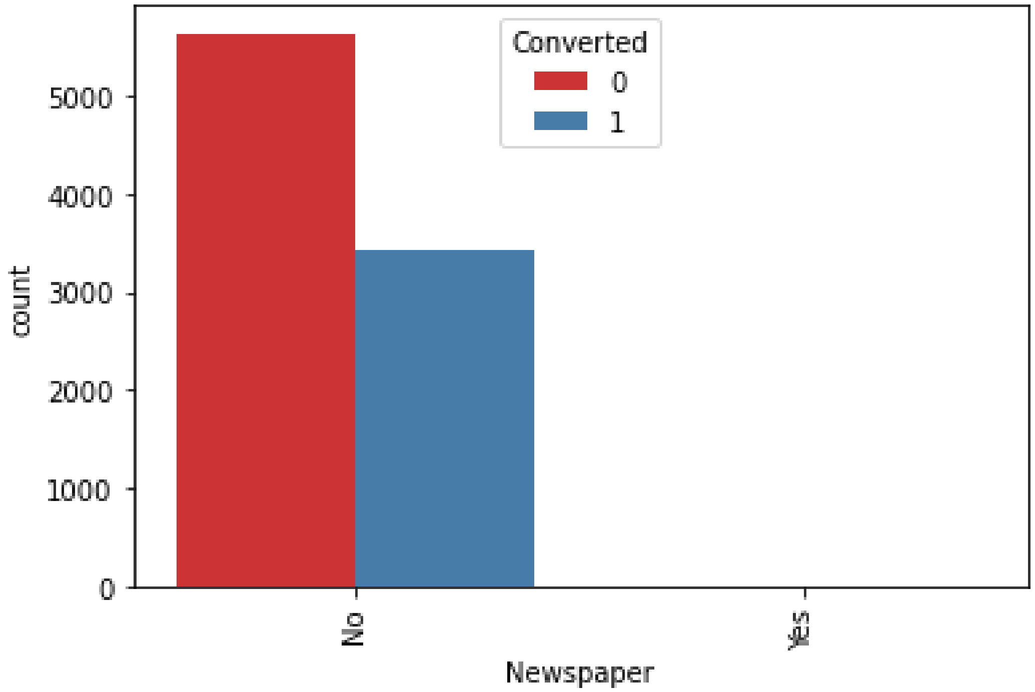
```
[62]: sns.countplot(x = "X Education Forums", hue = "Converted", data =␣
       ↪lead_data,palette='Set1')
      plt.xticks(rotation = 90)
```

```
[62]: (array([0, 1]), [Text(0, 0, 'No'), Text(1, 0, 'Yes')])
```



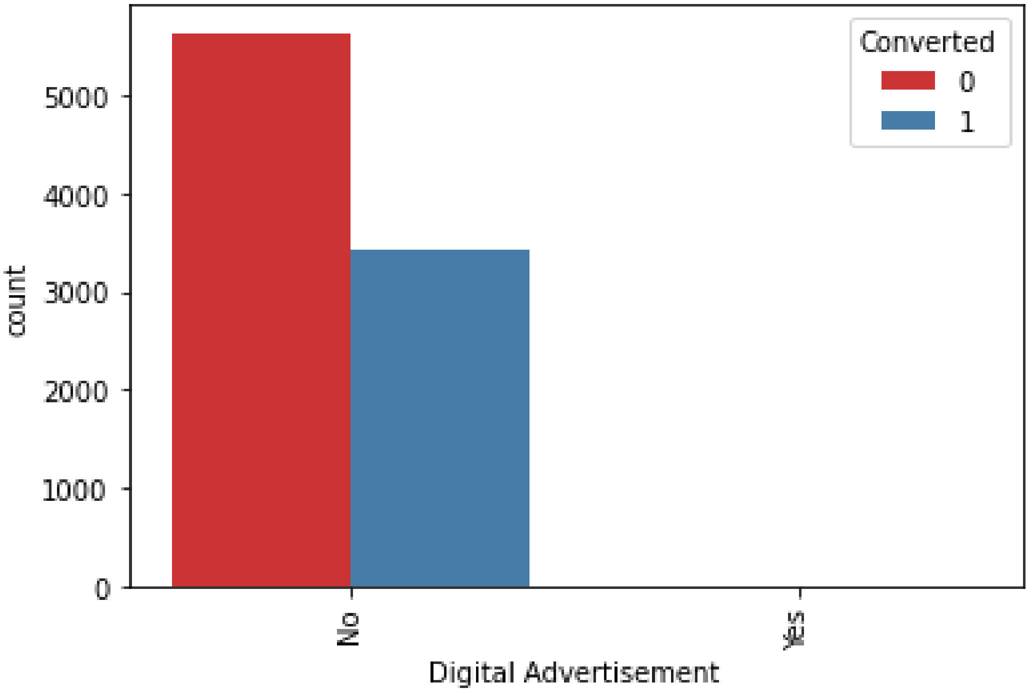
```
[63]: sns.countplot(x = "Newspaper", hue = "Converted", data =␣
       ↪lead_data,palette='Set1')
      plt.xticks(rotation = 90)
```

```
[63]: (array([0, 1]), [Text(0, 0, 'No'), Text(1, 0, 'Yes')])
```



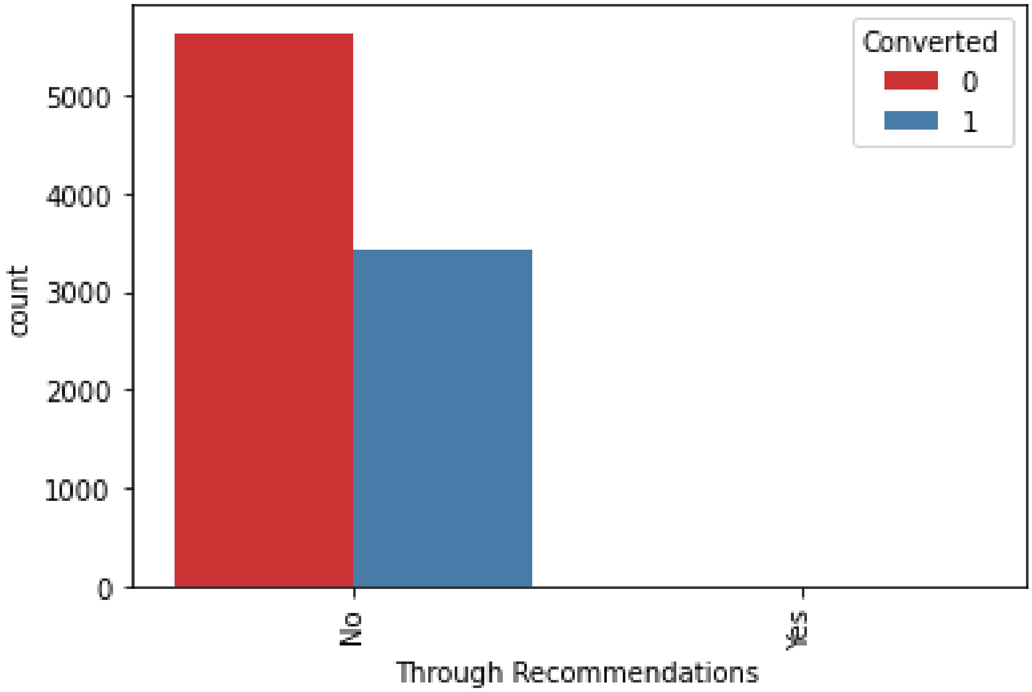
```
[64]: sns.countplot(x = "Digital Advertisement", hue = "Converted", data =␣
       ↪lead_data,palette='Set1')
      plt.xticks(rotation = 90)
```

```
[64]: (array([0, 1]), [Text(0, 0, 'No'), Text(1, 0, 'Yes')])
```



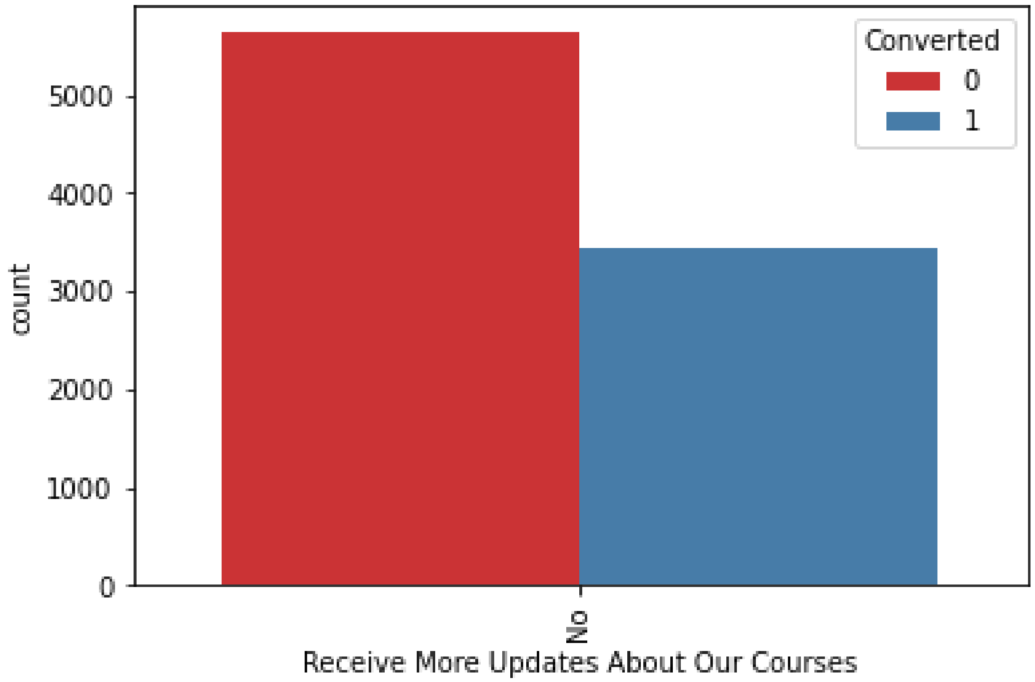
[65]:
```
sns.countplot(x = "Through Recommendations", hue = "Converted", data =␣
 ↪lead_data,palette='Set1')
plt.xticks(rotation = 90)
```

[65]:
```
(array([0, 1]), [Text(0, 0, 'No'), Text(1, 0, 'Yes')])
```



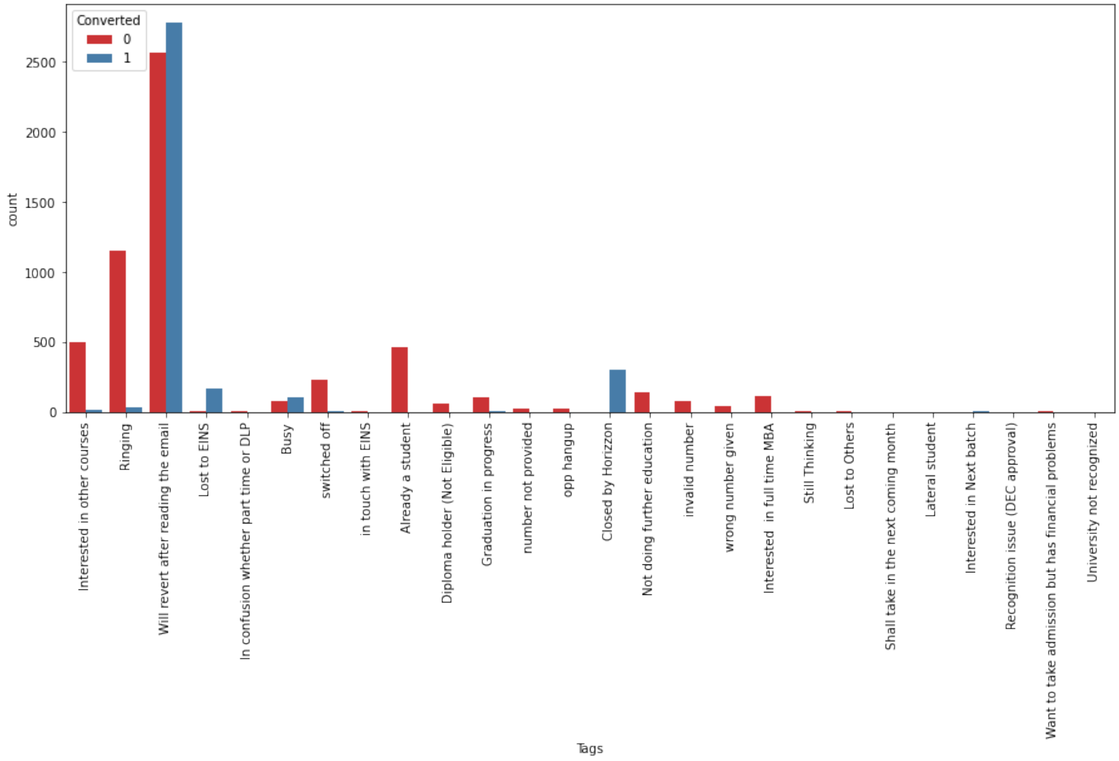
```
[66]: sns.countplot(x = "Receive More Updates About Our Courses", hue = "Converted",␣
        ↪data = lead_data,palette='Set1')
      plt.xticks(rotation = 90)
```

```
[66]: (array([0]), [Text(0, 0, 'No')])
```



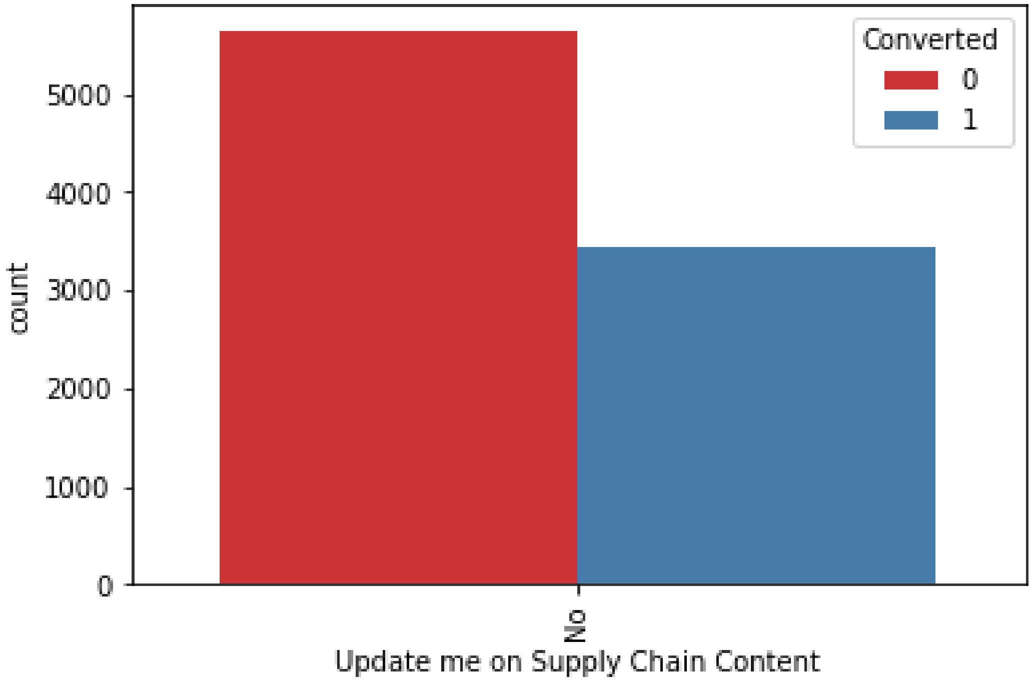
```
[67]: plt.figure(figsize=(15,6))
      sns.countplot(x = "Tags", hue = "Converted", data = lead_data,palette='Set1')
      plt.xticks(rotation = 90)
```

```
[67]: (array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16,
              17, 18, 19, 20, 21, 22, 23, 24, 25]),
       [Text(0, 0, 'Interested in other courses'),
        Text(1, 0, 'Ringing'),
        Text(2, 0, 'Will revert after reading the email'),
        Text(3, 0, 'Lost to EINS'),
        Text(4, 0, 'In confusion whether part time or DLP'),
        Text(5, 0, 'Busy'),
        Text(6, 0, 'switched off'),
        Text(7, 0, 'in touch with EINS'),
        Text(8, 0, 'Already a student'),
        Text(9, 0, 'Diploma holder (Not Eligible)'),
        Text(10, 0, 'Graduation in progress'),
        Text(11, 0, 'number not provided'),
        Text(12, 0, 'opp hangup'),
        Text(13, 0, 'Closed by Horizzon'),
        Text(14, 0, 'Not doing further education'),
        Text(15, 0, 'invalid number'),
        Text(16, 0, 'wrong number given'),
        Text(17, 0, 'Interested  in full time MBA'),
        Text(18, 0, 'Still Thinking'),
        Text(19, 0, 'Lost to Others'),
        Text(20, 0, 'Shall take in the next coming month'),
        Text(21, 0, 'Lateral student'),
        Text(22, 0, 'Interested in Next batch'),
        Text(23, 0, 'Recognition issue (DEC approval)'),
        Text(24, 0, 'Want to take admission but has financial problems'),
        Text(25, 0, 'University not recognized')])
```



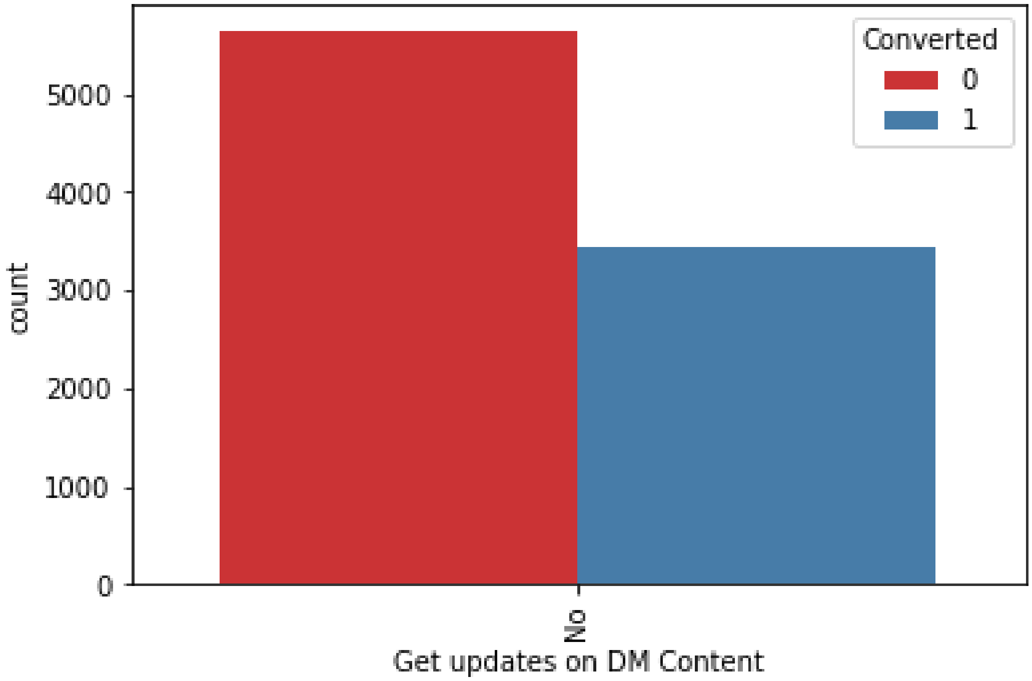
[68]:
```
sns.countplot(x = "Update me on Supply Chain Content", hue = "Converted", data␣
 ↪= lead_data,palette='Set1')
plt.xticks(rotation = 90)
```

[68]:
```
(array([0]), [Text(0, 0, 'No')])
```



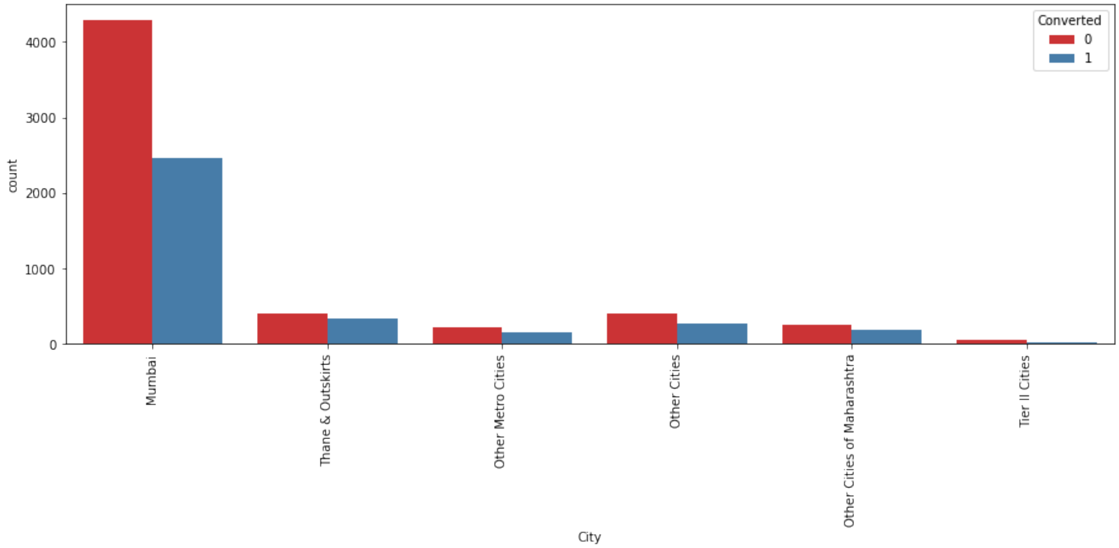
```
[69]: sns.countplot(x = "Get updates on DM Content", hue = "Converted", data =␣
        ↪lead_data,palette='Set1')
      plt.xticks(rotation = 90)
```

```
[69]: (array([0]), [Text(0, 0, 'No')])
```



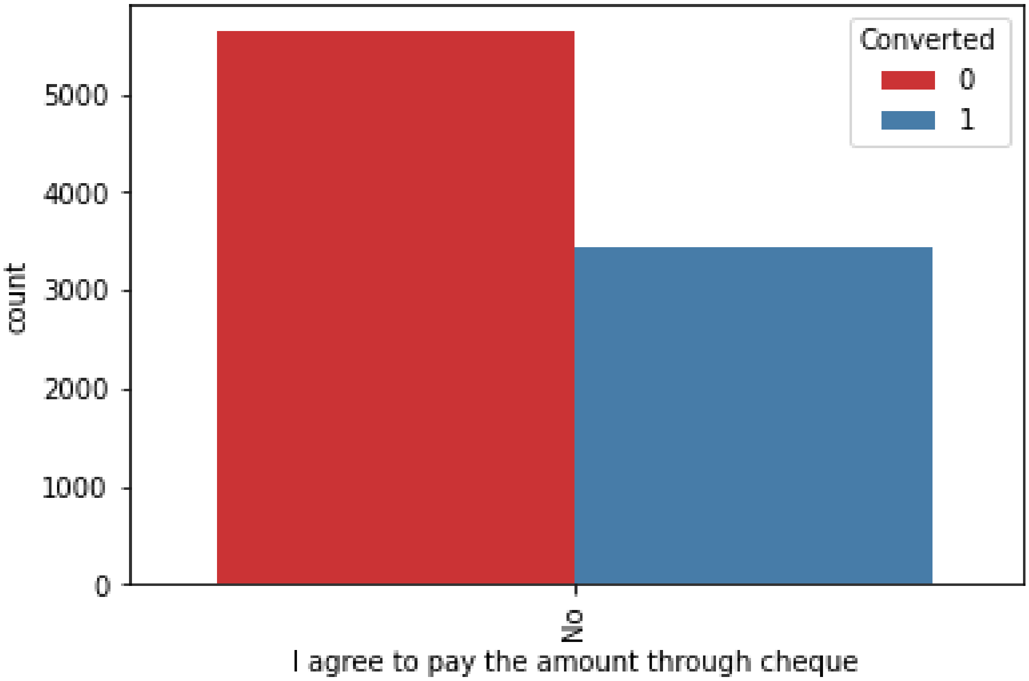
[70]:
```
plt.figure(figsize=(15,5))
sns.countplot(x = "City", hue = "Converted", data = lead_data,palette='Set1')
plt.xticks(rotation = 90)
```

[70]:
```
(array([0, 1, 2, 3, 4, 5]),
 [Text(0, 0, 'Mumbai'),
  Text(1, 0, 'Thane & Outskirts'),
  Text(2, 0, 'Other Metro Cities'),
  Text(3, 0, 'Other Cities'),
  Text(4, 0, 'Other Cities of Maharashtra'),
  Text(5, 0, 'Tier II Cities')])
```



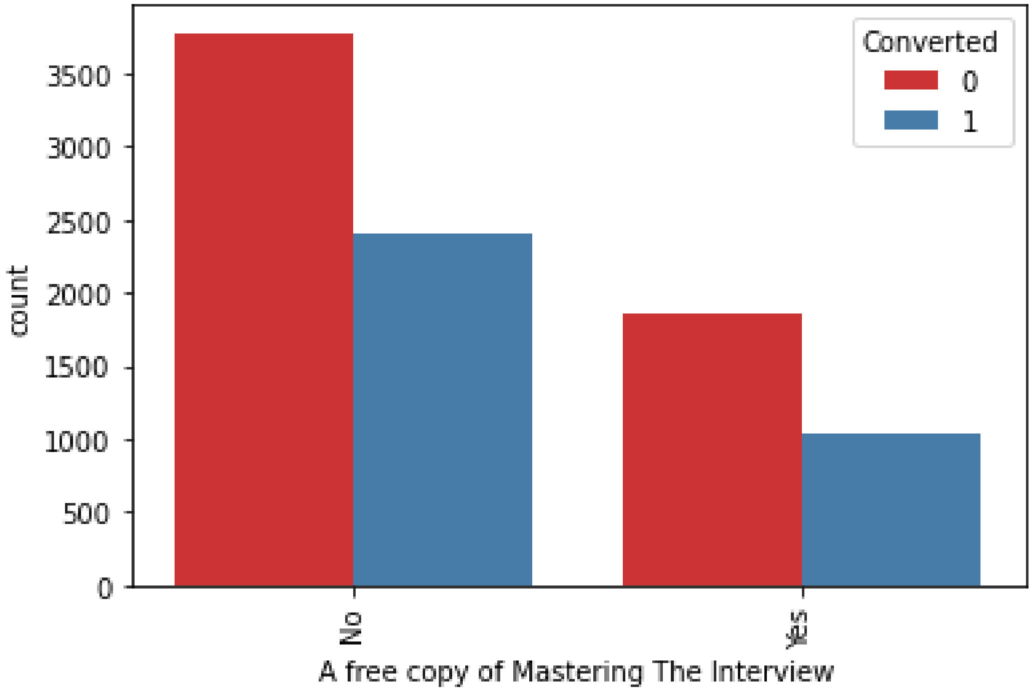
[71]:
```
sns.countplot(x = "I agree to pay the amount through cheque", hue =␣
↪"Converted", data = lead_data,palette='Set1')
plt.xticks(rotation = 90)
```

[71]:
```
(array([0]), [Text(0, 0, 'No')])
```



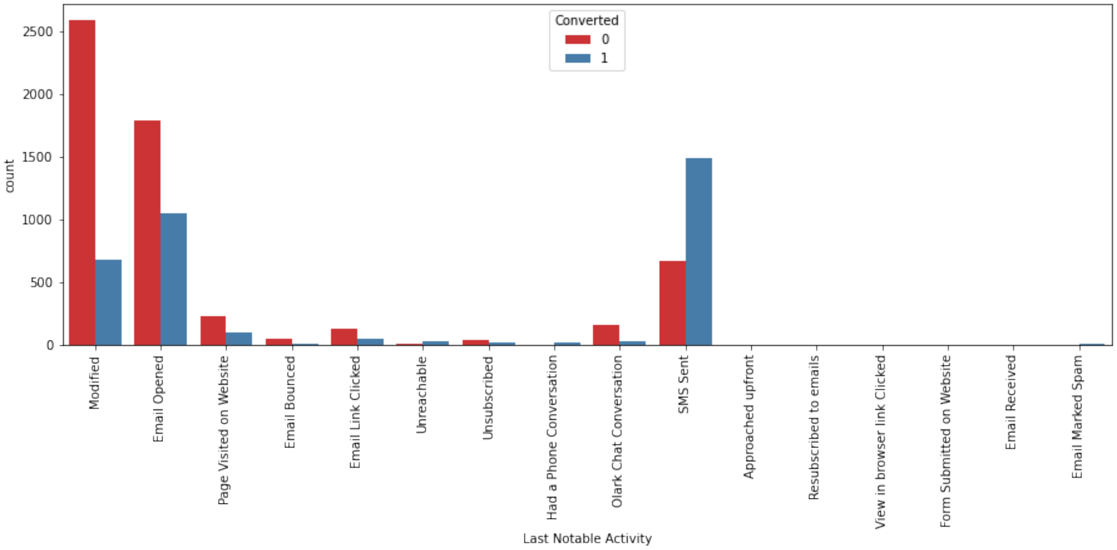
[72]:
```
sns.countplot(x = "A free copy of Mastering The Interview", hue = "Converted",␣
 ↪data = lead_data,palette='Set1')
plt.xticks(rotation = 90)
```

[72]:
```
(array([0, 1]), [Text(0, 0, 'No'), Text(1, 0, 'Yes')])
```



[73]:
```
plt.figure(figsize=(15,5))
sns.countplot(x = "Last Notable Activity", hue = "Converted", data =␣
 ↪lead_data,palette='Set1')
plt.xticks(rotation = 90)
```

[73]:
```
(array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15]),
 [Text(0, 0, 'Modified'),
  Text(1, 0, 'Email Opened'),
  Text(2, 0, 'Page Visited on Website'),
  Text(3, 0, 'Email Bounced'),
  Text(4, 0, 'Email Link Clicked'),
  Text(5, 0, 'Unreachable'),
  Text(6, 0, 'Unsubscribed'),
  Text(7, 0, 'Had a Phone Conversation'),
  Text(8, 0, 'Olark Chat Conversation'),
  Text(9, 0, 'SMS Sent'),
  Text(10, 0, 'Approached upfront'),
  Text(11, 0, 'Resubscribed to emails'),
  Text(12, 0, 'View in browser link Clicked'),
  Text(13, 0, 'Form Submitted on Website'),
  Text(14, 0, 'Email Received'),
  Text(15, 0, 'Email Marked Spam')])
```



[74]:
```
lead_data = lead_data.drop(['Lead␣
↪Number','Tags','Country','Search','Magazine','Newspaper Article','X␣
↪Education Forums',
                            'Newspaper','Digital Advertisement','Through␣
↪Recommendations','Receive More Updates About Our Courses',
                            'Update me on Supply Chain Content','Get updates on␣
↪DM Content','I agree to pay the amount through cheque',
                            'A free copy of Mastering The Interview'],1)
```

[75]:
```
lead_data.shape
```

[75]:
```
(9074, 14)
```

[76]:
```
lead_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 9074 entries, 0 to 9239
Data columns (total 14 columns):
 #   Column                                  Non-Null Count  Dtype
---  ------                                  --------------  -----
 0   Prospect ID                             9074 non-null   object
 1   Lead Origin                             9074 non-null   object
 2   Lead Source                             9074 non-null   object
 3   Do Not Email                            9074 non-null   object
 4   Do Not Call                      9074 non-null   object
 5   Converted                        9074 non-null   int64
 6   TotalVisits                      9074 non-null   float64
 7   Total Time Spent on Website      9074 non-null   int64
 8   Page Views Per Visit             9074 non-null   float64
 9   Last Activity                    9074 non-null   object
 10  Specialization                   9074 non-null   object
 11  What is your current occupation  9074 non-null   object
 12  City                             9074 non-null   object
 13  Last Notable Activity            9074 non-null   object
dtypes: float64(2), int64(2), object(10)
memory usage: 1.0+ MB
```

4 Data Preparation

[77]:
```
vars =  ['Do Not Email', 'Do Not Call']

def binary_map(x):
    return x.map({'Yes': 1, "No": 0})

lead_data[vars] = lead_data[vars].apply(binary_map)
```

[78]:
```
# Creating a dummy variable for the categorical variables and dropping the␣
 ↪first one.
dummy_data = pd.get_dummies(lead_data[['Lead Origin', 'Lead Source', 'Last␣
 ↪Activity', 'Specialization','What is your current occupation',
                              'City','Last Notable Activity']], drop_first=True)
dummy_data.head()
```

[78]:
```
   Lead Origin_Landing Page Submission  Lead Origin_Lead Add Form  \
0                                    0                          0
1                                    0                          0
2                                    1                          0
3                                    1                          0
4                                    1                          0

   Lead Origin_Lead Import  Lead Source_Facebook  Lead Source_Google  \
0                        0                     0                   0
1                        0                     0                   0
2                        0                     0                   0
3                        0                     0                   0
4                        0                     0                   1

   Lead Source_Olark Chat  Lead Source_Organic Search  Lead Source_Others  \
0                       1                           0                   0
1                       0                           1                   0
```

```
2                       0                           0                   0
3                       0                           0                   0
4                       0                           0                   0

   Lead Source_Reference  Lead Source_Referral Sites  …  \
0                      0                           0  …
1                      0                           0  …
2                      0                           0  …
3                      0                           0  …
4                      0                           0  …

   Last Notable Activity_Form Submitted on Website  \
0                                                0
1                                                0
2                                                0
3                                                0
4                                                0

   Last Notable Activity_Had a Phone Conversation  \
0                                               0
1                                               0
2                                               0
3                                               0
4                                               0

   Last Notable Activity_Modified  \
0                               1
1                               0
2                               0
3                               1
4                               1

   Last Notable Activity_Olark Chat Conversation  \
0                                              0
1                                              0
2                                              0
3                                              0
4                                              0

   Last Notable Activity_Page Visited on Website  \
0                                              0
1                                              0
2                                              0
3                                              0
4                                              0

   Last Notable Activity_Resubscribed to emails  \
0                                              0
1                                              0
2                                              0
3                                              0
4                                              0

   Last Notable Activity_SMS Sent  Last Notable Activity_Unreachable  \
0                               0                                  0
1                               0                                  0
2                               0                                  0
3                               0                                  0
4                               0                                  0

   Last Notable Activity_Unsubscribed  \
0                                   0
1                                   0
2                                   0
3                                   0
4                                   0

   Last Notable Activity_View in browser link Clicked
0                                                  0
1                                                  0
2                                                  0
3                                                  0
4                                                  0

[5 rows x 64 columns]
```

[79]:

```
# Concatenating the dummy_data to the lead_data dataframe
lead_data = pd.concat([lead_data, dummy_data], axis=1)
lead_data.head()
```

[79]:

```
                            Prospect ID              Lead Origin  \
0  7927b2df-8bba-4d29-b9a2-b6e0beafe620                      API
1  2a272436-5132-4136-86fa-dcc88c88f482                      API
2  8cc8c611-a219-4f35-ad23-fdfd2656bd8a  Landing Page Submission
3  0cc2df48-7cf4-4e39-9de9-19797f9b38cc  Landing Page Submission
4  3256f628-e534-4826-9d63-4a8b88782852  Landing Page Submission

      Lead Source  Do Not Email  Do Not Call  Converted  TotalVisits  \
0      Olark Chat             0            0          0          0.0
1  Organic Search             0            0          0          5.0
2  Direct Traffic             0            0          1          2.0
3  Direct Traffic             0            0          0          1.0
4          Google             0            0          1          2.0
```

```
   Total Time Spent on Website  Page Views Per Visit            Last Activity  \
0                            0                   0.0  Page Visited on Website
1                          674                   2.5             Email Opened
2                         1532                   2.0             Email Opened
3                          305                   1.0              Unreachable
4                         1428                   1.0        Converted to Lead

   … Last Notable Activity_Form Submitted on Website  \
0  …                                               0
1  …                                               0
2  …                                               0
3  …                                               0
4  …                                               0

  Last Notable Activity_Had a Phone Conversation  \
0                                              0
1                                              0
2                                              0
3                                              0
4                                              0

  Last Notable Activity_Modified  \
0                              1
1                              0
2                              0
3                              1
4                              1

  Last Notable Activity_Olark Chat Conversation  \
0                                             0
1                                             0
2                                             0
3                                             0
4                                             0

   Last Notable Activity_Page Visited on Website  \
0                                              0
1                                              0
2                                              0
3                                              0
4                                              0

   Last Notable Activity_Resubscribed to emails  \
0                                             0
1                                             0
2                                             0
3                                             0
```

```
4                                             0

   Last Notable Activity_SMS Sent  Last Notable Activity_Unreachable  \
0                               0                                  0
1                               0                                  0
2                               0                                  0
3                               0                                  0
4                               0                                  0

   Last Notable Activity_Unsubscribed  \
0                                   0
1                                   0
2                                   0
3                                   0
4                                   0

   Last Notable Activity_View in browser link Clicked
0                                                   0
1                                                   0
2                                                   0
3                                                   0
4                                                   0

[5 rows x 78 columns]
```

[80]:

```
lead_data = lead_data.drop(['Lead Origin', 'Lead Source', 'Last Activity',␣
↪'Specialization','What is your current occupation',
                             'City','Last Notable Activity'], axis = 1)
```

[81]:

```
lead_data.head()
```

[81]:

```
                            Prospect ID  Do Not Email  Do Not Call  Converted  \
0  7927b2df-8bba-4d29-b9a2-b6e0beafe620             0            0          0
1  2a272436-5132-4136-86fa-dcc88c88f482             0            0          0
2  8cc8c611-a219-4f35-ad23-fdfd2656bd8a             0            0          1
3  0cc2df48-7cf4-4e39-9de9-19797f9b38cc             0            0          0
4  3256f628-e534-4826-9d63-4a8b88782852             0            0          1

   TotalVisits  Total Time Spent on Website  Page Views Per Visit  \
0          0.0                            0                   0.0
1          5.0                          674                   2.5
2          2.0                         1532                   2.0
3          1.0                          305                   1.0
4          2.0                         1428                   1.0

   Lead Origin_Landing Page Submission  Lead Origin_Lead Add Form  \
0                                    0                          0
```

```
1                                    0                          0
2                                    1                          0
3                                    1                          0
4                                    1                          0

   Lead Origin_Lead Import  …  \
0                        0  …
1                        0  …
2                        0  …
3                        0  …
4                        0  …

   Last Notable Activity_Form Submitted on Website  \
0                                                0
1                                                0
2                                                0
3                                                0
4                                                0

   Last Notable Activity_Had a Phone Conversation  \
0                                               0
1                                               0
2                                               0
3                                               0
4                                               0

   Last Notable Activity_Modified  \
0                               1
1                               0
2                               0
3                               1
4                               1

   Last Notable Activity_Olark Chat Conversation  \
0                                              0
1                                              0
2                                              0
3                                              0
4                                              0

   Last Notable Activity_Page Visited on Website  \
0                                              0
1                                              0
2                                              0
3                                              0
4                                              0
```

```
   Last Notable Activity_Resubscribed to emails  \
0                                             0   
1                                             0   
2                                             0   
3                                             0   
4                                             0   

   Last Notable Activity_SMS Sent  Last Notable Activity_Unreachable  \
0                               0                                  0   
1                               0                                  0   
2                               0                                  0   
3                               0                                  0   
4                               0                                  0   

   Last Notable Activity_Unsubscribed  \
0                                   0   
1                                   0   
2                                   0   
3                                   0   
4                                   0   

   Last Notable Activity_View in browser link Clicked  
0                                                   0  
1                                                   0  
2                                                   0  
3                                                   0  
4                                                   0  

[5 rows x 71 columns]
```

[82]:

```
# Splitting the data into train and test set.
from sklearn.model_selection import train_test_split

# Putting feature variable to X
X = lead_data.drop(['Prospect ID','Converted'], axis=1)
X.head()
```

[82]:

```
   Do Not Email  Do Not Call  TotalVisits  Total Time Spent on Website  \
0             0            0          0.0                            0   
1             0            0          5.0                          674   
2             0            0          2.0                         1532   
3             0            0          1.0                          305   
4             0            0          2.0                         1428   

   Page Views Per Visit  Lead Origin_Landing Page Submission  \
0                   0.0                                    0   
1                   2.5                                    0   
```

```
2                   2.0                                    1
3                   1.0                                    1
4                   1.0                                    1

   Lead Origin_Lead Add Form  Lead Origin_Lead Import  Lead Source_Facebook  \
0                          0                        0                     0
1                          0                        0                     0
2                          0                        0                     0
3                          0                        0                     0
4                          0                        0                     0

   Lead Source_Google  …  Last Notable Activity_Form Submitted on Website  \
0                   0  …                                                0
1                   0  …                                                0
2                   0  …                                                0
3                   0  …                                                0
4                   1  …                                                0

   Last Notable Activity_Had a Phone Conversation  \
0                                               0
1                                               0
2                                               0
3                                               0
4                                               0

   Last Notable Activity_Modified  \
0                               1
1                               0
2                               0
3                               1
4                               1

   Last Notable Activity_Olark Chat Conversation  \
0                                              0
1                                              0
2                                              0
3                                              0
4                                              0

   Last Notable Activity_Page Visited on Website  \
0                                              0
1                                              0
2                                              0
3                                              0
4                                              0

   Last Notable Activity_Resubscribed to emails  \
0                                             0
1                                             0
2                                             0
3                                             0
4                                             0

   Last Notable Activity_SMS Sent  Last Notable Activity_Unreachable  \
0                               0                                  0
1                               0                                  0
2                               0                                  0
3                               0                                  0
4                               0                                  0

   Last Notable Activity_Unsubscribed  \
0                                   0
1                                   0
2                                   0
3                                   0
4                                   0

   Last Notable Activity_View in browser link Clicked
0                                                  0
1                                                  0
2                                                  0
3                                                  0
4                                                  0

[5 rows x 69 columns]
```

[83]:

```
# Putting target variable to y
y = lead_data['Converted']

y.head()
```

[83]:

```
0    0
1    0
2    1
3    0
4    1
Name: Converted, dtype: int64
```

[84]:

```
# Splitting the data into train and test
X_train, X_test, y_train, y_test = train_test_split(X, y, train_size=0.7,␣
 ↪test_size=0.3, random_state=100)
```

[85]:

```
from sklearn.preprocessing import StandardScaler
```

```
scaler = StandardScaler()

X_train[['TotalVisits','Total Time Spent on Website','Page Views Per Visit']] =␣
 ↪scaler.fit_transform(X_train[['TotalVisits','Total Time Spent on␣
 ↪Website','Page Views Per Visit']])

X_train.head()
```

[85]:

```
      Do Not Email  Do Not Call  TotalVisits  Total Time Spent on Website  \
3009             0            0    -0.432779                    -0.160255
1012             1            0    -0.432779                    -0.540048
9226             0            0    -1.150329                    -0.888650
4750             0            0    -0.432779                     1.643304
7987             0            0     0.643547                     2.017593

      Page Views Per Visit  Lead Origin_Landing Page Submission  \
3009             -0.155018                                    1
1012             -0.155018                                    1
9226             -1.265540                                    0
4750             -0.155018                                    1
7987              0.122613                                    1

      Lead Origin_Lead Add Form  Lead Origin_Lead Import  \
3009                          0                        0
1012                          0                        0
9226                          0                        0
4750                          0                        0
7987                          0                        0

      Lead Source_Facebook  Lead Source_Google  …  \
3009                     0                   0  …
1012                     0                   0  …
9226                     0                   0  …
4750                     0                   0  …
7987                     0                   0  …

      Last Notable Activity_Form Submitted on Website  \
3009                                                0
1012                                                0
9226                                                0
4750                                                0
7987                                                0

      Last Notable Activity_Had a Phone Conversation  \
3009                                               0
1012                                               0
9226                                               0
```

```
4750                                               0
7987                                               0

      Last Notable Activity_Modified  \
3009                               0
1012                               0
9226                               1
4750                               0
7987                               1

      Last Notable Activity_Olark Chat Conversation  \
3009                                              0
1012                                              0
9226                                              0
4750                                              0
7987                                              0

      Last Notable Activity_Page Visited on Website  \
3009                                              0
1012                                              0
9226                                              0
4750                                              0
7987                                              0

      Last Notable Activity_Resubscribed to emails  \
3009                                             0
1012                                             0
9226                                             0
4750                                             0
7987                                             0

      Last Notable Activity_SMS Sent  Last Notable Activity_Unreachable  \
3009                               0                                  0
1012                               0                                  0
9226                               0                                  0
4750                               1                                  0
7987                               0                                  0

      Last Notable Activity_Unsubscribed  \
3009                                   0
1012                                   0
9226                                   0
4750                                   0
7987                                   0

      Last Notable Activity_View in browser link Clicked
3009                                                   0
```

```
1012                                                    0
9226                                                    0
4750                                                    0
7987                                                    0

[5 rows x 69 columns]
```

[86]:

```
# Checking the Lead Conversion rate
Converted = (sum(lead_data['Converted'])/len(lead_data['Converted'].index))*100
Converted
```

[86]:

```
37.85541106458012
```

[87]:

```
from sklearn.linear_model import LogisticRegression
logreg = LogisticRegression()

from sklearn.feature_selection import RFE
```

[88]:

```
rfe = RFE(logreg,n_features_to_select=20)             # running RFE with 20␣
 ↪variables as output
rfe = rfe.fit(X_train, y_train)
```

[89]:

```
rfe.support_
```

[89]:

```
array([ True, False, False,  True, False,  True,  True,  True, False,
       False,  True, False, False,  True, False,  True, False, False,
       False, False,  True,  True, False,  True, False,  True, False,
       False, False, False, False, False, False, False, False, False,
       False, False,  True, False, False, False, False, False,  True,
       False,  True,  True,  True, False, False, False, False, False,
       False, False, False, False, False, False,  True,  True, False,
       False, False, False,  True, False, False])
```

[90]:

```
list(zip(X_train.columns, rfe.support_, rfe.ranking_))
```

[90]:

```
[('Do Not Email', True, 1),
 ('Do Not Call', False, 9),
 ('TotalVisits', False, 21),
 ('Total Time Spent on Website', True, 1),
 ('Page Views Per Visit', False, 20),
 ('Lead Origin_Landing Page Submission', True, 1),
 ('Lead Origin_Lead Add Form', True, 1),
 ('Lead Origin_Lead Import', True, 1),
 ('Lead Source_Facebook', False, 24),
 ('Lead Source_Google', False, 25),
 ('Lead Source_Olark Chat', True, 1),
 ('Lead Source_Organic Search', False, 36),
('Lead Source_Others', False, 28),
('Lead Source_Reference', True, 1),
('Lead Source_Referral Sites', False, 48),
('Lead Source_Welingak Website', True, 1),
('Last Activity_Email Bounced', False, 19),
('Last Activity_Email Link Clicked', False, 13),
('Last Activity_Email Opened', False, 7),
('Last Activity_Form Submitted on Website', False, 35),
('Last Activity_Olark Chat Conversation', True, 1),
('Last Activity_Other_Activity', True, 1),
('Last Activity_Page Visited on Website', False, 12),
('Last Activity_SMS Sent', True, 1),
('Last Activity_Unreachable', False, 11),
('Last Activity_Unsubscribed', True, 1),
('Specialization_Business Administration', False, 30),
('Specialization_E-Business', False, 23),
('Specialization_E-COMMERCE', False, 32),
('Specialization_Finance Management', False, 44),
('Specialization_Healthcare Management', False, 39),
('Specialization_Hospitality Management', False, 10),
('Specialization_Human Resource Management', False, 43),
('Specialization_IT Projects Management', False, 47),
('Specialization_International Business', False, 26),
('Specialization_Marketing Management', False, 34),
('Specialization_Media and Advertising', False, 22),
('Specialization_Operations Management', False, 41),
('Specialization_Others', True, 1),
('Specialization_Retail Management', False, 27),
('Specialization_Rural and Agribusiness', False, 38),
('Specialization_Services Excellence', False, 18),
('Specialization_Supply Chain Management', False, 46),
('Specialization_Travel and Tourism', False, 33),
('What is your current occupation_Housewife', True, 1),
('What is your current occupation_Other', False, 31),
('What is your current occupation_Student', True, 1),
('What is your current occupation_Unemployed', True, 1),
('What is your current occupation_Working Professional', True, 1),
('City_Other Cities', False, 42),
('City_Other Cities of Maharashtra', False, 45),
('City_Other Metro Cities', False, 40),
('City_Thane & Outskirts', False, 50),
('City_Tier II Cities', False, 8),
('Last Notable Activity_Email Bounced', False, 16),
('Last Notable Activity_Email Link Clicked', False, 4),
('Last Notable Activity_Email Marked Spam', False, 29),
('Last Notable Activity_Email Opened', False, 6),
('Last Notable Activity_Email Received', False, 49),
 ('Last Notable Activity_Form Submitted on Website', False, 37),
 ('Last Notable Activity_Had a Phone Conversation', True, 1),
 ('Last Notable Activity_Modified', True, 1),
 ('Last Notable Activity_Olark Chat Conversation', False, 2),
 ('Last Notable Activity_Page Visited on Website', False, 5),
 ('Last Notable Activity_Resubscribed to emails', False, 17),
 ('Last Notable Activity_SMS Sent', False, 15),
 ('Last Notable Activity_Unreachable', True, 1),
 ('Last Notable Activity_Unsubscribed', False, 14),
 ('Last Notable Activity_View in browser link Clicked', False, 3)]
```

[91]:

```
# Viewing columns selected by RFE
cols = X_train.columns[rfe.support_]
cols
```

[91]:

```
Index(['Do Not Email', 'Total Time Spent on Website',
       'Lead Origin_Landing Page Submission', 'Lead Origin_Lead Add Form',
       'Lead Origin_Lead Import', 'Lead Source_Olark Chat',
       'Lead Source_Reference', 'Lead Source_Welingak Website',
       'Last Activity_Olark Chat Conversation', 'Last Activity_Other_Activity',
       'Last Activity_SMS Sent', 'Last Activity_Unsubscribed',
       'Specialization_Others', 'What is your current occupation_Housewife',
       'What is your current occupation_Student',
       'What is your current occupation_Unemployed',
       'What is your current occupation_Working Professional',
       'Last Notable Activity_Had a Phone Conversation',
       'Last Notable Activity_Modified', 'Last Notable Activity_Unreachable'],
      dtype='object')
```

[92]:

```
cols.shape
```

[92]:

```
(20,)
```

5 Model Building¶

[93]:

```
import statsmodels.api as sm
```

[95]:

```
X_train_sm = sm.add_constant(X_train[cols])
logm1 = sm.GLM(y_train,X_train_sm, family = sm.families.Binomial())
result = logm1.fit()
result.summary()
```

[95]:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
                 Generalized Linear Model Regression Results
==============================================================================
Dep. Variable:              Converted   No. Observations:                 6351
Model:                            GLM   Df Residuals:                     6330
Model Family:                Binomial   Df Model:                           20
Link Function:                  Logit   Scale:                          1.0000
Method:                          IRLS   Log-Likelihood:                -2590.3
Date:                Tue, 02 May 2023   Deviance:                       5180.6
Time:                        16:45:24   Pearson chi2:                 6.52e+03
No. Iterations:                    21   Pseudo R-squ. (CS):             0.4039
Covariance Type:            nonrobust
================================================================================
========================================
                                                           coef    std err
z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
----------------------------------------
const                                                    0.8338      0.637
1.309      0.190      -0.414       2.082
Do Not Email                                            -1.6759      0.191
-8.796      0.000      -2.049      -1.302
Total Time Spent on Website                              1.1081      0.041
27.194      0.000       1.028       1.188
Lead Origin_Landing Page Submission                     -1.1219      0.130
-8.663      0.000      -1.376      -0.868
Lead Origin_Lead Add Form                                1.6019      0.915
1.751      0.080      -0.191       3.395
Lead Origin_Lead Import                                  0.9059      0.480
1.888      0.059      -0.035       1.846
Lead Source_Olark Chat                                   1.1250      0.124
9.082      0.000       0.882       1.368
Lead Source_Reference                                    1.7697      0.938
1.887      0.059      -0.069       3.608
Lead Source_Welingak Website                             4.2961      1.165
3.687      0.000       2.012       6.580
Last Activity_Olark Chat Conversation                   -0.9504      0.172
-5.531      0.000      -1.287      -0.614
Last Activity_Other_Activity                             1.8717      0.537
3.483      0.000       0.818       2.925
Last Activity_SMS Sent                                   1.3454      0.076
17.766      0.000       1.197       1.494
Last Activity_Unsubscribed                               1.4083      0.483
2.917      0.004       0.462       2.355
Specialization_Others                                   -1.1410      0.126
-9.052      0.000      -1.388      -0.894
What is your current occupation_Housewife               21.7588   1.53e+04
0.001      0.999   -2.99e+04    2.99e+04
What is your current occupation_Student                 -0.5518      0.673
-0.820      0.412      -1.871       0.767
```

```
What is your current occupation_Unemployed              -1.0059      0.634
-1.587      0.113      -2.248       0.236
What is your current occupation_Working Professional     1.6281      0.660
2.466      0.014       0.334       2.922
Last Notable Activity_Had a Phone Conversation           1.4204      1.223
1.161      0.246      -0.978       3.818
Last Notable Activity_Modified                          -0.8675      0.082
-10.620      0.000      -1.028      -0.707
Last Notable Activity_Unreachable                        1.5785      0.476
3.316      0.001       0.645       2.512
================================================================================
========================================
"""
```

[96]:

```
X_train_sm.shape
```

[96]:

```
(6351, 21)
```

[97]:

```
# Dropping the column 'What is your current occupation_Housewife'
col1 = cols.drop('What is your current occupation_Housewife')
```

[98]:

```
X_train_sm = sm.add_constant(X_train[col1])
logm2 = sm.GLM(y_train,X_train_sm, family = sm.families.Binomial())
res = logm2.fit()
res.summary()
```

[98]:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
                 Generalized Linear Model Regression Results
==============================================================================
Dep. Variable:              Converted   No. Observations:                 6351
Model:                            GLM   Df Residuals:                     6331
Model Family:                Binomial   Df Model:                           19
Link Function:                  Logit   Scale:                          1.0000
Method:                          IRLS   Log-Likelihood:                -2592.3
Date:                Tue, 02 May 2023   Deviance:                       5184.5
Time:                        16:46:00   Pearson chi2:                 6.53e+03
No. Iterations:                     7   Pseudo R-squ. (CS):             0.4035
Covariance Type:            nonrobust
================================================================================
========================================
                                                           coef    std err
z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
----------------------------------------
const                                                    1.3160      0.590
2.230      0.026       0.159       2.473
```

```
Do Not Email                                            -1.6800      0.191
-8.812      0.000      -2.054      -1.306
Total Time Spent on Website                              1.1069      0.041
27.184      0.000       1.027       1.187
Lead Origin_Landing Page Submission                     -1.1154      0.129
-8.621      0.000      -1.369      -0.862
Lead Origin_Lead Add Form                                1.6044      0.915
1.754      0.079      -0.189       3.397
Lead Origin_Lead Import                                  0.9081      0.480
1.893      0.058      -0.032       1.848
Lead Source_Olark Chat                                   1.1254      0.124
9.085      0.000       0.883       1.368
Lead Source_Reference                                    1.7729      0.938
1.890      0.059      -0.066       3.611
Lead Source_Welingak Website                             4.2952      1.165
3.685      0.000       2.011       6.579
Last Activity_Olark Chat Conversation                   -0.9512      0.172
-5.531      0.000      -1.288      -0.614
Last Activity_Other_Activity                             1.8733      0.537
3.486      0.000       0.820       2.927
Last Activity_SMS Sent                                   1.3445      0.076
17.756      0.000       1.196       1.493
Last Activity_Unsubscribed                               1.4117      0.483
2.924      0.003       0.466       2.358
Specialization_Others                                   -1.1373      0.126
-9.031      0.000      -1.384      -0.890
What is your current occupation_Student                 -1.0384      0.627
-1.656      0.098      -2.268       0.191
What is your current occupation_Unemployed              -1.4919      0.585
-2.550      0.011      -2.638      -0.345
What is your current occupation_Working Professional     1.1419      0.613
1.862      0.063      -0.060       2.344
Last Notable Activity_Had a Phone Conversation           1.4165      1.223
1.158      0.247      -0.981       3.814
Last Notable Activity_Modified                          -0.8703      0.082
-10.657      0.000      -1.030      -0.710
Last Notable Activity_Unreachable                        1.5745      0.476
3.305      0.001       0.641       2.508
================================================================================
========================================
"""
```

[99]:
```
col1 = col1.drop('Last Notable Activity_Had a Phone Conversation')
```

[100]:
```
X_train_sm = sm.add_constant(X_train[col1])
logm3 = sm.GLM(y_train,X_train_sm, family = sm.families.Binomial())
res = logm3.fit()
```

```
res.summary()
```

[100]:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
                 Generalized Linear Model Regression Results
==============================================================================
Dep. Variable:              Converted   No. Observations:                 6351
Model:                            GLM   Df Residuals:                     6332
Model Family:                Binomial   Df Model:                           18
Link Function:                  Logit   Scale:                          1.0000
Method:                          IRLS   Log-Likelihood:                -2593.1
Date:                Tue, 02 May 2023   Deviance:                       5186.1
Time:                        16:46:28   Pearson chi2:                 6.53e+03
No. Iterations:                     7   Pseudo R-squ. (CS):             0.4034
Covariance Type:            nonrobust
================================================================================
========================================
                                                           coef    std err
z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
----------------------------------------
const                                                    1.3199      0.590
2.235      0.025       0.163       2.477
Do Not Email                                            -1.6826      0.191
-8.816      0.000      -2.057      -1.308
Total Time Spent on Website                              1.1059      0.041
27.170      0.000       1.026       1.186
Lead Origin_Landing Page Submission                     -1.1158      0.129
-8.626      0.000      -1.369      -0.862
Lead Origin_Lead Add Form                                1.6034      0.915
1.753      0.080      -0.190       3.396
Lead Origin_Lead Import                                  0.9065      0.480
1.890      0.059      -0.034       1.847
Lead Source_Olark Chat                                   1.1230      0.124
9.064      0.000       0.880       1.366
Lead Source_Reference                                    1.7724      0.938
1.889      0.059      -0.066       3.611
Lead Source_Welingak Website                             4.2977      1.165
3.688      0.000       2.013       6.582
Last Activity_Olark Chat Conversation                   -0.9462      0.172
-5.503      0.000      -1.283      -0.609
Last Activity_Other_Activity                             2.2308      0.463
4.820      0.000       1.324       3.138
Last Activity_SMS Sent                                   1.3440      0.076
17.751      0.000       1.196       1.492
Last Activity_Unsubscribed                               1.4134      0.483
2.928      0.003       0.467       2.360
```

```
Specialization_Others                                       -1.1413      0.126
-9.063      0.000      -1.388      -0.895
What is your current occupation_Student                     -1.0390      0.627
-1.656      0.098      -2.269       0.191
What is your current occupation_Unemployed                  -1.4916      0.585
-2.549      0.011      -2.639      -0.345
What is your current occupation_Working Professional         1.1383      0.614
1.855      0.064      -0.064       2.341
Last Notable Activity_Modified                              -0.8767      0.082
-10.750      0.000      -1.037      -0.717
Last Notable Activity_Unreachable                            1.5719      0.476
3.299      0.001      0.638       2.506
================================================================================
========================================
"""
```

[101]:

```python
col1 = col1.drop('What is your current occupation_Student')
```

[102]:

```python
X_train_sm = sm.add_constant(X_train[col1])
logm4 = sm.GLM(y_train,X_train_sm, family = sm.families.Binomial())
res = logm4.fit()
res.summary()
```

[102]:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
                 Generalized Linear Model Regression Results
==============================================================================
Dep. Variable:              Converted   No. Observations:                 6351
Model:                            GLM   Df Residuals:                     6333
Model Family:                Binomial   Df Model:                           17
Link Function:                  Logit   Scale:                          1.0000
Method:                          IRLS   Log-Likelihood:                -2594.5
Date:                Tue, 02 May 2023   Deviance:                       5189.0
Time:                        16:46:49   Pearson chi2:                 6.53e+03
No. Iterations:                     7   Pseudo R-squ. (CS):             0.4031
Covariance Type:            nonrobust
================================================================================
========================================
                                                           coef    std err
z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
----------------------------------------
const                                                        0.4409      0.240
1.836      0.066      -0.030       0.912
Do Not Email                                                -1.6789      0.191
-8.807      0.000      -2.053      -1.305
Total Time Spent on Website                                  1.1067      0.041
```

```
27.196      0.000       1.027       1.186
Lead Origin_Landing Page Submission                     -1.1290      0.129
-8.745      0.000      -1.382      -0.876
Lead Origin_Lead Add Form                                1.5974      0.914
1.747      0.081      -0.195       3.390
Lead Origin_Lead Import                                  0.8993      0.480
1.874      0.061      -0.041       1.840
Lead Source_Olark Chat                                   1.1178      0.124
9.029      0.000       0.875       1.360
Lead Source_Reference                                    1.7790      0.938
1.897      0.058      -0.059       3.617
Lead Source_Welingak Website                             4.3023      1.165
3.693      0.000       2.019       6.586
Last Activity_Olark Chat Conversation                   -0.9478      0.172
-5.518      0.000      -1.284      -0.611
Last Activity_Other_Activity                             2.2295      0.463
4.816      0.000       1.322       3.137
Last Activity_SMS Sent                                   1.3427      0.076
17.728      0.000       1.194       1.491
Last Activity_Unsubscribed                               1.4093      0.483
2.919      0.004       0.463       2.356
Specialization_Others                                   -1.1534      0.126
-9.171      0.000      -1.400      -0.907
What is your current occupation_Unemployed              -0.6003      0.213
-2.818      0.005      -1.018      -0.183
What is your current occupation_Working Professional     2.0282      0.283
7.161      0.000       1.473       2.583
Last Notable Activity_Modified                          -0.8740      0.081
-10.725      0.000      -1.034      -0.714
Last Notable Activity_Unreachable                        1.5774      0.475
3.318      0.001       0.646       2.509
================================================================================
========================================
"""
```

[103]:

```
col1 = col1.drop('Lead Origin_Lead Add Form')
```

[104]:

```
X_train_sm = sm.add_constant(X_train[col1])
logm5 = sm.GLM(y_train,X_train_sm, family = sm.families.Binomial())
res = logm5.fit()
res.summary()
```

[104]:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
                 Generalized Linear Model Regression Results
==============================================================================
Dep. Variable:              Converted   No. Observations:                 6351
```

```
Model:                            GLM   Df Residuals:                     6334
Model Family:                Binomial   Df Model:                           16
Link Function:                  Logit   Scale:                          1.0000
Method:                          IRLS   Log-Likelihood:                -2596.2
Date:                Tue, 02 May 2023   Deviance:                       5192.3
Time:                        16:47:18   Pearson chi2:                 6.54e+03
No. Iterations:                     7   Pseudo R-squ. (CS):             0.4028
Covariance Type:            nonrobust
================================================================================
========================================
                                                           coef    std err
z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
----------------------------------------
const                                                    0.4578      0.240
1.907      0.056      -0.013       0.928
Do Not Email                                            -1.6806      0.191
-8.816      0.000      -2.054      -1.307
Total Time Spent on Website                              1.1047      0.041
27.190      0.000       1.025       1.184
Lead Origin_Landing Page Submission                     -1.1473      0.129
-8.907      0.000      -1.400      -0.895
Lead Origin_Lead Import                                  0.8826      0.480
1.838      0.066      -0.059       1.824
Lead Source_Olark Chat                                   1.1108      0.124
8.993      0.000       0.869       1.353
Lead Source_Reference                                    3.3614      0.243
13.840      0.000       2.885       3.837
Lead Source_Welingak Website                             5.8902      0.730
8.073      0.000       4.460       7.320
Last Activity_Olark Chat Conversation                   -0.9522      0.172
-5.544      0.000      -1.289      -0.616
Last Activity_Other_Activity                             2.2254      0.463
4.808      0.000       1.318       3.133
Last Activity_SMS Sent                                   1.3427      0.076
17.732      0.000       1.194       1.491
Last Activity_Unsubscribed                               1.4077      0.483
2.916      0.004       0.462       2.354
Specialization_Others                                   -1.1652      0.126
-9.273      0.000      -1.411      -0.919
What is your current occupation_Unemployed              -0.5974      0.213
-2.804      0.005      -1.015      -0.180
What is your current occupation_Working Professional     2.0280      0.283
7.158      0.000       1.473       2.583
Last Notable Activity_Modified                          -0.8745      0.081
-10.736      0.000      -1.034      -0.715
Last Notable Activity_Unreachable                        1.5728      0.475
```

```
3.308      0.001       0.641       2.505
================================================================================
========================================
"""
```

[105]:

```
# Check for the VIF values of the feature variables.
from statsmodels.stats.outliers_influence import variance_inflation_factor

# Create a dataframe that will contain the names of all the feature variables␣
 ↪and their respective VIFs
vif = pd.DataFrame()
vif['Features'] = X_train[col1].columns
vif['VIF'] = [variance_inflation_factor(X_train[col1].values, i) for i in␣
 ↪range(X_train[col1].shape[1])]
vif['VIF'] = round(vif['VIF'], 2)
vif = vif.sort_values(by = "VIF", ascending = False)
vif
```

[105]:

```
                                              Features   VIF
12         What is your current occupation_Unemployed  9.72
2                 Lead Origin_Landing Page Submission  5.74
11                            Specialization_Others  3.99
4                              Lead Source_Olark Chat  2.24
14                     Last Notable Activity_Modified  1.86
13  What is your current occupation_Working Profes…  1.66
9                              Last Activity_SMS Sent  1.63
7               Last Activity_Olark Chat Conversation  1.59
5                             Lead Source_Reference  1.46
1                        Total Time Spent on Website  1.32
0                                      Do Not Email  1.21
6                        Lead Source_Welingak Website  1.11
10                       Last Activity_Unsubscribed  1.08
3                           Lead Origin_Lead Import  1.03
8                        Last Activity_Other_Activity  1.01
15                  Last Notable Activity_Unreachable  1.01
```

[106]:

```
# Dropping the column  'What is your current occupation_Unemployed' because it␣
 ↪has high VIF
col1 = col1.drop('What is your current occupation_Unemployed')
```

[107]:

```
X_train_sm = sm.add_constant(X_train[col1])
logm5 = sm.GLM(y_train,X_train_sm, family = sm.families.Binomial())
res = logm5.fit()
res.summary()
```

[107]:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
```

```
                 Generalized Linear Model Regression Results
==============================================================================
Dep. Variable:              Converted   No. Observations:                 6351
Model:                            GLM   Df Residuals:                     6335
Model Family:                Binomial   Df Model:                           15
Link Function:                  Logit   Scale:                          1.0000
Method:                          IRLS   Log-Likelihood:                -2600.0
Date:                Tue, 02 May 2023   Deviance:                       5200.0
Time:                        16:48:08   Pearson chi2:                 6.54e+03
No. Iterations:                     7   Pseudo R-squ. (CS):             0.4021
Covariance Type:            nonrobust
================================================================================
========================================
                                                           coef    std err
z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
----------------------------------------
const                                                   -0.1106      0.127
-0.868      0.385      -0.361       0.139
Do Not Email                                            -1.6767      0.191
-8.786      0.000      -2.051      -1.303
Total Time Spent on Website                              1.1047      0.041
27.207      0.000       1.025       1.184
Lead Origin_Landing Page Submission                     -1.1519      0.129
-8.935      0.000      -1.405      -0.899
Lead Origin_Lead Import                                  0.8640      0.480
1.799      0.072      -0.077       1.805
Lead Source_Olark Chat                                   1.1164      0.124
9.037      0.000       0.874       1.359
Lead Source_Reference                                    3.3731      0.243
13.906      0.000       2.898       3.848
Lead Source_Welingak Website                             5.8819      0.730
8.063      0.000       4.452       7.312
Last Activity_Olark Chat Conversation                   -0.9437      0.172
-5.502      0.000      -1.280      -0.608
Last Activity_Other_Activity                             2.2075      0.463
4.767      0.000       1.300       3.115
Last Activity_SMS Sent                                   1.3276      0.075
17.609      0.000       1.180       1.475
Last Activity_Unsubscribed                               1.3822      0.483
2.863      0.004       0.436       2.328
Specialization_Others                                   -1.1774      0.126
-9.356      0.000      -1.424      -0.931
What is your current occupation_Working Professional     2.6063      0.195
13.382      0.000       2.225       2.988
Last Notable Activity_Modified                          -0.8814      0.081
-10.826      0.000      -1.041      -0.722
```

```
Last Notable Activity_Unreachable                        1.5571      0.474
3.284      0.001       0.628       2.486
================================================================================
========================================
"""
```

[108]:

```
# Dropping the column  'Lead Origin_Lead Import' because it has high Pvalue
col1 = col1.drop('Lead Origin_Lead Import')
```

[109]:

```
X_train_sm = sm.add_constant(X_train[col1])
logm5 = sm.GLM(y_train,X_train_sm, family = sm.families.Binomial())
res = logm5.fit()
res.summary()
```

[109]:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
                 Generalized Linear Model Regression Results
==============================================================================
Dep. Variable:              Converted   No. Observations:                 6351
Model:                            GLM   Df Residuals:                     6336
Model Family:                Binomial   Df Model:                           14
Link Function:                  Logit   Scale:                          1.0000
Method:                          IRLS   Log-Likelihood:                -2601.5
Date:                Tue, 02 May 2023   Deviance:                       5203.0
Time:                        16:48:27   Pearson chi2:                 6.54e+03
No. Iterations:                     7   Pseudo R-squ. (CS):             0.4018
Covariance Type:            nonrobust
================================================================================
========================================
                                                           coef    std err
z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
----------------------------------------
const                                                   -0.0717      0.126
-0.570      0.569      -0.318       0.175
Do Not Email                                            -1.6783      0.191
-8.798      0.000      -2.052      -1.304
Total Time Spent on Website                              1.0976      0.040
27.211      0.000       1.019       1.177
Lead Origin_Landing Page Submission                     -1.1863      0.128
-9.291      0.000      -1.437      -0.936
Lead Source_Olark Chat                                   1.0915      0.123
8.905      0.000       0.851       1.332
Lead Source_Reference                                    3.3401      0.242
13.812      0.000       2.866       3.814
Lead Source_Welingak Website                             5.8588      0.729
8.033      0.000       4.429       7.288
```

```
Last Activity_Olark Chat Conversation                        -0.9485      0.171
-5.531      0.000      -1.285      -0.612
Last Activity_Other_Activity                                  2.1988      0.463
4.752      0.000      1.292      3.106
Last Activity_SMS Sent                                        1.3250      0.075
17.587      0.000       1.177       1.473
Last Activity_Unsubscribed                                    1.3784      0.482
2.858      0.004      0.433      2.324
Specialization_Others                                        -1.1983      0.126
-9.536      0.000      -1.445      -0.952
What is your current occupation_Working Professional          2.6064      0.195
13.389      0.000       2.225       2.988
Last Notable Activity_Modified                               -0.8816      0.081
-10.833      0.000      -1.041      -0.722
Last Notable Activity_Unreachable                             1.5470      0.474
3.264      0.001      0.618      2.476
================================================================================
========================================
"""
```

[110]:

```
# Check for the VIF values of the feature variables.
from statsmodels.stats.outliers_influence import variance_inflation_factor

# Create a dataframe that will contain the names of all the feature variables␣
 ↪and their respective VIFs
vif = pd.DataFrame()
vif['Features'] = X_train[col1].columns
vif['VIF'] = [variance_inflation_factor(X_train[col1].values, i) for i in␣
 ↪range(X_train[col1].shape[1])]
vif['VIF'] = round(vif['VIF'], 2)
vif = vif.sort_values(by = "VIF", ascending = False)
vif
```

[110]:

```
                                            Features   VIF
10                             Specialization_Others  2.17
3                              Lead Source_Olark Chat  2.03
12                    Last Notable Activity_Modified  1.79
2                Lead Origin_Landing Page Submission  1.70
6              Last Activity_Olark Chat Conversation  1.59
8                             Last Activity_SMS Sent  1.57
1                        Total Time Spent on Website  1.29
4                            Lead Source_Reference  1.24
0                                      Do Not Email  1.21
11  What is your current occupation_Working Profes…  1.19
5                       Lead Source_Welingak Website  1.09
9                         Last Activity_Unsubscribed  1.08
7                       Last Activity_Other_Activity  1.01
```

```
13                  Last Notable Activity_Unreachable  1.01
```

[111]:
```
# Dropping the column  'Last Activity_Unsubscribed' to reduce the variables
col1 = col1.drop('Last Activity_Unsubscribed')
```

[112]:
```
X_train_sm = sm.add_constant(X_train[col1])
logm5 = sm.GLM(y_train,X_train_sm, family = sm.families.Binomial())
res = logm5.fit()
res.summary()
```

[112]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                 Generalized Linear Model Regression Results
==============================================================================
Dep. Variable:              Converted   No. Observations:                 6351
Model:                            GLM   Df Residuals:                     6337
Model Family:                Binomial   Df Model:                           13
Link Function:                  Logit   Scale:                          1.0000
Method:                          IRLS   Log-Likelihood:                -2605.1
Date:                Tue, 02 May 2023   Deviance:                       5210.2
Time:                        16:48:57   Pearson chi2:                 6.54e+03
No. Iterations:                     7   Pseudo R-squ. (CS):             0.4011
Covariance Type:            nonrobust
================================================================================
========================================
                                                           coef    std err
z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
----------------------------------------
const                                                   -0.0616      0.126
-0.490      0.624      -0.308       0.185
Do Not Email                                            -1.5192      0.177
-8.594      0.000      -1.866      -1.173
Total Time Spent on Website                              1.0988      0.040
27.251      0.000       1.020       1.178
Lead Origin_Landing Page Submission                     -1.1893      0.128
-9.313      0.000      -1.440      -0.939
Lead Source_Olark Chat                                   1.0922      0.123
8.915      0.000      0.852       1.332
Lead Source_Reference                                    3.3284      0.241
13.787      0.000       2.855       3.802
Lead Source_Welingak Website                             5.8242      0.728
7.999      0.000      4.397       7.251
Last Activity_Olark Chat Conversation                   -0.9545      0.171
-5.568      0.000      -1.290      -0.619
Last Activity_Other_Activity                             2.1869      0.463
4.725      0.000      1.280       3.094
```

```
Last Activity_SMS Sent                                        1.3094      0.075
17.459      0.000       1.162       1.456
Specialization_Others                                        -1.1991      0.126
-9.547      0.000      -1.445      -0.953
What is your current occupation_Working Professional          2.6072      0.194
13.433      0.000       2.227       2.988
Last Notable Activity_Modified                               -0.8886      0.081
-10.930      0.000      -1.048      -0.729
Last Notable Activity_Unreachable                             1.5360      0.473
3.245      0.001       0.608       2.464
================================================================================
========================================
"""
```

[113]:

```python
# Check for the VIF values of the feature variables.
from statsmodels.stats.outliers_influence import variance_inflation_factor

# Create a dataframe that will contain the names of all the feature variables␣
 ↪and their respective VIFs
vif = pd.DataFrame()
vif['Features'] = X_train[col1].columns
vif['VIF'] = [variance_inflation_factor(X_train[col1].values, i) for i in␣
 ↪range(X_train[col1].shape[1])]
vif['VIF'] = round(vif['VIF'], 2)
vif = vif.sort_values(by = "VIF", ascending = False)
vif
```

[113]:

```
                                             Features   VIF
9                               Specialization_Others  2.17
3                              Lead Source_Olark Chat  2.03
11                     Last Notable Activity_Modified  1.78
2                 Lead Origin_Landing Page Submission  1.70
6                Last Activity_Olark Chat Conversation  1.59
8                              Last Activity_SMS Sent  1.57
1                         Total Time Spent on Website  1.29
4                               Lead Source_Reference  1.24
10  What is your current occupation_Working Profes…  1.19
0                                        Do Not Email  1.13
5                         Lead Source_Welingak Website  1.09
7                         Last Activity_Other_Activity  1.01
12                  Last Notable Activity_Unreachable  1.01
```

[114]:

```python
# Dropping the column  'Last Notable Activity_Unreachable' to reduce the␣
 ↪variables
col1 = col1.drop('Last Notable Activity_Unreachable')
```

[115]:

```
X_train_sm = sm.add_constant(X_train[col1])
logm5 = sm.GLM(y_train,X_train_sm, family = sm.families.Binomial())
res = logm5.fit()
res.summary()
```

[115]:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
                 Generalized Linear Model Regression Results
==============================================================================
Dep. Variable:              Converted   No. Observations:                 6351
Model:                            GLM   Df Residuals:                     6338
Model Family:                Binomial   Df Model:                           12
Link Function:                  Logit   Scale:                          1.0000
Method:                          IRLS   Log-Likelihood:                -2610.5
Date:                Tue, 02 May 2023   Deviance:                       5221.0
Time:                        16:49:33   Pearson chi2:                 6.53e+03
No. Iterations:                     7   Pseudo R-squ. (CS):             0.4001
Covariance Type:            nonrobust
================================================================================
========================================
                                                           coef    std err
z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
----------------------------------------
const                                                   -0.0376      0.125
-0.300      0.764      -0.283       0.208
Do Not Email                                            -1.5218      0.177
-8.611      0.000      -1.868      -1.175
Total Time Spent on Website                              1.0954      0.040
27.225      0.000       1.017       1.174
Lead Origin_Landing Page Submission                     -1.1940      0.128
-9.360      0.000      -1.444      -0.944
Lead Source_Olark Chat                                   1.0819      0.122
8.847      0.000       0.842       1.322
Lead Source_Reference                                    3.3166      0.241
13.747      0.000       2.844       3.789
Lead Source_Welingak Website                             5.8115      0.728
7.981      0.000       4.384       7.239
Last Activity_Olark Chat Conversation                   -0.9613      0.171
-5.610      0.000      -1.297      -0.625
Last Activity_Other_Activity                             2.1751      0.463
4.699      0.000       1.268       3.082
Last Activity_SMS Sent                                   1.2942      0.075
17.308      0.000       1.148       1.441
Specialization_Others                                   -1.2025      0.125
-9.582      0.000      -1.448      -0.957
What is your current occupation_Working Professional     2.6083      0.194
```

```
13.454      0.000       2.228       2.988
Last Notable Activity_Modified                          -0.9004      0.081
-11.097      0.000      -1.059      -0.741
================================================================================
========================================
"""
```

[116]:
```
# Check for the VIF values of the feature variables.
from statsmodels.stats.outliers_influence import variance_inflation_factor

# Create a dataframe that will contain the names of all the feature variables␣
 ↪and their respective VIFs
vif = pd.DataFrame()
vif['Features'] = X_train[col1].columns
vif['VIF'] = [variance_inflation_factor(X_train[col1].values, i) for i in␣
 ↪range(X_train[col1].shape[1])]
vif['VIF'] = round(vif['VIF'], 2)
vif = vif.sort_values(by = "VIF", ascending = False)
vif
```

[116]:
```
                                          Features   VIF
9                           Specialization_Others  2.16
3                           Lead Source_Olark Chat  2.03
11                  Last Notable Activity_Modified  1.78
2                Lead Origin_Landing Page Submission  1.69
6               Last Activity_Olark Chat Conversation  1.59
8                           Last Activity_SMS Sent  1.56
1                      Total Time Spent on Website  1.29
4                           Lead Source_Reference  1.24
10  What is your current occupation_Working Profes…  1.18
0                                     Do Not Email  1.13
5                      Lead Source_Welingak Website  1.09
7                     Last Activity_Other_Activity  1.01
```

[117]:
```
cols
```

[117]:
```
Index(['Do Not Email', 'Total Time Spent on Website',
       'Lead Origin_Landing Page Submission', 'Lead Origin_Lead Add Form',
       'Lead Origin_Lead Import', 'Lead Source_Olark Chat',
       'Lead Source_Reference', 'Lead Source_Welingak Website',
       'Last Activity_Olark Chat Conversation', 'Last Activity_Other_Activity',
       'Last Activity_SMS Sent', 'Last Activity_Unsubscribed',
       'Specialization_Others', 'What is your current occupation_Housewife',
       'What is your current occupation_Student',
       'What is your current occupation_Unemployed',
       'What is your current occupation_Working Professional',
       'Last Notable Activity_Had a Phone Conversation',
       'Last Notable Activity_Modified', 'Last Notable Activity_Unreachable'],
      dtype='object')
```

```
[118]: # Getting the predicted values on the train set
       y_train_pred = res.predict(X_train_sm)
       y_train_pred[:10]
```

```
[118]: 3009    0.196697
       1012    0.125746
       9226    0.323477
       4750    0.865617
       7987    0.797752
       1281    0.744001
       2880    0.100027
       4971    0.965845
       7536    0.854512
       1248    0.768071
       dtype: float64
```

```
[119]: X_train_sm.shape
```

```
[119]: (6351, 13)
```

```
[120]: # Reshaping into an array
       y_train_pred = y_train_pred.values.reshape(-1)
       y_train_pred[:10]
```

```
[120]: array([0.19669707, 0.12574636, 0.32347712, 0.86561739, 0.79775204,
              0.74400101, 0.10002735, 0.96584525, 0.85451189, 0.76807088])
```

```
[121]: y_train_pred_final = pd.DataFrame({'Converted':y_train.values, 'Converted_prob':
         ↪y_train_pred})
       y_train_pred_final['Prospect ID'] = y_train.index
       y_train_pred_final.head()
```

```
[121]:    Converted  Converted_prob  Prospect ID
       0          0        0.196697         3009
       1          0        0.125746         1012
       2          0        0.323477         9226
       3          1        0.865617         4750
       4          1        0.797752         7987
```

```
[122]: y_train_pred_final['predicted'] = y_train_pred_final.Converted_prob.map(lambda␣
         ↪x: 1 if x > 0.5 else 0)

       # Let's see the head
       y_train_pred_final.head()
```

```
[122]:    Converted  Converted_prob  Prospect ID  predicted
       0          0        0.196697         3009          0
       1          0        0.125746         1012          0
       2          0        0.323477         9226          0
       3          1        0.865617         4750          1
       4          1        0.797752         7987          1
```

[123]:

```
from sklearn import metrics

# Confusion matrix
confusion = metrics.confusion_matrix(y_train_pred_final.Converted,␣
  ↪y_train_pred_final.predicted )
print(confusion)
```

```
[[3461  444]
 [ 719 1727]]
```

[124]:

```
# Let's check the overall accuracy.
print('Accuracy :',metrics.accuracy_score(y_train_pred_final.Converted,␣
  ↪y_train_pred_final.predicted))
```

```
Accuracy : 0.8168792316170682
```

[125]:

```
TP = confusion[1,1] # true positive
TN = confusion[0,0] # true negatives
FP = confusion[0,1] # false positives
FN = confusion[1,0] # false negatives
```

[126]:

```
# Sensitivity of our logistic regression model
print("Sensitivity : ",TP / float(TP+FN))
```

```
Sensitivity :  0.7060506950122649
```

[127]:

```
# Let us calculate specificity
print("Specificity : ",TN / float(TN+FP))
```

```
Specificity :  0.8862996158770806
```

[128]:

```
# Calculate false postive rate - predicting converted lead when the lead␣
  ↪actually was not converted
print("False Positive Rate :",FP/ float(TN+FP))
```

```
False Positive Rate : 0.11370038412291933
```

[129]:

```
# positive predictive value
print("Positive Predictive Value :",TP / float(TP+FP))
```

```
Positive Predictive Value : 0.7954859511745739
```

[130]:

```
# Negative predictive value
print ("Negative predictive value :",TN / float(TN+ FN))
```

```
Negative predictive value : 0.8279904306220096
```

[131]:

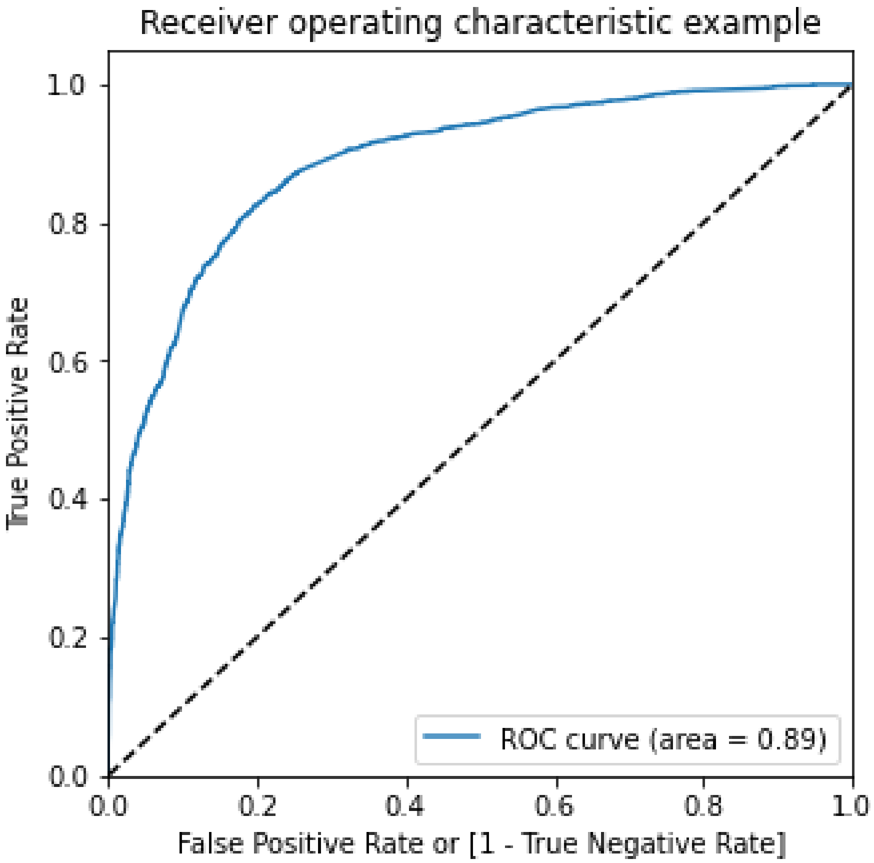
```
def draw_roc( actual, probs ):
    fpr, tpr, thresholds = metrics.roc_curve( actual, probs,
                                              drop_intermediate = False )
    auc_score = metrics.roc_auc_score( actual, probs )
    plt.figure(figsize=(5, 5))
    plt.plot( fpr, tpr, label='ROC curve (area = %0.2f)' % auc_score )
    plt.plot([0, 1], [0, 1], 'k--')
    plt.xlim([0.0, 1.0])
    plt.ylim([0.0, 1.05])
    plt.xlabel('False Positive Rate or [1 - True Negative Rate]')
    plt.ylabel('True Positive Rate')
    plt.title('Receiver operating characteristic example')
    plt.legend(loc="lower right")
    plt.show()

    return None
```

[132]:

```
fpr, tpr, thresholds = metrics.roc_curve( y_train_pred_final.Converted,␣
 ↪y_train_pred_final.Converted_prob,
                                          drop_intermediate = False )
```

[133]:

```
draw_roc(y_train_pred_final.Converted, y_train_pred_final.Converted_prob)
```



```
[134]: # Let's create columns with different probability cutoffs
       numbers = [float(x)/10 for x in range(10)]
       for i in numbers:
           y_train_pred_final[i]= y_train_pred_final.Converted_prob.map(lambda x: 1 if␣
        ↪x > i else 0)
       y_train_pred_final.head()
```

```
[134]:    Converted  Converted_prob  Prospect ID  predicted  0.0  0.1  0.2  0.3  0.4  \
       0          0        0.196697         3009          0    1    1    0    0    0
       1          0        0.125746         1012          0    1    1    0    0    0
       2          0        0.323477         9226          0    1    1    1    1    0
       3          1        0.865617         4750          1    1    1    1    1    1
       4          1        0.797752         7987          1    1    1    1    1    1

          0.5  0.6  0.7  0.8  0.9
       0    0    0    0    0    0
       1    0    0    0    0    0
       2    0    0    0    0    0
       3    1    1    1    1    0
```

```
4    1    1    1    0    0
```

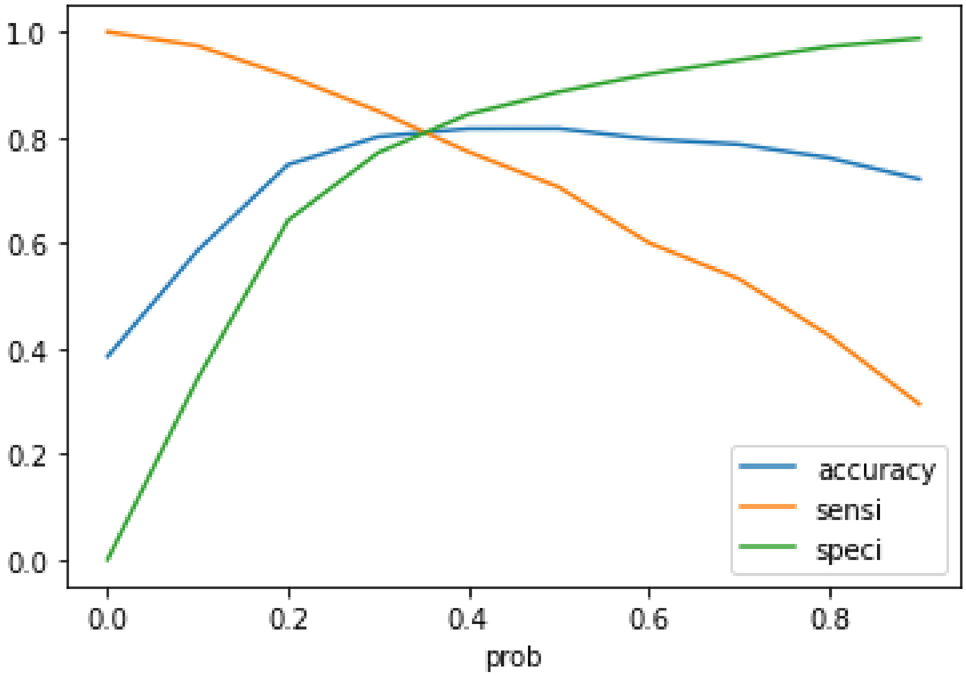
[135]:

```
# Now let's calculate accuracy sensitivity and specificity for various probability cutoffs.
cutoff_df = pd.DataFrame( columns = ['prob','accuracy','sensi','speci'])
from sklearn.metrics import confusion_matrix

# TP = confusion[1,1] # true positive
# TN = confusion[0,0] # true negatives
# FP = confusion[0,1] # false positives
# FN = confusion[1,0] # false negatives

num = [0.0,0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9]
for i in num:
    cm1 = metrics.confusion_matrix(y_train_pred_final.Converted, y_train_pred_final[i] )
    total1=sum(sum(cm1))
    accuracy = (cm1[0,0]+cm1[1,1])/total1

    speci = cm1[0,0]/(cm1[0,0]+cm1[0,1])
    sensi = cm1[1,1]/(cm1[1,0]+cm1[1,1])
    cutoff_df.loc[i] =[ i ,accuracy,sensi,speci]
print(cutoff_df)
```

```
     prob  accuracy     sensi     speci
0.0   0.0  0.385136  1.000000  0.000000
0.1   0.1  0.586049  0.973426  0.343406
0.2   0.2  0.748386  0.916599  0.643022
0.3   0.3  0.801449  0.849959  0.771063
0.4   0.4  0.816564  0.772690  0.844046
0.5   0.5  0.816879  0.706051  0.886300
0.6   0.6  0.797040  0.600572  0.920102
0.7   0.7  0.786963  0.531889  0.946735
0.8   0.8  0.761297  0.424775  0.972087
0.9   0.9  0.720831  0.294767  0.987708
```

[136]:

```
# Let's plot accuracy sensitivity and specificity for various probabilities.
cutoff_df.plot.line(x='prob', y=['accuracy','sensi','speci'])
plt.show()
```



[137]:

```
y_train_pred_final['final_predicted'] = y_train_pred_final.Converted_prob.map(␣
 ↪lambda x: 1 if x > 0.34 else 0)

y_train_pred_final.head()
```

[137]:

```
   Converted  Converted_prob  Prospect ID  predicted  0.0  0.1  0.2  0.3  0.4  \
0          0        0.196697         3009          0    1    1    0    0    0
1          0        0.125746         1012          0    1    1    0    0    0
2          0        0.323477         9226          0    1    1    1    1    0
3          1        0.865617         4750          1    1    1    1    1    1
4          1        0.797752         7987          1    1    1    1    1    1

   0.5  0.6  0.7  0.8  0.9  final_predicted
0    0    0    0    0    0                0
1    0    0    0    0    0                0
2    0    0    0    0    0                0
3    1    1    1    1    0                1
4    1    1    1    0    0                1
```

[138]:

```
y_train_pred_final['Lead_Score'] = y_train_pred_final.Converted_prob.map(␣
 ↪lambda x: round(x*100))

y_train_pred_final.head()
```

```
[138]:    Converted  Converted_prob  Prospect ID  predicted  0.0  0.1  0.2  0.3  0.4  \
       0          0        0.196697         3009          0    1    1    0    0    0
       1          0        0.125746         1012          0    1    1    0    0    0
       2          0        0.323477         9226          0    1    1    1    1    0
       3          1        0.865617         4750          1    1    1    1    1    1
       4          1        0.797752         7987          1    1    1    1    1    1

          0.5  0.6  0.7  0.8  0.9  final_predicted  Lead_Score
       0    0    0    0    0    0                0          20
       1    0    0    0    0    0                0          13
       2    0    0    0    0    0                0          32
       3    1    1    1    1    0                1          87
       4    1    1    1    0    0                1          80
```

6 Model Evaluation

```
[139]: # Let's check the overall accuracy.
       print("Accuracy :",metrics.accuracy_score(y_train_pred_final.Converted,␣
        ↪y_train_pred_final.final_predicted))
```

```
Accuracy : 0.8108959219020627
```

```
[140]: # Confusion matrix
       confusion2 = metrics.confusion_matrix(y_train_pred_final.Converted,␣
        ↪y_train_pred_final.final_predicted )
       confusion2
```

```
[140]: array([[3151,  754],
              [ 447, 1999]], dtype=int64)
```

```
[141]: TP = confusion2[1,1] # true positive
       TN = confusion2[0,0] # true negatives
       FP = confusion2[0,1] # false positives
       FN = confusion2[1,0] # false negatives
```

```
[142]: # Let's see the sensitivity of our logistic regression model
       print("Sensitivity : ",TP / float(TP+FN))
```

```
Sensitivity :  0.8172526573998364
```

```
[143]: # Let us calculate specificity
       print("Specificity :",TN / float(TN+FP))
```

```
Specificity : 0.8069142125480153
```

[144]:
```
# Calculate false postive rate - predicting converted lead when the lead was␣
 ↪actually not have converted
print("False Positive rate : ",FP/ float(TN+FP))
```

```
False Positive rate :  0.19308578745198463
```

[145]:
```
# Positive predictive value
print("Positive Predictive Value :",TP / float(TP+FP))
```

```
Positive Predictive Value : 0.7261169633127498
```

[146]:
```
# Negative predictive value
print("Negative Predictive Value : ",TN / float(TN+ FN))
```

```
Negative Predictive Value :  0.8757643135075042
```

7 Precision and Recall¶

[147]:
```
#Looking at the confusion matrix again

confusion = metrics.confusion_matrix(y_train_pred_final.Converted,␣
 ↪y_train_pred_final.predicted )
confusion
```

[147]:
```
array([[3461,  444],
       [ 719, 1727]], dtype=int64)
```

[148]:
```
# Precision
TP / TP + FP

print("Precision : ",confusion[1,1]/(confusion[0,1]+confusion[1,1]))
```

```
Precision :  0.7954859511745739
```

[149]:
```
# Recall
TP / TP + FN

print("Recall :",confusion[1,1]/(confusion[1,0]+confusion[1,1]))
```

```
Recall : 0.7060506950122649
```

[150]:
```
from sklearn.metrics import precision_score, recall_score
```

[151]:
```
print("Precision :",precision_score(y_train_pred_final.Converted ,␣
 ↪y_train_pred_final.predicted))
```

```
Precision : 0.7954859511745739
```

```
[152]: print("Recall :",recall_score(y_train_pred_final.Converted, y_train_pred_final.
        ↪predicted))
```

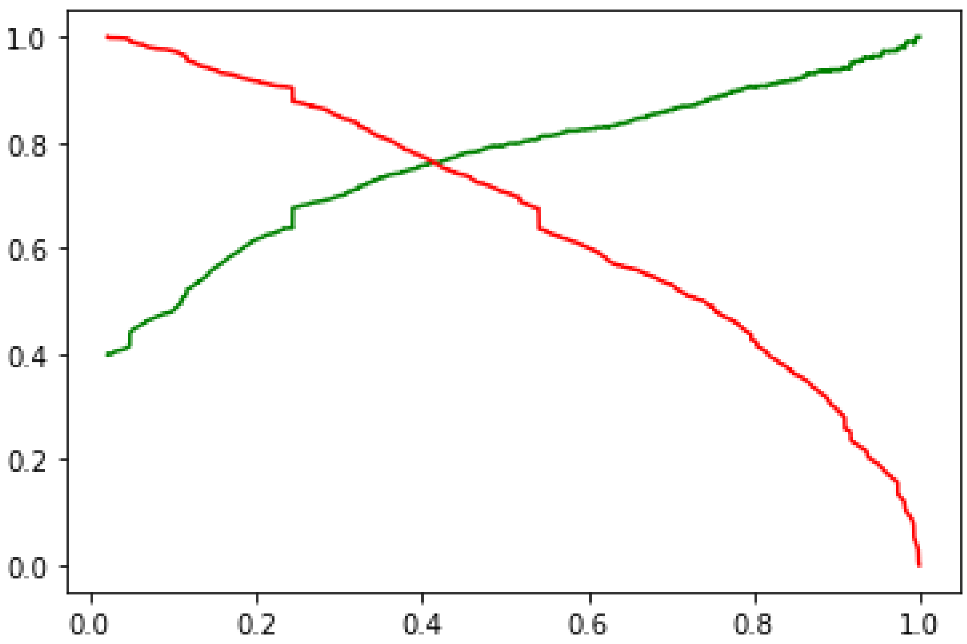
```
Recall : 0.7060506950122649
```

```
[153]: from sklearn.metrics import precision_recall_curve

       y_train_pred_final.Converted, y_train_pred_final.predicted
```

```
[153]: (0       0
        1       0
        2       0
        3       1
        4       1
               ..
        6346    0
        6347    1
        6348    0
        6349    0
        6350    0
        Name: Converted, Length: 6351, dtype: int64,
        0       0
        1       0
        2       0
        3       1
        4       1
               ..
        6346    0
        6347    1
        6348    1
        6349    0
        6350    0
        Name: predicted, Length: 6351, dtype: int64)
```

```
[154]: p, r, thresholds = precision_recall_curve(y_train_pred_final.Converted,␣
        ↪y_train_pred_final.Converted_prob)
```

```
[155]: # plotting a trade-off curve between precision and recall
       plt.plot(thresholds, p[:-1], "g-")
       plt.plot(thresholds, r[:-1], "r-")
       plt.show()
```



8 Making predictions on the test set¶

[156]:
```
X_test
```

[156]:
```
      Do Not Email  Do Not Call  TotalVisits  Total Time Spent on Website  \
3271             0            0          4.0                          157
1490             0            0          5.0                         1513
7936             0            0          2.0                           74
4216             0            0          0.0                            0
3830             0            0          8.0                          164
…              …          …          …                          …
850              0            0          3.0                          829
2879             0            0          2.0                          589
6501             0            0          8.0                         1335
7155             0            0          3.0                          515
376              0            0          4.0                          372

      Page Views Per Visit  Lead Origin_Landing Page Submission  \
3271                   4.0                                    0
1490                   5.0                                    1
7936                   2.0                                    0
4216                   0.0                                    0
3830                   6.0                                    1
…                    …                                  …
850                    1.5                                    1
```

```
2879                   2.0                                    1
6501                   6.0                                    1
7155                   3.0                                    1
376                    4.0                                    1

      Lead Origin_Lead Add Form  Lead Origin_Lead Import  \
3271                          0                        0
1490                          0                        0
7936                          0                        0
4216                          1                        0
3830                          0                        0
…                         …                      …
850                           0                        0
2879                          0                        0
6501                          0                        0
7155                          0                        0
376                           0                        0

      Lead Source_Facebook  Lead Source_Google  …  \
3271                     0                   1  …
1490                     0                   0  …
7936                     0                   1  …
4216                     0                   0  …
3830                     0                   0  …
…                    …                 …  …
850                      0                   1  …
2879                     0                   1  …
6501                     0                   0  …
7155                     0                   0  …
376                      0                   1  …

      Last Notable Activity_Form Submitted on Website  \
3271                                                0
1490                                                0
7936                                                0
4216                                                0
3830                                                0
…                                               …
850                                                 0
2879                                                0
6501                                                0
7155                                                0
376                                                 0

      Last Notable Activity_Had a Phone Conversation  \
3271                                               0
1490                                               0
```

```
7936                                               0
4216                                               0
3830                                               0
…                                              …
850                                                0
2879                                               0
6501                                               0
7155                                               0
376                                                0

      Last Notable Activity_Modified  \
3271                               0
1490                               0
7936                               0
4216                               1
3830                               0
…                              …
850                                1
2879                               1
6501                               0
7155                               1
376                                1

      Last Notable Activity_Olark Chat Conversation  \
3271                                              0
1490                                              0
7936                                              0
4216                                              0
3830                                              0
…                                             …
850                                               0
2879                                              0
6501                                              0
7155                                              0
376                                               0

      Last Notable Activity_Page Visited on Website  \
3271                                              0
1490                                              0
7936                                              0
4216                                              0
3830                                              0
…                                             …
850                                               0
2879                                              0
6501                                              0
7155                                              0
```

```
376                                               0

      Last Notable Activity_Resubscribed to emails  \
3271                                             0
1490                                             0
7936                                             0
4216                                             0
3830                                             0
…                                            …
850                                              0
2879                                             0
6501                                             0
7155                                             0
376                                              0

      Last Notable Activity_SMS Sent  Last Notable Activity_Unreachable  \
3271                               0                                  0
1490                               0                                  0
7936                               0                                  0
4216                               0                                  0
3830                               0                                  0
…                              …                                …
850                                0                                  0
2879                               0                                  0
6501                               1                                  0
7155                               0                                  0
376                                0                                  0

      Last Notable Activity_Unsubscribed  \
3271                                   0
1490                                   0
7936                                   0
4216                                   0
3830                                   0
…                                  …
850                                    0
2879                                   0
6501                                   0
7155                                   0
376                                    0

      Last Notable Activity_View in browser link Clicked
3271                                                  0
1490                                                  0
7936                                                  0
4216                                                  0
3830                                                  0
```

```
…                                                  …
850                                                   0
2879                                                  0
6501                                                  0
7155                                                  0
376                                                   0

[2723 rows x 69 columns]
```

[157]:

```
X_test[['TotalVisits','Total Time Spent on Website','Page Views Per Visit']] =␣
↪scaler.transform(X_test[['TotalVisits',
                                                                              ␣
↪                       'Total Time Spent on Website',
                                                                              ␣
↪                       'Page Views Per Visit']])
```

[158]:

```
X_test
```

[158]:

```
      Do Not Email  Do Not Call  TotalVisits  Total Time Spent on Website  \
3271             0            0     0.284772                    -0.600595
1490             0            0     0.643547                     1.887326
7936             0            0    -0.432779                    -0.752879
4216             0            0    -1.150329                    -0.888650
3830             0            0     1.719873                    -0.587751
…              …          …          …                        …
850              0            0    -0.074003                     0.632357
2879             0            0    -0.432779                     0.192017
6501             0            0     1.719873                     1.560740
7155             0            0    -0.074003                     0.056246
376              0            0     0.284772                    -0.206123

      Page Views Per Visit  Lead Origin_Landing Page Submission  \
3271              0.955505                                    0
1490              1.510766                                    1
7936             -0.155018                                    0
4216             -1.265540                                    0
3830              2.066027                                    1
…                  …                                  …
850              -0.432648                                    1
2879             -0.155018                                    1
6501              2.066027                                    1
7155              0.400244                                    1
376               0.955505                                    1

      Lead Origin_Lead Add Form  Lead Origin_Lead Import  \
3271                          0                        0
1490                          0                        0
```

```
7936                          0                        0
4216                          1                        0
3830                          0                        0
…                         …                      …
850                           0                        0
2879                          0                        0
6501                          0                        0
7155                          0                        0
376                           0                        0

      Lead Source_Facebook  Lead Source_Google  …  \
3271                     0                   1  …
1490                     0                   0  …
7936                     0                   1  …
4216                     0                   0  …
3830                     0                   0  …
…                    …                 …  …
850                      0                   1  …
2879                     0                   1  …
6501                     0                   0  …
7155                     0                   0  …
376                      0                   1  …

      Last Notable Activity_Form Submitted on Website  \
3271                                                0
1490                                                0
7936                                                0
4216                                                0
3830                                                0
…                                               …
850                                                 0
2879                                                0
6501                                                0
7155                                                0
376                                                 0

      Last Notable Activity_Had a Phone Conversation  \
3271                                               0
1490                                               0
7936                                               0
4216                                               0
3830                                               0
…                                              …
850                                                0
2879                                               0
6501                                               0
7155                                               0
```

```
376                                               0

      Last Notable Activity_Modified  \
3271                               0
1490                               0
7936                               0
4216                               1
3830                               0
…                              …
850                                1
2879                               1
6501                               0
7155                               1
376                                1

      Last Notable Activity_Olark Chat Conversation  \
3271                                              0
1490                                              0
7936                                              0
4216                                              0
3830                                              0
…                                             …
850                                               0
2879                                              0
6501                                              0
7155                                              0
376                                               0

      Last Notable Activity_Page Visited on Website  \
3271                                              0
1490                                              0
7936                                              0
4216                                              0
3830                                              0
…                                             …
850                                               0
2879                                              0
6501                                              0
7155                                              0
376                                               0

      Last Notable Activity_Resubscribed to emails  \
3271                                             0
1490                                             0
7936                                             0
4216                                             0
3830                                             0
```

```
…                                            …
850                                              0
2879                                             0
6501                                             0
7155                                             0
376                                              0

      Last Notable Activity_SMS Sent  Last Notable Activity_Unreachable  \
3271                               0                                  0
1490                               0                                  0
7936                               0                                  0
4216                               0                                  0
3830                               0                                  0
…                              …                                …
850                                0                                  0
2879                               0                                  0
6501                               1                                  0
7155                               0                                  0
376                                0                                  0

      Last Notable Activity_Unsubscribed  \
3271                                   0
1490                                   0
7936                                   0
4216                                   0
3830                                   0
…                                  …
850                                    0
2879                                   0
6501                                   0
7155                                   0
376                                    0

      Last Notable Activity_View in browser link Clicked
3271                                                   0
1490                                                   0
7936                                                   0
4216                                                   0
3830                                                   0
…                                                 …
850                                                    0
2879                                                   0
6501                                                   0
7155                                                   0
376                                                    0

[2723 rows x 69 columns]
```

[159]:
```
cols
```

[159]:
```
Index(['Do Not Email', 'Total Time Spent on Website',
       'Lead Origin_Landing Page Submission', 'Lead Origin_Lead Add Form',
       'Lead Origin_Lead Import', 'Lead Source_Olark Chat',
       'Lead Source_Reference', 'Lead Source_Welingak Website',
       'Last Activity_Olark Chat Conversation', 'Last Activity_Other_Activity',
       'Last Activity_SMS Sent', 'Last Activity_Unsubscribed',
       'Specialization_Others', 'What is your current occupation_Housewife',
       'What is your current occupation_Student',
       'What is your current occupation_Unemployed',
       'What is your current occupation_Working Professional',
       'Last Notable Activity_Had a Phone Conversation',
       'Last Notable Activity_Modified', 'Last Notable Activity_Unreachable'],
      dtype='object')
```

[160]:
```
col1
```

[160]:
```
Index(['Do Not Email', 'Total Time Spent on Website',
       'Lead Origin_Landing Page Submission', 'Lead Source_Olark Chat',
       'Lead Source_Reference', 'Lead Source_Welingak Website',
       'Last Activity_Olark Chat Conversation', 'Last Activity_Other_Activity',
       'Last Activity_SMS Sent', 'Specialization_Others',
       'What is your current occupation_Working Professional',
       'Last Notable Activity_Modified'],
      dtype='object')
```

[161]:
```
# Assigning the columns selected by the final model to the X_test
X_test = X_test[col1]
X_test.head()
```

[161]:
```
      Do Not Email  Total Time Spent on Website  \
3271             0                    -0.600595
1490             0                     1.887326
7936             0                    -0.752879
4216             0                    -0.888650
3830             0                    -0.587751

      Lead Origin_Landing Page Submission  Lead Source_Olark Chat  \
3271                                    0                       0
1490                                    1                       0
7936                                    0                       0
4216                                    0                       0
3830                                    1                       0

      Lead Source_Reference  Lead Source_Welingak Website  \
3271                      0                             0
```

```
1490                      0                             0
7936                      0                             0
4216                      1                             0
3830                      0                             0

      Last Activity_Olark Chat Conversation  Last Activity_Other_Activity  \
3271                                      0                             0
1490                                      0                             0
7936                                      0                             0
4216                                      0                             0
3830                                      0                             0

      Last Activity_SMS Sent  Specialization_Others  \
3271                       0                      1
1490                       0                      0
7936                       0                      1
4216                       0                      0
3830                       0                      0

      What is your current occupation_Working Professional  \
3271                                                  0
1490                                                  1
7936                                                  0
4216                                                  0
3830                                                  0

      Last Notable Activity_Modified
3271                               0
1490                               0
7936                               0
4216                               1
3830                               0
```

[162]:

```
# Adding a const
X_test_sm = sm.add_constant(X_test)

# Making predictions on the test set
y_test_pred = res.predict(X_test_sm)
y_test_pred[:10]
```

[162]:

```
3271    0.130342
1490    0.969057
7936    0.112570
4216    0.802999
3830    0.132924
1800    0.635544
6507    0.342648
```

```
4821    0.302742
4223    0.916621
4714    0.323477
dtype: float64
```

[163]:

```
# Converting y_test_pred to a dataframe which is an array
y_pred_1 = pd.DataFrame(y_test_pred)
```

[164]:

```
# Let's see the head
y_pred_1.head()
```

[164]:

```
             0
3271  0.130342
1490  0.969057
7936  0.112570
4216  0.802999
3830  0.132924
```

[165]:

```
# Converting y_test to dataframe
y_test_df = pd.DataFrame(y_test)
```

[166]:

```
# Putting Prospect ID to index
y_test_df['Prospect ID'] = y_test_df.index
```

[167]:

```
# Removing index for both dataframes to append them side by side
y_pred_1.reset_index(drop=True, inplace=True)
y_test_df.reset_index(drop=True, inplace=True)
```

[168]:

```
# Appending y_test_df and y_pred_1
y_pred_final = pd.concat([y_test_df, y_pred_1],axis=1)
```

[169]:

```
y_pred_final.head()
```

[169]:

```
   Converted  Prospect ID         0
0          0         3271  0.130342
1          1         1490  0.969057
2          0         7936  0.112570
3          1         4216  0.802999
4          0         3830  0.132924
```

[170]:

```
# Renaming the column
y_pred_final= y_pred_final.rename(columns={ 0 : 'Converted_prob'})
```

[171]:

```
# Rearranging the columns
y_pred_final = y_pred_final.reindex(columns=['Prospect␣
 ↪ID','Converted','Converted_prob'])
```

[172]:
```
# Let's see the head of y_pred_final
y_pred_final.head()
```

[172]:
```
   Prospect ID  Converted  Converted_prob
0         3271          0        0.130342
1         1490          1        0.969057
2         7936          0        0.112570
3         4216          1        0.802999
4         3830          0        0.132924
```

[173]:
```
y_pred_final['final_predicted'] = y_pred_final.Converted_prob.map(lambda x: 1␣
 ↪if x > 0.34 else 0)
```

[174]:
```
y_pred_final.head()
```

[174]:
```
   Prospect ID  Converted  Converted_prob  final_predicted
0         3271          0        0.130342                0
1         1490          1        0.969057                1
2         7936          0        0.112570                0
3         4216          1        0.802999                1
4         3830          0        0.132924                0
```

[175]:
```
# Let's check the overall accuracy.
print("Accuracy :",metrics.accuracy_score(y_pred_final.Converted, y_pred_final.
 ↪final_predicted))
```

```
Accuracy : 0.8049944913698127
```

[176]:
```
# Making the confusion matrix
confusion2 = metrics.confusion_matrix(y_pred_final.Converted, y_pred_final.
 ↪final_predicted )
confusion2
```

[176]:
```
array([[1396,  338],
       [ 193,  796]], dtype=int64)
```

[177]:
```
TP = confusion2[1,1] # true positive
TN = confusion2[0,0] # true negatives
FP = confusion2[0,1] # false positives
FN = confusion2[1,0] # false negatives
```

[178]:
```
# Let's see the sensitivity of our logistic regression model
print("Sensitivity :",TP / float(TP+FN))
```

```
Sensitivity : 0.8048533872598584
```

```
[179]: # Let us calculate specificity
       print("Specificity :",TN / float(TN+FP))
```

```
Specificity : 0.8050749711649365
```

```
[180]: y_pred_final['Lead_Score'] = y_pred_final.Converted_prob.map( lambda x:␣
         ↪round(x*100))

       y_pred_final.head()
```

```
[180]:    Prospect ID  Converted  Converted_prob  final_predicted  Lead_Score
       0         3271          0        0.130342                0          13
       1         1490          1        0.969057                1          97
       2         7936          0        0.112570                0          11
       3         4216          1        0.802999                1          80
       4         3830          0        0.132924                0          13
```

```
[181]: hot_leads=y_pred_final.loc[y_pred_final["Lead_Score"]>=85]
       hot_leads
```

```
[181]:       Prospect ID  Converted  Converted_prob  final_predicted  Lead_Score
       1            1490          1        0.969057                1          97
       8            4223          1        0.916621                1          92
       16           1946          1        0.924467                1          92
       21           2461          1        0.992551                1          99
       23           5822          1        0.997991                1         100
       …              …         …               …                …           …
       2694         1566          1        0.947723                1          95
       2699         6461          1        0.961562                1          96
       2703         5741          1        0.908283                1          91
       2715         6299          1        0.871977                1          87
       2720         6501          1        0.854745                1          85

       [368 rows x 5 columns]
```

```
[182]: print("The Prospect ID of the customers which should be contacted are :")

       hot_leads_ids = hot_leads["Prospect ID"].values.reshape(-1)
       hot_leads_ids
```

```
The Prospect ID of the customers which should be contacted are :
```

```
[182]: array([1490, 4223, 1946, 2461, 5822, 2684, 2010, 4062, 7696, 9049, 1518,
              4543, 4830, 4365, 3542, 2504, 7674, 8596, 4003, 4963, 6947, 4807,
               446,  789, 8372, 5805, 3758, 1561, 5367,  737, 6423, 8286, 7174,
              4461, 1436, 7552, 3932, 4080, 1475, 5785, 2860, 7253, 4297, 5490,
              1995, 4498, 5797, 8687,  831, 7653, 2018, 6743, 3976, 5769, 1051,
              1663, 3288, 8959, 7521, 8282, 8213, 9063, 5292, 6913, 1481,  785,
              3265, 3285, 7433, 3858, 3810, 2009, 8106,  373, 7417, 4179, 8568,
              7268, 6784, 6754, 7236, 2960, 7753, 3983,  802, 8745, 4717,  505,
              8509, 6094, 4992, 7036, 2680, 7065,  112, 6149, 7157, 7175, 1675,
              6999, 5826, 8492, 6499, 2481, 3439, 4612, 7129, 4793, 4837, 2495,
               822, 8111, 2378, 5075, 7699, 5638, 2342, 8077, 2727,  720, 7489,
              2961, 1542, 5656, 2630, 6728, 8205, 6332, 8461, 2427, 5087,  174,
              2674, 8065, 2095, 1568, 8597, 4865, 3535, 4708, 1304, 6066, 6538,
              5700, 1388, 5815, 7970, 7902, 5804, 7805, 5042, 4081, 6684, 5440,
              1927, 5032, 5824,   64, 2650, 5808, 4578, 4803, 1470, 5810, 2473,
              2584, 2578, 7259, 3727, 1454, 6064, 3150, 2118, 4403, 3194, 8475,
              1200, 2575, 1299, 1525, 4613, 4909, 8204, 4772, 1374, 8888, 8082,
              4862, 1595, 8942, 1899, 8474, 3463, 2022, 7893, 3248, 6486, 1729,
              8620, 1190, 2486, 2158, 3355, 5353, 2994, 4559, 8521,  973, 7168,
              4677, 7537,  493, 1563, 4860, 9076, 2153, 5389, 1783, 2105, 1578,
              6729, 1263, 2011, 4330, 6252, 1820, 6760, 3015, 2285, 7091, 2598,
              7018, 6290, 5061,  356, 8271, 4285, 8540, 2854, 8375, 4310, 4505,
              1979, 3532, 1444, 4934, 8804, 1416, 7334, 2652, 7057, 5525, 2560,
              3085, 7445, 3396, 9062, 2943, 7690, 8198, 4233, 8265, 7750,  353,
              8088, 7193, 7978, 8928, 6685, 4378, 5455, 5363, 2354, 2714,  718,
              2559, 5000, 2664, 6040, 4068, 3570, 9043, 8090, 2483, 3762, 4112,
              1407, 6740, 6892, 5175,  662, 8452, 7304, 3207, 8505, 6175, 5561,
              5633, 8415, 3660, 3770,  220, 6994, 4253, 1112, 3723, 6725,  746,
              8592, 3496, 5502, 4241, 6933, 4388, 7021, 3097, 3836, 4116, 6314,
              8322, 3165, 6723, 3817, 1534, 1360, 7053, 6944, 4671, 5877, 2673,
              3146,  745, 1950, 4382, 2174, 1682, 7240, 6375, 7941, 5293, 3736,
              7450, 2617, 6127, 4371, 1026, 8113, 6242, 1089, 2841, 7136, 3477,
              2763, 6890, 4734, 7823, 2870, 5337, 4879, 1467, 3942, 8343, 8052,
              1566, 6461, 5741, 6299, 6501], dtype=int64)
```

[183]:

```
res.params.sort_values(ascending=False)
```

[183]:

```
Lead Source_Welingak Website                            5.811465
Lead Source_Reference                                   3.316598
What is your current occupation_Working Professional    2.608292
Last Activity_Other_Activity                            2.175096
Last Activity_SMS Sent                                  1.294180
Total Time Spent on Website                             1.095412
Lead Source_Olark Chat                                  1.081908
const                                                  -0.037565
Last Notable Activity_Modified                         -0.900449
Last Activity_Olark Chat Conversation                  -0.961276
Lead Origin_Landing Page Submission                    -1.193957
Specialization_Others                                  -1.202474
Do Not Email                                           -1.521825
dtype: float64
```

[ ]:

```
```