In [1]:

```
import numpy as np
import pandas as pd
```

In [2]:

```
import warnings
warnings.filterwarnings('ignore')
```

In [3]:

```
lead_data=pd.read_csv('machine learning data/leads.csv')
```

In [4]:

```
lead_data.head()
```

Out[4]:

	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	...	Get updates on DM Content	Lead Profile	City	As A
0	7927b2df-8bba-4d29-b9a2-b6e0beafe620	660737	API	Olark Chat	No	No	0	0.0	0	0.0	...	No	Select	Select	
1	2a272436-5132-4136-86fa-dcc88c88f482	660728	API	Organic Search	No	No	0	5.0	674	2.5	...	No	Select	Select	
2	8cc8c611-a219-4f35-ad23-fdfd2656bd8a	660727	Landing Page Submission	Direct Traffic	No	No	1	2.0	1532	2.0	...	No	Potential Lead	Mumbai	
3	0cc2df48-7cf4-4e39-9de9-19797f9b38cc	660719	Landing Page Submission	Direct Traffic	No	No	0	1.0	305	1.0	...	No	Select	Mumbai	
4	3256f628-e534-4826-9d63-4a8b88782852	660681	Landing Page Submission	Google	No	No	1	2.0	1428	1.0	...	No	Select	Mumbai	

5 rows × 37 columns

In [5]:

```
lead_data.shape
```

Out[5]:

```
(9240, 37)
```

In [6]:

```
lead_data.describe()
```

Out[6]:

	Lead Number	Converted	TotalVisits	Total Time Spent on Website	Page Views Per Visit	Asymmetrique Activity Score	Asymmetrique Profile Score
count	9240.000000	9240.000000	9103.000000	9240.000000	9103.000000	5022.000000	5022.000000
mean	617188.435606	0.385390	3.445238	487.698268	2.362820	14.306252	16.344883

	Lead Number	Converted	TotalVisits	Total Time Spent on Website	Page Views Per Visit	Asymmetrique Activity Score	Asymmetrique Profile Score
std	23405.995698	0.486714	4.854853	548.021466	2.161418	1.386694	1.811395
min	579533.000000	0.000000	0.000000	0.000000	0.000000	7.000000	11.000000
25%	596484.500000	0.000000	1.000000	12.000000	1.000000	14.000000	15.000000
50%	615479.000000	0.000000	3.000000	248.000000	2.000000	14.000000	16.000000
75%	637387.250000	1.000000	5.000000	936.000000	3.000000	15.000000	18.000000
max	660737.000000	1.000000	251.000000	2272.000000	55.000000	18.000000	20.000000

In [7]:

```
lead_data=lead_data.replace('Select',np.nan)
```

In [8]:

```
lead_data.isnull().sum()
```

Out[8]:

```
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
```

In [9]:

```
round(100*(lead_data.isnull().sum()/len(lead_data.index)),2)
```

Out[9]:

```
Prospect ID                                    0.00
Lead Number                                    0.00
Lead Origin                                    0.00
Lead Source                                    0.39
Do Not Email                                   0.00
Do Not Call                                    0.00
Converted                                      0.00
TotalVisits                                    1.48
```

```
Total Time Spent on Website                      0.00
Page Views Per Visit                             1.48
Last Activity                                    1.11
Country                                         26.63
Specialization                                  36.58
How did you hear about X Education              78.46
What is your current occupation                 29.11
What matters most to you in choosing a course   29.32
Search                                           0.00
Magazine                                         0.00
Newspaper Article                                0.00
X Education Forums                               0.00
Newspaper                                        0.00
Digital Advertisement                            0.00
Through Recommendations                          0.00
Receive More Updates About Our Courses           0.00
Tags                                            36.29
Lead Quality                                    51.59
Update me on Supply Chain Content                0.00
Get updates on DM Content                        0.00
Lead Profile                                    74.19
City                                            39.71
Asymmetrique Activity Index                     45.65
Asymmetrique Profile Index                      45.65
Asymmetrique Activity Score                     45.65
Asymmetrique Profile Score                      45.65
I agree to pay the amount through cheque         0.00
A free copy of Mastering The Interview           0.00
Last Notable Activity                            0.00
dtype: float64
```

In [10]:

```
cols=lead_data.columns
for i in cols:
    if((100*(lead_data[i].isnull().sum()/len(lead_data.index)))>=45):
        lead_data.drop(i,1,inplace=True)
```

In [11]:

```
round(100*(lead_data.isnull().sum()/len(lead_data.index)),2)
```

Out[11]:

```
Prospect ID                                      0.00
Lead Number                                      0.00
Lead Origin                                      0.00
Lead Source                                      0.39
Do Not Email                                     0.00
Do Not Call                                      0.00
Converted                                        0.00
TotalVisits                                      1.48
Total Time Spent on Website                      0.00
Page Views Per Visit                             1.48
Last Activity                                    1.11
Country                                         26.63
Specialization                                  36.58
What is your current occupation                 29.11
What matters most to you in choosing a course   29.32
Search                                           0.00
Magazine                                         0.00
Newspaper Article                                0.00
X Education Forums                               0.00
Newspaper                                        0.00
Digital Advertisement                            0.00
Through Recommendations                          0.00
Receive More Updates About Our Courses           0.00
Tags                                            36.29
Update me on Supply Chain Content                0.00
Get updates on DM Content                        0.00
City                                            39.71
I agree to pay the amount through cheque         0.00
A free copy of Mastering The Interview           0.00
Last Notable Activity                            0.00
dtype: float64
```

--

categorical attribute analysis

In [12]:

```
lead_data['Country'].value_counts(dropna=False)
```

Out[12]:

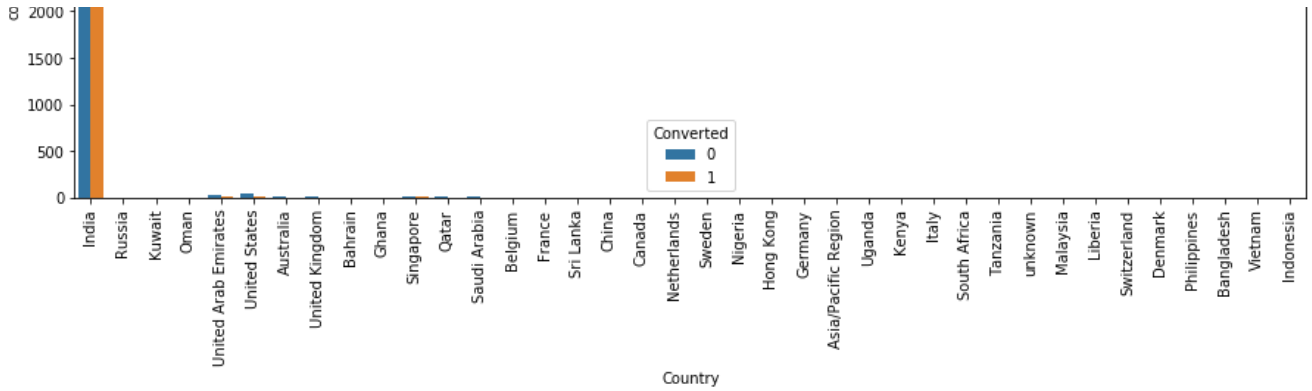
```
India                   6492
NaN                     2461
United States             69
United Arab Emirates      53
Singapore                 24
Saudi Arabia              21
United Kingdom            15
Australia                 13
Qatar                     10
Bahrain                    7
Hong Kong                  7
France                     6
Oman                       6
unknown                    5
Nigeria                    4
Canada                     4
Germany                    4
Kuwait                     4
South Africa               4
Sweden                     3
Italy                      2
China                      2
Philippines                2
Belgium                    2
Bangladesh                 2
Ghana                      2
Uganda                     2
Asia/Pacific Region        2
Netherlands                2
Sri Lanka                  1
Vietnam                    1
Kenya                      1
Switzerland                1
Russia                     1
Denmark                    1
Malaysia                   1
Indonesia                  1
Liberia                    1
Tanzania                   1
Name: Country, dtype: int64
```

In [13]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

In [14]:

```
plt.figure(figsize=(15,5))
s1=sns.countplot(lead_data.Country, hue=lead_data.Converted)
s1.set_xticklabels(s1.get_xticklabels(),rotation=90)
plt.show()
```

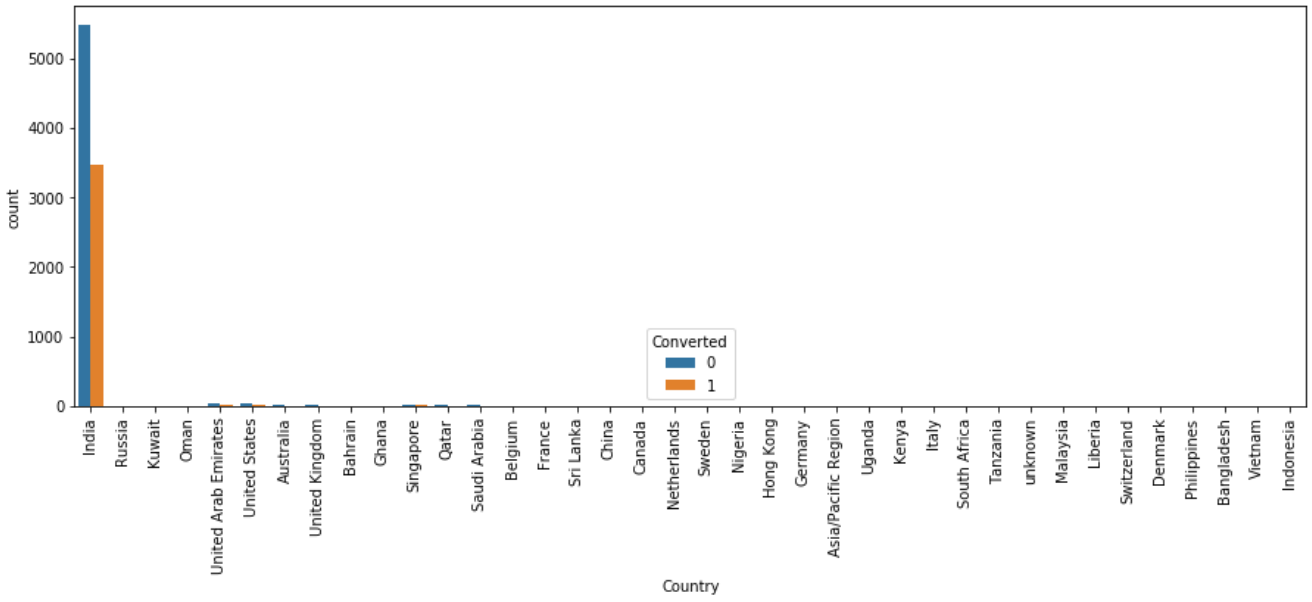


In [15]:

```
lead_data['Country'] = lead_data['Country'].replace(np.nan,'India')
```

In [16]:

```
plt.figure(figsize=(15,5))
s1=sns.countplot(lead_data.Country, hue=lead_data.Converted)
s1.set_xticklabels(s1.get_xticklabels(),rotation=90)
plt.show()
```



In [17]:

```
cols_to_drop=['Country']
```

In [18]:

```
lead_data['City'].value_counts(dropna=False)
```

Out[18]:

```
NaN                          3669
Mumbai                       3222
Thane & Outskirts             752
Other Cities                  686
Other Cities of Maharashtra   457
Other Metro Cities            380
Tier II Cities                 74
Name: City, dtype: int64
```

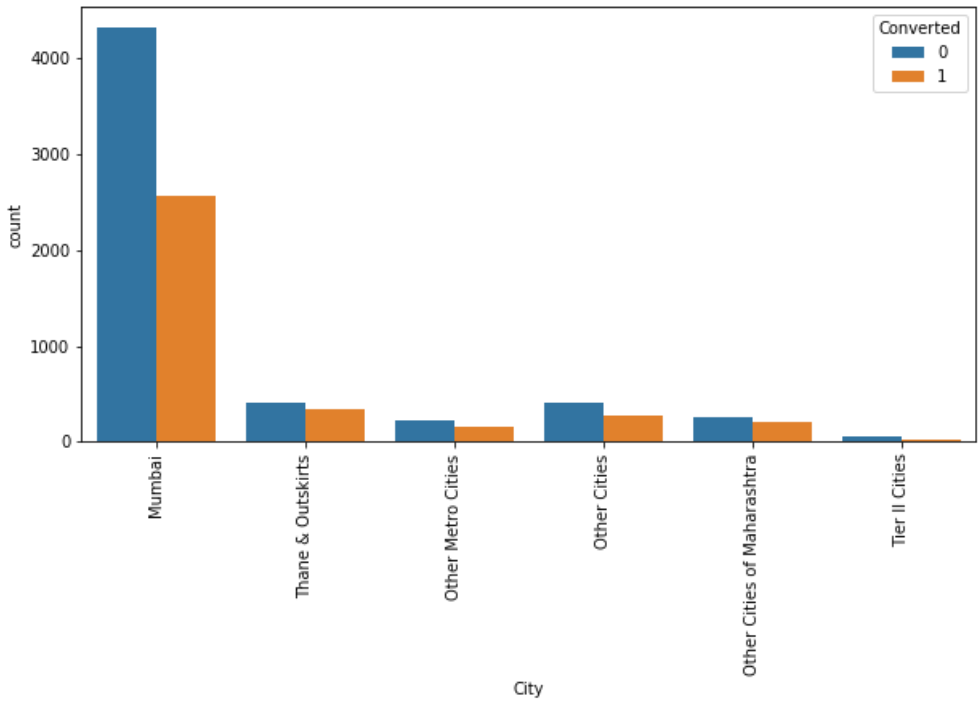
In [19]:

```
lead_data['City'] = lead_data['City'].replace(np.nan,'Mumbai')
```

```
lead_data['City'] = lead_data['City'].replace(np.nan,'Mumbai')
```

In [20]:

```
plt.figure(figsize=(10,5))
s1=sns.countplot(lead_data.City, hue=lead_data.Converted)
s1.set_xticklabels(s1.get_xticklabels(),rotation=90)
plt.show()
```



In [21]:

```
#checking value counts of Specialization column

lead_data['Specialization'].value_counts(dropna=False)
```

Out[21]:

```
NaN                                3380
Finance Management                  976
Human Resource Management           848
Marketing Management                838
Operations Management               503
Business Administration             403
IT Projects Management              366
Supply Chain Management             349
Banking, Investment And Insurance   338
Travel and Tourism                  203
Media and Advertising               203
International Business              178
Healthcare Management               159
Hospitality Management              114
E-COMMERCE                          112
Retail Management                   100
Rural and Agribusiness               73
E-Business                           57
Services Excellence                  40
Name: Specialization, dtype: int64
```

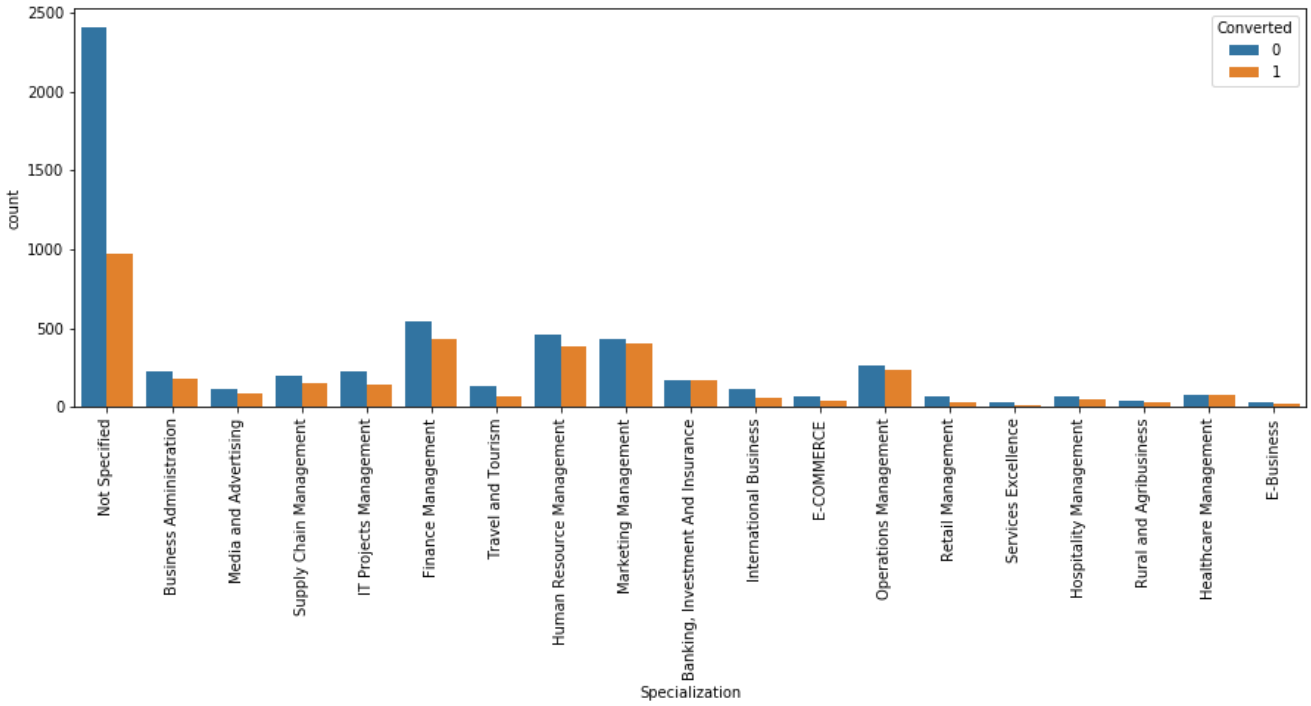
In [22]:

```
lead_data['Specialization'] = lead_data['Specialization'].replace(np.nan, 'Not Specified')
```

In [23]:

```
plt.figure(figsize=(15,5))
```

```
s1=sns.countplot(lead_data.Specialization, hue=lead_data.Converted)
s1.set_xticklabels(s1.get_xticklabels(),rotation=90)
plt.show()
```

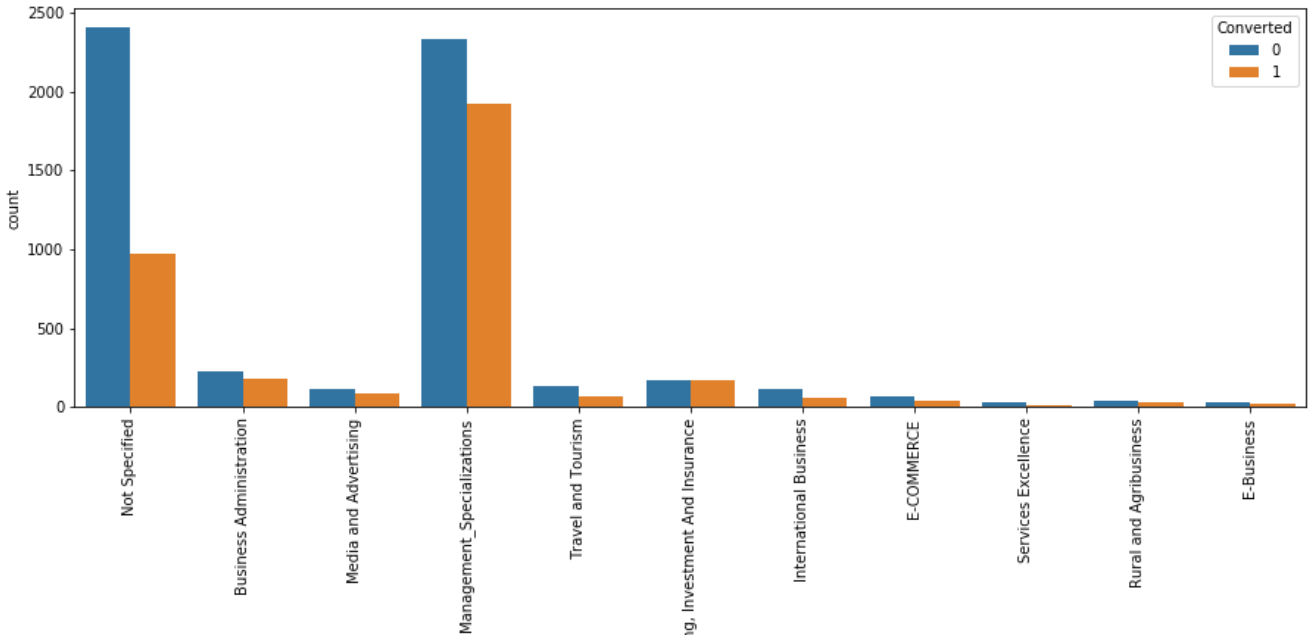


In [24]:

```
lead_data['Specialization'] = lead_data['Specialization'].replace(['Finance Management','Human
Resource Management','Marketing Management','Operations Management',
                                                    'IT Projects Management','Supply Chain M
agement','Healthcare Management','Hospitality Management',
                                                    'Retail Management']
,'Management_Specializations')
```

In [25]:

```
#visualizing count of Variable based on Converted value


plt.figure(figsize=(15,5))
s1=sns.countplot(lead_data.Specialization, hue=lead_data.Converted)
s1.set_xticklabels(s1.get_xticklabels(),rotation=90)
plt.show()
```



Bankir
Specialization

In [26]:

```
lead_data['What is your current occupation'].value_counts(dropna=False)
```

Out[26]:

```
Unemployed              5600
NaN                     2690
Working Professional     706
Student                  210
Other                     16
Housewife                 10
Businessman                8
Name: What is your current occupation, dtype: int64
```

In [27]:

```
lead_data['What is your current occupation'] = lead_data['What is your current
occupation'].replace(np.nan, 'Unemployed')
```

In [28]:

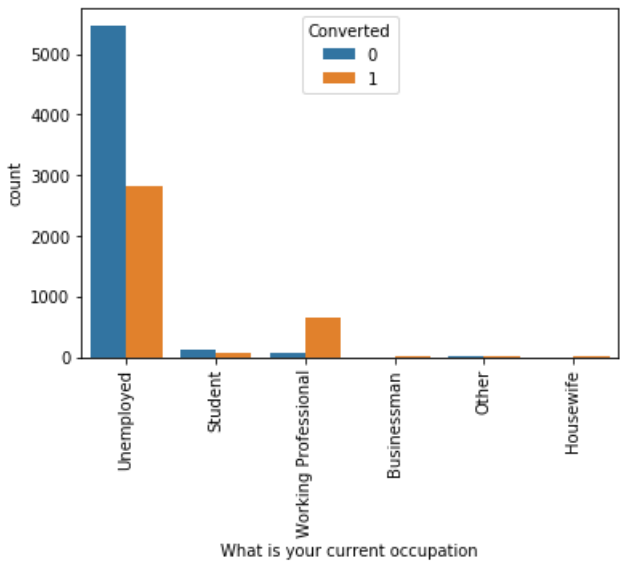
```
lead_data['What is your current occupation'].value_counts(dropna=False)
```

Out[28]:

```
Unemployed              8290
Working Professional     706
Student                  210
Other                     16
Housewife                 10
Businessman                8
Name: What is your current occupation, dtype: int64
```

In [29]:

```
s1=sns.countplot(lead_data['What is your current occupation'], hue=lead_data.Converted)
s1.set_xticklabels(s1.get_xticklabels(),rotation=90)
plt.show()
```



In [30]:

```
lead_data['What matters most to you in choosing a course'].value_counts(dropna=False)
```

Out[30]:

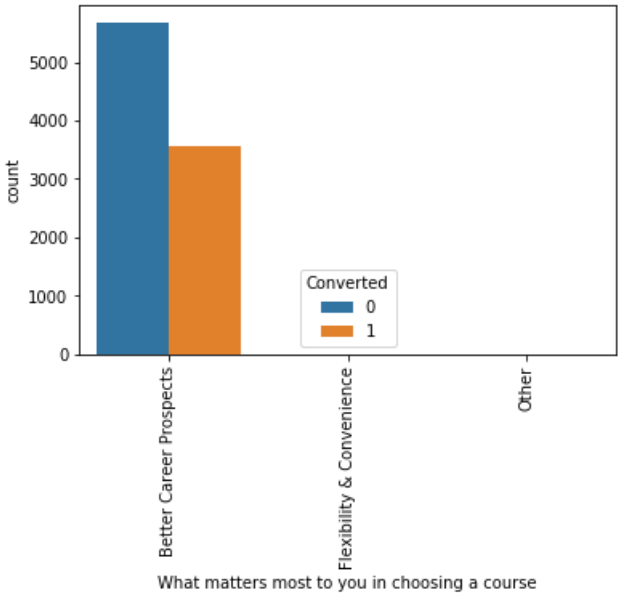
```
Better Career Prospects      6528
NaN                          2709
Flexibility & Convenience       2
Other                           1
Name: What matters most to you in choosing a course, dtype: int64
```

In [31]:

```
lead_data['What matters most to you in choosing a course'] = lead_data['What matters most to you i
n choosing a course'].replace(np.nan,'Better Career Prospects')
```

In [32]:

```
s1=sns.countplot(lead_data['What matters most to you in choosing a course'], hue=lead_data.Convert
ed)
s1.set_xticklabels(s1.get_xticklabels(),rotation=90)
plt.show()
```



In [33]:

```
lead_data['What matters most to you in choosing a course'].value_counts(dropna=False)
```

Out[33]:

```
Better Career Prospects      9237
Flexibility & Convenience       2
Other                           1
Name: What matters most to you in choosing a course, dtype: int64
```

In [34]:

```
cols_to_drop.append('What matters most to you in choosing a course')
cols_to_drop
```

Out[34]:

```
['Country', 'What matters most to you in choosing a course']
```

In [35]:

```
lead_data['Tags'].value_counts(dropna=False)
```

Out[35]:

```
NaN                                              3353
Will revert after reading the email              2072
```

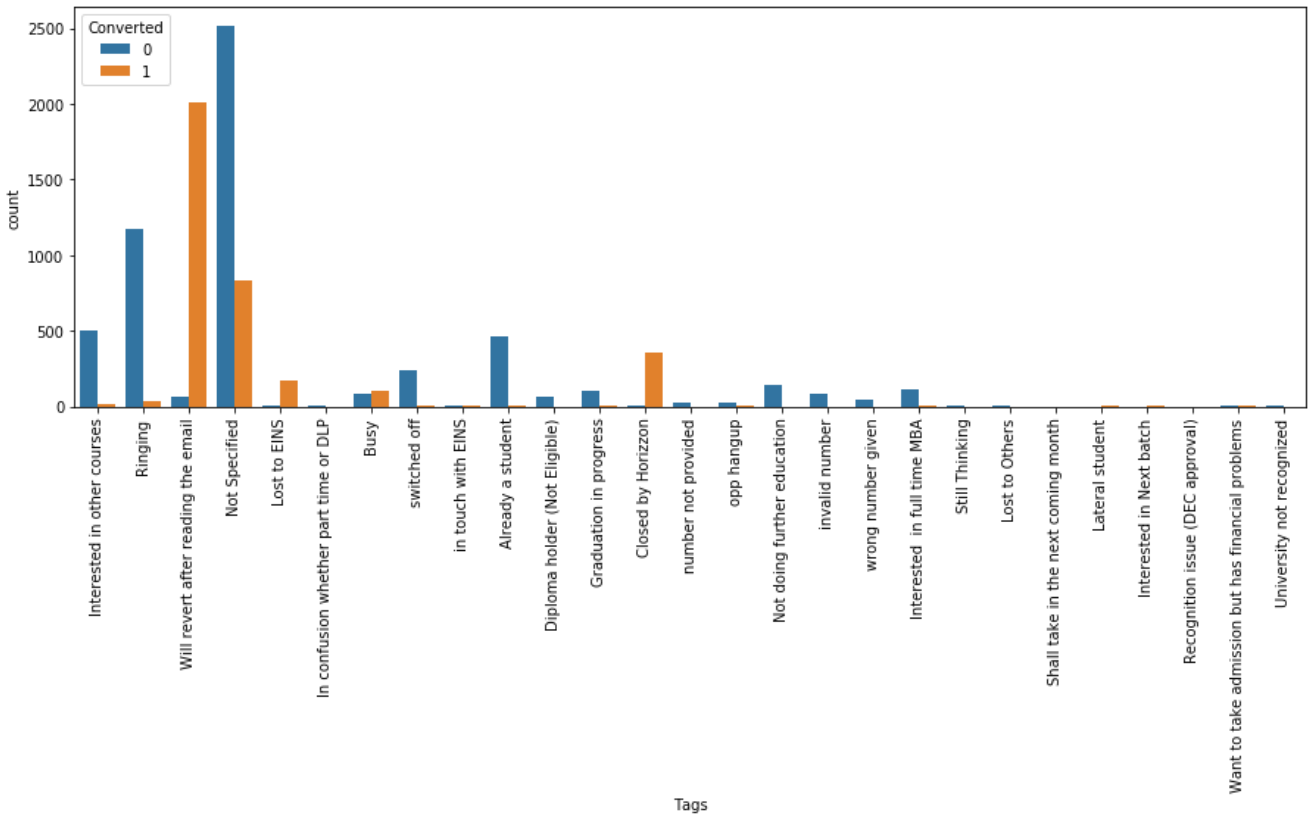
```
Ringing                                              1203
Interested in other courses                           513
Already a student                                     465
Closed by Horizzon                                    358
switched off                                          240
Busy                                                  186
Lost to EINS                                          175
Not doing further education                           145
Interested  in full time MBA                          117
Graduation in progress                                111
invalid number                                         83
Diploma holder (Not Eligible)                          63
wrong number given                                     47
opp hangup                                             33
number not provided                                    27
in touch with EINS                                     12
Lost to Others                                          7
Want to take admission but has financial problems       6
Still Thinking                                          6
In confusion whether part time or DLP                   5
Interested in Next batch                                5
Lateral student                                         3
Shall take in the next coming month                     2
University not recognized                               2
Recognition issue (DEC approval)                        1
Name: Tags, dtype: int64
```

In [36]:

```
#replacing Nan values with "Not Specified"
lead_data['Tags'] = lead_data['Tags'].replace(np.nan,'Not Specified')
```

In [37]:

```
plt.figure(figsize=(15,5))
s1=sns.countplot(lead_data['Tags'], hue=lead_data.Converted)
s1.set_xticklabels(s1.get_xticklabels(),rotation=90)
plt.show()
```



In [38]:

```
lead data['Tags'] = lead data['Tags'].replace(['In confusion whether part time or DLP', 'in touch
```

```
with EINS','Diploma holder (Not Eligible)',
                                     'Approached upfront','Graduation in progress','number not prov
ded', 'opp hangup','Still Thinking',
                                    'Lost to Others','Shall take in the next coming month','Lateral
student','Interested in Next batch',
                                    'Recognition issue (DEC approval)','Want to take admission but
as financial problems',
                                    'University not recognized'], 'Other_Tags')

lead_data['Tags'] = lead_data['Tags'].replace(['switched off','Already a student','Not doing
further education','invalid number', 'wrong number given', 'Interested  in full time MBA'] , 'Other
_Tags')
```

In [39]:

```
#checking percentage of missing values
round(100*(lead_data.isnull().sum()/len(lead_data.index)), 2)
```

Out[39]:

```
Prospect ID                                      0.00
Lead Number                                      0.00
Lead Origin                                      0.00
Lead Source                                      0.39
Do Not Email                                     0.00
Do Not Call                                      0.00
Converted                                        0.00
TotalVisits                                      1.48
Total Time Spent on Website                      0.00
Page Views Per Visit                             1.48
Last Activity                                    1.11
Country                                          0.00
Specialization                                   0.00
What is your current occupation                  0.00
What matters most to you in choosing a course    0.00
Search                                           0.00
Magazine                                         0.00
Newspaper Article                                0.00
X Education Forums                               0.00
Newspaper                                        0.00
Digital Advertisement                            0.00
Through Recommendations                          0.00
Receive More Updates About Our Courses           0.00
Tags                                             0.00
Update me on Supply Chain Content                0.00
Get updates on DM Content                        0.00
City                                             0.00
I agree to pay the amount through cheque         0.00
A free copy of Mastering The Interview           0.00
Last Notable Activity                            0.00
dtype: float64
```

In [40]:

```
lead_data['Lead Source'].value_counts(dropna=False)
```

Out[40]:

```
Google               2868
Direct Traffic       2543
Olark Chat           1755
Organic Search       1154
Reference             534
Welingak Website      142
Referral Sites        125
Facebook               55
NaN                    36
bing                    6
google                  5
Click2call              4
Press_Release           2
Social Media            2
Live Chat               2
NC_EDM                  1
```

```
Pay per Click Ads       1
youtubechannel          1
WeLearn                 1
welearnblog_Home        1
testone                 1
blog                    1
Name: Lead Source, dtype: int64
```

In [41]:

```
#replacing Nan Values and combining low frequency values
lead_data['Lead Source'] = lead_data['Lead Source'].replace(np.nan,'Others')
lead_data['Lead Source'] = lead_data['Lead Source'].replace('google','Google')
lead_data['Lead Source'] = lead_data['Lead Source'].replace('Facebook','Social Media')
lead_data['Lead Source'] = lead_data['Lead Source'].replace(['bing','Click2call','Press_Release','
youtubechannel','welearnblog_Home','WeLearn','blog','Pay per Click Ads',
                                                    'testone','NC_EDM'] ,'Others')
```

In [42]:

```
lead_data['Last Activity'].value_counts(dropna=False)
```

Out[42]:

```
Email Opened                    3437
SMS Sent                        2745
Olark Chat Conversation          973
Page Visited on Website          640
Converted to Lead                428
Email Bounced                    326
Email Link Clicked               267
Form Submitted on Website        116
NaN                              103
Unreachable                       93
Unsubscribed                      61
Had a Phone Conversation          30
Approached upfront                 9
View in browser link Clicked       6
Email Received                     2
Email Marked Spam                  2
Visited Booth in Tradeshow         1
Resubscribed to emails             1
Name: Last Activity, dtype: int64
```

In [43]:

```
lead_data['Last Activity'] = lead_data['Last Activity'].replace(np.nan,'Others')
lead_data['Last Activity'] = lead_data['Last Activity'].replace(['Unreachable','Unsubscribed','Had
a Phone Conversation',  'Approached upfront',
                                                    'View in browser link Clicked','Email Marke
Spam',
                                                    'Email Received','Resubscribed to emails',
isited Booth in Tradeshow'],'Others')
```

In [44]:

```
lead_data['Last Activity'].value_counts(dropna=False)
```

Out[44]:

```
Email Opened                 3437
SMS Sent                     2745
Olark Chat Conversation       973
Page Visited on Website       640
Converted to Lead             428
Email Bounced                 326
Others                        308
Email Link Clicked            267
Form Submitted on Website     116
Name: Last Activity, dtype: int64
```

In [45]:

```
#Check the Null Values in All Columns:
round(100*(lead_data.isnull().sum()/len(lead_data.index)), 2)
```

Out[45]:

```
Prospect ID                                      0.00
Lead Number                                      0.00
Lead Origin                                      0.00
Lead Source                                      0.00
Do Not Email                                     0.00
Do Not Call                                      0.00
Converted                                        0.00
TotalVisits                                      1.48
Total Time Spent on Website                      0.00
Page Views Per Visit                             1.48
Last Activity                                    0.00
Country                                          0.00
Specialization                                   0.00
What is your current occupation                  0.00
What matters most to you in choosing a course    0.00
Search                                           0.00
Magazine                                         0.00
Newspaper Article                                0.00
X Education Forums                               0.00
Newspaper                                        0.00
Digital Advertisement                            0.00
Through Recommendations                          0.00
Receive More Updates About Our Courses           0.00
Tags                                             0.00
Update me on Supply Chain Content                0.00
Get updates on DM Content                        0.00
City                                             0.00
I agree to pay the amount through cheque         0.00
A free copy of Mastering The Interview           0.00
Last Notable Activity                            0.00
dtype: float64
```

In [46]:

```
lead_data = lead_data.dropna()
```

In [47]:

```
round(100*(lead_data.isnull().sum()/len(lead_data.index)), 2)
```

Out[47]:

```
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
What matters most to you in choosing a course    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
```

In [48]:

```
#Lead Origin
lead_data['Lead Origin'].value_counts(dropna=False)
```

Out[48]:

```
Landing Page Submission    4886
API                        3578
Lead Add Form               608
Lead Import                  31
Name: Lead Origin, dtype: int64
```

In [49]:

```
#checking value counts for Do Not Call
lead_data['Do Not Call'].value_counts(dropna=False)
```

Out[49]:

```
No     9101
Yes       2
Name: Do Not Call, dtype: int64
```

In [50]:

```
#checking value counts for Do Not Email
lead_data['Do Not Email'].value_counts(dropna=False)
```

Out[50]:

```
No     8379
Yes     724
Name: Do Not Email, dtype: int64
```

In [51]:

```
cols_to_drop.extend(['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'])
```

In [52]:

```
lead_data.drop(['Prospect ID','Lead Number'],1,inplace=True)
```

In [53]:

```
#checking value counts of last Notable Activity
lead_data['Last Notable Activity'].value_counts()
```

Out[53]:

```
Modified                       3270
Email Opened                   2827
SMS Sent                       2172
Page Visited on Website         318
Olark Chat Conversation         183
Email Link Clicked              173
Email Bounced                    60
Unsubscribed                     47
Unreachable                      32
```

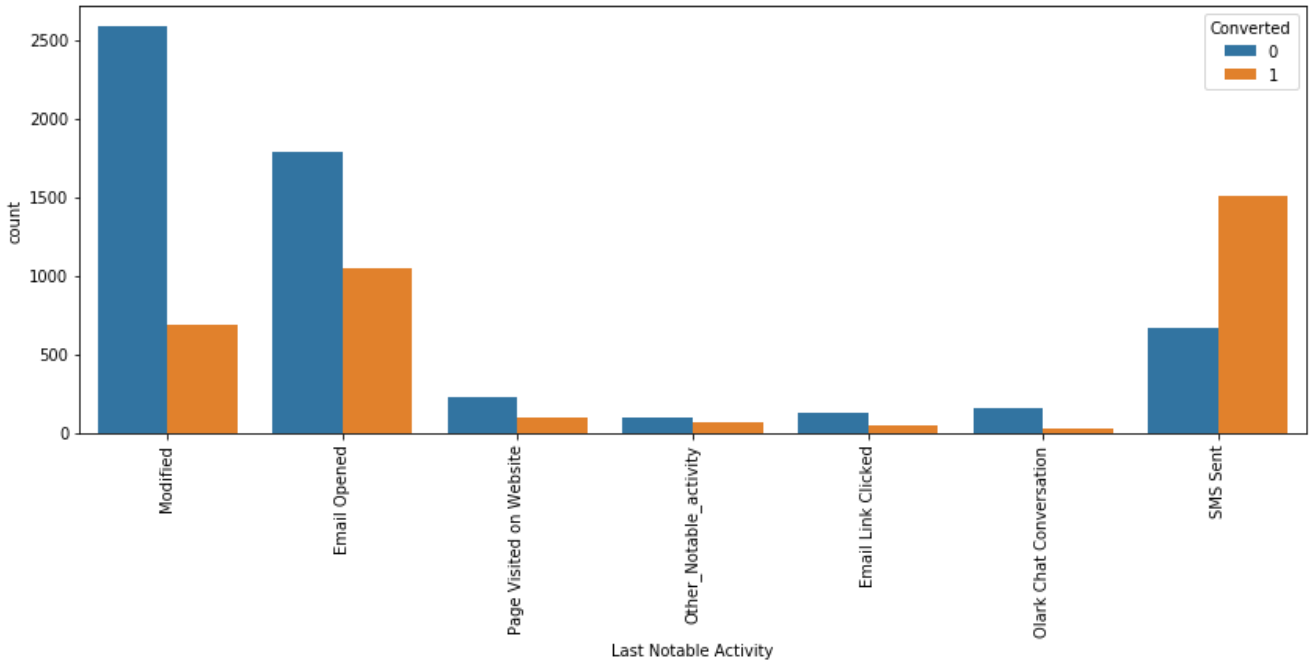
```
Had a Phone Conversation          14
Email Marked Spam                  2
Form Submitted on Website          1
Resubscribed to emails             1
View in browser link Clicked       1
Approached upfront                 1
Email Received                     1
Name: Last Notable Activity, dtype: int64
```

In [54]:

```
lead_data['Last Notable Activity'] = lead_data['Last Notable Activity'].replace(['Had a Phone Conv
ersation','Email Marked Spam','Unreachable',
                                                                                'Unsubscribed', 'Email Bou
d', 'Resubscribed to emails',
                                                                               'View in browser link Click
, 'Approached upfront',
                                                                               'Form Submitted on Website',
mail Received'],'Other_Notable_activity')
```

In [55]:

```
plt.figure(figsize = (14,5))
ax1=sns.countplot(x = "Last Notable Activity", hue = "Converted", data = lead_data)
ax1.set_xticklabels(ax1.get_xticklabels(),rotation=90)
plt.show()
```



In [56]:

```
lead_data['Last Notable Activity'].value_counts()
```

Out[56]:

```
Modified                   3270
Email Opened               2827
SMS Sent                   2172
Page Visited on Website     318
Olark Chat Conversation     183
Email Link Clicked          173
Other_Notable_activity      160
Name: Last Notable Activity, dtype: int64
```

In [57]:

```
#list of columns to be dropped
cols_to_drop
```

Out[57]:

```
['Country',
 'What matters most to you in choosing a course',
 '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']
```

In [58]:

```
#dropping columns
lead_data = lead_data.drop(cols_to_drop,1)
lead_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 9103 entries, 0 to 9239
Data columns (total 15 columns):
Lead Origin                                9103 non-null object
Lead Source                                9103 non-null object
Do Not Email                               9103 non-null object
Do Not Call                                9103 non-null object
Converted                                  9103 non-null int64
TotalVisits                                9103 non-null float64
Total Time Spent on Website                9103 non-null int64
Page Views Per Visit                       9103 non-null float64
Last Activity                              9103 non-null object
Specialization                             9103 non-null object
What is your current occupation            9103 non-null object
Tags                                       9103 non-null object
City                                       9103 non-null object
A free copy of Mastering The Interview     9103 non-null object
Last Notable Activity                      9103 non-null object
dtypes: float64(2), int64(2), object(11)
memory usage: 1.4+ MB
```

In [59]:

```
#Check the % of Data that has Converted Values = 1:

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

In [60]:

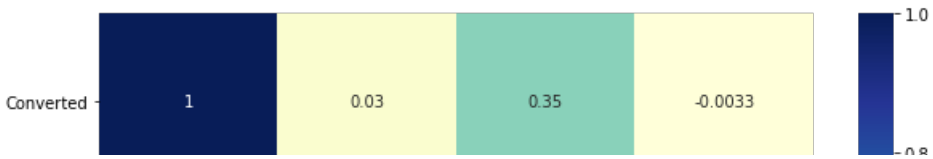
```
Converted
```

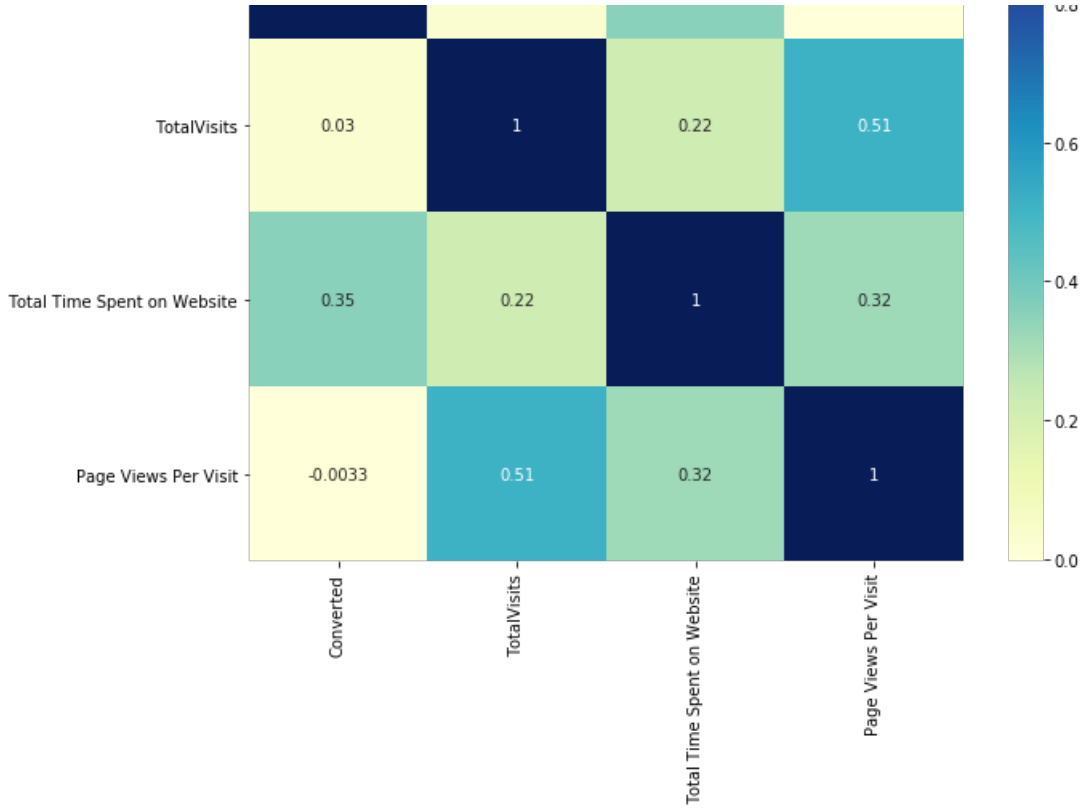
Out[60]:

```
38.02043282434362
```

In [61]:

```
plt.figure(figsize=(10,8))

# heatmap
sns.heatmap(lead_data.corr(), cmap="YlGnBu", annot=True)
plt.show()
```





In [62]:

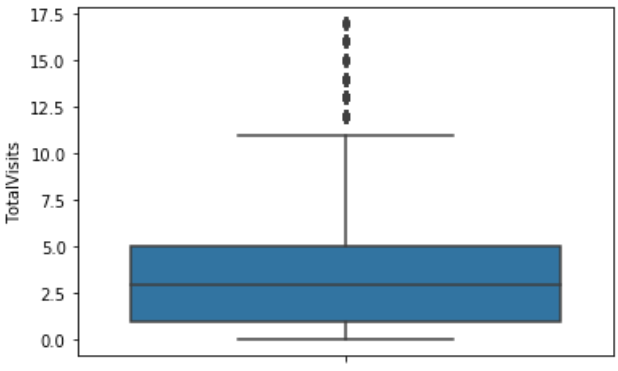
```
lead_data['TotalVisits'].describe(percentiles=[0.05,0.25,0.50,0.75,0.90,0.95,0.99])
```

Out[62]:

```
count    9103.000000
mean        3.445238
std         4.854853
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
```

In [63]:

```
Q3=lead_data.TotalVisits.quantile(0.99)
lead_data=lead_data[(lead_data.TotalVisits <=Q3)]
Q1= lead_data.TotalVisits.quantile(0.01)
lead_data=lead_data[(lead_data.TotalVisits >=Q1)]
sns.boxplot(y=lead_data['TotalVisits'])
plt.show()
```



In [64]:

```
lead_data.shape
```

Out[64]:

```
(9020, 15)
```

In [65]:

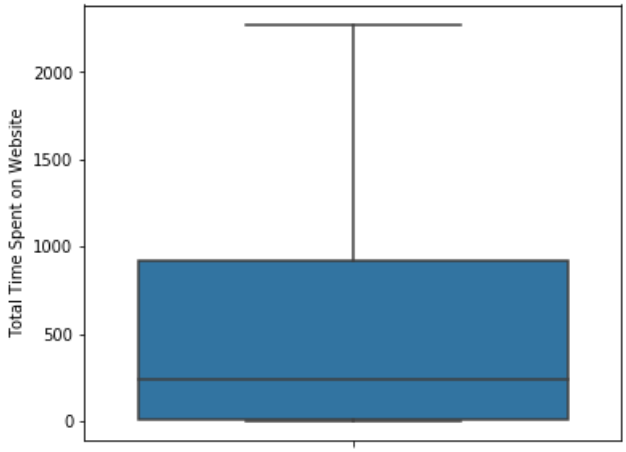
```
lead_data['Total Time Spent on Website'].describe(percentiles=[0.05,.25,.50,.75,.90,.99])
```

Out[65]:

```
count    9020.000000
mean      479.759534
std       544.688157
min         0.000000
5%          0.000000
25%         7.000000
50%       243.000000
75%       915.250000
90%      1371.000000
99%      1836.620000
max      2272.000000
Name: Total Time Spent on Website, dtype: float64
```

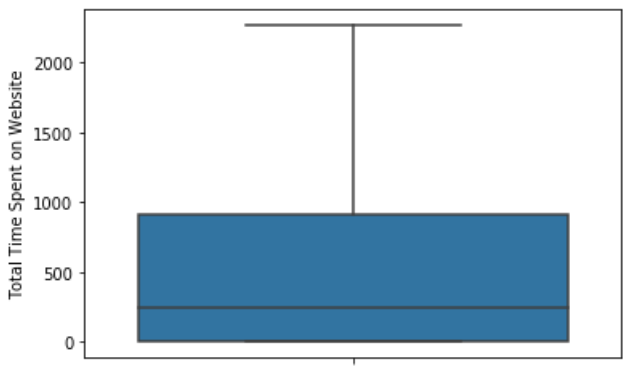
In [66]:

```
plt.figure(figsize=(6,5))
sns.boxplot(y=lead_data['Total Time Spent on Website'])
plt.show()
```



In [67]:

```
plt.figure(figsize=(6,4))
sns.boxplot(y=lead_data['Total Time Spent on Website'])
plt.show()
```



In [68]:

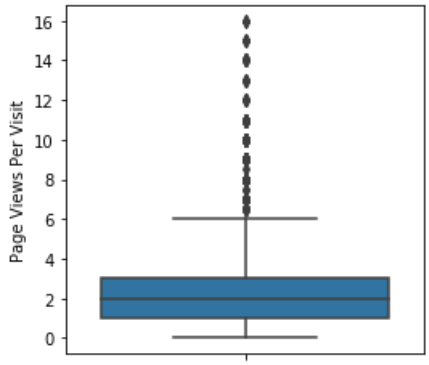
```
lead_data['Page Views Per Visit'].describe()
```

Out[68]:

```
count    9020.000000
mean        2.337271
std         2.062363
min         0.000000
25%         1.000000
50%         2.000000
75%         3.000000
max        16.000000
Name: Page Views Per Visit, dtype: float64
```

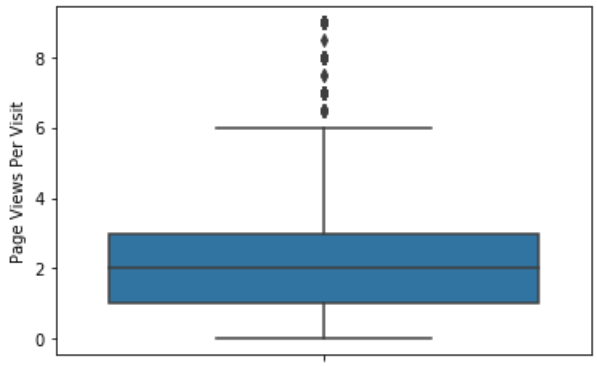
In [69]:

```
plt.figure(figsize=(4,4))
sns.boxplot(y=lead_data['Page Views Per Visit'])
plt.show()
```



In [70]:

```
Q3 = lead_data['Page Views Per Visit'].quantile(0.99)
lead_data = lead_data[lead_data['Page Views Per Visit'] <= Q3]
Q1 = lead_data['Page Views Per Visit'].quantile(0.01)
lead_data = lead_data[lead_data['Page Views Per Visit'] >= Q1]
sns.boxplot(y=lead_data['Page Views Per Visit'])
plt.show()
```



In [71]:

```
lead_data.shape
```

Out[71]:

```
(8953, 15)
```

In [72]:

```
round(100*(lead_data.isnull().sum()/len(lead_data.index)),2)
```

Out[72]:

```
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
Specialization                             0.0
What is your current occupation            0.0
Tags                                       0.0
City                                       0.0
A free copy of Mastering The Interview     0.0
Last Notable Activity                      0.0
dtype: float64
```

creation of dummy variable

In [73]:

```
#the list of categorical columns
cat_cols=lead_data.select_dtypes(include=['object']).columns
cat_cols
```

Out[73]:

```
Index(['Lead Origin', 'Lead Source', 'Do Not Email', 'Do Not Call',
       'Last Activity', 'Specialization', 'What is your current occupation',
       'Tags', 'City', 'A free copy of Mastering The Interview',
       'Last Notable Activity'],
      dtype='object')
```

In [74]:

```
varlist = ['A free copy of Mastering The Interview','Do Not Email']

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

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

In [75]:

```
dummy = pd.get_dummies(lead_data[['Lead Origin','What is your current occupation','City']],
drop_first=True)
lead_data = pd.concat([lead_data,dummy],1)

#specialization
dummy=pd.get_dummies(lead_data['Specialization'],prefix='Specialization')
dummy=dummy.drop(['Specialization_Not Specified'],1)
lead_data = pd.concat([lead_data , dummy],axis=1)

#lead source
dummy=pd.get_dummies(lead_data['Lead Source'],prefix='Lead Source')
dummy=dummy.drop(['Lead Source_Others'],1)
lead_data=pd.concat([lead_data,dummy],axis=1)

#lead activity
dummy = pd.get_dummies(lead_data['Last Activity'], prefix  = 'Last Activity')
dummy = dummy.drop(['Last Activity_Others'], 1)
lead_data = pd.concat([lead_data, dummy], axis = 1)

#last notable activity
dummy = pd.get_dummies(lead_data['Last Notable Activity'], prefix  = 'Last Notable Activity')
dummy = dummy.drop(['Last Notable Activity_Other_Notable_activity'], 1)
lead_data = pd.concat([lead_data, dummy], axis = 1)
```

```
#tags
dummy=pd.get_dummies(lead_data['Tags'],prefix='Tags')
dummy=dummy.drop(['Tags_Not Specified'],1)
lead_data=pd.concat([lead_data,dummy],axis=1)
```

In [76]:

```
lead_data.drop(cat_cols,1,inplace=True)
```

In [77]:

```
lead_data.head()
```

Out[77]:

	Converted	TotalVisits	Total Time Spent on Website	Page Views Per Visit	Lead Origin_Landing Page Submission	Lead Origin_Lead Add Form	Lead Origin_Lead Import	What is your current occupation_Housewife	What is your current occupation_Other	occupa
0	0	0.0	0	0.0	0	0	0	0	0	
1	0	5.0	674	2.5	0	0	0	0	0	
2	1	2.0	1532	2.0	1	0	0	0	0	
3	0	1.0	305	1.0	1	0	0	0	0	
4	1	2.0	1428	1.0	1	0	0	0	0	

5 rows × 57 columns

In [78]:

```
from sklearn.model_selection import train_test_split

# Putting response variable to y
y = lead_data['Converted']

y.head()

X=lead_data.drop('Converted', axis=1)
```

In [79]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, train_size=0.7, test_size=0.3,
random_state=100)
```

In [80]:

```
X_train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 6267 entries, 9196 to 5825
Data columns (total 56 columns):
TotalVisits                                           6267 non-null float64
Total Time Spent on Website                           6267 non-null int64
Page Views Per Visit                                  6267 non-null float64
Lead Origin_Landing Page Submission                   6267 non-null uint8
Lead Origin_Lead Add Form                             6267 non-null uint8
Lead Origin_Lead Import                               6267 non-null uint8
What is your current occupation_Housewife             6267 non-null uint8
What is your current occupation_Other                 6267 non-null uint8
What is your current occupation_Student               6267 non-null uint8
What is your current occupation_Unemployed            6267 non-null uint8
What is your current occupation_Working Professional  6267 non-null uint8
City_Other Cities                                     6267 non-null uint8
City_Other Cities of Maharashtra                      6267 non-null uint8
City_Other Metro Cities                               6267 non-null uint8
City_Thane & Outskirts                                6267 non-null uint8
City Tier II Cities                                   6267 non-null uint8
```

```
Specialization_Banking, Investment And Insurance        6267 non-null uint8
Specialization_Business Administration                  6267 non-null uint8
Specialization_E-Business                               6267 non-null uint8
Specialization_E-COMMERCE                               6267 non-null uint8
Specialization_International Business                   6267 non-null uint8
Specialization_Management_Specializations               6267 non-null uint8
Specialization_Media and Advertising                    6267 non-null uint8
Specialization_Rural and Agribusiness                   6267 non-null uint8
Specialization_Services Excellence                      6267 non-null uint8
Specialization_Travel and Tourism                       6267 non-null uint8
Lead Source_Direct Traffic                              6267 non-null uint8
Lead Source_Google                                      6267 non-null uint8
Lead Source_Live Chat                                   6267 non-null uint8
Lead Source_Olark Chat                                  6267 non-null uint8
Lead Source_Organic Search                              6267 non-null uint8
Lead Source_Reference                                   6267 non-null uint8
Lead Source_Referral Sites                              6267 non-null uint8
Lead Source_Social Media                                6267 non-null uint8
Lead Source_Welingak Website                            6267 non-null uint8
Last Activity_Converted to Lead                         6267 non-null uint8
Last Activity_Email Bounced                             6267 non-null uint8
Last Activity_Email Link Clicked                        6267 non-null uint8
Last Activity_Email Opened                              6267 non-null uint8
Last Activity_Form Submitted on Website                 6267 non-null uint8
Last Activity_Olark Chat Conversation                   6267 non-null uint8
Last Activity_Page Visited on Website                   6267 non-null uint8
Last Activity_SMS Sent                                  6267 non-null uint8
Last Notable Activity_Email Link Clicked                6267 non-null uint8
Last Notable Activity_Email Opened                      6267 non-null uint8
Last Notable Activity_Modified                          6267 non-null uint8
Last Notable Activity_Olark Chat Conversation           6267 non-null uint8
Last Notable Activity_Page Visited on Website           6267 non-null uint8
Last Notable Activity_SMS Sent                          6267 non-null uint8
Tags_Busy                                               6267 non-null uint8
Tags_Closed by Horizzon                                 6267 non-null uint8
Tags_Interested in other courses                        6267 non-null uint8
Tags_Lost to EINS                                       6267 non-null uint8
Tags_Other_Tags                                         6267 non-null uint8
Tags_Ringing                                            6267 non-null uint8
Tags_Will revert after reading the email                6267 non-null uint8
dtypes: float64(2), int64(1), uint8(53)
memory usage: 520.2 KB
```

In [81]:

```
from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()

num_cols=X_train.select_dtypes(include=['float64', 'int64']).columns

X_train[num_cols] = scaler.fit_transform(X_train[num_cols])

X_train.head()
```

```
C:\Users\Pujitha\Anaconda3\lib\site-packages\sklearn\preprocessing\data.py:645:
DataConversionWarning: Data with input dtype int64, float64 were all converted to float64 by
StandardScaler.
  return self.partial_fit(X, y)
C:\Users\Pujitha\Anaconda3\lib\site-packages\sklearn\base.py:464: DataConversionWarning: Data with
input dtype int64, float64 were all converted to float64 by StandardScaler.
  return self.fit(X, **fit_params).transform(X)
```

Out[81]:

	TotalVisits	Total Time Spent on Website	Page Views Per Visit	Lead Origin_Landing Page Submission	Lead Origin_Lead Add Form	Lead Origin_Lead Import	What is your current occupation_Housewife	What is your current occupation_Other	Wha occupation_
9196	0.668862	1.848117	1.455819	1	0	0	0	0	
4696	-0.030697	-0.037832	0.399961	1	0	0	0	0	

	TotalVisits	Total Time Spent on Website	Page Views Per Visit	Lead Origin_Landing Page Submission	Lead Origin_Lead Add Form	Lead Origin_Lead Import	What is your current occupation_Housewife	What is your current occupation_Other	Wha
3274	0.319082	-0.642138	-0.127967	1	0	0	0	0	
2164	-0.380477	-0.154670	-0.127967	0	0	0	0	0	occupation_
1667	0.319082	1.258415	-0.481679	0	0	0	0	0	

5 rows × 56 columns

In [82]:

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

In [83]:

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

from sklearn.feature_selection import RFE
rfe = RFE(logreg, 15)             # running RFE with 15 variables as output
rfe = rfe.fit(X_train, y_train)
```

In [84]:

```
rfe.support_
```

Out[84]:

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

In [85]:

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

Out[85]:

```
[('TotalVisits', False, 26),
 ('Total Time Spent on Website', True, 1),
 ('Page Views Per Visit', False, 24),
 ('Lead Origin_Landing Page Submission', False, 10),
 ('Lead Origin_Lead Add Form', True, 1),
 ('Lead Origin_Lead Import', False, 16),
 ('What is your current occupation_Housewife', False, 30),
 ('What is your current occupation_Other', False, 34),
 ('What is your current occupation_Student', False, 23),
 ('What is your current occupation_Unemployed', False, 20),
 ('What is your current occupation_Working Professional', False, 8),
 ('City_Other Cities', False, 22),
 ('City_Other Cities of Maharashtra', False, 37),
 ('City_Other Metro Cities', False, 40),
 ('City_Thane & Outskirts', False, 38),
 ('City_Tier II Cities', False, 27),
 ('Specialization_Banking, Investment And Insurance', False, 14),
 ('Specialization_Business Administration', False, 39),
 ('Specialization_E-Business', False, 35),
 ('Specialization_E-COMMERCE', False, 21),
 ('Specialization_International Business', False, 41),
 ('Specialization_Management_Specializations', False, 36),
 ('Specialization_Media and Advertising', False, 33),
 ('Specialization_Rural and Agribusiness', False, 28),
 ('Specialization_Services Excellence', False, 31),
 ('Specialization_Travel and Tourism', False, 7),
 ('Lead Source_Direct Traffic', True, 1),
 ('Lead Source_Google', False, 3),
 ('Lead Source_Live Chat', False, 42),
 ('Lead Source_Olark Chat', False, 32),
```

```
 ('Lead Source_Organic Search', False, 2),
 ('Lead Source_Reference', False, 13),
 ('Lead Source_Referral Sites', True, 1),
 ('Lead Source_Social Media', False, 15),
 ('Lead Source_Welingak Website', True, 1),
 ('Last Activity_Converted to Lead', False, 11),
 ('Last Activity_Email Bounced', False, 5),
 ('Last Activity_Email Link Clicked', False, 29),
 ('Last Activity_Email Opened', False, 19),
 ('Last Activity_Form Submitted on Website', False, 17),
 ('Last Activity_Olark Chat Conversation', False, 6),
 ('Last Activity_Page Visited on Website', False, 12),
 ('Last Activity_SMS Sent', True, 1),
 ('Last Notable Activity_Email Link Clicked', False, 4),
 ('Last Notable Activity_Email Opened', False, 18),
 ('Last Notable Activity_Modified', True, 1),
 ('Last Notable Activity_Olark Chat Conversation', True, 1),
 ('Last Notable Activity_Page Visited on Website', False, 25),
 ('Last Notable Activity_SMS Sent', True, 1),
 ('Tags_Busy', False, 9),
 ('Tags_Closed by Horizzon', True, 1),
 ('Tags_Interested in other courses', True, 1),
 ('Tags_Lost to EINS', True, 1),
 ('Tags_Other_Tags', True, 1),
 ('Tags_Ringing', True, 1),
 ('Tags_Will revert after reading the email', True, 1)]
```

In [86]:

```
#list of RFE supported columns
col = X_train.columns[rfe.support_]
col
```

Out[86]:

```
Index(['Total Time Spent on Website', 'Lead Origin_Lead Add Form',
       'Lead Source_Direct Traffic', 'Lead Source_Referral Sites',
       'Lead Source_Welingak Website', 'Last Activity_SMS Sent',
       'Last Notable Activity_Modified',
       'Last Notable Activity_Olark Chat Conversation',
       'Last Notable Activity_SMS Sent', 'Tags_Closed by Horizzon',
       'Tags_Interested in other courses', 'Tags_Lost to EINS',
       'Tags_Other_Tags', 'Tags_Ringing',
       'Tags_Will revert after reading the email'],
      dtype='object')
```

In [87]:

```
X_train.columns[~rfe.support_]
```

Out[87]:

```
Index(['TotalVisits', 'Page Views Per Visit',
       'Lead Origin_Landing Page Submission', 'Lead Origin_Lead Import',
       'What is your current occupation_Housewife',
       'What is your current occupation_Other',
       'What is your current occupation_Student',
       'What is your current occupation_Unemployed',
       'What is your current occupation_Working Professional',
       'City_Other Cities', 'City_Other Cities of Maharashtra',
       'City_Other Metro Cities', 'City_Thane & Outskirts',
       'City_Tier II Cities',
       'Specialization_Banking, Investment And Insurance',
       'Specialization_Business Administration', 'Specialization_E-Business',
       'Specialization_E-COMMERCE', 'Specialization_International Business',
       'Specialization_Management_Specializations',
       'Specialization_Media and Advertising',
       'Specialization_Rural and Agribusiness',
       'Specialization_Services Excellence',
       'Specialization_Travel and Tourism', 'Lead Source_Google',
       'Lead Source_Live Chat', 'Lead Source_Olark Chat',
       'Lead Source_Organic Search', 'Lead Source_Reference',
       'Lead Source_Social Media', 'Last Activity_Converted to Lead',
       'Last Activity_Email Bounced', 'Last Activity_Email Link Clicked',
       'Last Activity_Email Opened', 'Last Activity_Form Submitted on Website'
```

```
       'Last Activity_Email Opened', 'Last Activity_Form Submitted on Website',
       'Last Activity_Olark Chat Conversation',
       'Last Activity_Page Visited on Website',
       'Last Notable Activity_Email Link Clicked',
       'Last Notable Activity_Email Opened',
       'Last Notable Activity_Page Visited on Website', 'Tags_Busy'],
      dtype='object')
```

In [88]:

```
#BUILDING MODEL 1

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

Out[88]:

Generalized Linear Model Regression Results

Dep. Variable:	Converted	**No. Observations:**	6267
Model:	GLM	**Df Residuals:**	6251
Model Family:	Binomial	**Df Model:**	15
Link Function:	logit	**Scale:**	1.0000
Method:	IRLS	**Log-Likelihood:**	-1254.7
Date:	Tue, 12 May 2020	**Deviance:**	2509.3
Time:	15:23:02	**Pearson chi2:**	8.34e+03
No. Iterations:	8	**Covariance Type:**	nonrobust

	coef	std err	z	P>|z|	[0.025	0.975]
const	-1.1899	0.088	-13.480	0.000	-1.363	-1.017
Total Time Spent on Website	0.8970	0.053	16.999	0.000	0.794	1.000
Lead Origin_Lead Add Form	1.6712	0.450	3.714	0.000	0.789	2.553
Lead Source_Direct Traffic	-0.8320	0.129	-6.471	0.000	-1.084	-0.580
Lead Source_Referral Sites	-0.5284	0.465	-1.138	0.255	-1.439	0.382
Lead Source_Welingak Website	3.9043	1.110	3.518	0.000	1.729	6.079
Last Activity_SMS Sent	1.2373	0.223	5.555	0.000	0.801	1.674
Last Notable Activity_Modified	-1.2839	0.150	-8.532	0.000	-1.579	-0.989
Last Notable Activity_Olark Chat Conversation	-1.7123	0.490	-3.496	0.000	-2.672	-0.752
Last Notable Activity_SMS Sent	1.0151	0.257	3.943	0.000	0.511	1.520
Tags_Closed by Horizzon	6.9834	1.019	6.853	0.000	4.986	8.981
Tags_Interested in other courses	-2.1641	0.407	-5.321	0.000	-2.961	-1.367
Tags_Lost to EINS	5.7302	0.608	9.419	0.000	4.538	6.923
Tags_Other_Tags	-2.4417	0.210	-11.633	0.000	-2.853	-2.030
Tags_Ringing	-3.5858	0.243	-14.752	0.000	-4.062	-3.109
Tags_Will revert after reading the email	4.4263	0.185	23.989	0.000	4.065	4.788

In [89]:

```
#p value is high in lead source rferral sites
col = col.drop('Lead Source_Referral Sites',1)
```

In [90]:

```
#BUILDING MODEL 2

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

```
res.summary()
```

Out[90]:

Generalized Linear Model Regression Results

Dep. Variable:	Converted	**No. Observations:**	6267
Model:	GLM	**Df Residuals:**	6252
Model Family:	Binomial	**Df Model:**	14
Link Function:	logit	**Scale:**	1.0000
Method:	IRLS	**Log-Likelihood:**	-1255.3
Date:	Tue, 12 May 2020	**Deviance:**	2510.7
Time:	15:23:02	**Pearson chi2:**	8.34e+03
No. Iterations:	8	**Covariance Type:**	nonrobust

	coef	std err	z	P>|z|	[0.025	0.975]
const	-1.2029	0.088	-13.729	0.000	-1.375	-1.031
Total Time Spent on Website	0.8963	0.053	16.979	0.000	0.793	1.000
Lead Origin_Lead Add Form	1.6795	0.450	3.735	0.000	0.798	2.561
Lead Source_Direct Traffic	-0.8224	0.128	-6.409	0.000	-1.074	-0.571
Lead Source_Welingak Website	3.9060	1.110	3.520	0.000	1.731	6.081
Last Activity_SMS Sent	1.2437	0.223	5.584	0.000	0.807	1.680
Last Notable Activity_Modified	-1.2791	0.150	-8.501	0.000	-1.574	-0.984
Last Notable Activity_Olark Chat Conversation	-1.7079	0.489	-3.491	0.000	-2.667	-0.749
Last Notable Activity_SMS Sent	1.0150	0.257	3.943	0.000	0.510	1.520
Tags_Closed by Horizzon	6.9868	1.019	6.857	0.000	4.990	8.984
Tags_Interested in other courses	-2.2028	0.409	-5.391	0.000	-3.004	-1.402
Tags_Lost to EINS	5.7337	0.608	9.426	0.000	4.541	6.926
Tags_Other_Tags	-2.4401	0.210	-11.625	0.000	-2.852	-2.029
Tags_Ringing	-3.5818	0.243	-14.740	0.000	-4.058	-3.106
Tags_Will revert after reading the email	4.4234	0.184	23.993	0.000	4.062	4.785

In [91]:

```
y_train_pred = res.predict(X_train_sm)
y_train_pred[:10]
```

Out[91]:

```
9196    0.295345
4696    0.032852
3274    0.617801
2164    0.007975
1667    0.987238
7024    0.120820
8018    0.024302
778     0.139180
6942    0.003322
4440    0.089262
dtype: float64
```

In [92]:

```
y_train_pred = y_train_pred.values.reshape(-1)
y_train_pred[:10]
```

Out[92]:

```
array([0.29534528, 0.03285235, 0.6178014 , 0.00797479, 0.98723783,
       0.12082046, 0.02430221, 0.13918024, 0.00332173, 0.08926236])
```

In [93]:

```
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()
```

Out[93]:

	Converted	Converted_prob	Prospect ID
0	1	0.295345	9196
1	0	0.032852	4696
2	0	0.617801	3274
3	0	0.007975	2164
4	1	0.987238	1667

In [94]:

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

y_train_pred_final.head()
```

Out[94]:

	Converted	Converted_prob	Prospect ID	Predicted
0	1	0.295345	9196	0
1	0	0.032852	4696	0
2	0	0.617801	3274	1
3	0	0.007975	2164	0
4	1	0.987238	1667	1

In [95]:

```
from sklearn import metrics

# Confusion matrix
confusion = metrics.confusion_matrix(y_train_pred_final.Converted, y_train_pred_final.Predicted )
print(confusion)
```

```
[[3701  181]
 [ 286 2099]]
```

In [96]:

```
print(metrics.accuracy_score(y_train_pred_final.Converted, y_train_pred_final.Predicted))
```

```
0.9254826870911121
```

In [97]:

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

In [98]:

```
TP / float(TP+FN)
```

Out[98]:

```
0.880083857442348
```

In [99]:

```
TN / float(TN+FP)
```

Out[99]:

0.9533745492014426

In [100]:

```
print(FP/ float(TN+FP))
```

0.04662545079855744

In [101]:

```
# positive predictive value
print (TP / float(TP+FP))
```

0.9206140350877193

In [102]:

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

0.928266867318786

In [103]:

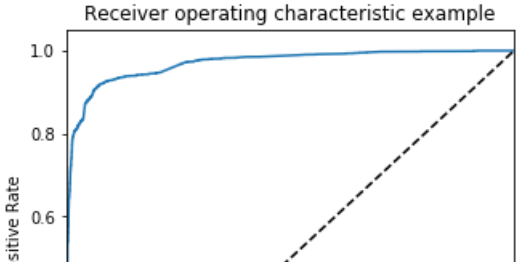
```
def draw_roc( actual, probs ):
    fpr, tpr, thresholds = metrics.roc_curve( actual, probs,
                                              drop_intermediate = False )
    auc_score = metrics.roc_auc_score( actual, probs )
    plt.figure(figsize=(5, 5))
    plt.plot( fpr, tpr, label='ROC curve (area = %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
```

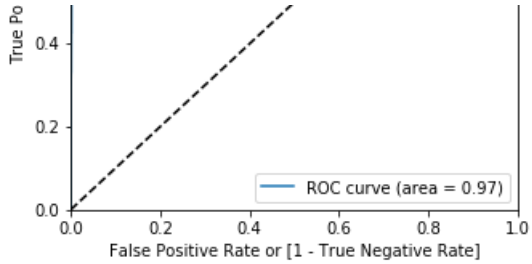
In [104]:

```
fpr, tpr, thresholds = metrics.roc_curve( y_train_pred_final.Converted, y_train_pred_final.Converte
d_prob, drop_intermediate = False )
```

In [105]:

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





In [106]:

```
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()
```

Out[106]:

	Converted	Converted_prob	Prospect ID	Predicted	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	1	0.295345	9196	0	1	1	1	0	0	0	0	0	0	0
1	0	0.032852	4696	0	1	0	0	0	0	0	0	0	0	0
2	0	0.617801	3274	1	1	1	1	1	1	1	1	0	0	0
3	0	0.007975	2164	0	1	0	0	0	0	0	0	0	0	0
4	1	0.987238	1667	1	1	1	1	1	1	1	1	1	1	1

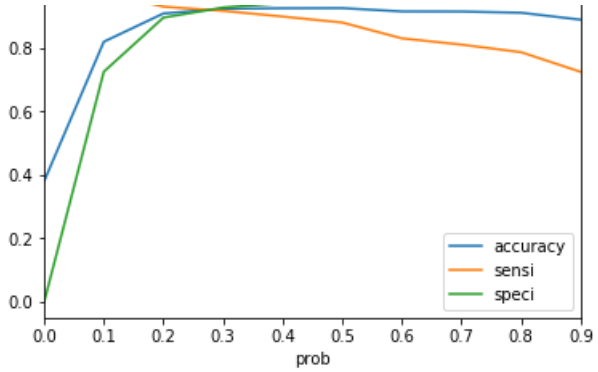
In [108]:

```
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  0.380565  1.000000  0.000000
0.1   0.1  0.819531  0.973166  0.725142
0.2   0.2  0.908728  0.929979  0.895672
0.3   0.3  0.923408  0.916981  0.927357
0.4   0.4  0.925164  0.898952  0.941267
0.5   0.5  0.925483  0.880084  0.953375
0.6   0.6  0.915111  0.830189  0.967285
0.7   0.7  0.914792  0.810482  0.978877
0.8   0.8  0.910962  0.786583  0.987378
0.9   0.9  0.889102  0.724528  0.990211
```

In [109]:

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



In [110]:

```
y_train_pred_final['final_Predicted'] = y_train_pred_final.Converted_prob.map( lambda x: 1 if x > 0
.3 else 0)

y_train_pred_final.head()
```

Out[110]:

	Converted	Converted_prob	Prospect ID	Predicted	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	final_Predicted
0	1	0.295345	9196	0	1	1	1	0	0	0	0	0	0	0	0
1	0	0.032852	4696	0	1	0	0	0	0	0	0	0	0	0	0
2	0	0.617801	3274	1	1	1	1	1	1	1	1	0	0	0	1
3	0	0.007975	2164	0	1	0	0	0	0	0	0	0	0	0	0
4	1	0.987238	1667	1	1	1	1	1	1	1	1	1	1	1	1

In [111]:

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

y_train_pred_final[['Converted','Converted_prob','Prospect ID','final_Predicted','Lead_Score']].he
ad()
```

Out[111]:

	Converted	Converted_prob	Prospect ID	final_Predicted	Lead_Score
0	1	0.295345	9196	0	30
1	0	0.032852	4696	0	3
2	0	0.617801	3274	1	62
3	0	0.007975	2164	0	1
4	1	0.987238	1667	1	99

In [112]:

```
# overall accuracy.
metrics.accuracy_score(y_train_pred_final.Converted, y_train_pred_final.final_Predicted)
```

Out[112]:

```
0.9234083293441838
```

In [113]:

```
confusion2 = metrics.confusion_matrix(y_train_pred_final.Converted,
y_train_pred_final.final_Predicted )
confusion2
```

Out[113]:

```
array([[3600,  282],
```

```
       [ 198, 2187]], dtype=int64)
```

In [132]:

```
##### Precision
TP / TP + FP

confusion[1,1]/(confusion[0,1]+confusion[1,1])
```

Out[132]:

```
0.9206140350877193
```

In [133]:

```
##### Recall
TP / TP + FN

confusion[1,1]/(confusion[1,0]+confusion[1,1])
```

Out[133]:

```
0.880083857442348
```

In [134]:

```
from sklearn.metrics import precision_score, recall_score
```

In [135]:

```
precision_score(y_train_pred_final.Converted , y_train_pred_final.final_Predicted)
```

Out[135]:

```
0.8857837181044957
```

In [136]:

```
recall_score(y_train_pred_final.Converted, y_train_pred_final.final_Predicted)
```

Out[136]:

```
0.9169811320754717
```

In [114]:

```
#  sensitivity of logistic regression model
TP / float(TP+FN)a
```

Out[114]:

```
0.880083857442348
```

In [137]:

```
# Let us calculate specificity
TN / float(TN+FP)
```

Out[137]:

```
0.9533745492014426
```

In [138]:

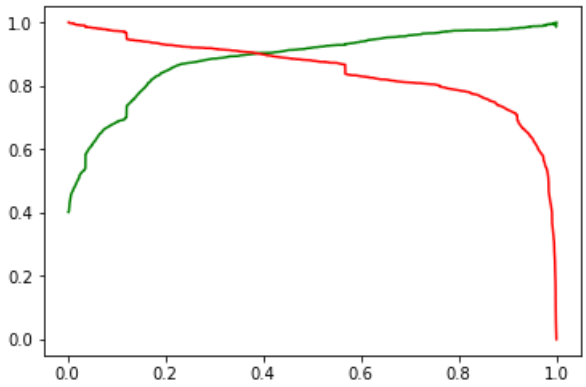
```
from sklearn.metrics import precision_recall_curve
```

In [139]:

```
y_train_pred_final.Converted, y_train_pred_final.final_Predicted
p, r, thresholds = precision_recall_curve(y_train_pred_final.Converted, y_train_pred_final.Converte
d_prob)
```

In [146]:

```
plt.plot(thresholds, p[:-1], "g-")
plt.plot(thresholds, r[:-1], "r-")
plt.show()
```



In [147]:

```
num_cols=X_test.select_dtypes(include=['float64', 'int64']).columns

X_test[num_cols] = scaler.fit_transform(X_test[num_cols])

X_test.head()
```

Out[147]:

	Total Time Spent on Website	Lead Origin_Lead Add Form	Lead Source_Direct Traffic	Lead Source_Welingak Website	Last Activity_SMS Sent	Last Notable Activity_Modified	Last Notable Activity_Olark Chat Conversation	Last Notable Activity_SMS Sent	Tags_Clos by Horizz
7681	-0.311318	0	1	0	1	0	0	1	
984	-0.550262	0	0	0	1	1	0	0	
8135	0.812462	0	1	0	1	0	0	1	
6915	-0.628665	0	0	0	0	0	0	0	
2712	-0.421456	0	0	0	0	0	0	0	

In [148]:

```
X_test = X_test[col]
X_test.head()
```

Out[148]:

	Total Time Spent on Website	Lead Origin_Lead Add Form	Lead Source_Direct Traffic	Lead Source_Welingak Website	Last Activity_SMS Sent	Last Notable Activity_Modified	Last Notable Activity_Olark Chat Conversation	Last Notable Activity_SMS Sent	Tags_Clos by Horizz
7681	-0.311318	0	1	0	1	0	0	1	
984	-0.550262	0	0	0	1	1	0	0	
8135	0.812462	0	1	0	1	0	0	1	

	Total Time Spent on Website	Lead Origin_Lead Add Form	Lead Source_Direct Traffic	Lead Source_Welingak Website	Last Activity_SMS Sent	Last Notable Activity_Modified	Last Notable Activity_Olark Chat Conversation	Last Notable Activity_SMS Sent	Tags_Closed by Horizz
8135	0.812462	0	1	0	1	0	0	1	
6915	0.632661	0	0	0	0	0	0	0	
2712	0.421456	0	0	0	0	0	0	0	

In [149]:

```
X_test_sm = sm.add_constant(X_test)
```

In [150]:

```
y_test_pred = res.predict(X_test_sm)
```

In [151]:

```
y_test_pred[:10]
```

Out[151]:

```
7681    0.025895
984     0.015191
8135    0.723450
6915    0.004734
2712    0.944942
244     0.002817
4698    0.012590
8287    0.036213
6791    0.978399
8970    0.007065
dtype: float64
```

In [152]:

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

In [153]:

```
y_pred_1.head()
```

Out[153]:

	0
7681	0.025895
984	0.015191
8135	0.723450
6915	0.004734
2712	0.944942

In [154]:

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

In [155]:

```
y_test_df['Prospect ID'] = y_test_df.index
```

In [156]:

```
y_pred_1.reset_index(drop=True, inplace=True)
y_test_df.reset_index(drop=True, inplace=True)
```

In [157]:

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

In [158]:

```
y_pred_final.head()
```

Out[158]:

	Converted	Prospect ID	0
0	0	7681	0.025895
1	0	984	0.015191
2	0	8135	0.723450
3	0	6915	0.004734
4	1	2712	0.944942

In [159]:

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

In [160]:

```
y_pred_final.head()
```

Out[160]:

	Converted	Prospect ID	Converted_prob
0	0	7681	0.025895
1	0	984	0.015191
2	0	8135	0.723450
3	0	6915	0.004734
4	1	2712	0.944942

In [161]:

```
# Rearranging the columns
y_pred_final = y_pred_final[['Prospect ID','Converted','Converted_prob']]
y_pred_final['Lead_Score'] = y_pred_final.Converted_prob.map( lambda x: round(x*100))
```

In [162]:

```
y_pred_final.head()
```

Out[162]:

	Prospect ID	Converted	Converted_prob	Lead_Score
0	7681	0	0.025895	3
1	984	0	0.015191	2
2	8135	0	0.723450	72
3	6915	0	0.004734	0
4	2712	1	0.944942	94

In [163]:

```
y_pred_final['final_Predicted'] = y_pred_final.Converted_prob.map(lambda x: 1 if x > 0.3 else 0)
```

In [164]:

```
y_pred_final.head()
```

Out[164]:

	Prospect ID	Converted	Converted_prob	Lead_Score	final_Predicted
0	7681	0	0.025895	3	0
1	984	0	0.015191	2	0
2	8135	0	0.723450	72	1
3	6915	0	0.004734	0	0
4	2712	1	0.944942	94	1

In [165]:

```
# Let's check the overall accuracy.
metrics.accuracy_score(y_pred_final.Converted, y_pred_final.final_Predicted)
```

Out[165]:

```
0.926656738644825
```

In [166]:

```
confusion2 = metrics.confusion_matrix(y_pred_final.Converted, y_pred_final.final_Predicted )
confusion2
```

Out[166]:

```
array([[1564,  112],
       [  85,  925]], dtype=int64)
```

In [167]:

```
# sensitivity of our logistic regression model
TP / float(TP+FN)
```

Out[167]:

```
0.880083857442348
```

In [168]:

```
# Let us calculate specificity
TN / float(TN+FP)
```

Out[168]:

```
0.9533745492014426
```

In [169]:

```
precision_score(y_pred_final.Converted , y_pred_final.final_Predicted)
```

Out[169]:

```
0.8919961427193829
```

In [170]:

```
recall_score(y_pred_final.Converted, y_pred_final.final_Predicted)
```

Out[170]:

```
0.915841584158415
```

0.9158415841584159

the accuracy of training data is 92.29 and test data is 92.78 so the model seems to predict the conversion rate well and to give the CEO confidence in making good calls

1. Which are the top three variables in your model that contribute most towards the probability of a lead getting converted?

Answer:

The features used to build the model have been represented below based on their importance in lead conversion as per their coefficient values. As per the jupyter notebook result, the top 3 variables that contribute most towards the probability of a lead getting converted are:

1. Tags_Lost to EINS
2. Tags_Closed by Horizzon
3. Tags_Will revert after reading the email

2.What are the top 3 categorical/dummy variables in the model which get maximum focus in order to increase the probability of lead conversion?

Answer: As per the above diagram, the top 3 categorical/dummy variables that contribute the most towards the probability of a lead getting converted are also :

1. Tags_Lost to EINS
2. Tags_Closed by Horizzon
3. Tags_Will revert after reading the email

1. 3.X Education has a period of 2 months every year during which they hire few interns. The sales team, in particular, has around 10 interns allotted to them. So, during this phase, they wish to make the lead conversion more aggressive. So they want almost all of the potential leads (i.e. the customers who have been predicted as 1 by the model) to be converted and hence, want to make phone calls to as much of such people as possible. Suggest a good strategy they should employ at this stage.

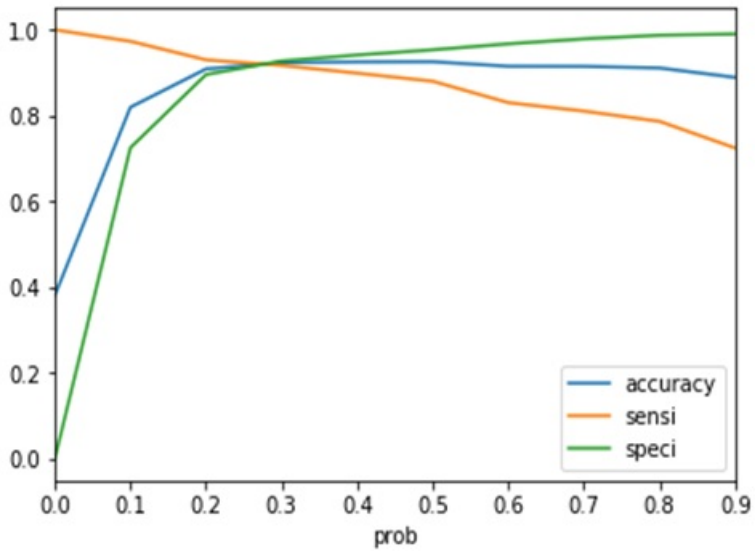
Ans:

Sensitivity with respect to our model can be defined as the ratio of total number of actual Conversions correctly predicted to the total no of actual Conversions.

Similarly, Specificity can be defined as the ratio of total no of actual non-Conversions correctly predicted to the total number of actual non-Conversions.

For a particular model, as one increases, the other decreases and vice versa. Different values of the sensitivity and specificity can be achieved for the same model by changing the Conversion Probability cutoff threshold value.

For our model, the below graph shows how the Sensitivity and Specificity rating changes with change in the threshold value



When the probability thresholds are very low, the sensitivity is very high and specificity is very low. Similarly, for larger probability thresholds, the sensitivity values are very low but the specificity values are very high.

High sensitivity implies that our model will correctly identify almost all leads who are likely to Convert. It will do that by over-estimating the Conversion likelihood, i.e. it will misclassify some non-Conversion cases as Conversions.

Now, since X Education has more man-power for these 2 months and they wish to make the lead conversion more aggressive by wanting almost all of the potential leads, we can choose a lower threshold value for Conversion Probability.

This will ensure the Sensitivity rating is very high which in turn will make sure almost all leads who are likely to Convert are identified correctly and the agents can make phone calls to as much of such people as possible.

1. Similarly, at times, the company reaches its target for a quarter before the deadline. During this time, the company wants the sales team to focus on some new work as well. So during this time, the company's aim is to not make phone calls unless it's extremely necessary, i.e. they want to minimize the rate of useless phone calls. Suggest a strategy they should employ at this stage.

Answer:

Following the similar logic and context from the previous question, High Specificity implies that our model will correctly identify almost all leads who are not likely to Convert. It will do that at the cost of losing out some low Conversion rate risky leads to the competition, i.e. it will misclassify some Conversion cases as non-Conversions.

Therefore, since X Education has already reached its target for a quarter and doesn't want to make phone calls unless it's extremely necessary, i.e. they want to minimize the rate of useless phone calls, we can choose a higher threshold value for Conversion Probability.

This will ensure the Specificity rating is very high, which in turn will make sure almost all leads who are on the brink of the probability of getting Converted or not are not selected. As a result the agents won't have to make unnecessary phone calls and can focus on some new work.

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