Telecom Customer Churn Analysis

1. Domain Exploration
    - understand the business process
    - Identify beleifs, loopholes, losses, data flow in the business flow

1. Data Collection & data exploration
    - Collecting data from different business verticals, preparing a dataset out of it
    - explore data for common challenges and data quality issues.

1. Data Cleaning
    - Handling missing values
    - Handling unwanted columns - identifiers
    - Handling duplicate entries
    - Handling outliers

1. Descriptive & Exploratory Analysis
    - Statistics
    - Data Visualization

1. Preparing the report

Data Exploration

In [2]:

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

In [3]:

```
#load data
df = pd.read_excel(r"E:\MLIoT\ML\dataset\telecom\telecom_churn_modelling.xlsx")
df.shape
```

Out[3]:

```
(3333, 20)
```

In [4]:

```
df.head()
```

Out[4]:

	State	Account length	Area code	International plan	Voice mail plan	Number vmail messages	Total day minutes	Total day calls	Total day charge	Total eve minutes
0	KS	128	415	No	Yes	25	265.1	110	45.07	197.4
1	OH	107	415	No	Yes	26	161.6	123	27.47	195.5
2	NJ	137	415	No	No	0	243.4	114	41.38	121.2
3	OH	84	408	Yes	No	0	299.4	71	50.90	61.9
4	OK	75	415	Yes	No	0	166.7	113	28.34	148.3

In [5]:

```
len(df['State'].unique())
```

Out[5]:

```
51
```

In [6]:

```
df['Area code'].unique()
```

Out[6]:

```
array([415, 408, 510], dtype=int64)
```

Observations -

```
- unwanted columns - State may be an identifier and may not be needed, Area code
- Customer having no voice mail plan will have the value of number of vmail mess
ages as 0
- mostly total xxx minutes should be highly correlated to total xxx charge
```

In [7]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 3333 entries, 0 to 3332
Data columns (total 20 columns):
 #   Column                  Non-Null Count  Dtype  
---  ------                  --------------  -----  
 0   State                   3333 non-null   object 
 1   Account length          3333 non-null   int64  
 2   Area code               3333 non-null   int64  
 3   International plan      3333 non-null   object 
 4   Voice mail plan         3333 non-null   object 
 5   Number vmail messages   3333 non-null   int64  
 6   Total day minutes       3333 non-null   float64
 7   Total day calls         3333 non-null   int64  
 8   Total day charge        3333 non-null   float64
 9   Total eve minutes       3333 non-null   float64
 10  Total eve calls         3333 non-null   int64  
 11  Total eve charge        3333 non-null   float64
 12  Total night minutes     3333 non-null   float64
 13  Total night calls       3333 non-null   int64  
 14  Total night charge      3333 non-null   float64
 15  Total intl minutes      3333 non-null   float64
 16  Total intl calls        3333 non-null   int64  
 17  Total intl charge       3333 non-null   float64
 18  Customer service calls  3333 non-null   int64  
 19  Churn                   3333 non-null   bool   
dtypes: bool(1), float64(8), int64(8), object(3)
memory usage: 498.1+ KB
```

In [8]:

```
df['State'].unique()
```

Out[8]:

```
array(['KS', 'OH', 'NJ', 'OK', 'AL', 'MA', 'MO', 'LA', 'WV', 'IN', 'RI',
       'IA', 'MT', 'NY', 'ID', 'VT', 'VA', 'TX', 'FL', 'CO', 'AZ', 'SC',
       'NE', 'WY', 'HI', 'IL', 'NH', 'GA', 'AK', 'MD', 'AR', 'WI', 'OR',
       'MI', 'DE', 'UT', 'CA', 'MN', 'SD', 'NC', 'WA', 'NM', 'NV', 'DC',
       'KY', 'ME', 'MS', 'TN', 'PA', 'CT', 'ND'], dtype=object)
```

In [9]:

```
df['International plan'].unique()
```

Out[9]:

```
array(['No', 'Yes'], dtype=object)
```

In [10]:

```
df['Voice mail plan'].unique()
```

Out[10]:

```
array(['Yes', 'No'], dtype=object)
```

Data Cleaning

In [11]:

```
# check for duplicated rows
df.duplicated().sum()
```

Out[11]:

```
0
```

In [12]:

```
# check for missng values
df.isnull().sum()
```

Out[12]:

```
State                     0
Account length            0
Area code                 0
International plan        0
Voice mail plan           0
Number vmail messages     0
Total day minutes         0
Total day calls           0
Total day charge          0
Total eve minutes         0
Total eve calls           0
Total eve charge          0
Total night minutes       0
Total night calls         0
Total night charge        0
Total intl minutes        0
Total intl calls          0
Total intl charge         0
Customer service calls    0
Churn                     0
dtype: int64
```

In [13]:

```
# Dropping unwanted columns
# - analyse the categorical columns
```

In [14]:

```
# check for outliers
df.skew()
```

Out[14]:

```
Account length            0.096606
Area code                 1.126823
Number vmail messages     1.264824
Total day minutes        -0.029077
Total day calls          -0.111787
Total day charge         -0.029083
Total eve minutes        -0.023877
Total eve calls          -0.055563
Total eve charge         -0.023858
Total night minutes       0.008921
Total night calls         0.032500
Total night charge        0.008886
Total intl minutes       -0.245136
Total intl calls          1.321478
Total intl charge        -0.245287
Customer service calls    1.091359
Churn                     2.018356
dtype: float64
```

Descriptive Analysis

In [15]:

```
df.head()
```

Out[15]:

	State	Account length	Area code	International plan	Voice mail plan	Number vmail messages	Total day minutes	Total day calls	Total day charge	Total eve minutes
0	KS	128	415	No	Yes	25	265.1	110	45.07	197.4
1	OH	107	415	No	Yes	26	161.6	123	27.47	195.5
2	NJ	137	415	No	No	0	243.4	114	41.38	121.2
3	OH	84	408	Yes	No	0	299.4	71	50.90	61.9
4	OK	75	415	Yes	No	0	166.7	113	28.34	148.3

State

In [16]:

```
df['State'].value_counts()
```

Out[16]:

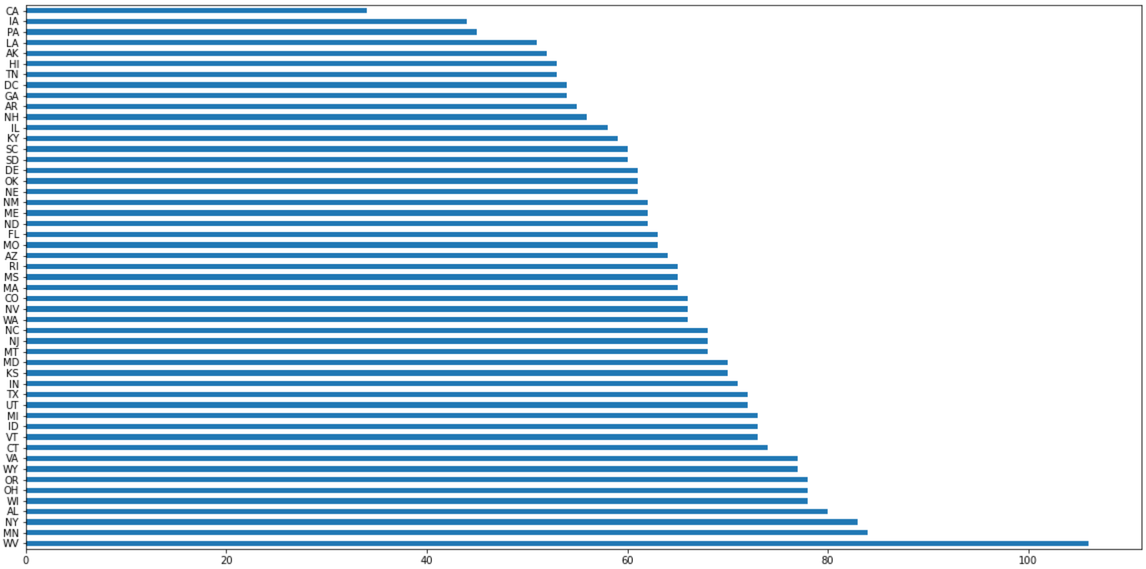
```
WV    106
MN     84
NY     83
AL     80
WI     78
OH     78
OR     78
WY     77
VA     77
CT     74
VT     73
ID     73
MI     73
UT     72
TX     72
IN     71
KS     70
MD     70
MT     68
NJ     68
NC     68
WA     66
NV     66
CO     66
MA     65
MS     65
RI     65
AZ     64
MO     63
FL     63
ND     62
ME     62
NM     62
NE     61
OK     61
DE     61
SD     60
SC     60
KY     59
IL     58
NH     56
AR     55
GA     54
DC     54
TN     53
HI     53
AK     52
LA     51
PA     45
IA     44
CA     34
Name: State, dtype: int64
```

In [19]:

```
df['State'].value_counts().plot(kind='barh',figsize=(20,10))
```

Out[19]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x2a4cecb4288>
```



Observation -

```
    - the number of customers from each state is differently distributed
```

In [21]:

```
df.columns
```

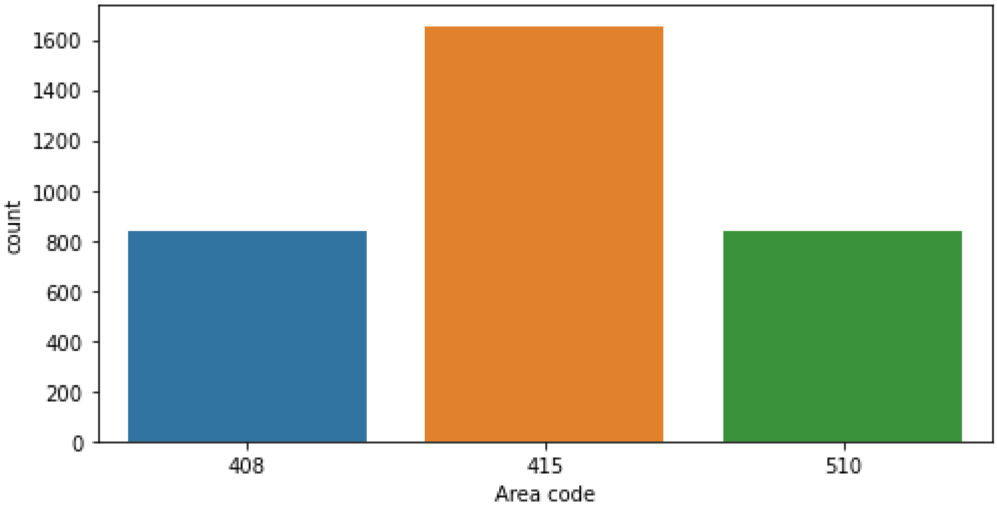
Out[21]:

```
Index(['State', 'Account length', 'Area code', 'International plan',
       'Voice mail plan', 'Number vmail messages', 'Total day minutes',
       'Total day calls', 'Total day charge', 'Total eve minutes',
       'Total eve calls', 'Total eve charge', 'Total night minutes',
       'Total night calls', 'Total night charge', 'Total intl minutes',
       'Total intl calls', 'Total intl charge', 'Customer service calls',
       'Churn'],
      dtype='object')
```

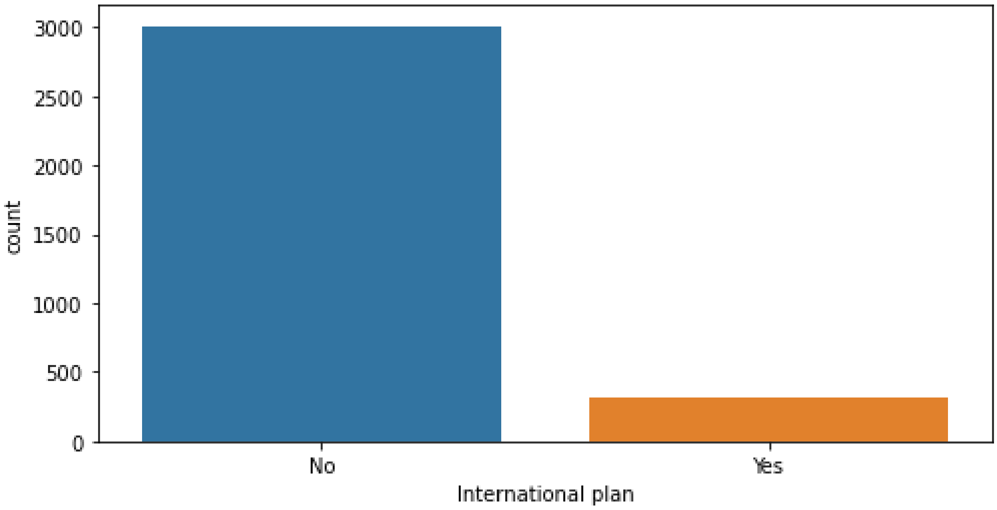
In [22]:

```
cats = ['Area code', 'International plan','Voice mail plan','Churn']
for col in cats:
    print(df[col].value_counts())

    plt.figure(figsize=(8,4))
    sns.countplot(df[col])
    plt.show()
```

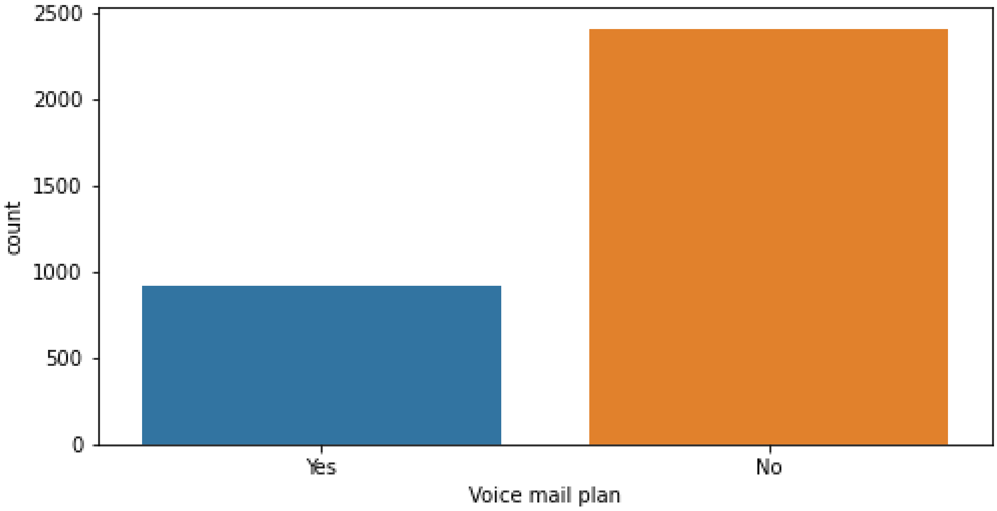
```
415    1655
510     840
408     838
Name: Area code, dtype: int64
```



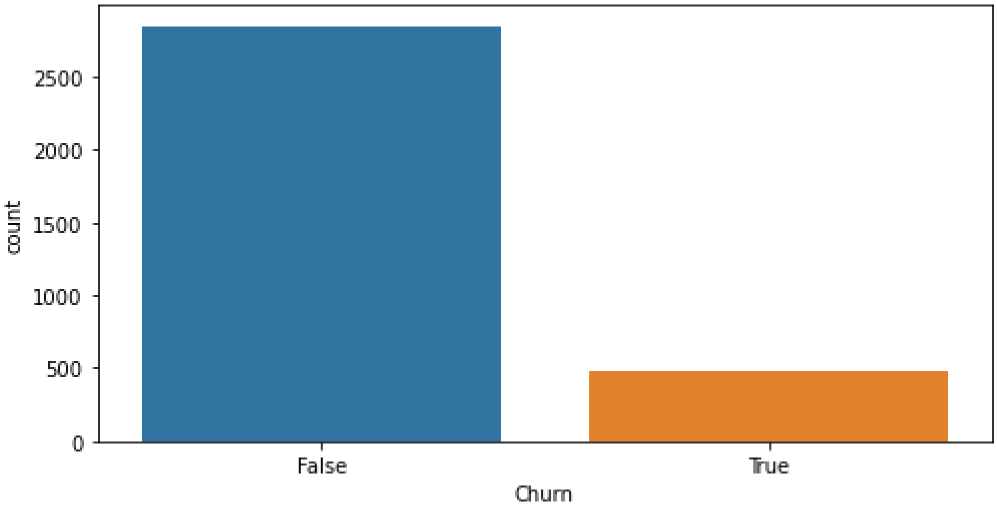
```
No     3010
Yes     323
Name: International plan, dtype: int64
```



```
No     2411
Yes     922
Name: Voice mail plan, dtype: int64
```



```
False    2850
True      483
Name: Churn, dtype: int64
```



Observations -

```
- Area code - almost half of customers are from area code 415, 1/4 from other tw
o area code each
- Internation Plan - almost 90% of customers do not have internation plan
- Voice mail Message - almost 30% of customers have opted for voice mail message
- Churn - alomst 14% of cusomers left the telecom company
```

Numeric variables

In [23]:

```
df.describe()
```

Out[23]:

	Account length	Area code	Number vmail messages	Total day minutes	Total day calls	Total day charge	To m
count	3333.000000	3333.000000	3333.000000	3333.000000	3333.000000	3333.000000	3333.
mean	101.064806	437.182418	8.099010	179.775098	100.435644	30.562307	200.
std	39.822106	42.371290	13.688365	54.467389	20.069084	9.259435	50.
min	1.000000	408.000000	0.000000	0.000000	0.000000	0.000000	0.
25%	74.000000	408.000000	0.000000	143.700000	87.000000	24.430000	166.
50%	101.000000	415.000000	0.000000	179.400000	101.000000	30.500000	201.
75%	127.000000	510.000000	20.000000	216.400000	114.000000	36.790000	235.
max	243.000000	510.000000	51.000000	350.800000	165.000000	59.640000	363.

In [24]:

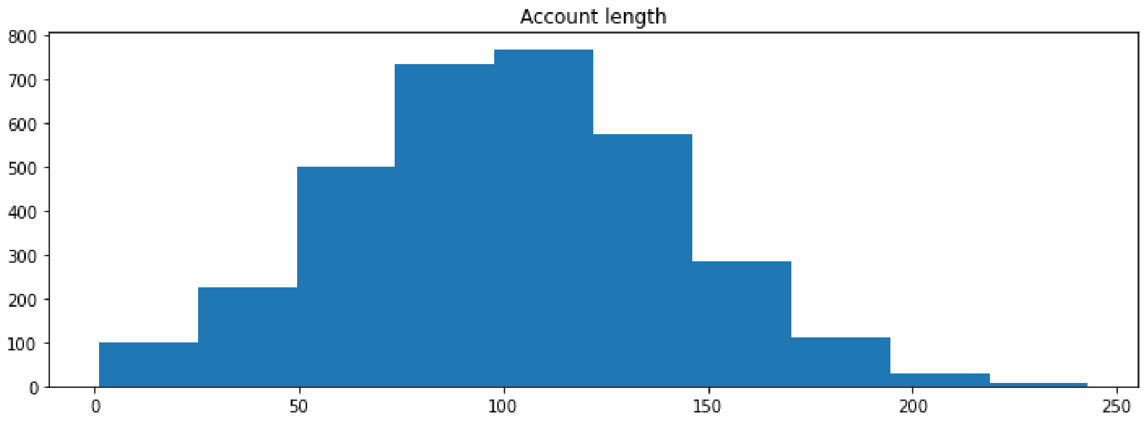
```
df.columns
```

Out[24]:

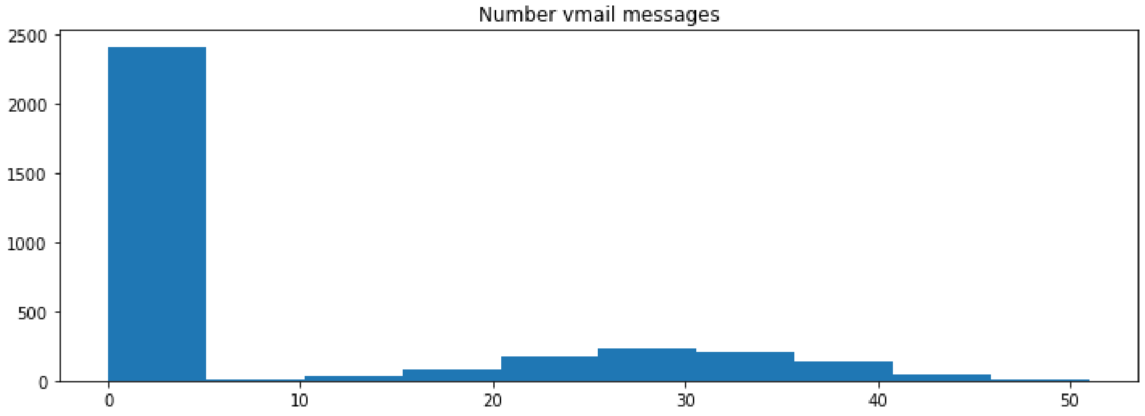
```
Index(['State', 'Account length', 'Area code', 'International plan',
       'Voice mail plan', 'Number vmail messages', 'Total day minutes',
       'Total day calls', 'Total day charge', 'Total eve minutes',
       'Total eve calls', 'Total eve charge', 'Total night minutes',
       'Total night calls', 'Total night charge', 'Total intl minutes',
       'Total intl calls', 'Total intl charge', 'Customer service calls',
       'Churn'],
      dtype='object')
```

In [28]:

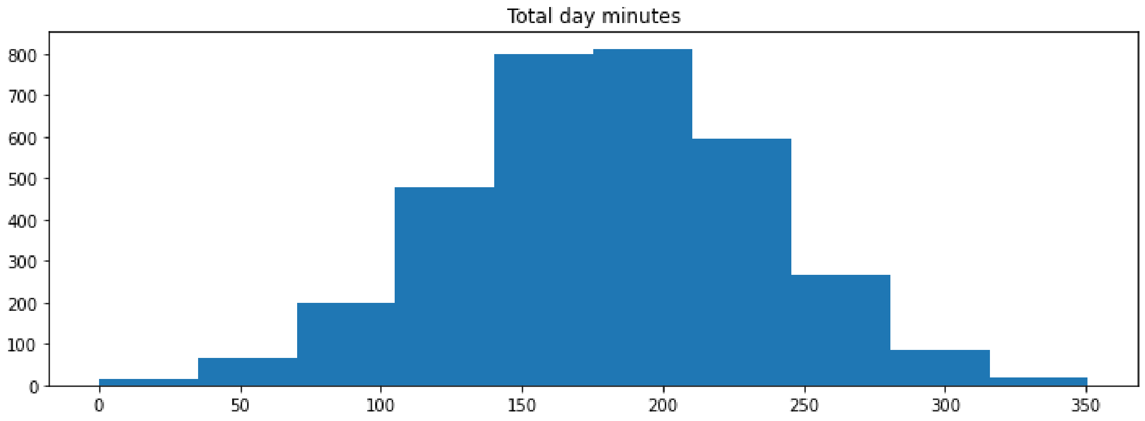
```
nums = ['Account length', 'Number vmail messages', 'Total day minutes',
       'Total day calls', 'Total day charge', 'Total eve minutes',
       'Total eve calls', 'Total eve charge', 'Total night minutes',
       'Total night calls', 'Total night charge', 'Total intl minutes',
       'Total intl calls', 'Total intl charge', 'Customer service calls']

for col in nums:
    plt.figure(figsize=(12,4))
    plt.hist(df[col])
    plt.title(col)
    plt.show()
```



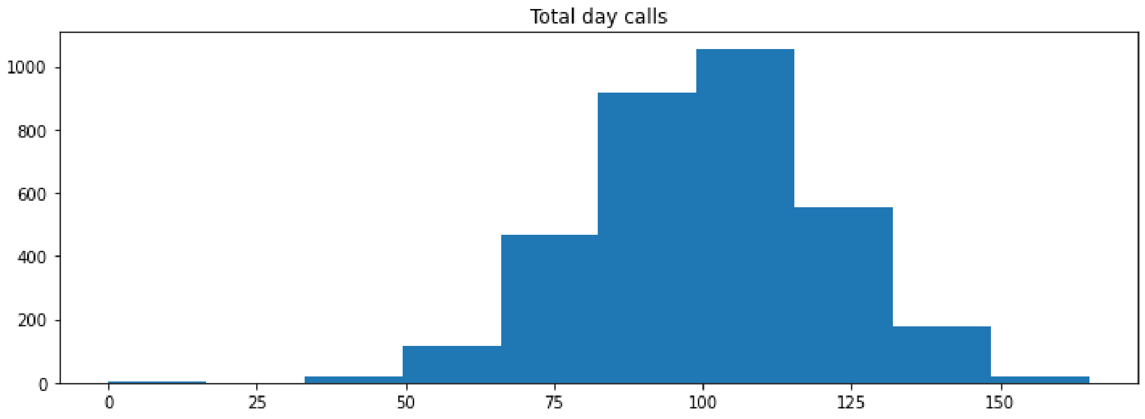
Account length



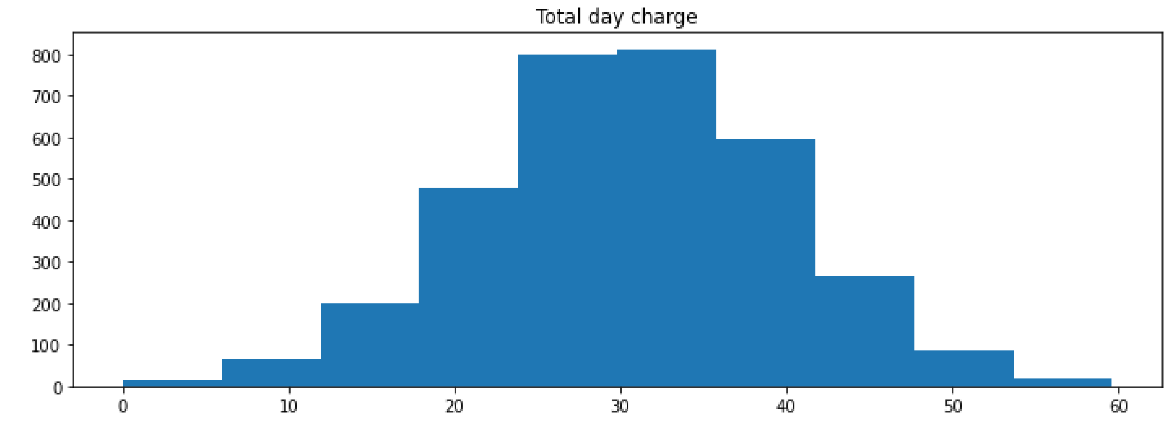
Number vmail messages

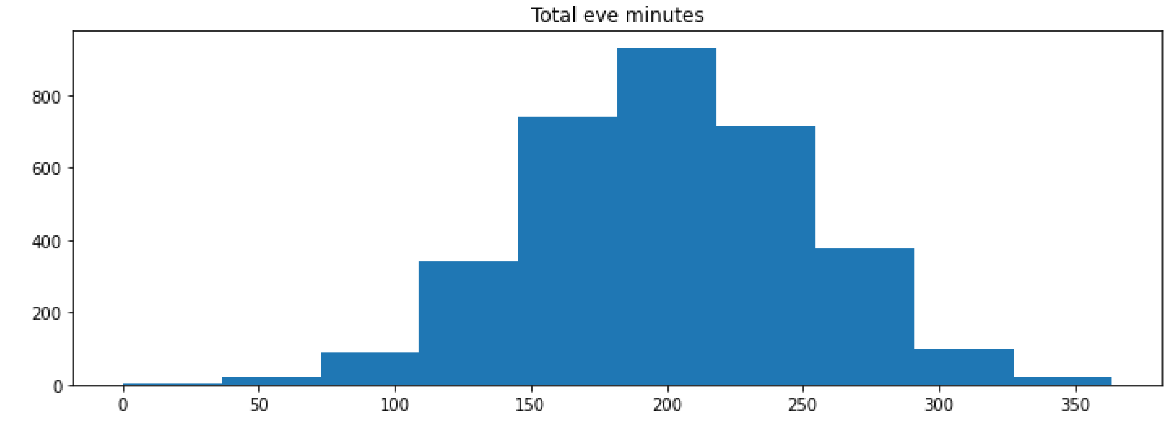


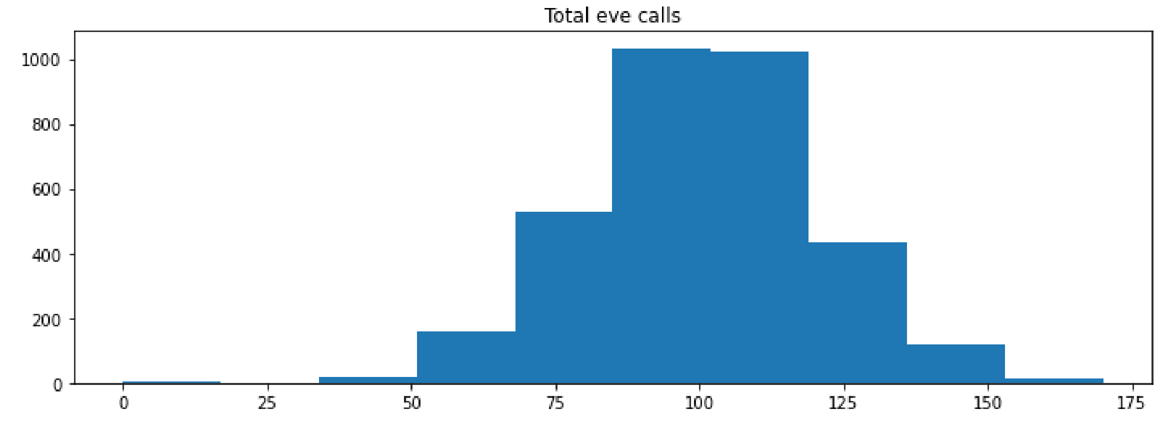
Total day minutes

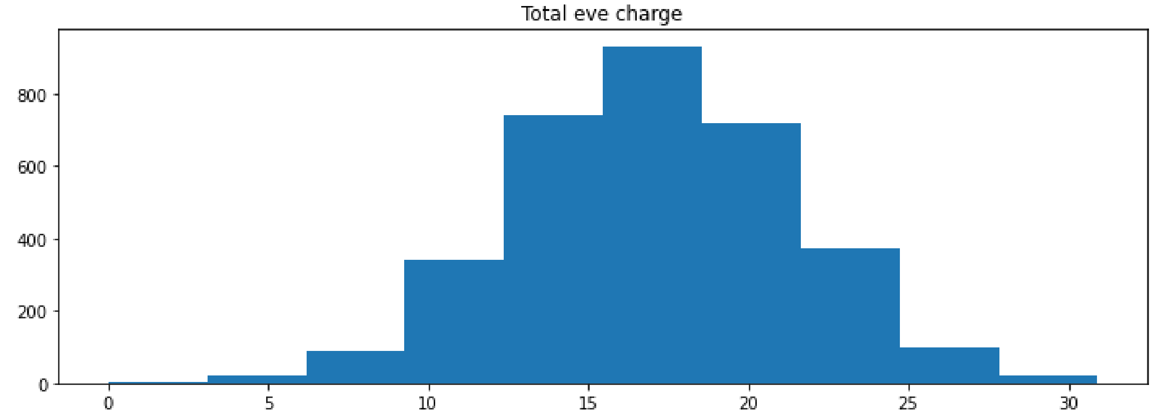


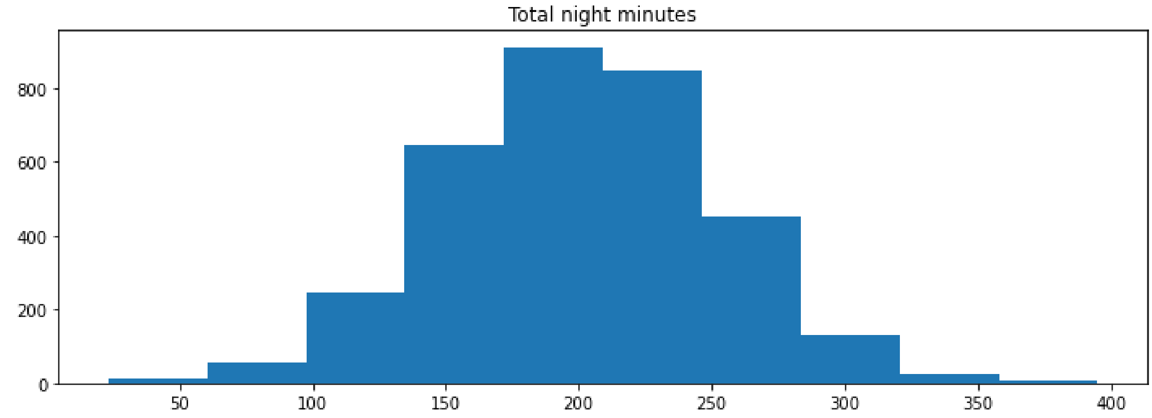
Total day calls

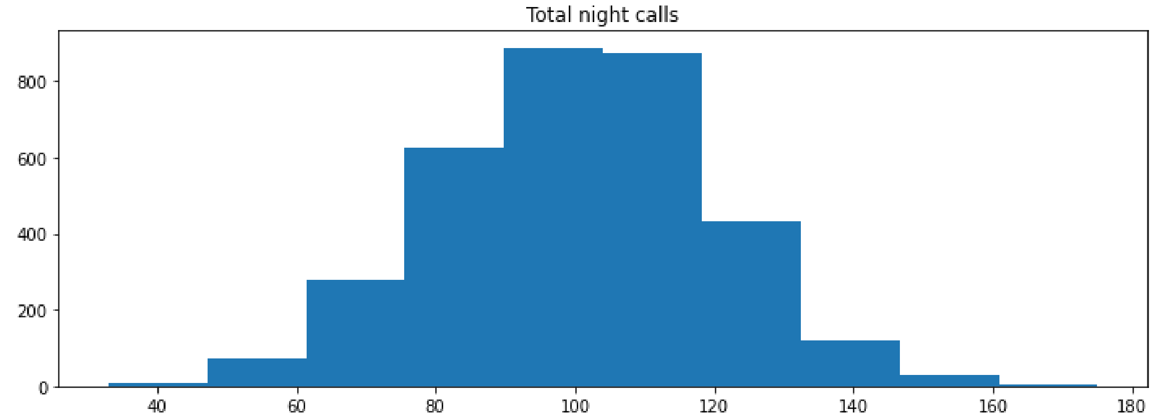

Total day charge
0
100
200
300
400
500
600
700
800
0
10
20
30
40
50
60

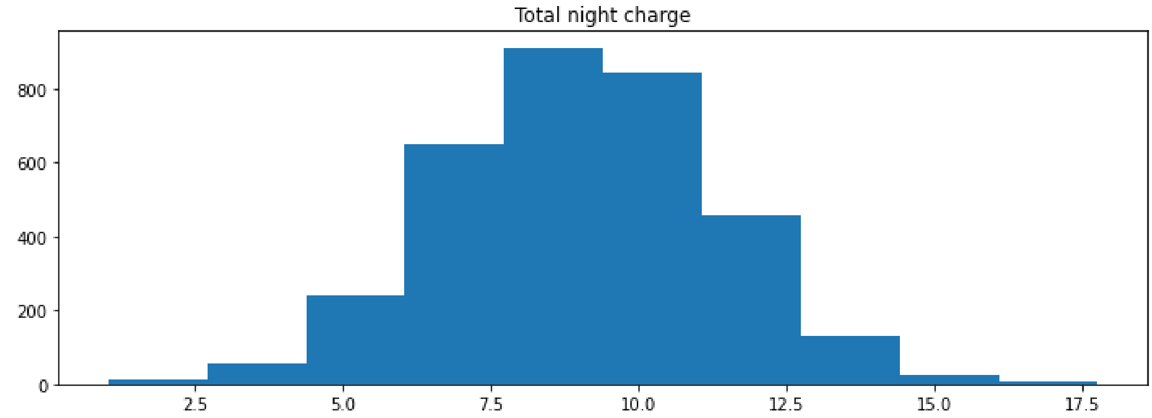

Total eve minutes
0
200
400
600
800
0
50
100
150
200
250
300
350

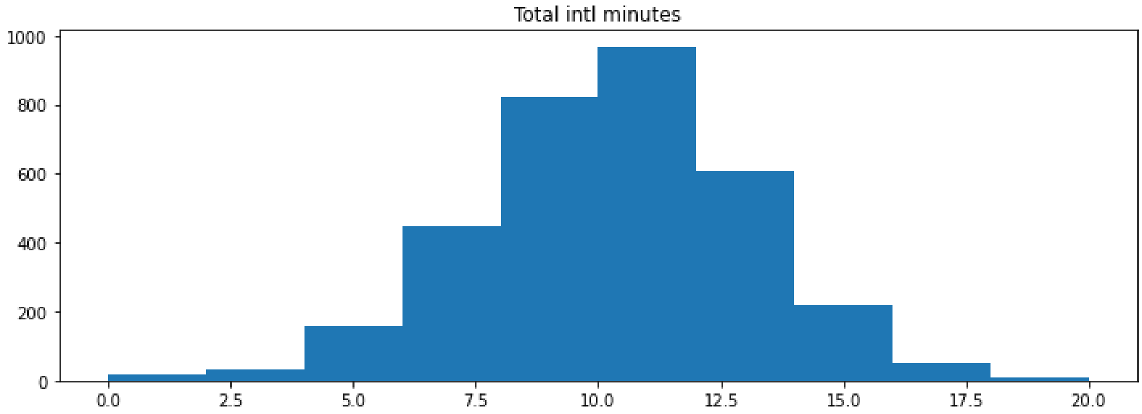

Total eve calls
0
200
400
600
800
1000
0
25
50
75
100
125
150
175

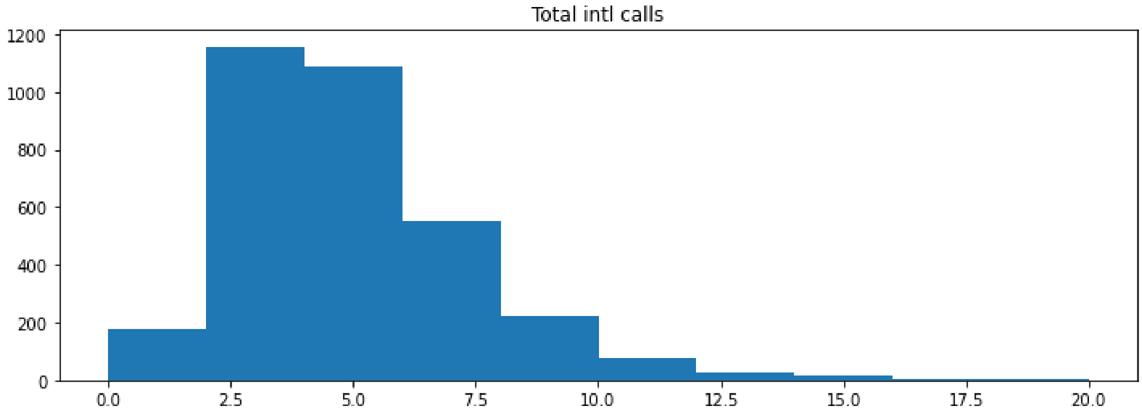

Total eve charge
0
200
400
600
800
0
5
10
15
20
25
30

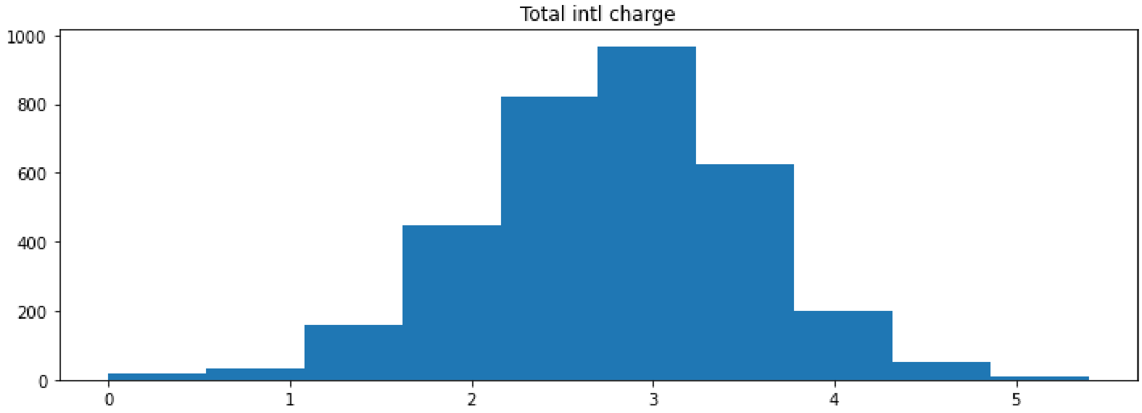

Total night minutes
0
200
400
600
800
50
100
150
200
250
300
350
400

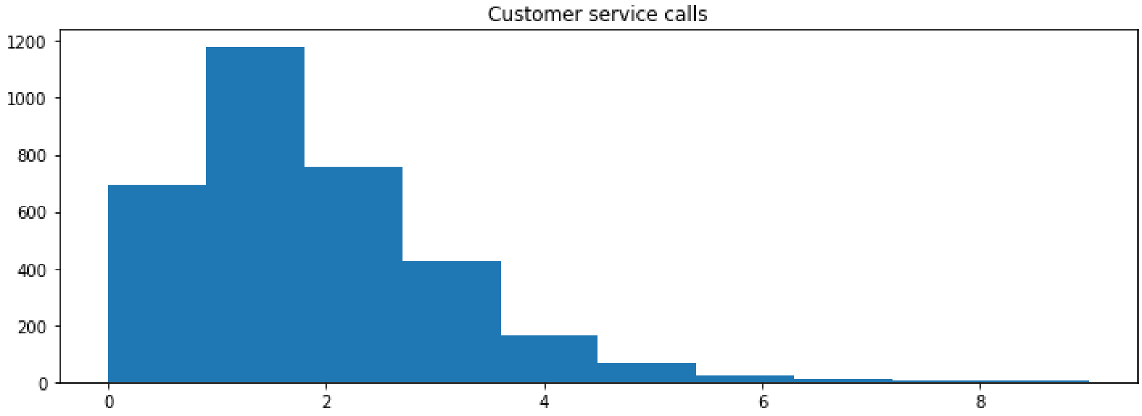

Total night calls
0
200
400
600
800
40
60
80
100
120
140
160
180


Total night charge
0
200
400
600
800
2.5
5.0
7.5
10.0
12.5
15.0
17.5


Total intl minutes
0
200
400
600
800
1000
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Total intl calls
0
200
400
600
800
1000
1200
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Total intl charge
0
200
400
600
800
1000
0
1
2
3
4
5


Customer service calls
0
200
400
600
800
1000
1200
0
2
4
6
8

Observation -

```
- total xx minutes is having similar distribution to total xx charges
- Customer service calls, are having outliers present
- Number vmail messages is having multimodel distribution
```

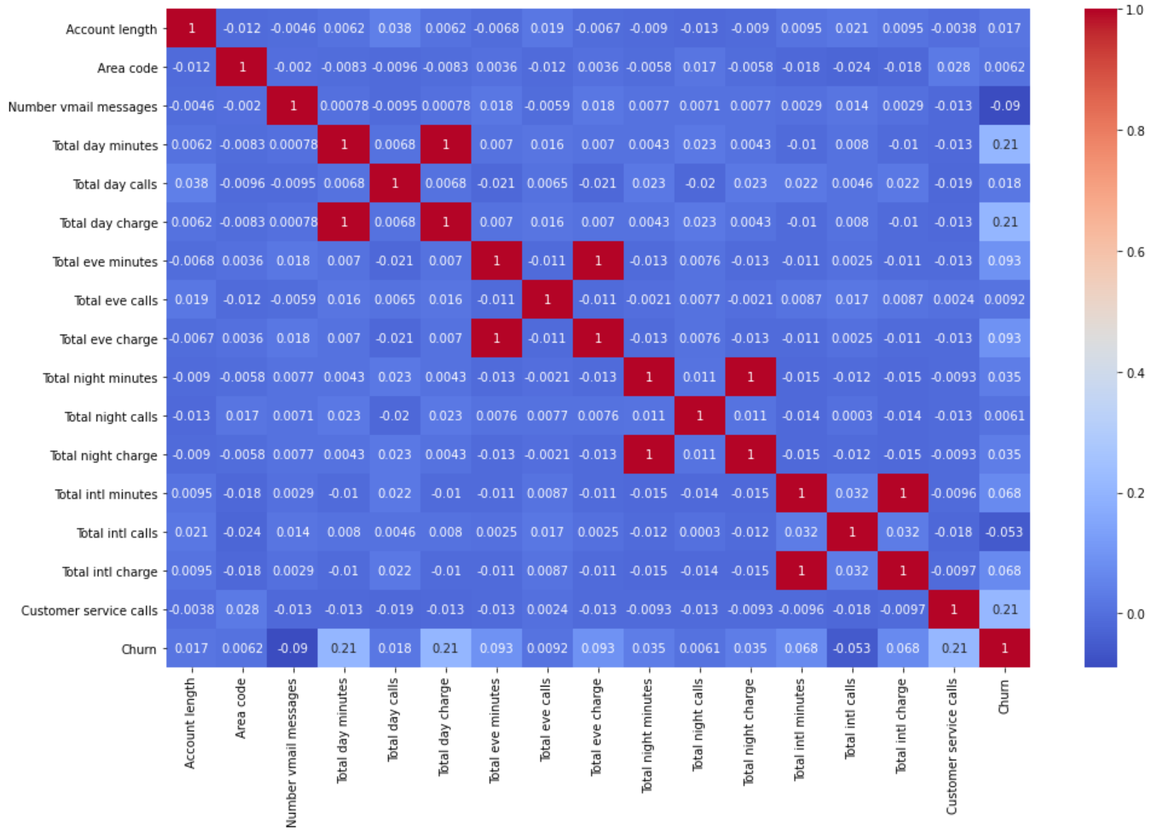
Exploratory Analysis

```
- Correlation Analysis
- ANOVA
- Chi Square test
```

Correlation Analysis

In [32]:

```
corr = df.corr()

plt.figure(figsize=(16,10))
sns.heatmap(corr,annot=True,cmap='coolwarm')
plt.show()
```



Observation -

```
     - slightly good correlating factors to customer churn include - Total day minut
    es and customer service calls
     - Total xx minutes are exactly multiplier of total xx charge
```

ANOVA - Analysis of Variance

In [33]:

```
print(nums)
```

```
['Account length', 'Number vmail messages', 'Total day minutes', 'Total da
y calls', 'Total day charge', 'Total eve minutes', 'Total eve calls', 'Tot
al eve charge', 'Total night minutes', 'Total night calls', 'Total night c
harge', 'Total intl minutes', 'Total intl calls', 'Total intl charge', 'Cu
stomer service calls']
```

In [35]:

```
xnum = df[nums]
y = df['Churn']

from sklearn.feature_selection import f_classif
fvalue, pvalue = f_classif(xnum,y)
```

In [36]:

```
for i in range(len(nums)):
    print(nums[i],pvalue[i])
```

```
Account length 0.339760007057206666
Number vmail messages 2.1175218402696038e-07
Total day minutes 5.300278227509361e-33
Total day calls 0.28670102402211844
Total day charge 5.30060595239102e-33
Total eve minutes 8.011338561256927e-08
Total eve calls 0.5941305829720491
Total eve charge 8.036524227754477e-08
Total night minutes 0.04046648463758881
Total night calls 0.7230277872081609
Total night charge 0.040451218769160205
Total intl minutes 8.05731126549437e-05
Total intl calls 0.002274701409850077
Total intl charge 8.018753583047257e-05
Customer service calls 3.900360240185746e-34
```

Observations -

```
    - important informative features - Number vmail messages, total day mins, total
     eve mins,
    total night mins, total intl mins, total int calls, customer service calls
```

Chi Square test

In [39]:

```
cats = ['State','Area code', 'International plan', 'Voice mail plan']
```

In [41]:

```
xcat = df[cats]
y = df['Churn']
```

In [42]:

```
from sklearn.preprocessing import LabelEncoder
xcat['State'] = LabelEncoder().fit_transform(xcat['State'])
xcat['International plan'] = LabelEncoder().fit_transform(xcat['International plan'])
xcat['Voice mail plan'] = LabelEncoder().fit_transform(xcat['Voice mail plan'])
```

```
C:\ProgramData\Anaconda3\lib\site-packages\ipykernel_launcher.py:2: Settin
gWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-doc
s/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

C:\ProgramData\Anaconda3\lib\site-packages\ipykernel_launcher.py:3: Settin
gWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-doc
s/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  This is separate from the ipykernel package so we can avoid doing import
s until
C:\ProgramData\Anaconda3\lib\site-packages\ipykernel_launcher.py:4: Settin
gWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-doc
s/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  after removing the cwd from sys.path.
```

In [43]:

```
from sklearn.feature_selection import chi2
chi_val, pvalue = chi2(xcat,y)
```

In [44]:

```
for i in range(len(cats)):
    print(cats[i],pvalue[i])
```

```
State 0.19214978695607624
Area code 0.4701527286099566
International plan 4.0917347294154797e-46
Voice mail plan 5.28486023170551e-07
```

Observation -

```
    - Important / informative features - International Plan, Voice mail plan
```

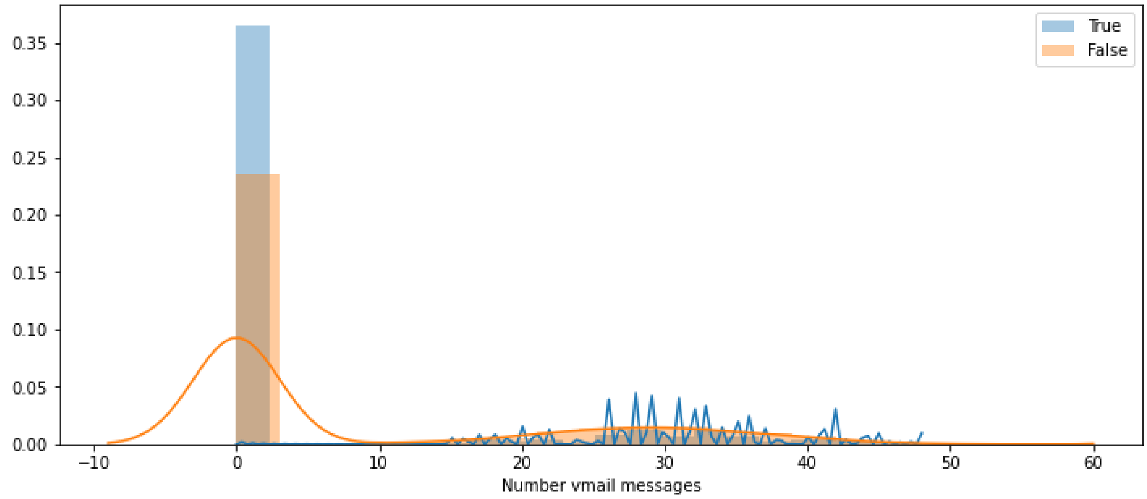
Data Visualization

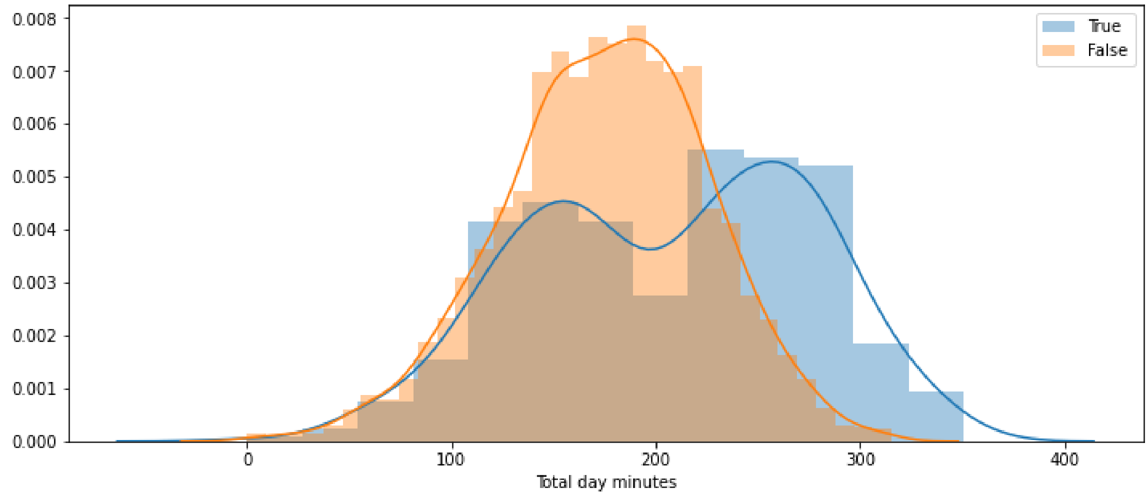
In [46]:

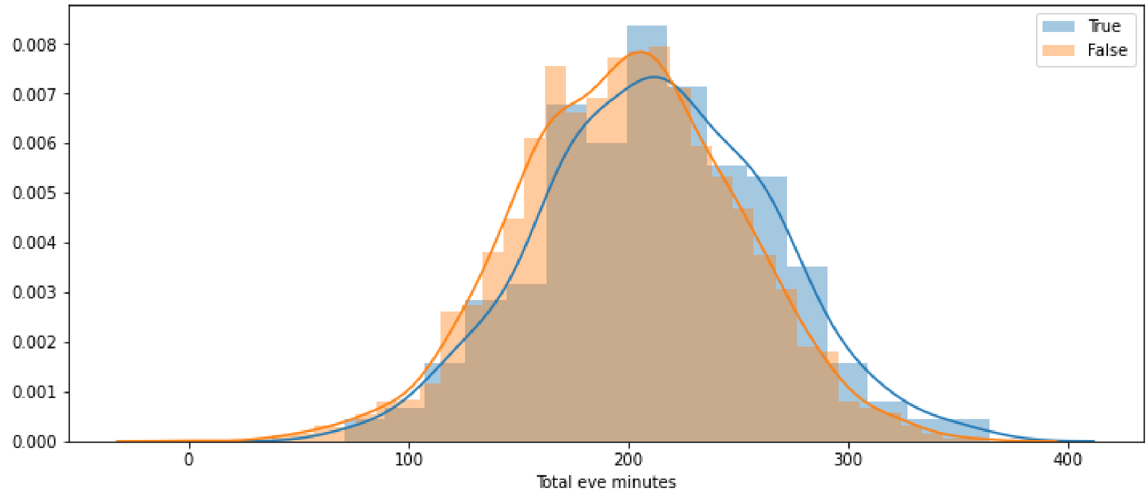
```
nums = ['Number vmail messages','Total day minutes', 'Total eve minutes','Total night minutes',
 'Total intl minutes', 'Total intl calls','Customer service calls']
```

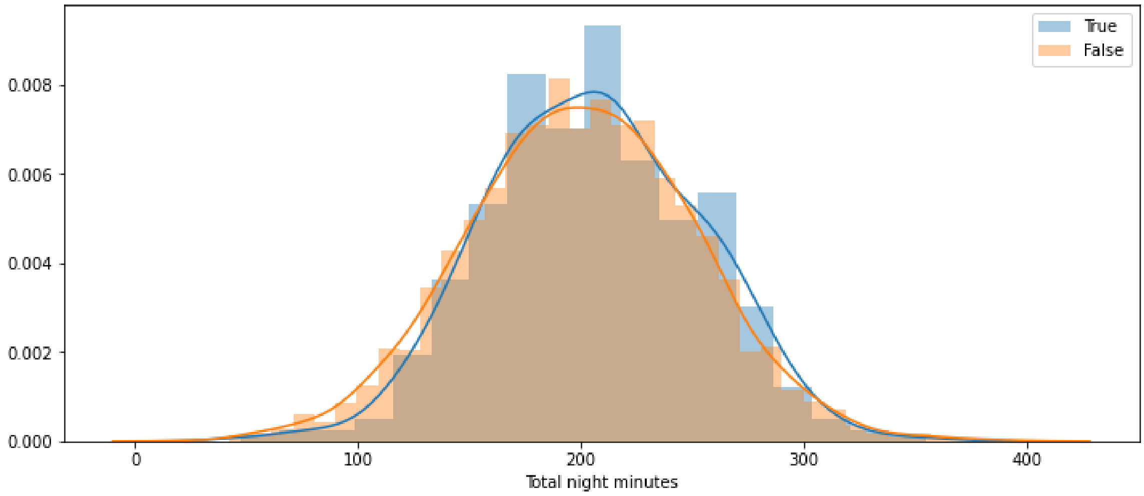
In [47]:

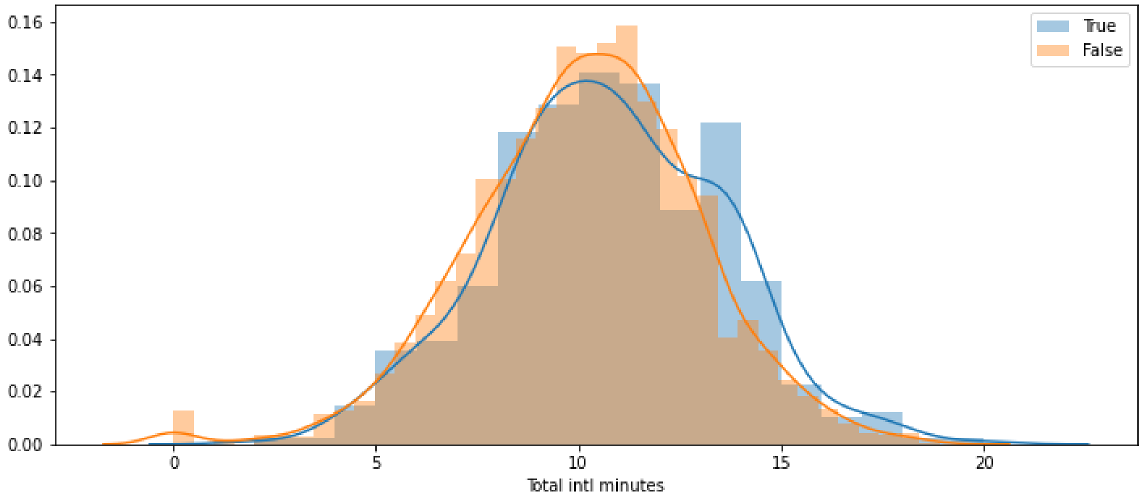
```
for col in nums:
    plt.figure(figsize=(12,5))
    sns.distplot(df[col][df.Churn==True])
    sns.distplot(df[col][df.Churn==False])
    plt.legend([True,False])
    plt.show()
```

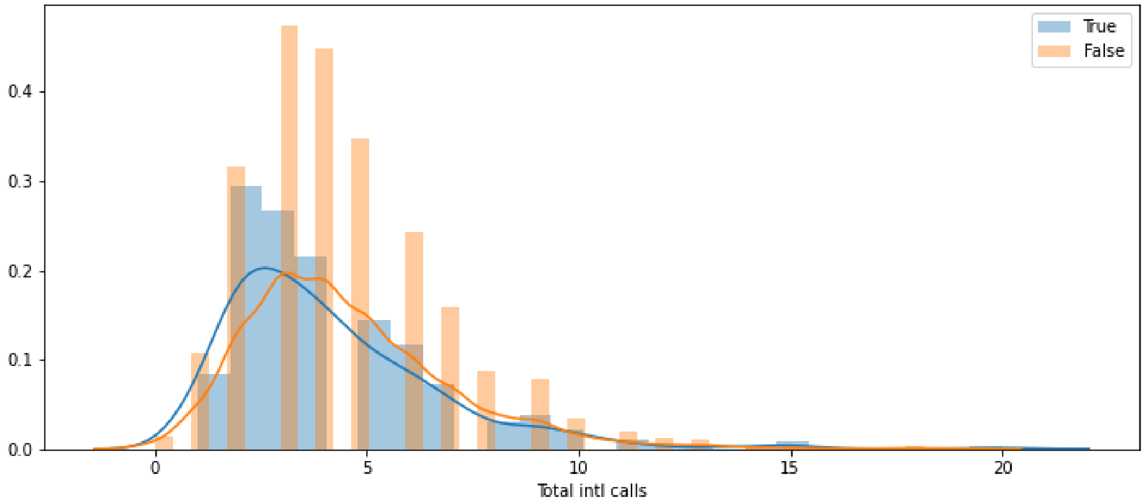

0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
−10
0
10
20
30
40
50
60
Number vmail messages
True
False

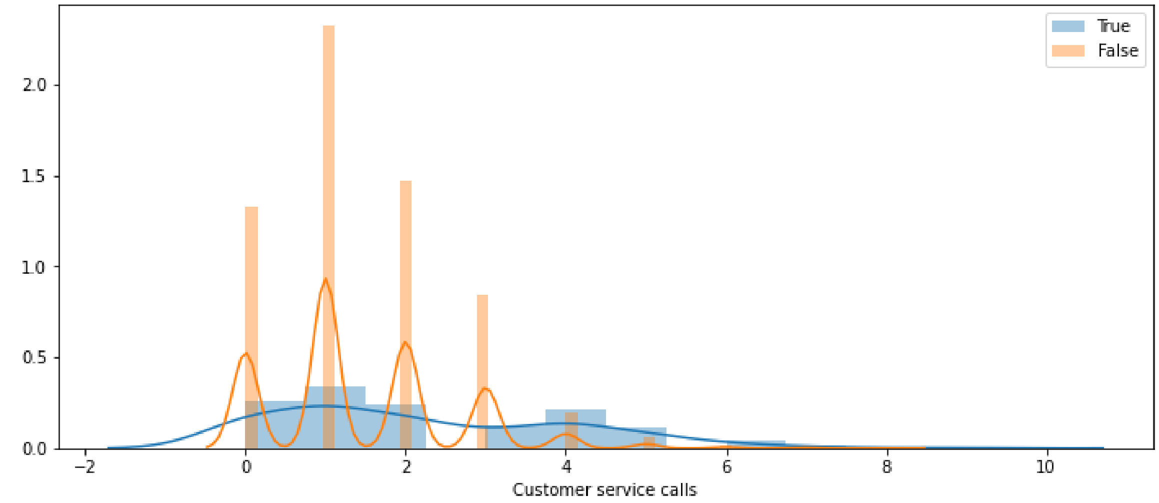

0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
0
100
200
300
400
Total day minutes
True
False


0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
0
100
200
300
400
Total eve minutes
True
False


True
False
0.008
0.006
0.004
0.002
0.000
0
100
200
300
400
Total night minutes


True
False
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0
5
10
15
20
Total intl minutes


True
False
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
Total intl calls



In [48]:

```
cats
```

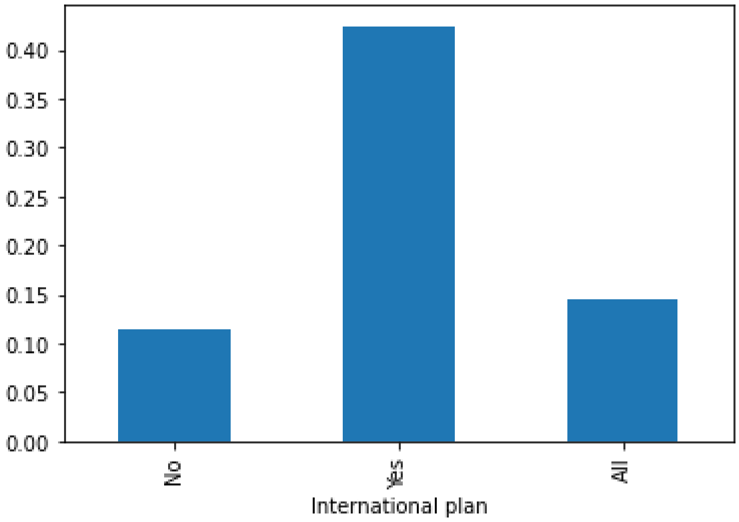
Out[48]:

```
['State', 'Area code', 'International plan', 'Voice mail plan']
```

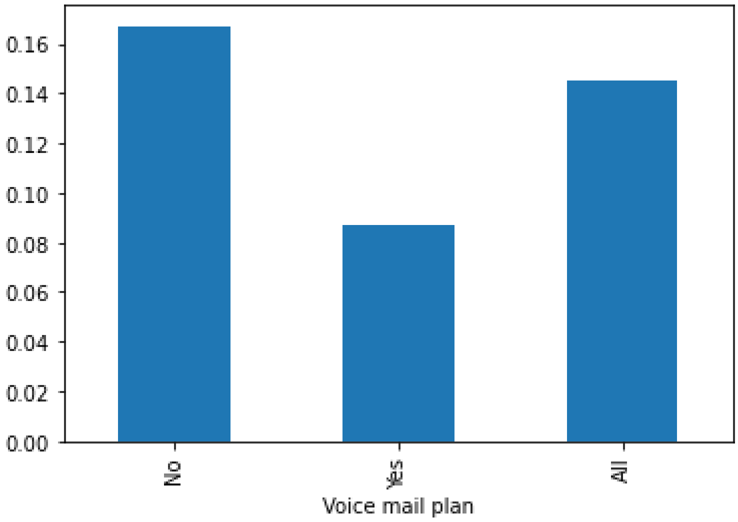
In [52]:

```
cats=['International plan', 'Voice mail plan']
for col in cats:
    pivot = pd.crosstab(df[col],df['Churn'],margins=True)
    print(pivot)
    ratio = pivot[True]/pivot['All']
    print(ratio)
    ratio.plot(kind='bar')
    plt.show()
```

```
Churn                False  True   All
International plan                    
No                    2664   346  3010
Yes                    186   137   323
All                   2850   483  3333
International plan
No     0.114950
Yes    0.424149
All    0.144914
dtype: float64
```



```
Churn             False  True   All
Voice mail plan                    
No                 2008   403  2411
Yes                 842    80   922
All                2850   483  3333
Voice mail plan
No     0.167151
Yes    0.086768
All    0.144914
dtype: float64
```



```
In [ ]:
```