Telecom Churn Predication Project

August 3, 2023

[5]:
```
import pandas as pd
from sklearn import metrics
from sklearn.model_selection import train_test_split
from sklearn.metrics import recall_score
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
from sklearn.tree import DecisionTreeClassifier
import seaborn as sns
import matplotlib.pyplot as plt
import numpy as np
```

[20]:
```
Tdata = pd.read_csv("WA_Fn-UseC_-Telco-Customer-Churn.csv")
```

[21]:
```
Tdata.head()
```

[21]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	…	DeviceProtection	TechSupport	StreamingTV	StreamingMovies	Contract	PaperlessBilling	PaymentMethod	MonthlyCharges	TotalCharges	Churn
0	7590-VHVEG	Female	0	Yes	No	1	No	…	No	No	No	No	Month-to-month	Yes	Electronic check	29.85	29.85	No
1	5575-GNVDE	Male	0	No	No	34	Yes	…	Yes	No	No	No	One year	No				
2	3668-QPYBK	Male	0	No	No	2	Yes	…	No	No	No	No	Month-to-month	Yes				
3	7795-CFOCW	Male	0	No	No	45	No	…	Yes	Yes	No	No	One year	No				
4	9237-HQITU	Female	0	No	No	2	Yes	…	No	No	No	No	Month-to-month	Yes				

```
1              Mailed check          56.95        1889.5    No
2              Mailed check          53.85         108.15   Yes
3  Bank transfer (automatic)         42.30        1840.75    No
4           Electronic check         70.70         151.65   Yes

[5 rows x 21 columns]
```

[22]:
```
Tdata.tail()
```

[22]:
```
      customerID  gender  SeniorCitizen Partner Dependents  tenure  \
7038  6840-RESVB    Male              0     Yes        Yes      24
7039  2234-XADUH  Female              0     Yes        Yes      72
7040  4801-JZAZL  Female              0     Yes        Yes      11
7041  8361-LTMKD    Male              1     Yes         No       4
7042  3186-AJIEK    Male              0      No         No      66

     PhoneService     MultipleLines InternetService OnlineSecurity  …  \
7038          Yes               Yes             DSL            Yes  …
7039          Yes               Yes     Fiber optic             No  …
7040           No  No phone service             DSL            Yes  …
7041          Yes               Yes     Fiber optic             No  …
7042          Yes                No     Fiber optic            Yes  …

     DeviceProtection TechSupport StreamingTV StreamingMovies        Contract  \
7038              Yes         Yes         Yes              Yes        One year
7039              Yes          No         Yes              Yes        One year
7040               No          No          No               No  Month-to-month
7041               No          No          No               No  Month-to-month
7042              Yes         Yes         Yes              Yes        Two year

     PaperlessBilling              PaymentMethod MonthlyCharges  TotalCharges  \
7038              Yes               Mailed check          84.80        1990.5
7039              Yes    Credit card (automatic)         103.20        7362.9
7040              Yes           Electronic check          29.60        346.45
7041              Yes               Mailed check          74.40         306.6
7042              Yes  Bank transfer (automatic)         105.65        6844.5

     Churn
7038    No
7039    No
7040    No
7041   Yes
7042    No

[5 rows x 21 columns]
```

[5]:
```
Tdata.dtypes
```

[5]:
```
customerID           object
gender               object
SeniorCitizen         int64
Partner              object
Dependents           object
tenure                int64
PhoneService         object
MultipleLines        object
InternetService      object
OnlineSecurity       object
OnlineBackup         object
DeviceProtection     object
TechSupport          object
StreamingTV          object
StreamingMovies      object
Contract             object
PaperlessBilling     object
PaymentMethod        object
MonthlyCharges      float64
TotalCharges         object
Churn                object
dtype: object
```

[6]:
```
# Converting TotalCharges to Numerical value
```

[32]:
```
Tdata["TotalCharges"] = pd.to_numeric(Tdata["TotalCharges"],errors='coerce')
```

[33]:
```
Tdata.isnull().sum()
```

[33]:
```
customerID           0
gender               0
SeniorCitizen        0
Partner              0
Dependents           0
tenure               0
PhoneService         0
MultipleLines        0
InternetService      0
OnlineSecurity       0
OnlineBackup         0
DeviceProtection     0
TechSupport          0
StreamingTV          0
StreamingMovies      0
Contract             0
PaperlessBilling     0
PaymentMethod        0
```

```
MonthlyCharges       0
TotalCharges        11
Churn                0
dtype: int64
```

[9]:
```
# As we can see that TotalCharges is ratio of the
```

[6]:
```
Tdata.loc[Tdata["TotalCharges"].isnull() == True]
```

[6]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	\
488	4472-LVYGI	Female	0	Yes	Yes	0	
753	3115-CZMZD	Male	0	No	Yes	0	
936	5709-LVOEQ	Female	0	Yes	Yes	0	
1082	4367-NUYAO	Male	0	Yes	Yes	0	
1340	1371-DWPAZ	Female	0	Yes	Yes	0	
3331	7644-OMVMY	Male	0	Yes	Yes	0	
3826	3213-VVOLG	Male	0	Yes	Yes	0	
4380	2520-SGTTA	Female	0	Yes	Yes	0	
5218	2923-ARZLG	Male	0	Yes	Yes	0	
6670	4075-WKNIU	Female	0	Yes	Yes	0	
6754	2775-SEFEE	Male	0	No	Yes	0	

	PhoneService	MultipleLines	InternetService	OnlineSecurity	…	\
488	No	No phone service	DSL	Yes	…	
753	Yes	No	No	No internet service	…	
936	Yes	No	DSL	Yes	…	
1082	Yes	Yes	No	No internet service	…	
1340	No	No phone service	DSL	Yes	…	
3331	Yes	No	No	No internet service	…	
3826	Yes	Yes	No	No internet service	…	
4380	Yes	No	No	No internet service	…	
5218	Yes	No	No	No internet service	…	
6670	Yes	Yes	DSL	No	…	
6754	Yes	Yes	DSL	Yes	…	

	DeviceProtection	TechSupport	StreamingTV	\
488	Yes	Yes	Yes	
753	No internet service	No internet service	No internet service	
936	Yes	No	Yes	
1082	No internet service	No internet service	No internet service	
1340	Yes	Yes	Yes	
3331	No internet service	No internet service	No internet service	
3826	No internet service	No internet service	No internet service	
4380	No internet service	No internet service	No internet service	
5218	No internet service	No internet service	No internet service	
6670	Yes	Yes	Yes	
6754	No	Yes	No	

```
          StreamingMovies  Contract PaperlessBilling  \
488                    No  Two year              Yes
753   No internet service  Two year               No
936                   Yes  Two year               No
1082  No internet service  Two year               No
1340                   No  Two year               No
3331  No internet service  Two year               No
3826  No internet service  Two year               No
4380  No internet service  Two year               No
5218  No internet service  One year              Yes
6670                   No  Two year               No
6754                   No  Two year              Yes

                  PaymentMethod MonthlyCharges  TotalCharges  Churn
488   Bank transfer (automatic)          52.55           NaN     No
753                Mailed check          20.25           NaN     No
936                Mailed check          80.85           NaN     No
1082               Mailed check          25.75           NaN     No
1340    Credit card (automatic)          56.05           NaN     No
3331               Mailed check          19.85           NaN     No
3826               Mailed check          25.35           NaN     No
4380               Mailed check          20.00           NaN     No
5218               Mailed check          19.70           NaN     No
6670               Mailed check          73.35           NaN     No
6754  Bank transfer (automatic)          61.90           NaN     No

[11 rows x 21 columns]
```

[12]:
```
Tdata.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 7032 entries, 0 to 7042
Data columns (total 21 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  -----
 0   customerID        7032 non-null   object
 1   gender            7032 non-null   object
 2   SeniorCitizen     7032 non-null   int64
 3   Partner           7032 non-null   object
 4   Dependents        7032 non-null   object
 5   tenure            7032 non-null   int64
 6   PhoneService      7032 non-null   object
 7   MultipleLines     7032 non-null   object
 8   InternetService   7032 non-null   object
 9   OnlineSecurity    7032 non-null   object
 10  OnlineBackup      7032 non-null   object
 11  DeviceProtection  7032 non-null   object
```

```
 12  TechSupport       7032 non-null   object
 13  StreamingTV       7032 non-null   object
 14  StreamingMovies   7032 non-null   object
 15  Contract          7032 non-null   object
 16  PaperlessBilling  7032 non-null   object
 17  PaymentMethod     7032 non-null   object
 18  MonthlyCharges    7032 non-null   float64
 19  TotalCharges      7032 non-null   float64
 20  Churn             7032 non-null   object
dtypes: float64(2), int64(2), object(17)
memory usage: 1.2+ MB
```

[12]:
```
# As we can see that Null value to is .15% then we are simple drop the null value
```

[34]:
```
Tdata.dropna(how="any",inplace=True)
```

[35]:
```
Tdata.isnull().sum()
```

[35]:
```
customerID          0
gender              0
SeniorCitizen       0
Partner             0
Dependents          0
tenure              0
PhoneService        0
MultipleLines       0
InternetService     0
OnlineSecurity      0
OnlineBackup        0
DeviceProtection    0
TechSupport         0
StreamingTV         0
StreamingMovies     0
Contract            0
PaperlessBilling    0
PaymentMethod       0
MonthlyCharges      0
TotalCharges        0
Churn               0
dtype: int64
```

[9]:
```
100*Tdata["Churn"].value_counts()/len(Tdata["Churn"])
```

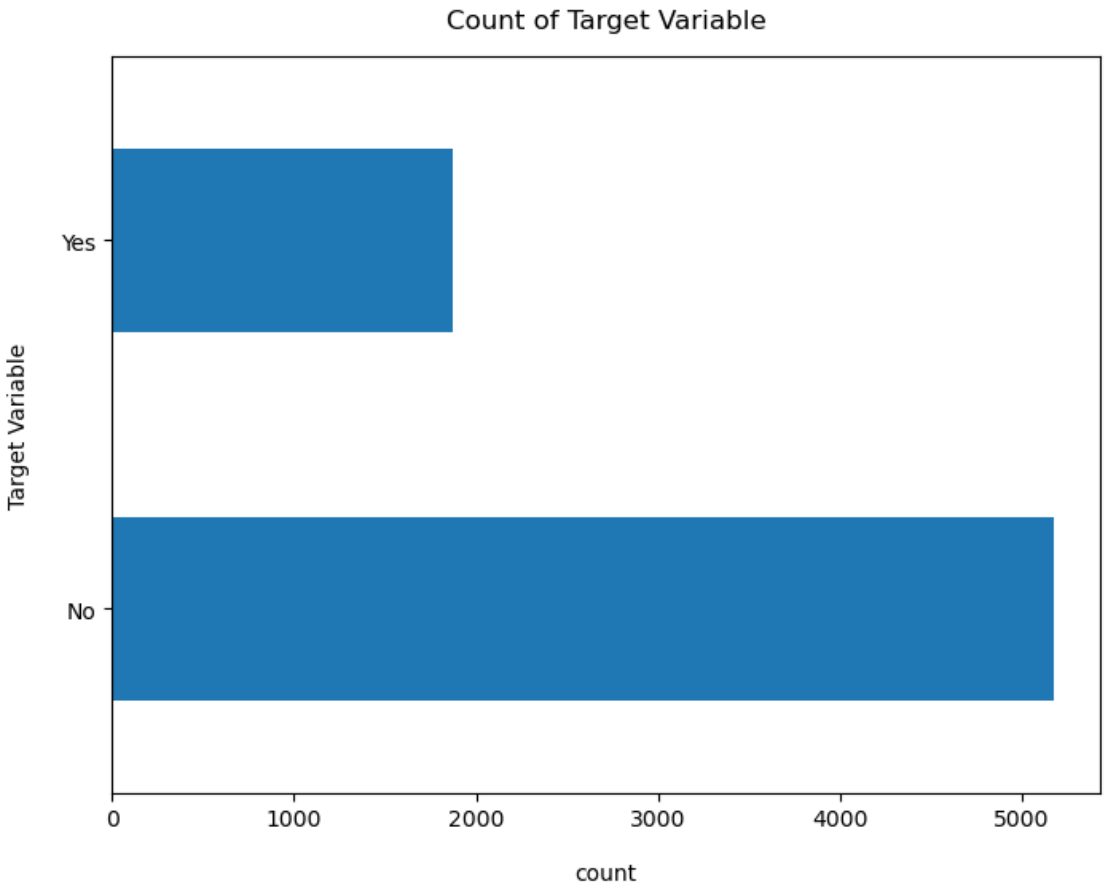
[9]:
```
No     73.421502
Yes    26.578498
Name: Churn, dtype: float64
```

[16]:
```
# Data is highly inbalanced,ratio = 73:27
# so we analyse the data with other feature while taking the target values␣
 ↪separatly to get some insights
```

[88]:
```
Tdata["Churn"].value_counts()
```

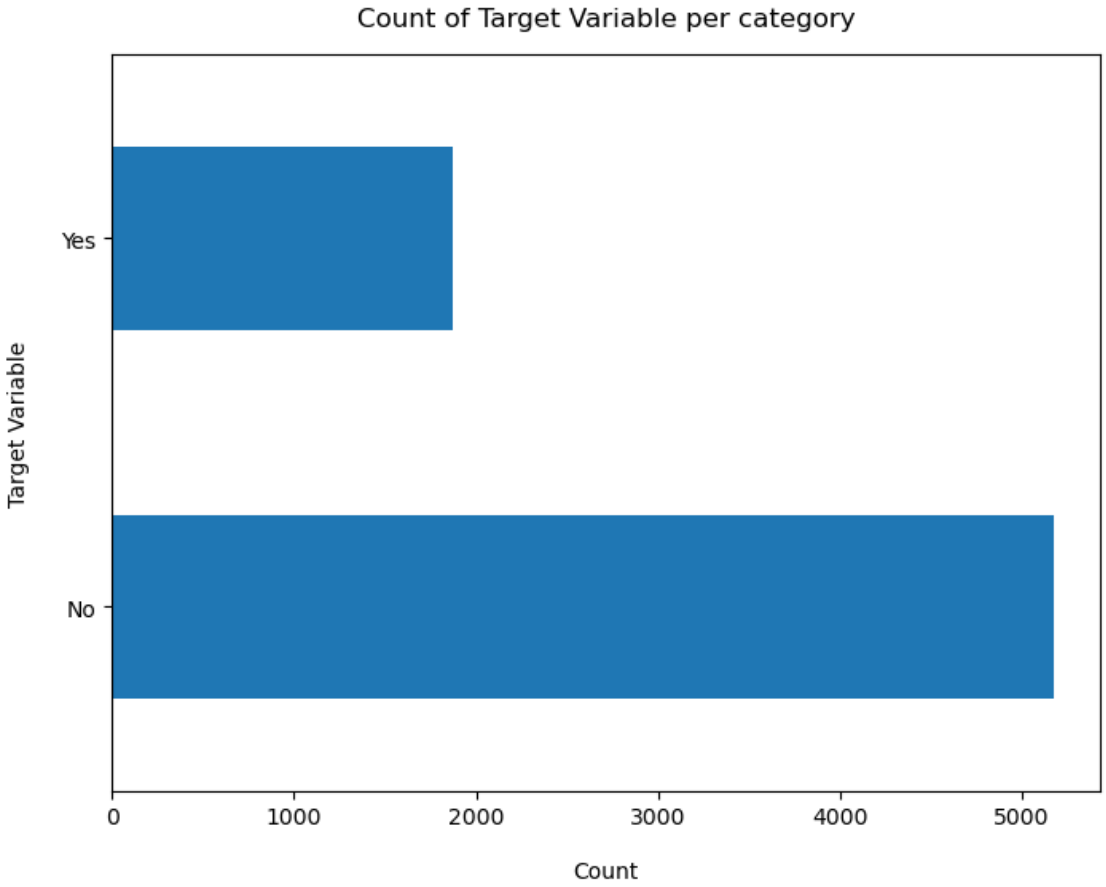
[88]:
```
No     5163
Yes    1869
Name: Churn, dtype: int64
```

[30]:
```
Tdata["Churn"].value_counts().plot(kind="barh",figsize=(8,6))
plt.xlabel("count",labelpad=14)
plt.ylabel("Target Variable",labelpad=14)
plt.title("Count of Target Variable",y=1.02);
```



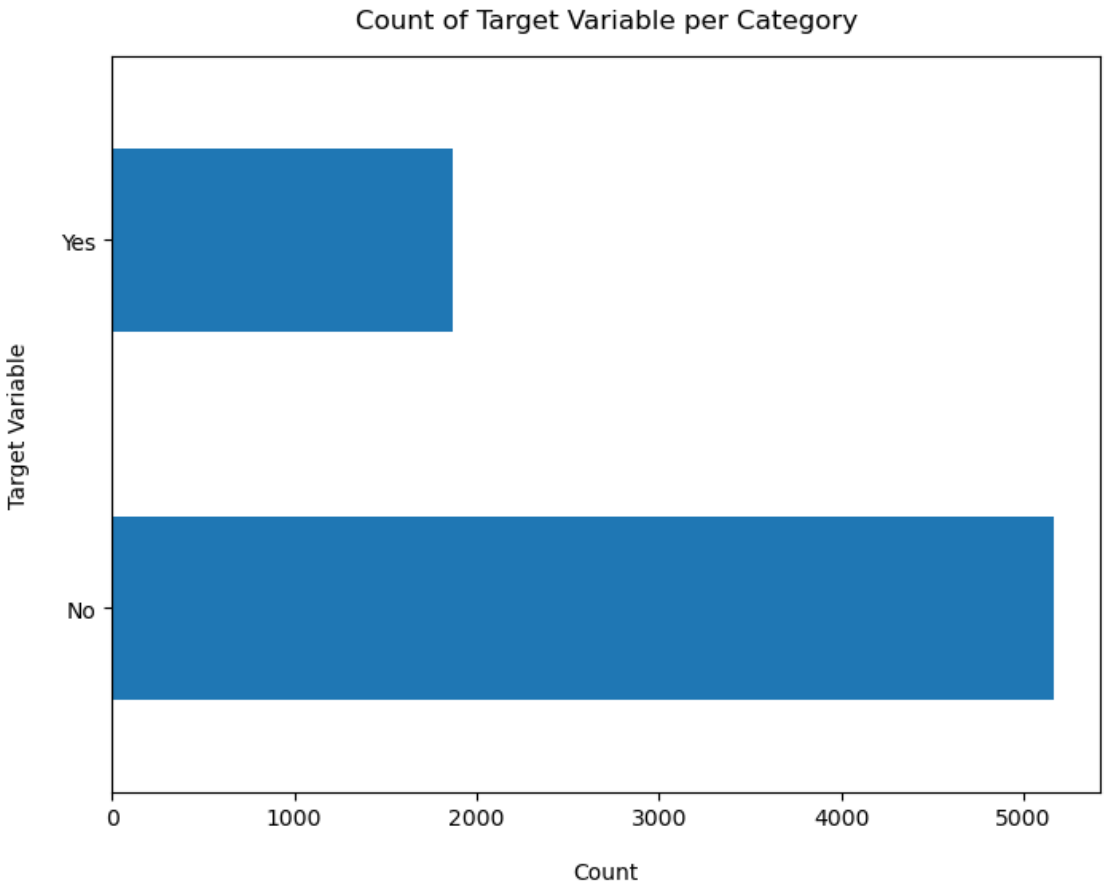
[31]:
```
Tdata["Churn"].value_counts().plot(kind="barh",figsize=(8,6))
plt.xlabel("Count",labelpad=14)
plt.ylabel("Target Variable",labelpad=14)
plt.title("Count of Target Variable per category",y=1.02)
```

[31]: Text(0.5, 1.02, 'Count of Target Variable per category')



[64]:
```
Tdata["Churn"].value_counts().plot(kind="barh",figsize=(8,6))
plt.xlabel("Count",labelpad=14)
plt.ylabel("Target Variable",labelpad=14)
plt.title("Count of Target Variable per Category",y=1.02)
```

[64]: Text(0.5, 1.02, 'Count of Target Variable per Category')



[65]:
```
Tdata.describe()
```

[65]:

	SeniorCitizen	tenure	MonthlyCharges	TotalCharges
count	7032.000000	7032.000000	7032.000000	7032.000000
mean	0.162400	32.421786	64.798208	2283.300441
std	0.368844	24.545260	30.085974	2266.771362
min	0.000000	1.000000	18.250000	18.800000
25%	0.000000	9.000000	35.587500	401.450000
50%	0.000000	29.000000	70.350000	1397.475000
75%	0.000000	55.000000	89.862500	3794.737500
max	1.000000	72.000000	118.750000	8684.800000

[66]:
```
Tdata
```

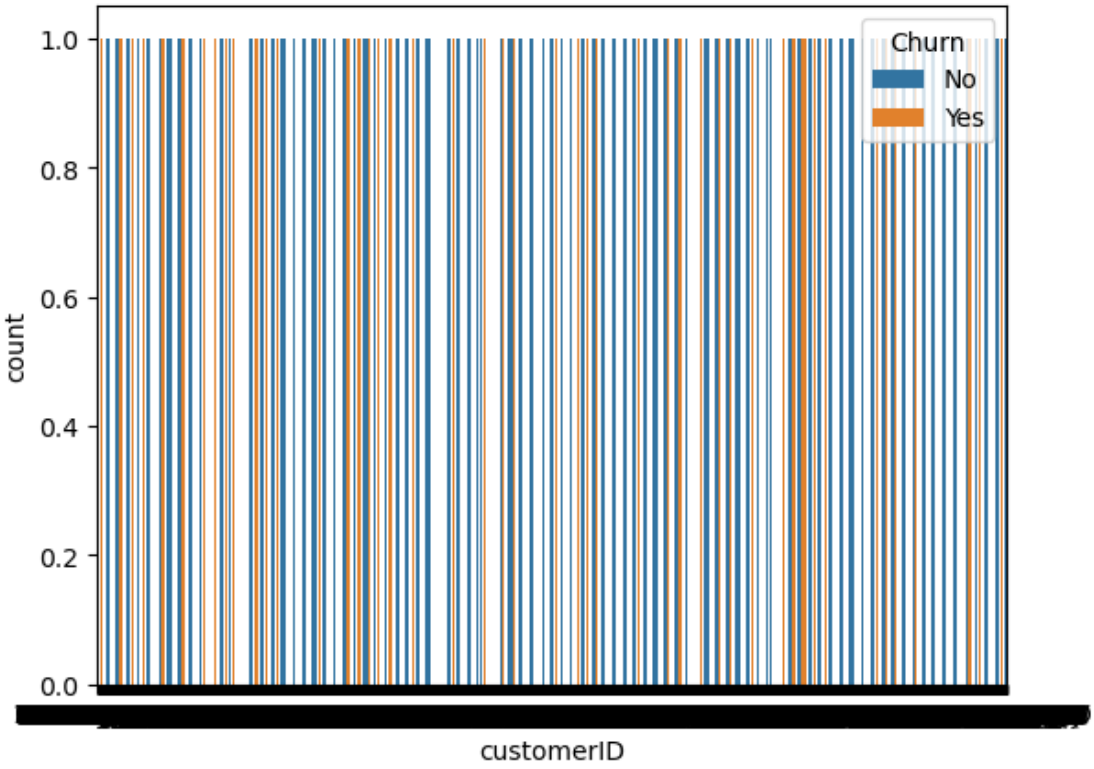
[66]:

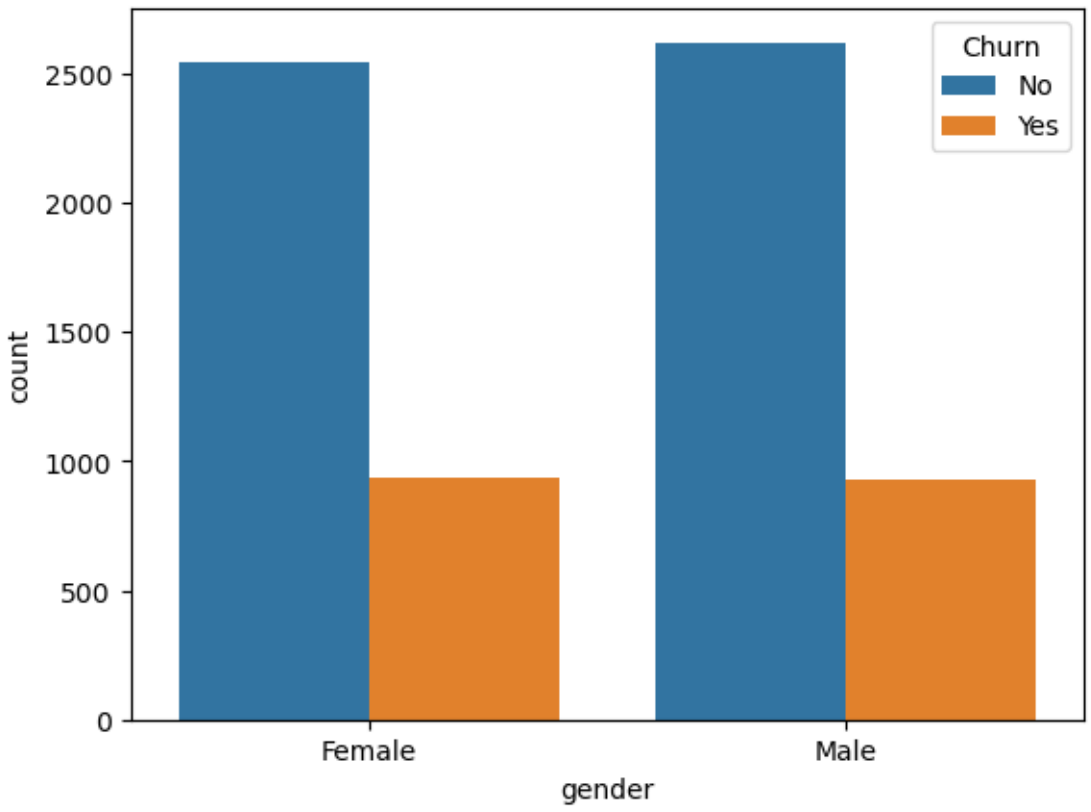
	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	\
0	7590-VHVEG	Female	0	Yes	No	1	
1	5575-GNVDE	Male	0	No	No	34	
2	3668-QPYBK	Male	0	No	No	2	
3	7795-CFOCW	Male	0	No	No	45	

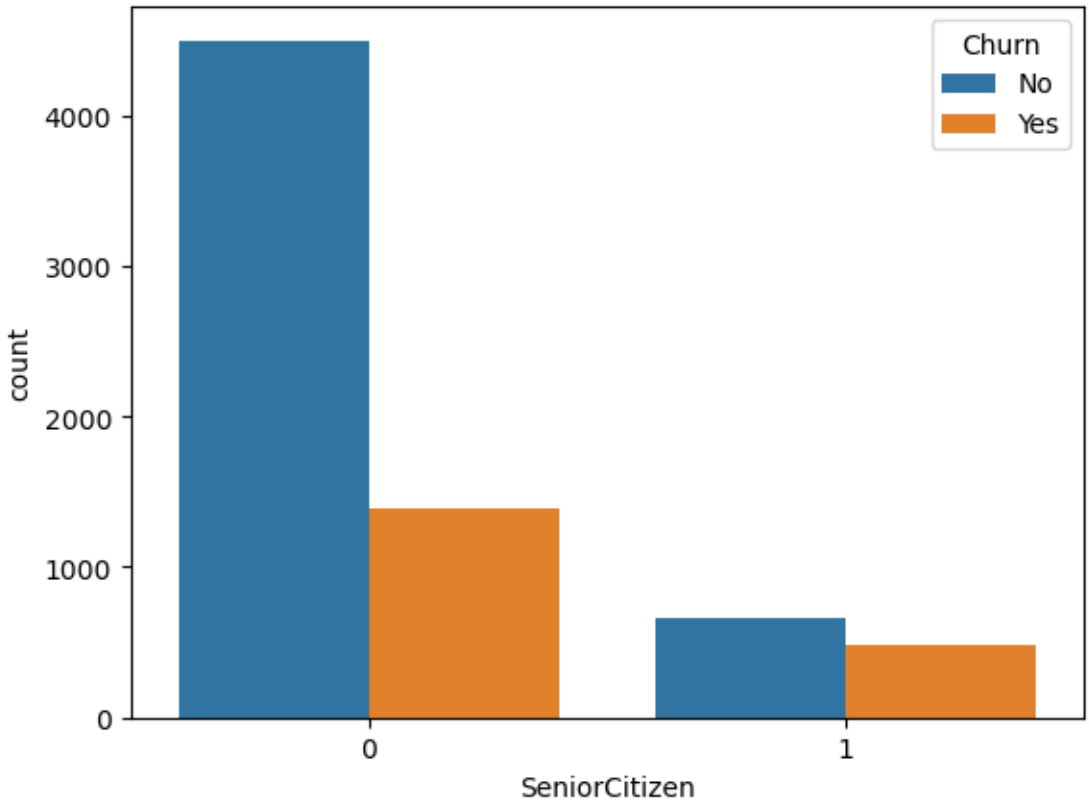
```
4     9237-HQITU  Female              0      No         No       2
…          …     …             …     …       …     …
7038  6840-RESVB    Male              0     Yes        Yes      24
7039  2234-XADUH  Female              0     Yes        Yes      72
7040  4801-JZAZL  Female              0     Yes        Yes      11
7041  8361-LTMKD    Male              1     Yes         No       4
7042  3186-AJIEK    Male              0      No         No      66

     PhoneService     MultipleLines InternetService OnlineSecurity  …  \
0              No  No phone service             DSL             No  …
1             Yes                No             DSL            Yes  …
2             Yes                No             DSL            Yes  …
3              No  No phone service             DSL            Yes  …
4             Yes                No     Fiber optic             No  …
…             …                  …             …            …  …
7038          Yes               Yes             DSL            Yes  …
7039          Yes               Yes     Fiber optic             No  …
7040           No  No phone service             DSL            Yes  …
7041          Yes               Yes     Fiber optic             No  …
7042          Yes                No     Fiber optic            Yes  …

     DeviceProtection TechSupport StreamingTV StreamingMovies        Contract  \
0                  No          No          No              No  Month-to-month
1                 Yes          No          No              No        One year
2                  No          No          No              No  Month-to-month
3                 Yes         Yes          No              No        One year
4                  No          No          No              No  Month-to-month
…                  …           …           …               …            …
7038              Yes         Yes         Yes             Yes        One year
7039              Yes          No         Yes             Yes        One year
7040               No          No          No              No  Month-to-month
7041               No          No          No              No  Month-to-month
7042              Yes         Yes         Yes             Yes        Two year

     PaperlessBilling              PaymentMethod MonthlyCharges  TotalCharges  \
0                 Yes           Electronic check          29.85         29.85
1                  No               Mailed check          56.95       1889.50
2                 Yes               Mailed check          53.85        108.15
3                  No  Bank transfer (automatic)          42.30       1840.75
4                 Yes           Electronic check          70.70        151.65
…                 …                          …             …           …
7038              Yes               Mailed check          84.80       1990.50
7039              Yes    Credit card (automatic)         103.20       7362.90
7040              Yes           Electronic check          29.60        346.45
7041              Yes               Mailed check          74.40        306.60
7042              Yes  Bank transfer (automatic)         105.65       6844.50
```

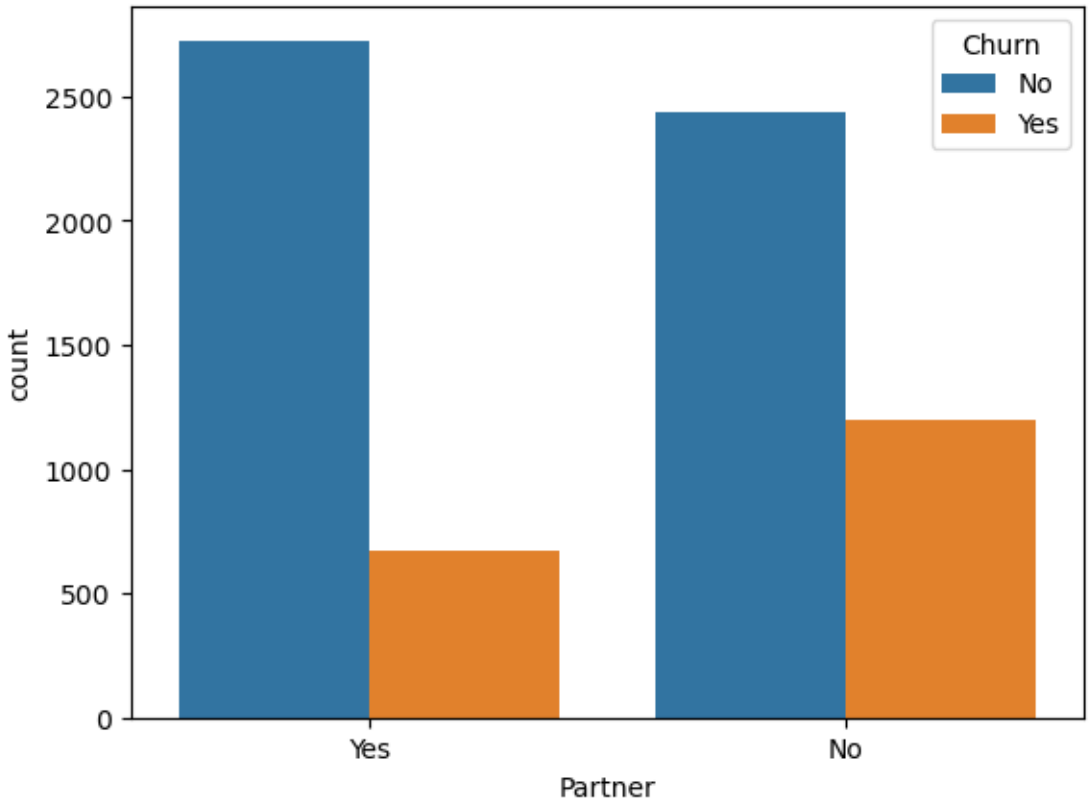
```
      Churn
0        No
1        No
2       Yes
3        No
4       Yes
…       …
7038     No
7039     No
7040     No
7041    Yes
7042     No

[7032 rows x 21 columns]
```

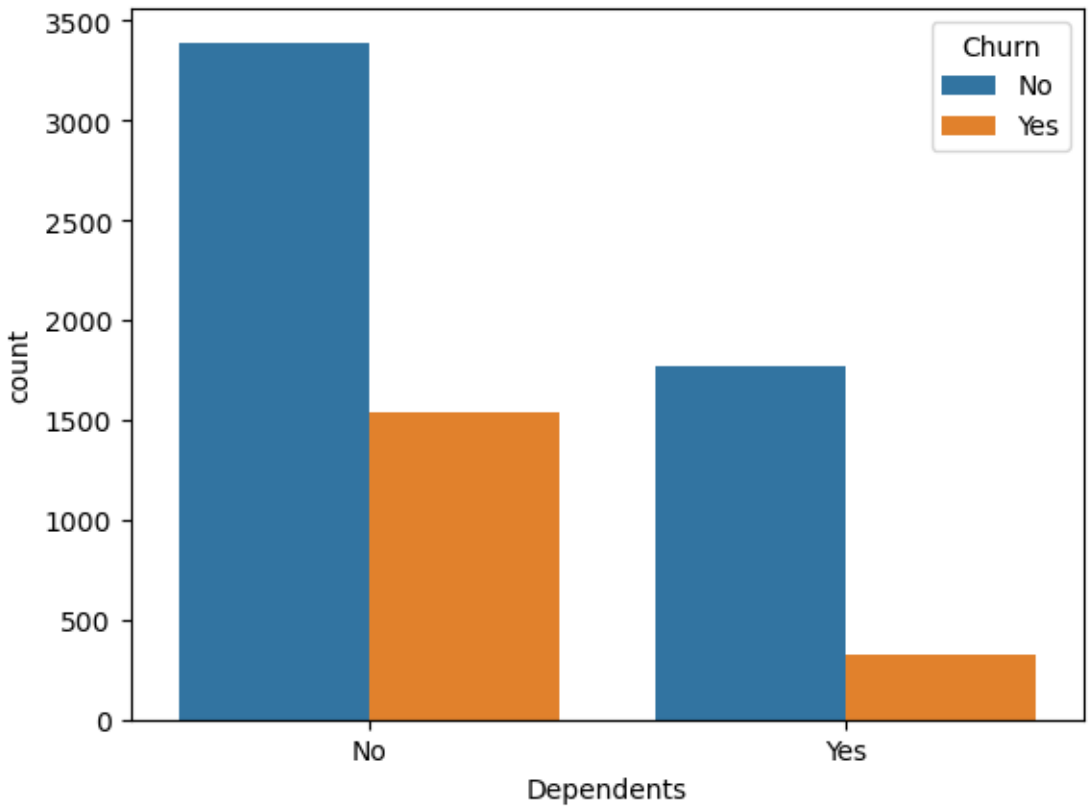
[67]:
```
for i,Predicator in enumerate(Tdata.
 ↪drop(columns=["MonthlyCharges","TotalCharges"],axis=1)):
    plt.figure(i)
    sns.countplot(x=Predicator,hue="Churn",data=Tdata)
```

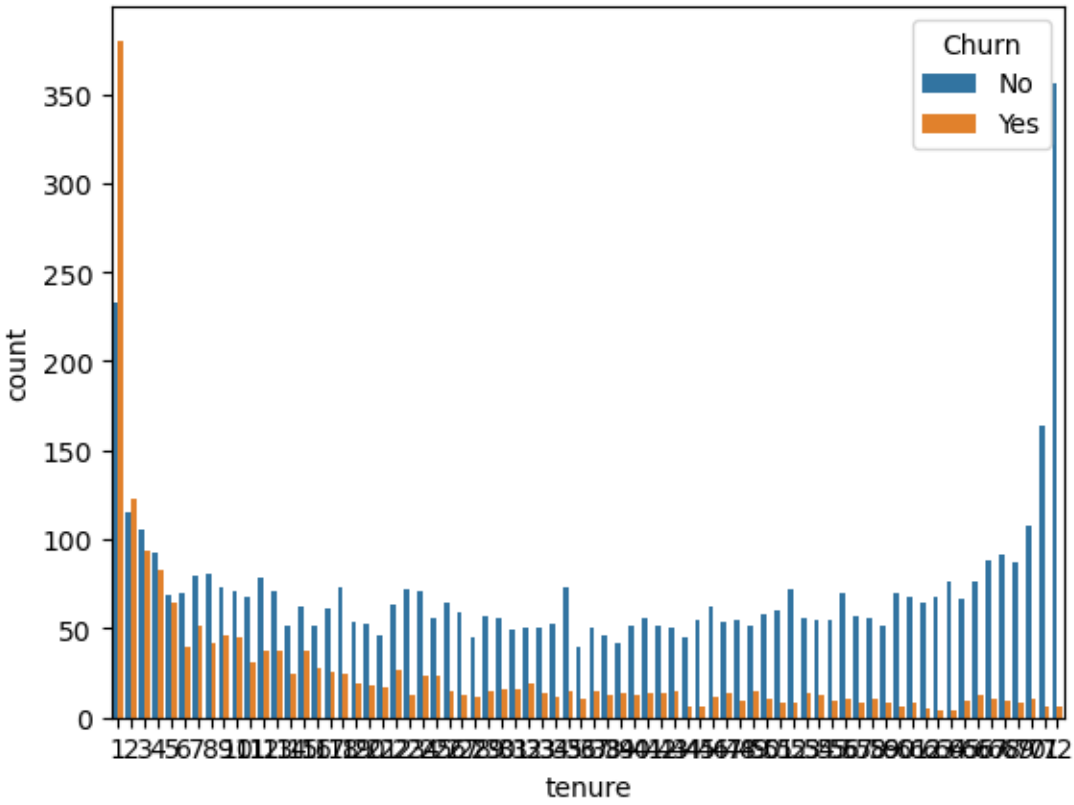


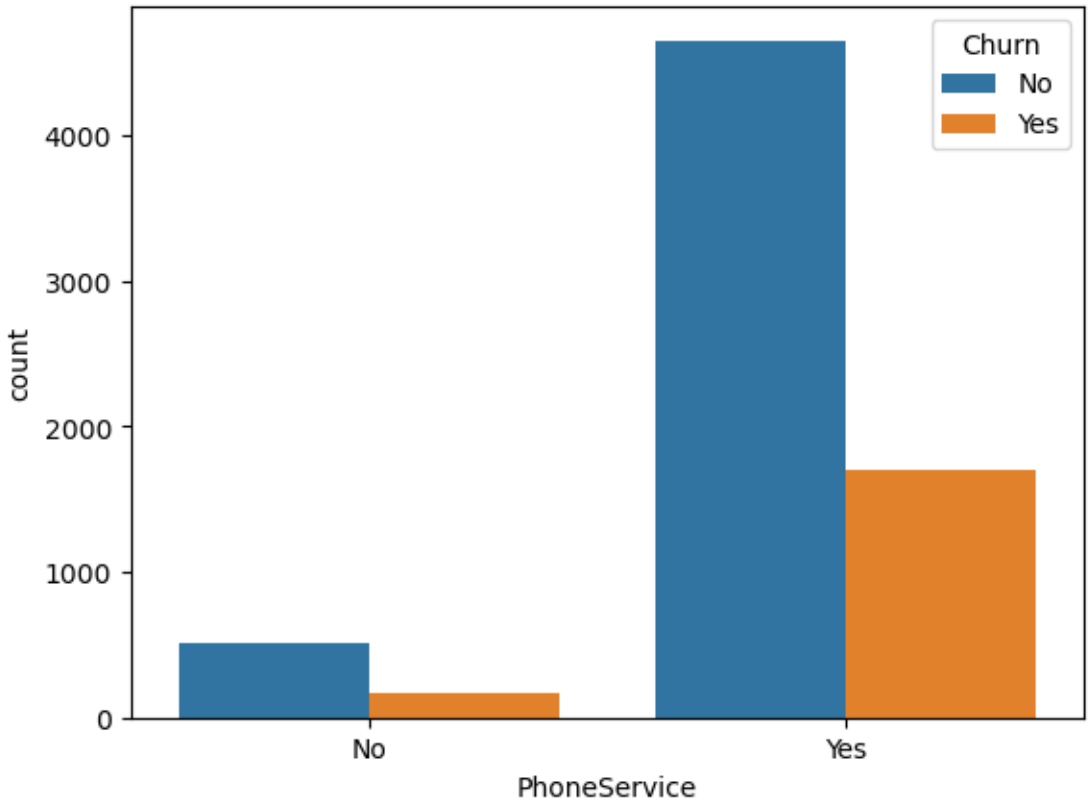

Churn
No
Yes
2500
2000
1500
1000
500
0
count
Female
Male
gender

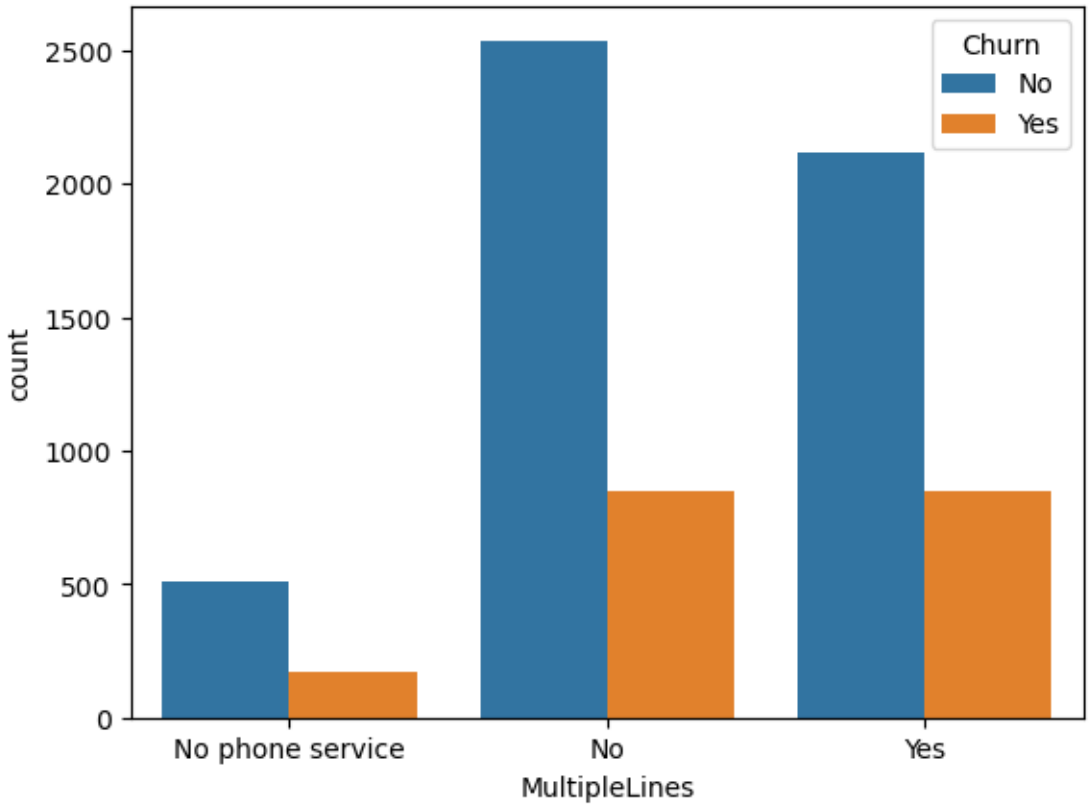

Churn
No
Yes
4000
3000
2000
1000
0
count
0
1
SeniorCitizen

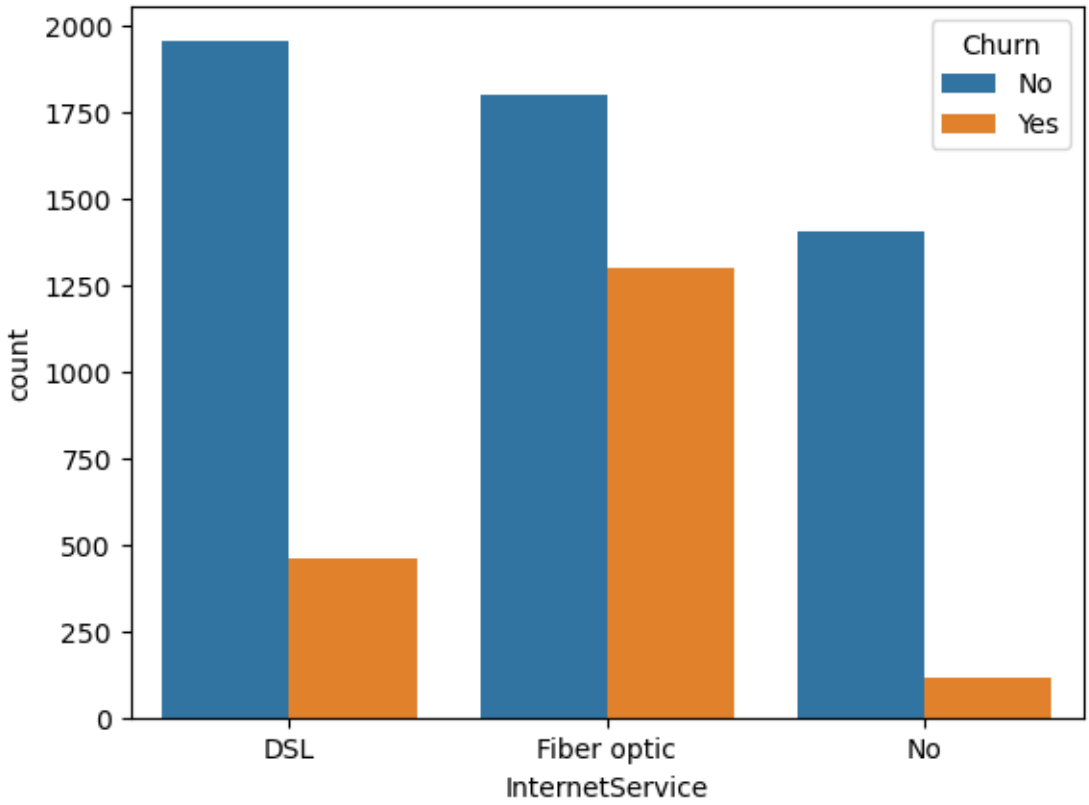

Churn
No
Yes
2500
2000
1500
1000
500
0
count
Yes
No
Partner

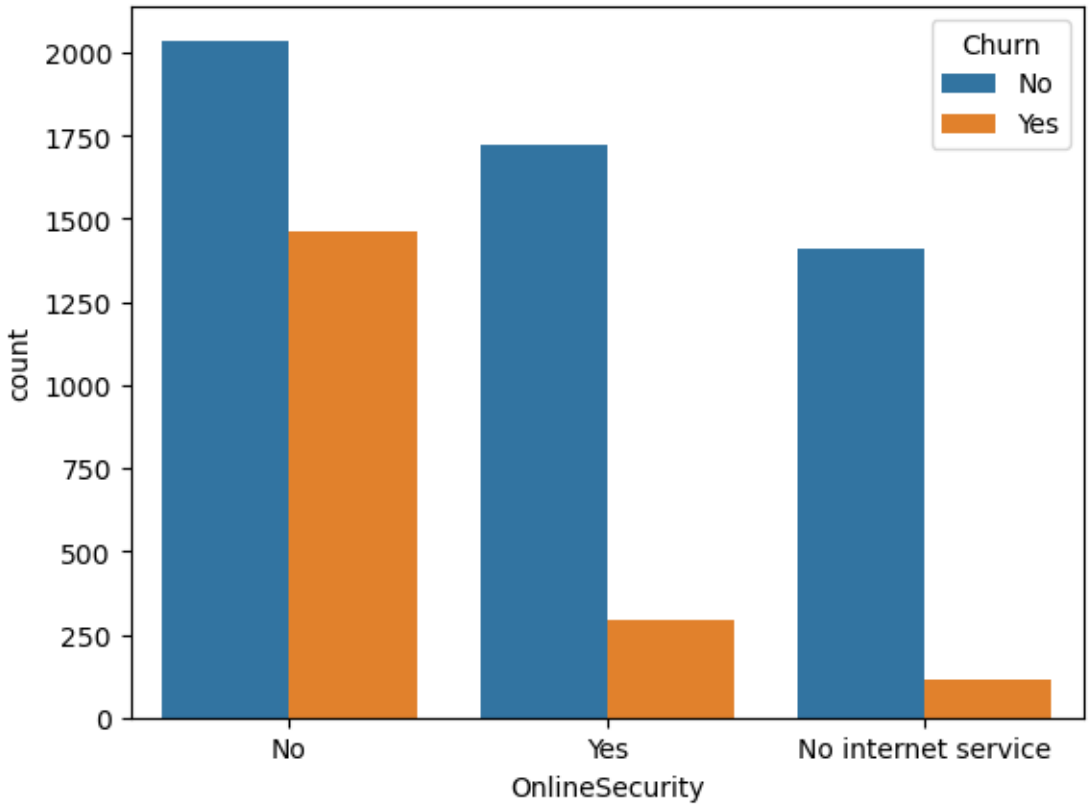

Churn
No
Yes
3500
3000
2500
2000
1500
1000
500
0
count
No
Yes
Dependents

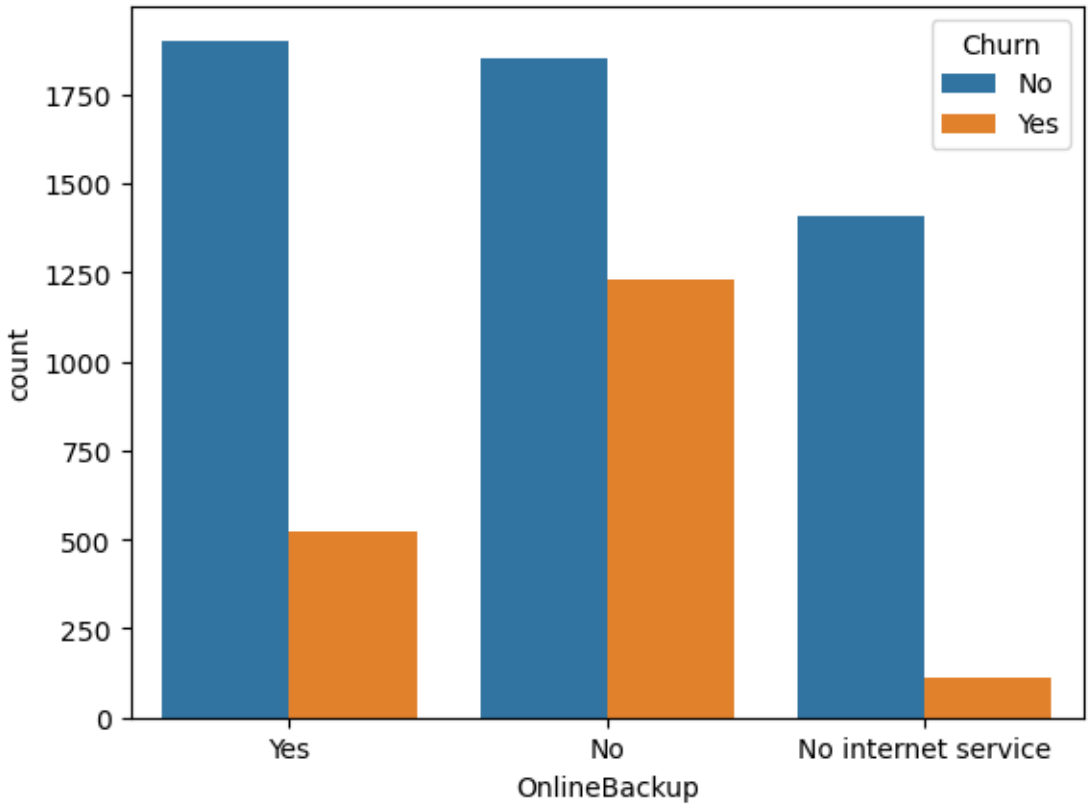

Churn
No
Yes
count
tenure
0
50
100
150
200
250
300
350

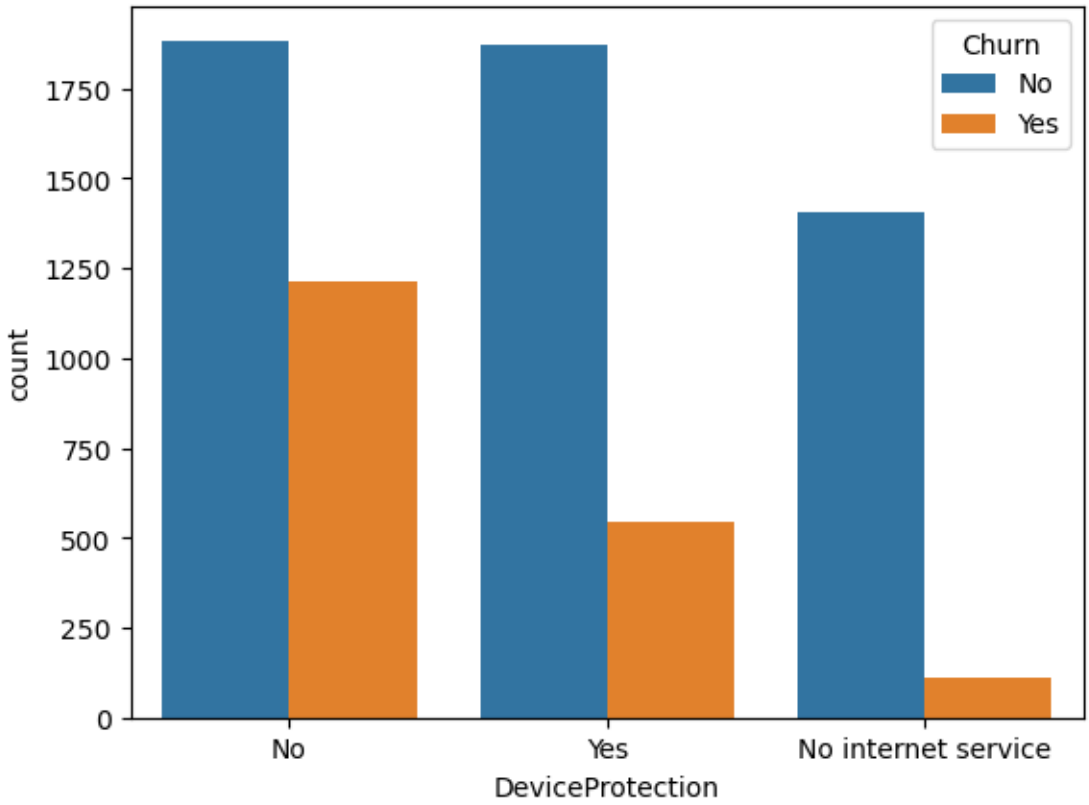

Churn
No
Yes
4000
3000
2000
1000
0
count
No
Yes
PhoneService

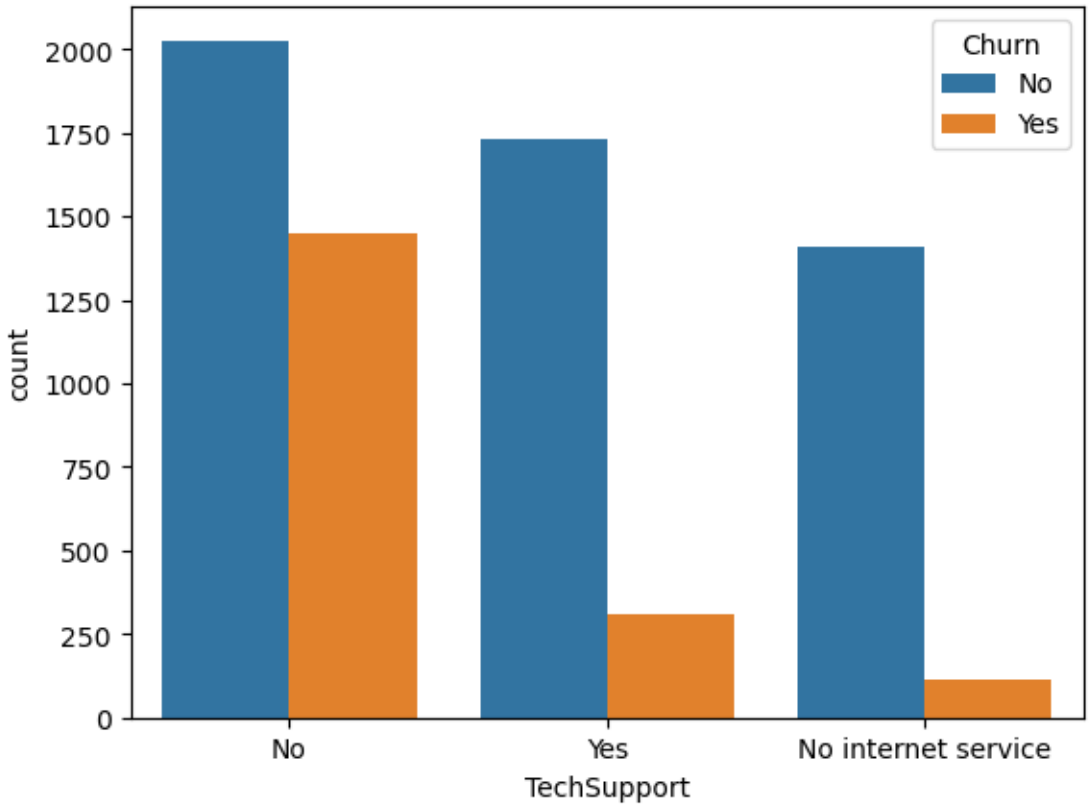

Churn
No
Yes
2500
2000
1500
1000
500
0
count
No phone service
No
Yes
MultipleLines

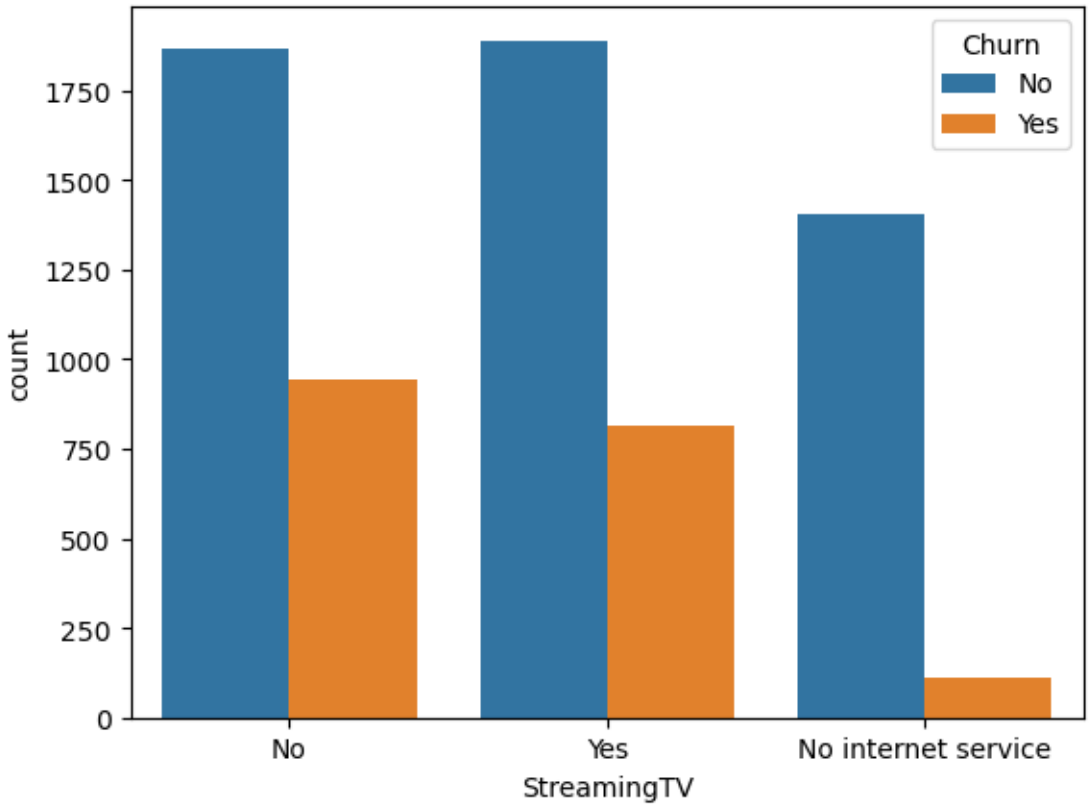

Churn
No
Yes
2000
1750
1500
1250
1000
750
500
250
0
count
DSL
Fiber optic
No
InternetService

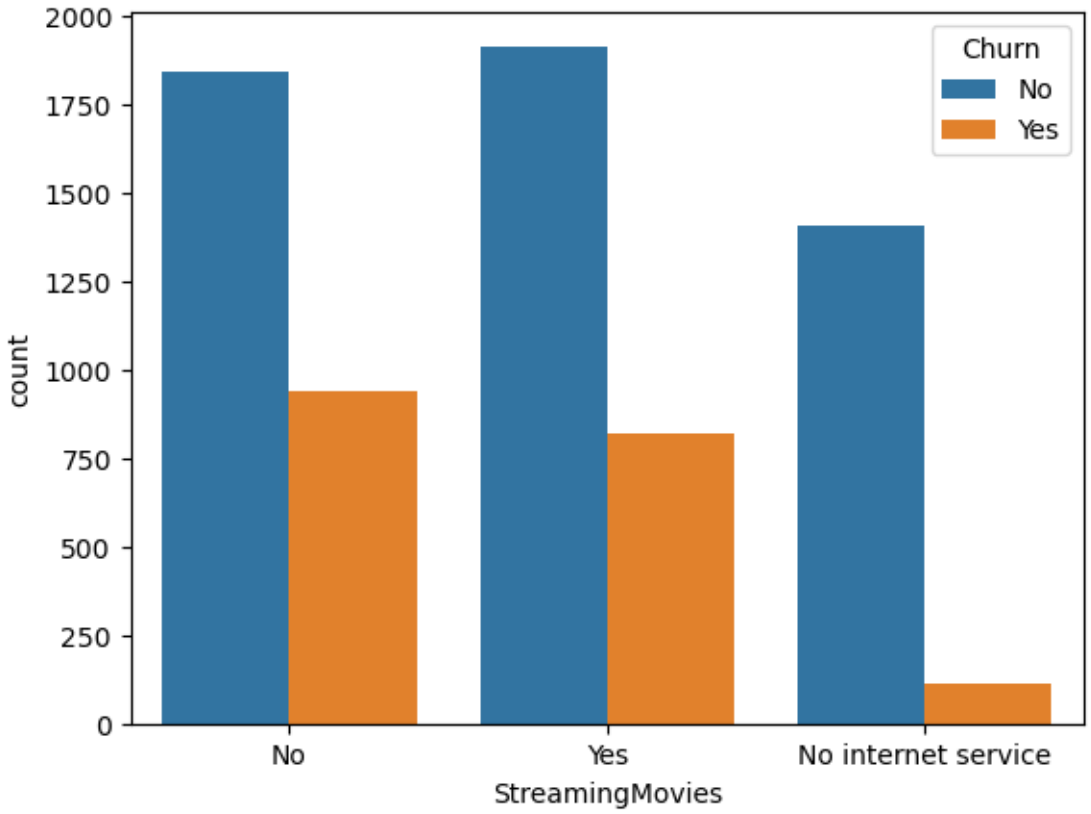

Churn
No
Yes
2000
1750
1500
1250
1000
750
500
250
0
count
No
Yes
No internet service
OnlineSecurity

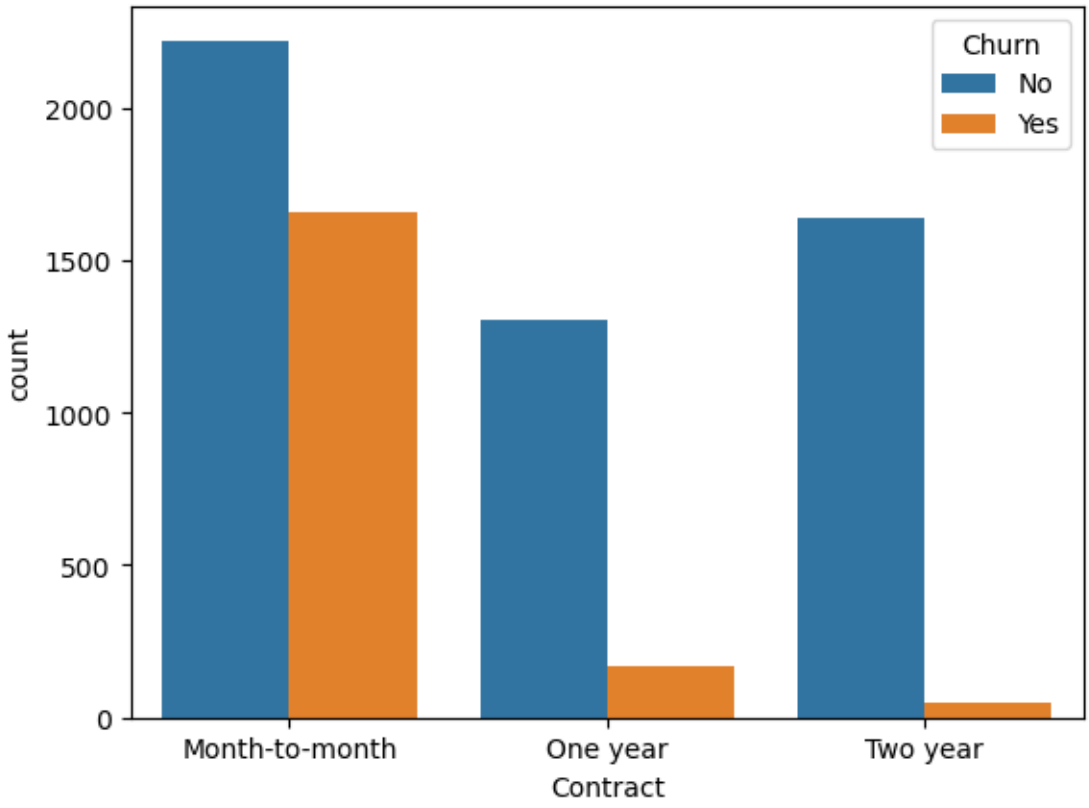

Churn
No
Yes
1750
1500
1250
1000
750
500
250
0
count
Yes
No
No internet service
OnlineBackup

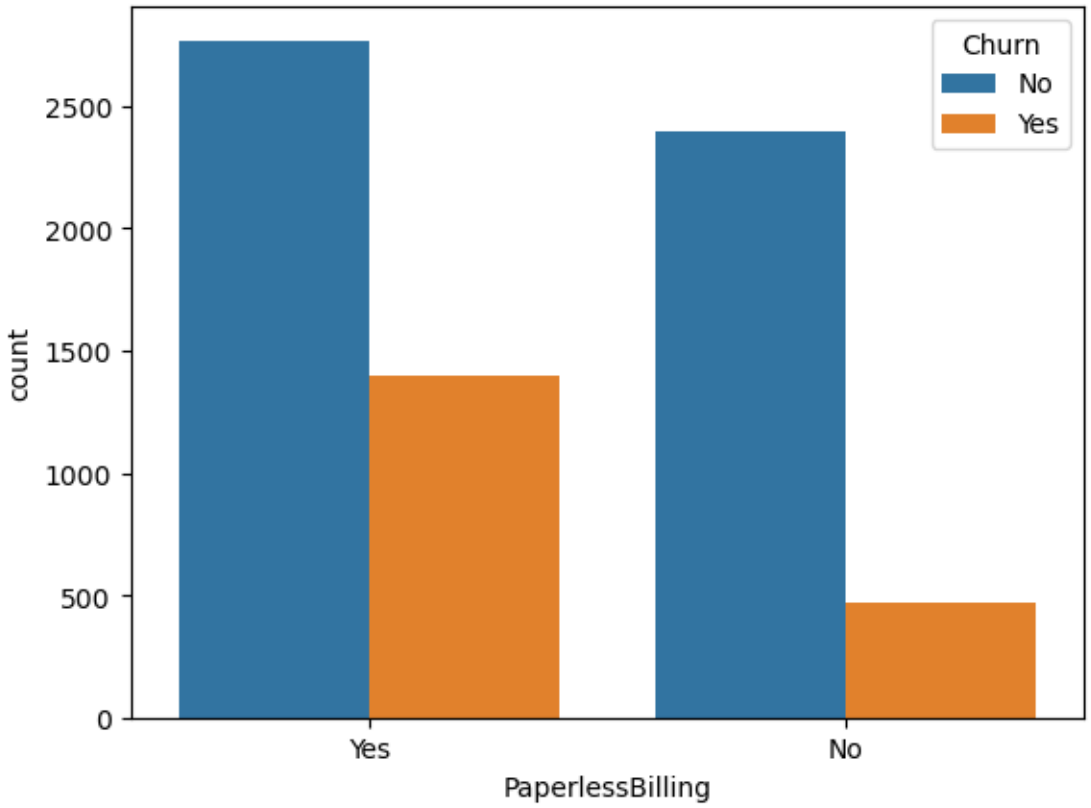

Churn
No
Yes
1750
1500
1250
1000
750
500
250
0
count
No
Yes
No internet service
DeviceProtection

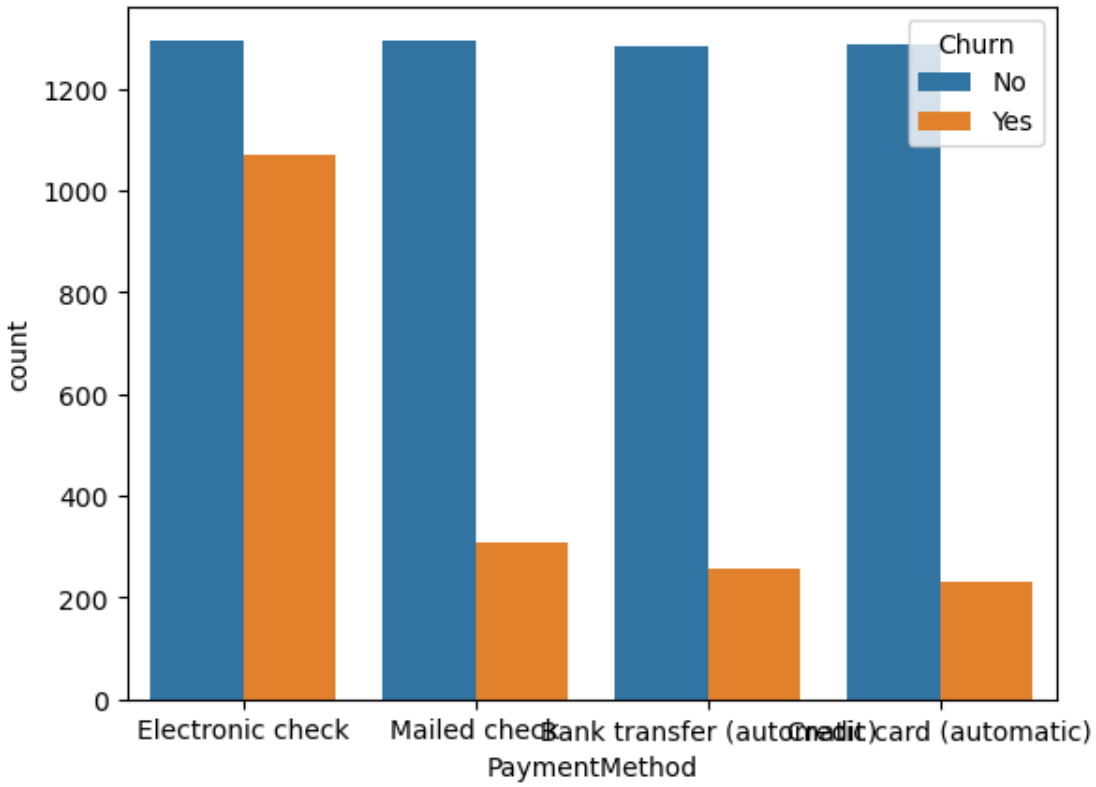

Churn
No
Yes
2000
1750
1500
1250
1000
750
500
250
0
count
No
Yes
No internet service
TechSupport

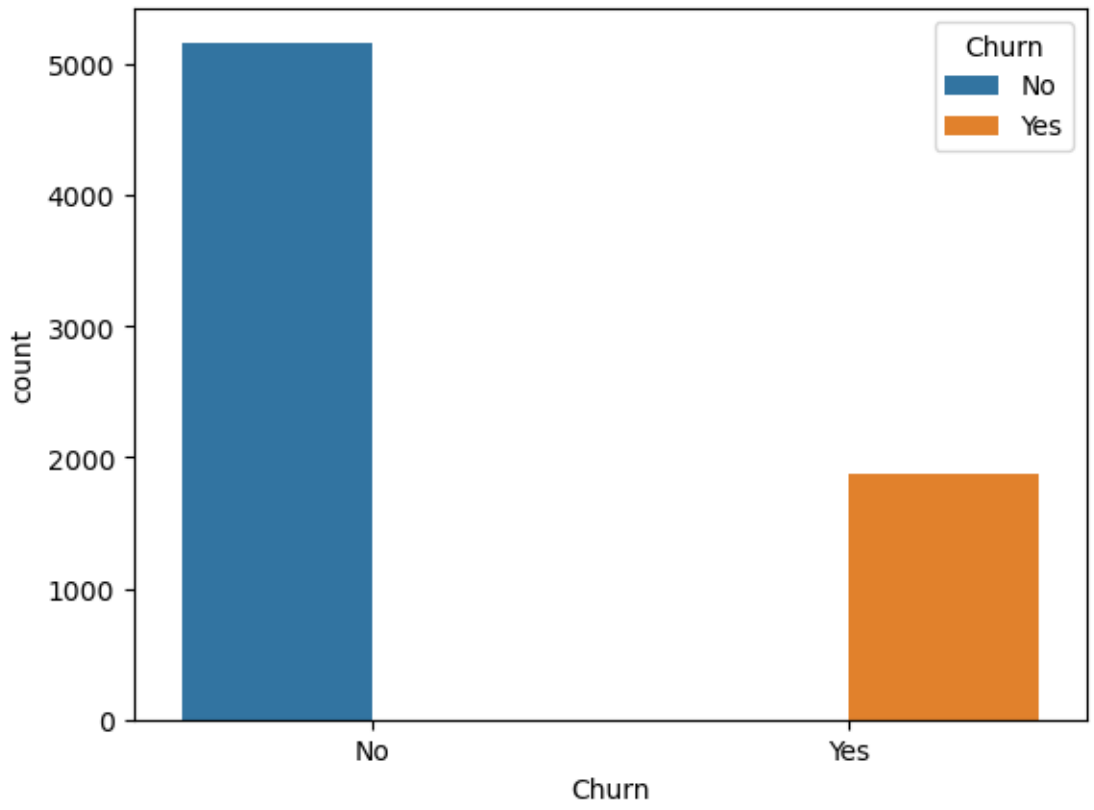

Churn
No
Yes
1750
1500
1250
1000
750
500
250
0
count
No
Yes
No internet service
StreamingTV


Churn
No
Yes
2000
1750
1500
1250
1000
750
500
250
0
count
No
Yes
No internet service
StreamingMovies


Churn
No
Yes
2000
1500
1000
500
0
count
Month-to-month
One year
Two year
Contract


Churn
No
Yes
2500
2000
1500
1000
500
0
count
Yes
No
PaperlessBilling


Churn
No
Yes
count
0
200
400
600
800
1000
1200
Electronic check
Mailed check
Bank transfer (automatic)
Credit card (automatic)
PaymentMethod



[24]:
```
Tdata["tenure"].max()
```

[24]: 72

[25]:
```
labels = ["{0} - {1}".format(i,i+11) for i in range(1,72,12)]

Tdata["tenure"] = pd.cut(Tdata.tenure,range(1,80,12),right=False,labels=labels)
```

[26]:
```
Tdata["Churn"] = np.where(Tdata.Churn == "Yes",1,0)
```

[27]:
```
Tdata["Churn"] = np.where(Tdata.Churn == "Yes",1,0)
```

[39]:
```
Tdata["Churn"] = np.where(Tdata.Churn == "Yes",1,0)
```

[40]:
```
Tdata_dummies = pd.get_dummies(Tdata)
Tdata_dummies.head()
```

[40]:

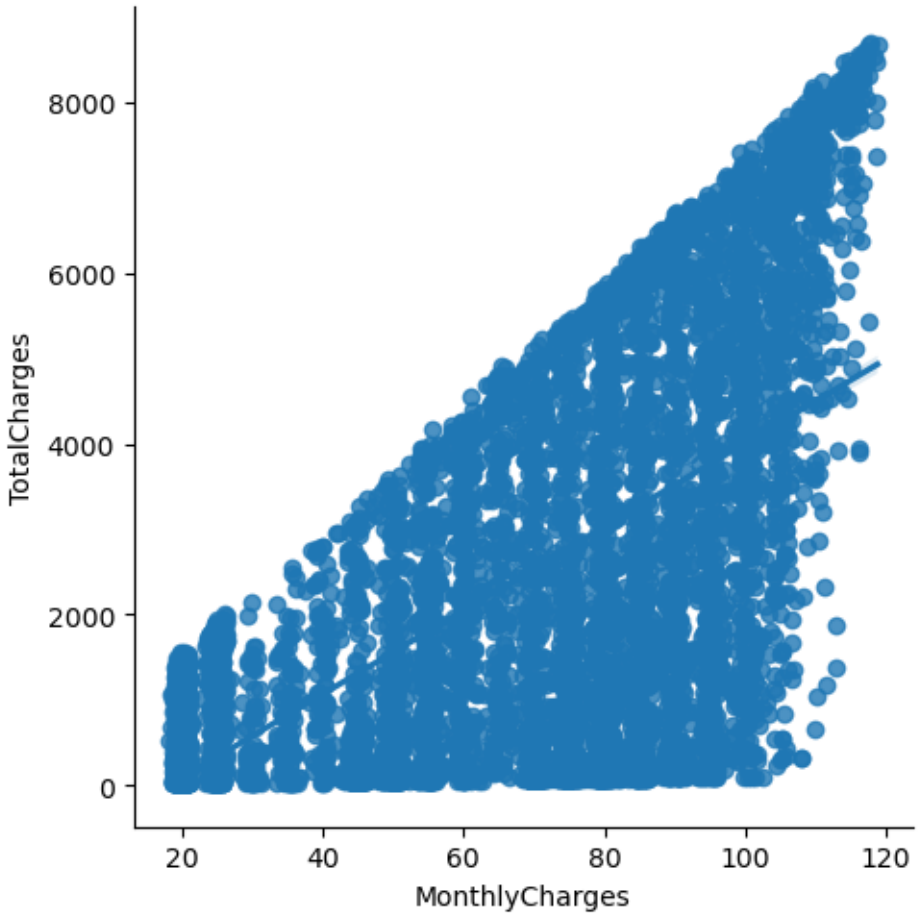
	SeniorCitizen	tenure	MonthlyCharges	TotalCharges	Churn	\
0	0	1	29.85	29.85	0	
1	0	34	56.95	1889.50	0	
2	0	2	53.85	108.15	1	

```
3              0      45           42.30       1840.75      0
4              0       2           70.70        151.65      1

   customerID_0002-ORFBO  customerID_0003-MKNFE  customerID_0004-TLHLJ  \
0                      0                      0                      0
1                      0                      0                      0
2                      0                      0                      0
3                      0                      0                      0
4                      0                      0                      0

   customerID_0011-IGKFF  customerID_0013-EXCHZ  …  StreamingMovies_Yes  \
0                      0                      0  …                    0
1                      0                      0  …                    0
2                      0                      0  …                    0
3                      0                      0  …                    0
4                      0                      0  …                    0

   Contract_Month-to-month  Contract_One year  Contract_Two year  \
0                        1                  0                  0
1                        0                  1                  0
2                        1                  0                  0
3                        0                  1                  0
4                        1                  0                  0

   PaperlessBilling_No  PaperlessBilling_Yes  \
0                    0                     1
1                    1                     0
2                    0                     1
3                    1                     0
4                    0                     1

   PaymentMethod_Bank transfer (automatic)  \
0                                        0
1                                        0
2                                        0
3                                        1
4                                        0

   PaymentMethod_Credit card (automatic)  PaymentMethod_Electronic check  \
0                                      0                                1
1                                      0                                0
2                                      0                                0
3                                      0                                0
4                                      0                                1

   PaymentMethod_Mailed check
0                           0
```

```
1                          1
2                          1
3                          0
4                          0

[5 rows x 7078 columns]
```

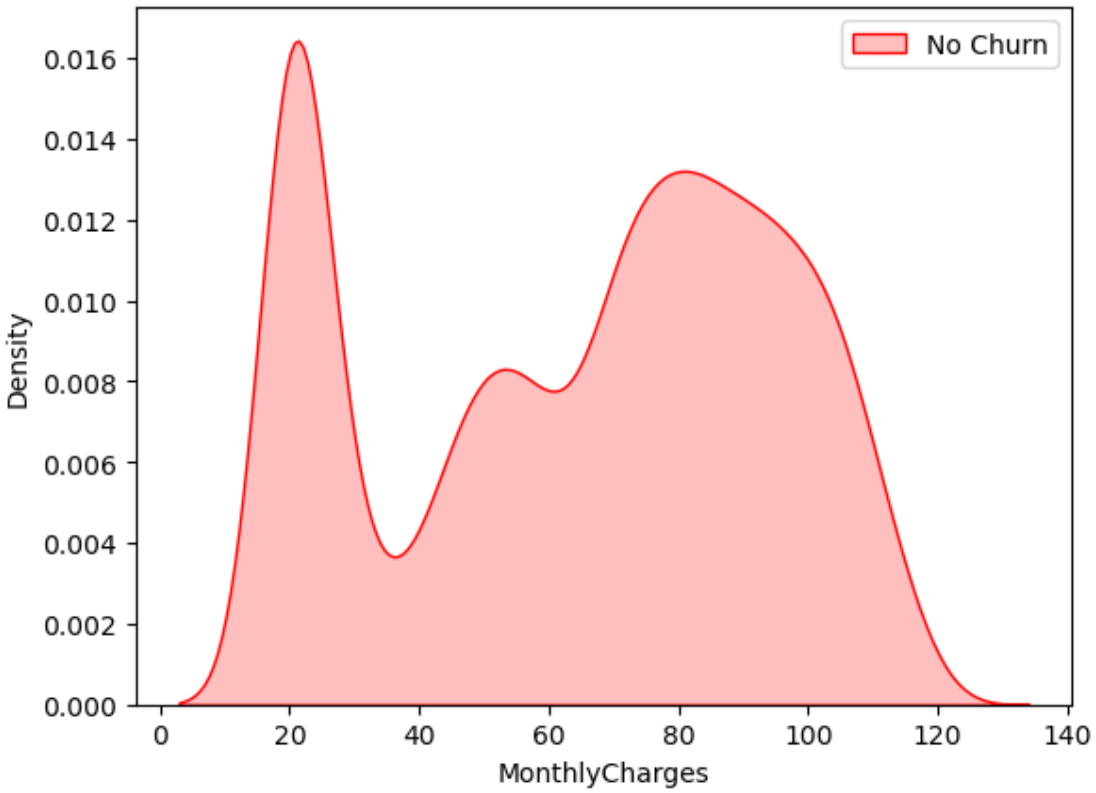
[30]:
```
sns.lmplot(data=Tdata_dummies,x="MonthlyCharges",y="TotalCharges")
```

[30]:
```
<seaborn.axisgrid.FacetGrid at 0x1fd22879670>
```



[31]:
```
Mth = sns.kdeplot(Tdata_dummies.MonthlyCharges[(Tdata_dummies["Churn"] == 0) ],
            color="Red",shade=True)
Mth = sns.kdeplot(Tdata_dummies.MonthlyCharges[(Tdata_dummies["Churn"] == 1) ],
                  ax=Mth,color="Blue",shade=True)
Mth.legend(["No Churn","Churn"],loc="upper right")
```

[31]:
```
<matplotlib.legend.Legend at 0x1fd2373b4f0>
```



[82]:
```
plt.figure(figsize=(20,8))
Tdata_dummies.corr()['Churn'].sort_values(ascending = False).plot(kind='bar')
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
~\AppData\Local\Temp\ipykernel_13880\2222817026.py in <module>
      1 plt.figure(figsize=(20,8))
----> 2 Tdata_dummies.corr()['Churn'].sort_values(ascending = False).
  ↪plot(kind='bar')

NameError: name 'Tdata_dummies' is not defined
```

```
<Figure size 2000x800 with 0 Axes>
```

[33]:
```
plt.figure(figsize=(20,8))
telco_data_dummies.corr()['Churn'].sort_values(ascending = False).
  ↪plot(kind='bar')
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
~\AppData\Local\Temp\ipykernel_11360\3490033627.py in <module>
```

```
      1 plt.figure(figsize=(20,8))
----> 2 telco_data_dummies.corr()['Churn'].sort_values(ascending = False).
 ↪plot(kind='bar')

NameError: name 'telco_data_dummies' is not defined
```

```
<Figure size 2000x800 with 0 Axes>
```

[ ]:
```
Tdata.corr().style.background_gradient(cmap="coolwarm")
```

1 Bivariate Analysis

[ ]:
```
new_df_target = Tdata.loc[Tdata["Churn"]==0]
new_df_target1 = Tdata.loc[Tdata["Churn"]==1]
```

[ ]:
```
def uniplot(df,col,title,hue =None):

    sns.set_style('whitegrid')
    sns.set_context('talk')
    plt.rcParams["axes.labelsize"] = 20
    plt.rcParams['axes.titlesize'] = 22
    plt.rcParams['axes.titlepad'] = 30


    temp = pd.Series(data = hue)
    fig, ax = plt.subplots()
    width = len(df[col].unique()) + 7 + 4*len(temp.unique())
    fig.set_size_inches(width , 8)
    plt.xticks(rotation=45)
    plt.yscale('log')
    plt.title(title)
    ax = sns.countplot(data = df, x= col, order=df[col].value_counts().
 ↪index,hue = hue,palette='bright')

    plt.show()
```

[ ]:
```
uniplot(new_df_target1,col='Partner',title='Distribution of Gender for Churned␣
 ↪Customers',hue='gender')
```

[ ]:
```
uniplot(new_df1_target0,col='Partner',title='Distribution of Gender for Non␣
 ↪Churned Customers',hue='gender')
```

[ ]:
```
uniplot(new_df1_target1,col='PaymentMethod',title='Distribution of␣
 ↪PaymentMethod for Churned Customers',hue='gender')
```

[ ]:
```
uniplot(new_df1_target1,col='Contract',title='Distribution of Contract for␣
↪Churned Customers',hue='gender')
```

[ ]:
```
uniplot(new_df1_target1,col='TechSupport',title='Distribution of TechSupport␣
↪for Churned Customers',hue='gender')
```

[ ]:
```
uniplot(new_df1_target1,col='SeniorCitizen',title='Distribution of␣
↪SeniorCitizen for Churned Customers',hue='gender')
```

1.1 Finding from this data

[ ]:
```
# Insights from this data


1. Electronic check medium are the highest churners
2. Contract Type - Monthly customers are more likely to churn because of no␣
↪contract terms, as they are free to go customers.
3. No Online security, No Tech Support category are high churners
4. Non senior Citizens are high churners
```

2 Model Building by using Decision Tree classifier

[46]:
```
# Dividing the data into training and test set

from sklearn.model_selection import train_test_split
X = Tdata_dummies.drop(['Churn'],axis=1)
y = Tdata_dummies["Churn"]

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2)
```

[107]:
```
X_train
```

[107]:

	SeniorCitizen	tenure	MonthlyCharges	TotalCharges	\
6770	0	4	78.90	299.75	
3382	0	72	25.55	1867.70	
6768	0	72	117.50	8670.10	
1698	0	71	84.80	6152.40	
4542	1	32	79.30	2570.00	
…	…	…	…	…	
223	0	4	50.05	179.35	
2161	0	2	75.80	160.75	
4257	0	49	99.40	5025.00	
361	0	41	98.80	3959.15	
510	1	20	94.30	1818.30	

	customerID_0002-ORFBO	customerID_0003-MKNFE	customerID_0004-TLHLJ	\

```
6770                        0                        0                        0
3382                        0                        0                        0
6768                        0                        0                        0
1698                        0                        0                        0
4542                        0                        0                        0
…                         …                        …                        …
223                         0                        0                        0
2161                        0                        0                        0
4257                        0                        0                        0
361                         0                        0                        0
510                         0                        0                        0

      customerID_0011-IGKFF  customerID_0013-EXCHZ  customerID_0013-MHZWF  \
6770                        0                        0                        0
3382                        0                        0                        0
6768                        0                        0                        0
1698                        0                        0                        0
4542                        0                        0                        0
…                         …                        …                        …
223                         0                        0                        0
2161                        0                        0                        0
4257                        0                        0                        0
361                         0                        0                        0
510                         0                        0                        0

      …  StreamingMovies_Yes  Contract_Month-to-month  Contract_One year  \
6770  …                     0                        1                  0
3382  …                     0                        0                  0
6768  …                     1                        0                  0
1698  …                     0                        0                  0
4542  …                     0                        1                  0
…   …                     …                        …                  …
223   …                     0                        1                  0
2161  …                     0                        1                  0
4257  …                     1                        1                  0
361   …                     1                        0                  0
510   …                     1                        0                  1

      Contract_Two year  PaperlessBilling_No  PaperlessBilling_Yes  \
6770                  0                    0                     1
3382                  1                    1                     0
6768                  1                    1                     0
1698                  1                    0                     1
4542                  0                    1                     0
…                   …                    …                     …
223                   0                    1                     0
2161                  0                    0                     1
```

```
4257                   0                     1                      0
361                    1                     0                      1
510                    0                     1                      0

      PaymentMethod_Bank transfer (automatic)  \
6770                                        0
3382                                        0
6768                                        0
1698                                        0
4542                                        0
…                                         …
223                                         0
2161                                        0
4257                                        0
361                                         1
510                                         0

      PaymentMethod_Credit card (automatic)  PaymentMethod_Electronic check  \
6770                                      0                                0
3382                                      1                                0
6768                                      1                                0
1698                                      0                                1
4542                                      0                                0
…                                       …                                …
223                                       0                                0
2161                                      0                                1
4257                                      0                                1
361                                       0                                0
510                                       1                                0

      PaymentMethod_Mailed check
6770                           1
3382                           0
6768                           0
1698                           0
4542                           1
…                            …
223                            1
2161                           0
4257                           0
361                            0
510                            0

[5625 rows x 7077 columns]
```

[91]:
```
print("The number of Samples in train data is {}.".format(X_train.shape[0]))
print("The number of Samples in test data is {}.".format(X_test.shape[1]))
```

```
The number of Samples in train data is 5625.
The number of Samples in test data is 20.
```

2.0.1 Decision Tree classifier

[108]:
```
from sklearn.tree import DecisionTreeClassifier
```

[109]:
```
model_dt = DecisionTreeClassifier(criterion="gini",random_state=␣
↪100,max_depth=6,min_samples_leaf=8)
```

[110]:
```
model_dt.fit(X_train,y_train)
```

[110]:
```
DecisionTreeClassifier(max_depth=6, min_samples_leaf=8, random_state=100)
```

[114]:
```
y_predict = model_dt.predict(X_test)
y_predict
```

[114]:
```
array([0, 0, 0, …, 0, 1, 0])
```

[116]:
```
model_dt.score(X_test,y_test)
```

[116]:
```
0.7924662402274343
```

[118]:
```
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
```

[122]:
```
print(classification_report(y_test,y_predict,labels=[0,1]))
```

```
              precision    recall  f1-score   support

           0       0.84      0.88      0.86      1030
           1       0.63      0.55      0.59       377

    accuracy                           0.79      1407
   macro avg       0.74      0.72      0.72      1407
weighted avg       0.79      0.79      0.79      1407
```

2.0.2 Now we are going to use the Logistic Regression

[68]:
```
from sklearn.linear_model import LogisticRegression
```

[69]:
```
logistic_model= LogisticRegression()
```

[71]:
```
logistic_model.fit(X_train,y_train)
```

```
C:\Users\Admin\anaconda3\lib\site-
packages\sklearn\linear_model\_logistic.py:814: ConvergenceWarning: lbfgs failed
to converge (status=1):
```

```
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-
regression
  n_iter_i = _check_optimize_result(
```

[71]:
```
LogisticRegression()
```

[76]:
```
accuracy = logistic_model.score(X_test,y_test)
print("Logistic Regression accuracy:",accuracy*100)
```

```
Logistic Regression accuracy: 78.60696517412936
```

[77]:
```
from sklearn.metrics import confusion_matrix
y_pred = logistic_model.predict(X_test)
cm_lr = confusion_matrix(y_test,y_pred)

print(cm_lr)
```

```
[[905 120]
 [181 201]]
```

[78]:
```
# Using search CV and L2 Penality for logistic regression
```

[ ]:
```

```