1.Problem Statement

The objective of this project is to predict customer churn based on historical service and demographic data. By identifying customers who are likely to leave, the business can take proactive measures to improve retention and reduce revenue loss.

In [436…

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

from sklearn.preprocessing import LabelEncoder,StandardScaler
from imblearn.over_sampling import SMOTE
from sklearn.model_selection import train_test_split

from sklearn.linear_model import LinearRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.svm import SVC
from sklearn.ensemble import RandomForestClassifier,GradientBoostingClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.naive_bayes import CategoricalNB,BernoulliNB,GaussianNB
from xgboost import XGBClassifier
from lightgbm import LGBMClassifier

from sklearn.metrics import accuracy_score,confusion_matrix,classification_repor

import warnings
warnings.filterwarnings('ignore')
pd.set_option('display.max_columns',100)
pd.set_option('display.width',120)
```

2.Import data

In [2]:

```
df = pd.read_csv('WA_Fn-UseC_-Telco-Customer-Churn.csv')
```

In [3]:

```
df.shape
```

Out[3]:

```
(7043, 21)
```

In [5]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 7043 entries, 0 to 7042
Data columns (total 21 columns):
 #   Column            Non-Null Count  Dtype  
---  ------            --------------  -----  
 0   customerID        7043 non-null   object 
 1   gender            7043 non-null   object 
 2   SeniorCitizen     7043 non-null   int64  
 3   Partner           7043 non-null   object 
 4   Dependents        7043 non-null   object 
 5   tenure            7043 non-null   int64  
 6   PhoneService      7043 non-null   object 
 7   MultipleLines     7043 non-null   object 
 8   InternetService   7043 non-null   object 
 9   OnlineSecurity    7043 non-null   object 
 10  OnlineBackup      7043 non-null   object 
 11  DeviceProtection  7043 non-null   object 
 12  TechSupport       7043 non-null   object 
 13  StreamingTV       7043 non-null   object 
 14  StreamingMovies   7043 non-null   object 
 15  Contract          7043 non-null   object 
 16  PaperlessBilling  7043 non-null   object 
 17  PaymentMethod     7043 non-null   object 
 18  MonthlyCharges    7043 non-null   float64
 19  TotalCharges      7043 non-null   object 
 20  Churn             7043 non-null   object 
dtypes: float64(1), int64(2), object(18)
memory usage: 1.1+ MB
```

3. Exploratory Data Analysis

3.1 Categorical Data

3.1.1 Total customers

In [6]:

```
df['customerID'].nunique()
```

Out[6]:

```
7043
```

Total unique customers 7043.

3.1.2 gender

In [9]:

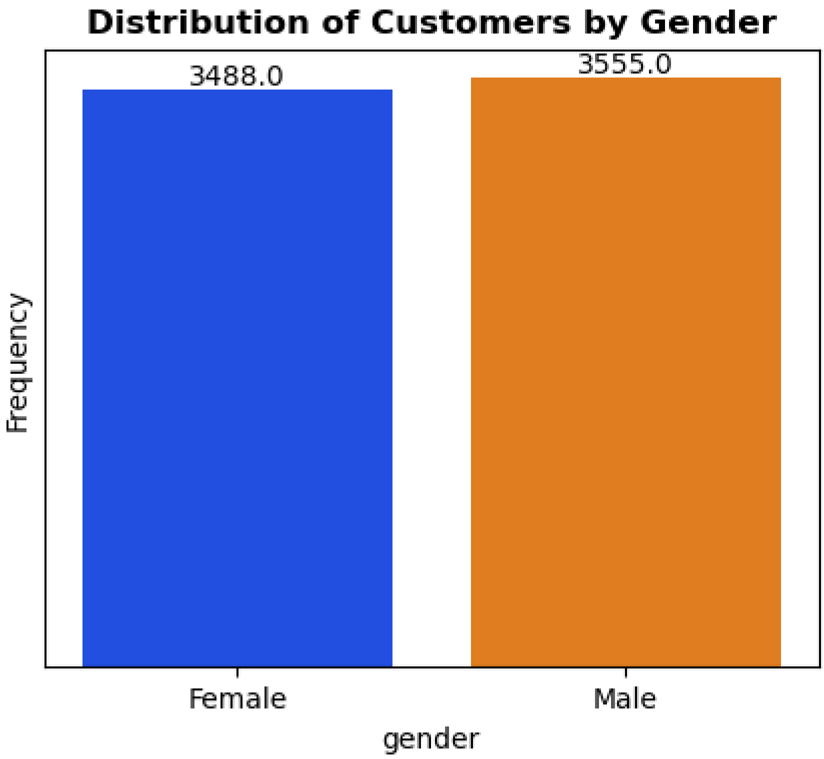
```
df['gender'].value_counts(dropna=False)
```

Out[9]:

```
gender
Male      3555
Female    3488
Name: count, dtype: int64
```

In [182…

```
plt.figure(figsize=(5,4))
ax = sns.countplot(x = 'gender',data=df,palette='bright')
for p in ax.patches:
    ax.annotate(
        str(p.get_height()),
        (p.get_x()+p.get_width()/2,p.get_height()),
        ha = 'center',va='bottom')

plt.title('Distribution of Customers by Gender',fontweight="bold")
plt.yticks([])
plt.ylabel('Frequency')
plt.show()
```



The customer's gender is almost similar; there is not much difference

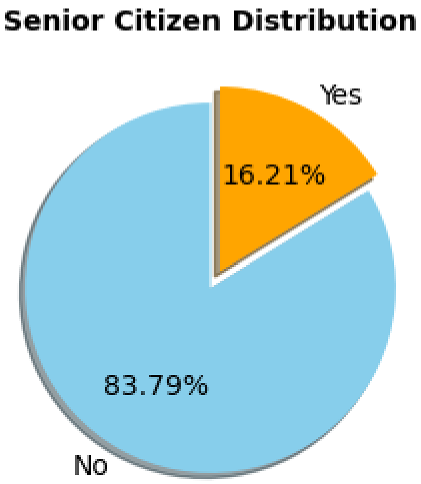
3.1.3 SeniorCitizen

In [26]:
```
df['SeniorCitizen'] = df['SeniorCitizen'].map({1:'Yes',0:'No'})
```

In [28]:
```
df['SeniorCitizen'].value_counts(dropna=False)
```

Out[28]:
```
SeniorCitizen
No     5901
Yes    1142
Name: count, dtype: int64
```

In [45]:
```
plt.figure(figsize=(3,3))
df_s = df['SeniorCitizen'].value_counts(normalize=True,dropna=False).reset_index
plt.pie(df_s['proportion'],labels=df_s['SeniorCitizen'],autopct='%.2f%%',explode
    colors=['skyblue', 'orange'])
plt.title("Senior Citizen Distribution",size=10,pad=10,fontweight="bold")
plt.show()
```



3.1.4 Partner

```
In [54]: df['Partner'].value_counts(dropna=False)
```

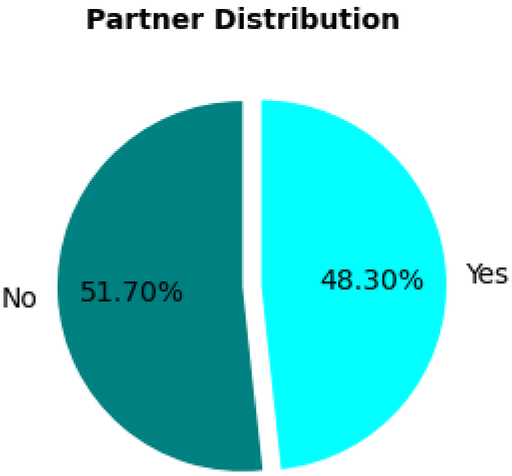
```
Out[54]: Partner
         No      3641
         Yes     3402
         Name: count, dtype: int64
```

```
In [59]: df_p = df['Partner'].value_counts(normalize=True).reset_index()
         df_p
```

Out[59]:

	Partner	proportion
0	No	0.516967
1	Yes	0.483033

```
In [71]: plt.figure(figsize=(3,3))
         plt.pie(df_p['proportion'],labels=df_p['Partner'],autopct='%.2f%%',explode=[0,0.
         plt.title("Partner Distribution",size=10,pad=10,fontweight="bold")
         plt.show()
```



3.1.5 Dependents

In [72]:
```
df['Dependents'].value_counts(dropna=False)
```

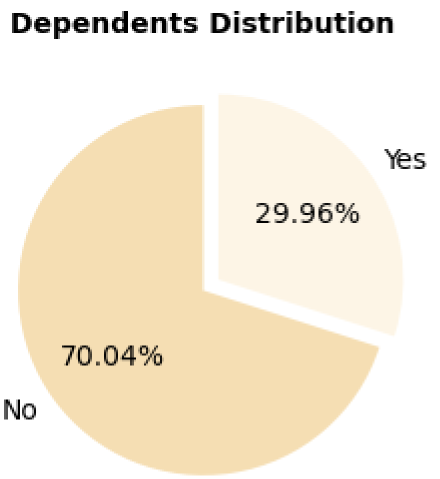
Out[72]:
```
Dependents
No     4933
Yes    2110
Name: count, dtype: int64
```

In [74]:
```
df['Dependents'].value_counts(normalize=True,dropna=False).reset_index()
```

Out[74]:

	Dependents	proportion
0	No	0.700412
1	Yes	0.299588

In [76]:
```
df_d = df['Dependents'].value_counts(normalize=True,dropna=False).reset_index()
plt.figure(figsize=(3,3))
plt.pie(df_d['proportion'],labels=df_d['Dependents'],autopct='%.2f%%',explode=[0
plt.title('Dependents Distribution',size=10,pad=10,fontweight="bold")
plt.show()
```



3.1.6 PhoneService

In [77]:
```
df['PhoneService'].value_counts()
```

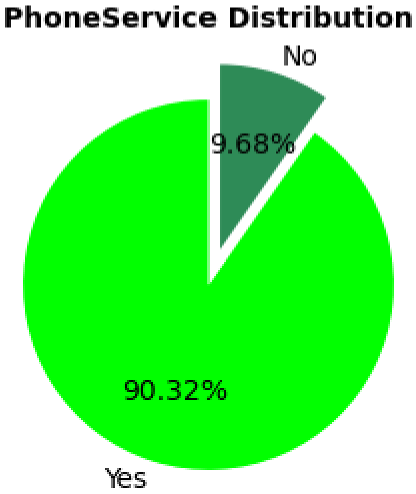
Out[77]:
```
PhoneService
Yes    6361
No      682
Name: count, dtype: int64
```

In [85]:
```
df_p = df['PhoneService'].value_counts(dropna=False,normalize=True).reset_index(
df_p['proportion']=df_p['proportion']*100
df_p
```

Out[85]:

	PhoneService	proportion
0	Yes	90.316626
1	No	9.683374

In [96]:
```
plt.figure(figsize=(3,3))
plt.pie(df_p['proportion'],labels=df_p['PhoneService'],autopct='%.2f%%',explode=
plt.title('PhoneService Distribution',size=10,pad=10,fontweight='bold')
plt.show()
```



3.1.7 MultipleLines

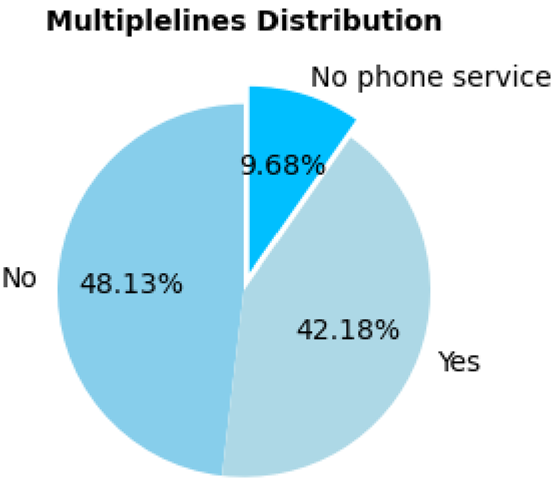
In [98]:
```
df['MultipleLines'].value_counts(dropna=False)
```

Out[98]:
```
MultipleLines
No                  3390
Yes                 2971
No phone service     682
Name: count, dtype: int64
```

In [99]:
```
df['MultipleLines'].value_counts(dropna=False,normalize=True)
```

Out[99]:
```
MultipleLines
No                  0.481329
Yes                 0.421837
No phone service    0.096834
Name: proportion, dtype: float64
```

In [108…
```
plt.figure(figsize=(3,4))
df_m = df['MultipleLines'].value_counts(dropna=False,normalize=True).reset_index
plt.pie(df_m['proportion'],labels=df_m['MultipleLines'],autopct='%.2f%%',explode
       startangle=90)
plt.title('Multiplelines Distribution',pad=10,size=10,fontweight='bold')
plt.show()
```



3.1.8 InternetService

In [110…

```
df['InternetService'].value_counts(dropna=False)
```

Out[110…

```
InternetService
Fiber optic    3096
DSL            2421
No             1526
Name: count, dtype: int64
```

In [112…

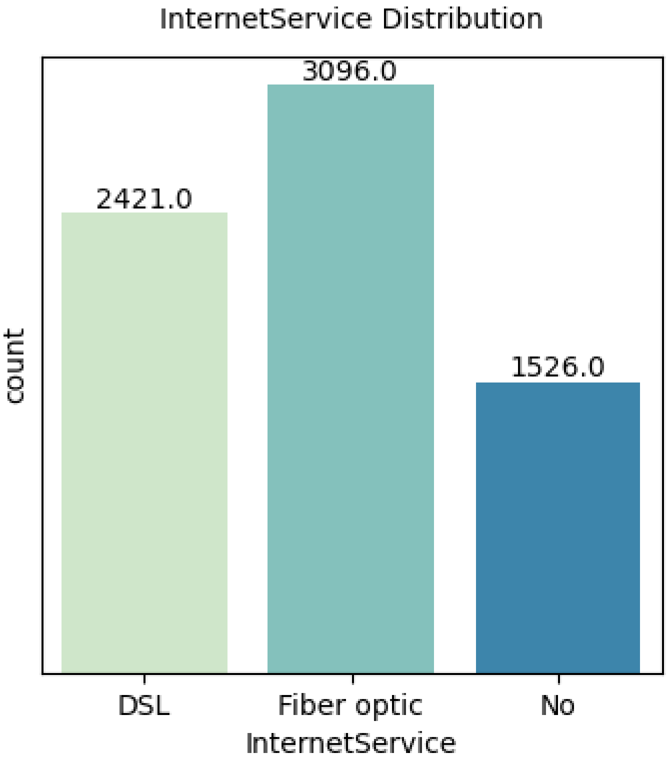
```
df_i = df['InternetService'].value_counts(dropna=False,normalize=True).reset_ind
df_i
```

Out[112…

	InternetService	proportion
0	Fiber optic	0.439585
1	DSL	0.343746
2	No	0.216669

In [185…

```
plt.figure(figsize=(4,4))
ax = sns.countplot(x=df['InternetService'],data=df,palette='GnBu')
for i in ax.patches:
    ax.annotate(
        str(i.get_height()),
        (i.get_x()+i.get_width()/2,i.get_height()),
        ha = 'center',va='bottom'
    )

plt.title('InternetService Distribution',pad=10,size=10)
plt.yticks([])
plt.show()
```



3.1.9 OnlineSecurity

In [128…

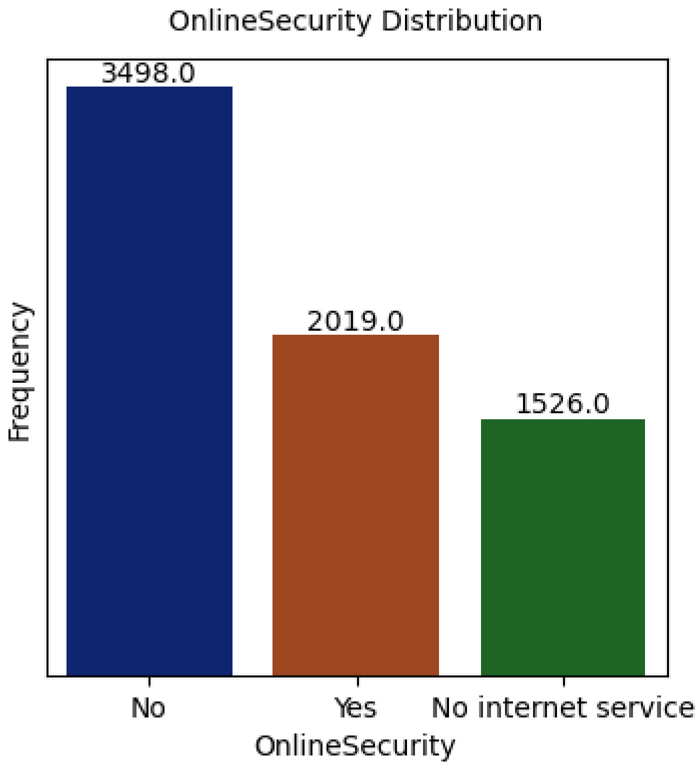
```
df['OnlineSecurity'].value_counts(dropna=False)
```

Out[128…

```
OnlineSecurity
No                     3498
Yes                    2019
No internet service    1526
Name: count, dtype: int64
```

In [136…

```
plt.figure(figsize=(4,4))
ax = sns.countplot(x='OnlineSecurity',data=df,palette='dark')

for i in ax.patches:
    ax.annotate(
        str(i.get_height()),
        (i.get_x()+i.get_width()/2,i.get_height()),
        ha='center',va='bottom')


plt.yticks([])
plt.ylabel('Frequency')
plt.title('OnlineSecurity Distribution',pad=10,size=10)
plt.show()
```



3.1.10 OnlineBackup

In [137…

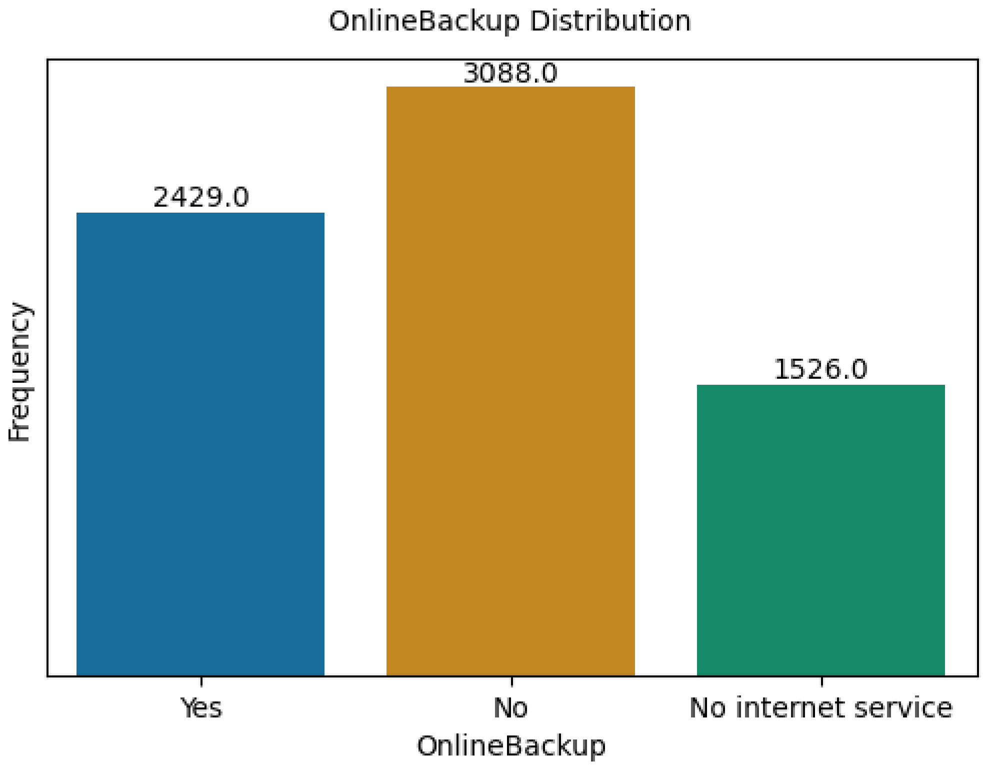
```
df['OnlineBackup'].value_counts(dropna=False)
```

Out[137…

```
OnlineBackup
No                     3088
Yes                    2429
No internet service    1526
Name: count, dtype: int64
```

In [151…

```
plt.figure(figsize=(6,4))
ax = sns.countplot(x = 'OnlineBackup',data=df,palette='colorblind',orient='y',)
for i in ax.patches:
    ax.annotate(
        str(i.get_height()),
        (i.get_x()+i.get_width()/2,i.get_height()),
        ha='center',va='bottom')

plt.title('OnlineBackup Distribution',size=10,pad=10)
plt.yticks([])
plt.ylabel('Frequency')
plt.show()
```



3.1.11 DeviceProtection

In [152…

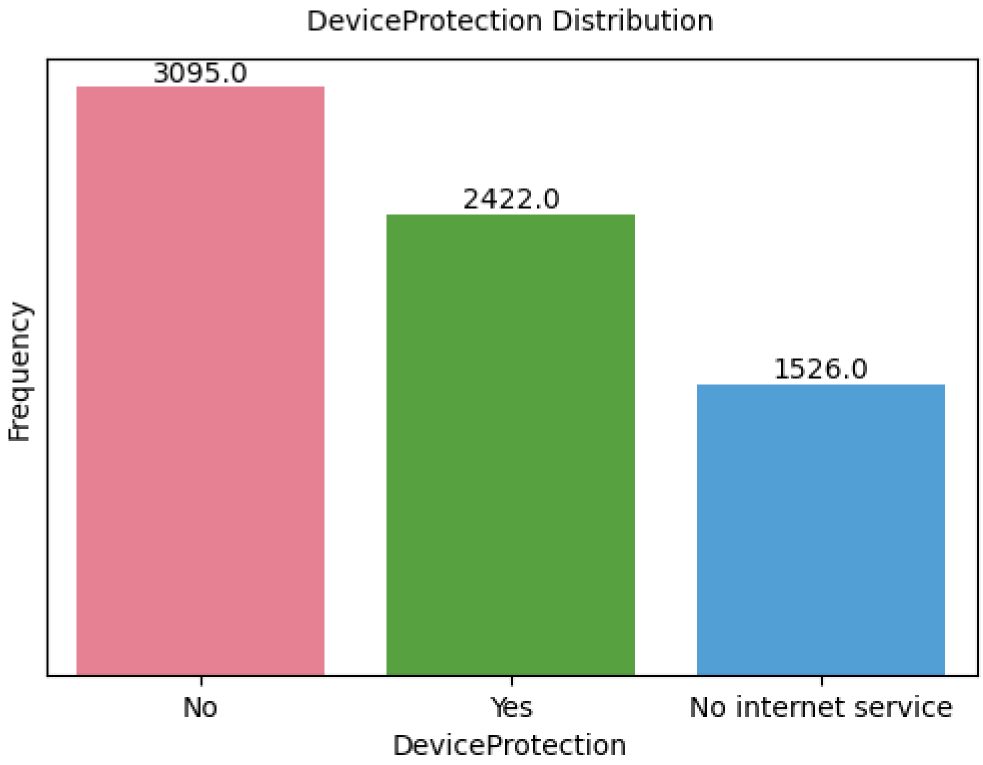
```
df['DeviceProtection'].value_counts(dropna=False)
```

Out[152…

```
DeviceProtection
No                     3095
Yes                    2422
No internet service    1526
Name: count, dtype: int64
```

In [154…

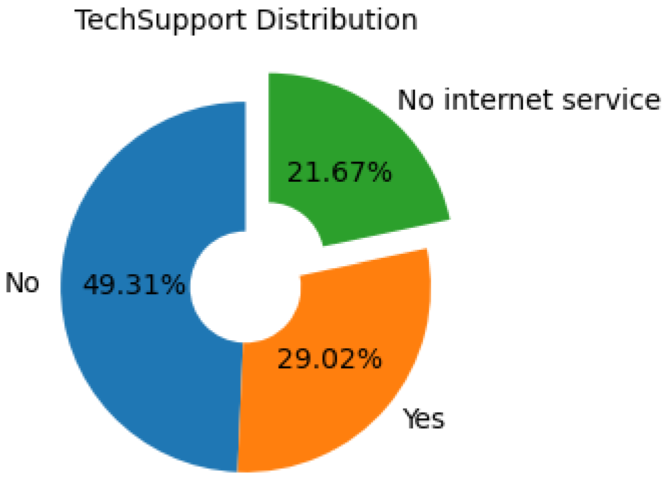
```
plt.figure(figsize=(6,4))

ax = sns.countplot(x ='DeviceProtection',data=df,palette='husl')

for i in ax.patches:
    ax.annotate(
        str(i.get_height()),
        (i.get_x()+i.get_width()/2,i.get_height()),
         ha='center',va='bottom')

plt.title('DeviceProtection Distribution',pad=10,size=10)
plt.ylabel('Frequency')
plt.yticks([])
plt.show()
```



3.1.12 TechSupport

In [176…

```
plt.figure(figsize=(3,3))
counts = df['TechSupport'].value_counts()
plt.pie(counts, labels=counts.index, autopct='%.2f%%', wedgeprops={'width':0.7},
plt.title("TechSupport Distribution",pad=10,size=10)
plt.show()
```



3.1.13 StreamingTV

In [177…

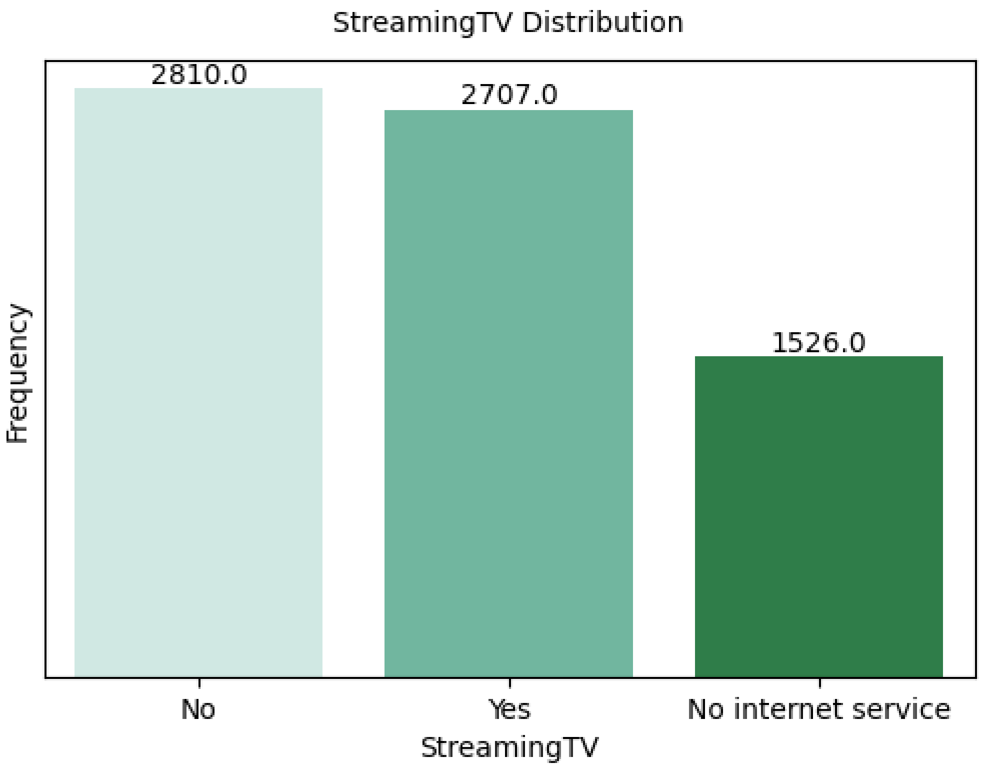
```
df['StreamingTV'].value_counts()
```

Out[177…

```
StreamingTV
No                     2810
Yes                    2707
No internet service    1526
Name: count, dtype: int64
```

In [179…

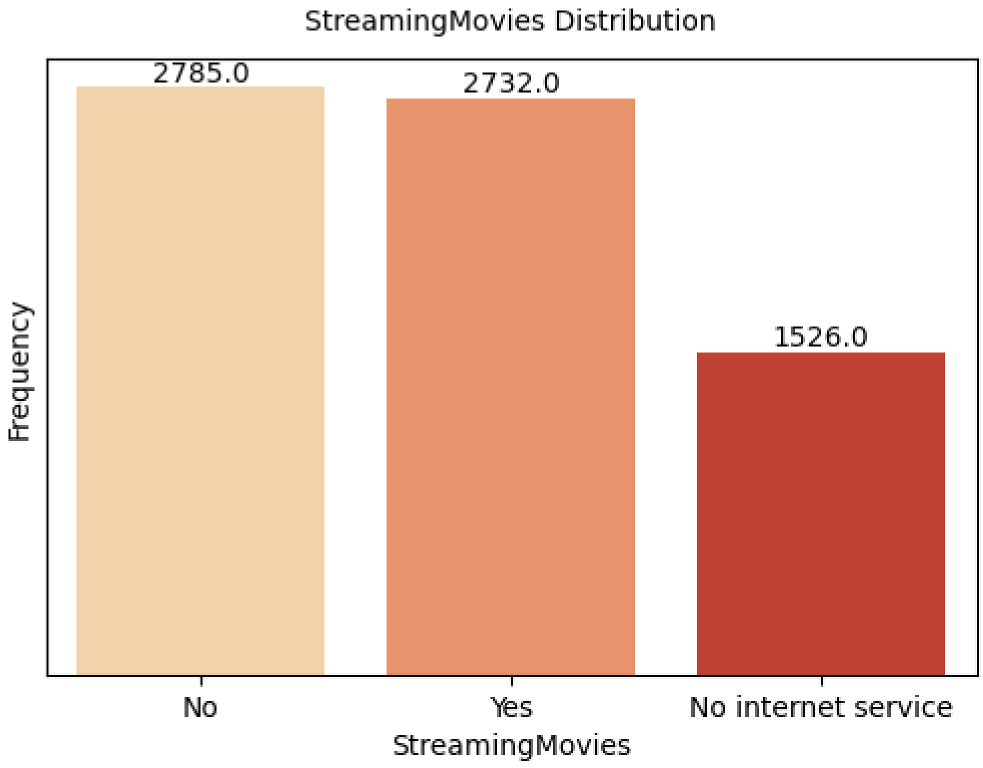
```
plt.figure(figsize=(6,4))

ax = sns.countplot(x='StreamingTV',data=df,palette='BuGn')

for i in ax.patches:
    ax.annotate(
        str(i.get_height()),
        (i.get_x()+i.get_width()/2,i.get_height()),
        ha='center',va='bottom')

plt.title('StreamingTV Distribution',pad=10,size=10)
plt.yticks([])
plt.ylabel('Frequency')
plt.show()
```



3.1.13 StreamingMovies

In [188…

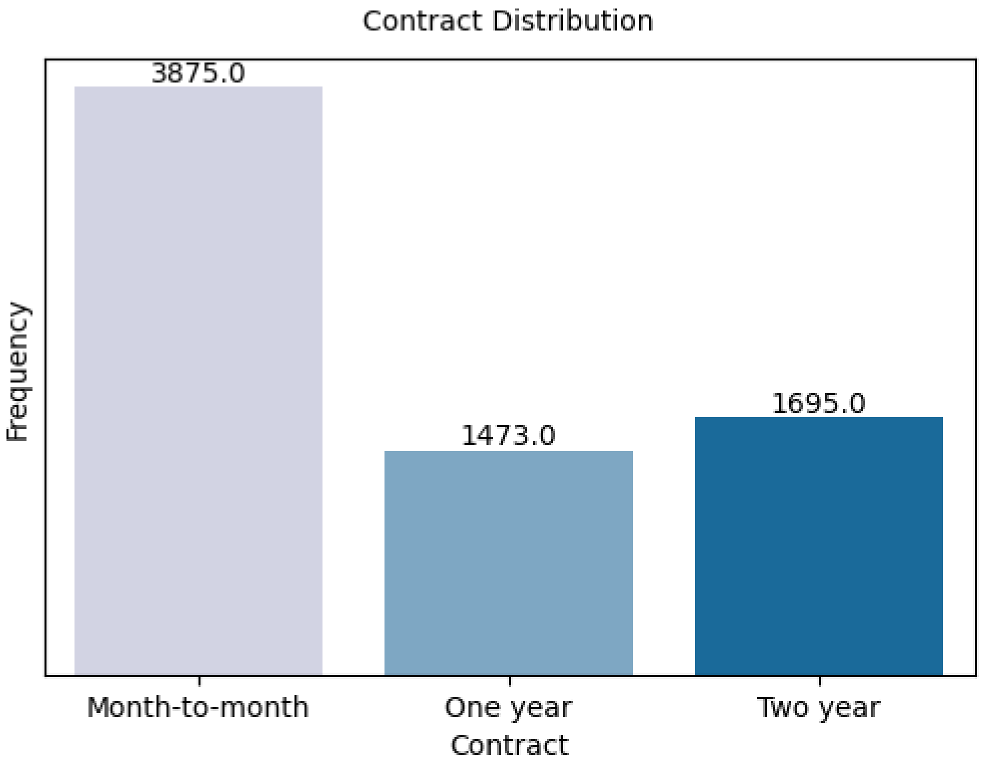
```
plt.figure(figsize=(6,4))
ax = sns.countplot(x = 'StreamingMovies',data=df,palette='OrRd')

for i in ax.patches:
    ax.annotate(
        str(i.get_height()),
        (i.get_x()+i.get_width()/2,i.get_height()),
        ha='center',va='bottom')

plt.title('StreamingMovies Distribution',pad=10,size=10)
plt.yticks([])
plt.ylabel('Frequency')
plt.show()
```



3.1.13 Contract

In [189…

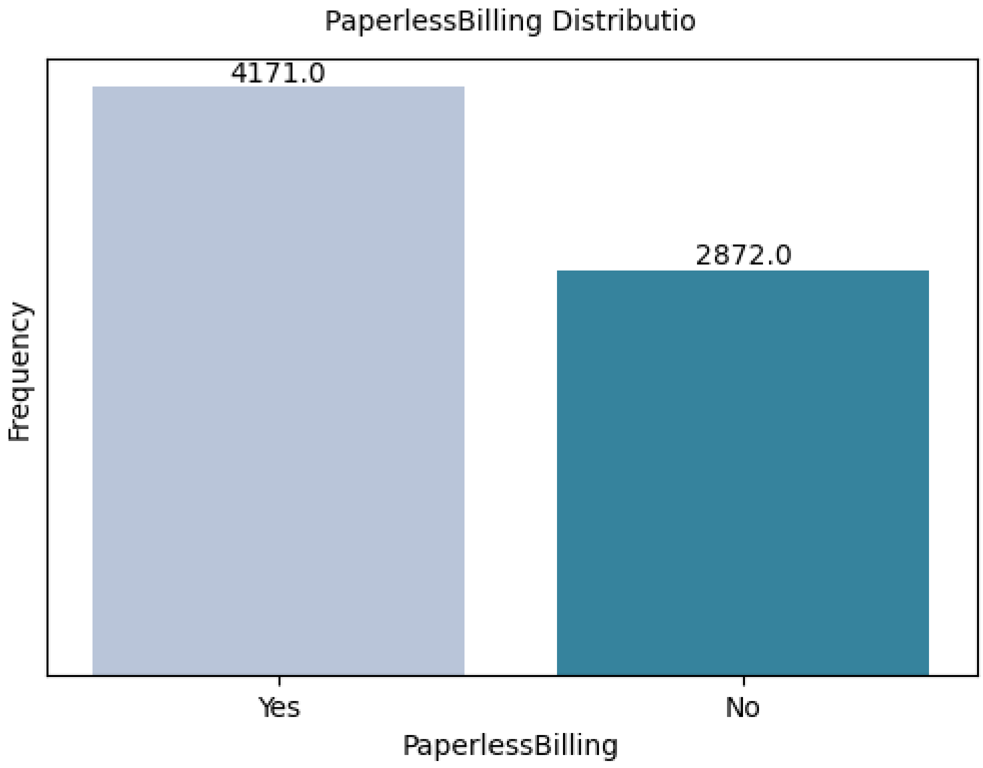
```
plt.figure(figsize=(6,4))
ax = sns.countplot(x = 'Contract',data=df,palette='PuBu')

for i in ax.patches:
    ax.annotate(
        str(i.get_height()),
        (i.get_x()+i.get_width()/2,i.get_height()),
        ha='center',va='bottom')

plt.title('Contract Distribution',pad=10,size=10)
plt.yticks([])
plt.ylabel('Frequency')
plt.show()
```



3.1.14 PaperlessBilling

In [190…

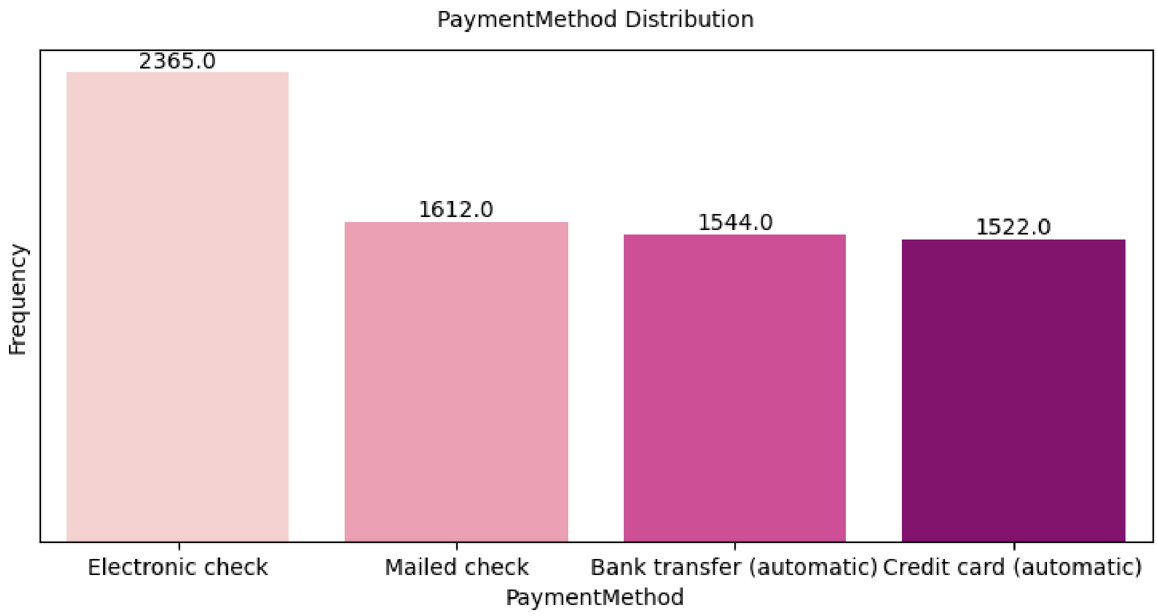
```
plt.figure(figsize=(6,4))
ax = sns.countplot(x = 'PaperlessBilling',data=df,palette='PuBuGn')

for i in ax.patches:
    ax.annotate(
        str(i.get_height()),
        (i.get_x()+i.get_width()/2,i.get_height()),
        ha='center',va='bottom')

plt.title('PaperlessBilling Distributio',pad=10,size=10)
plt.yticks([])
plt.ylabel('Frequency')
plt.show()
```



3.1.15 PaymentMethod

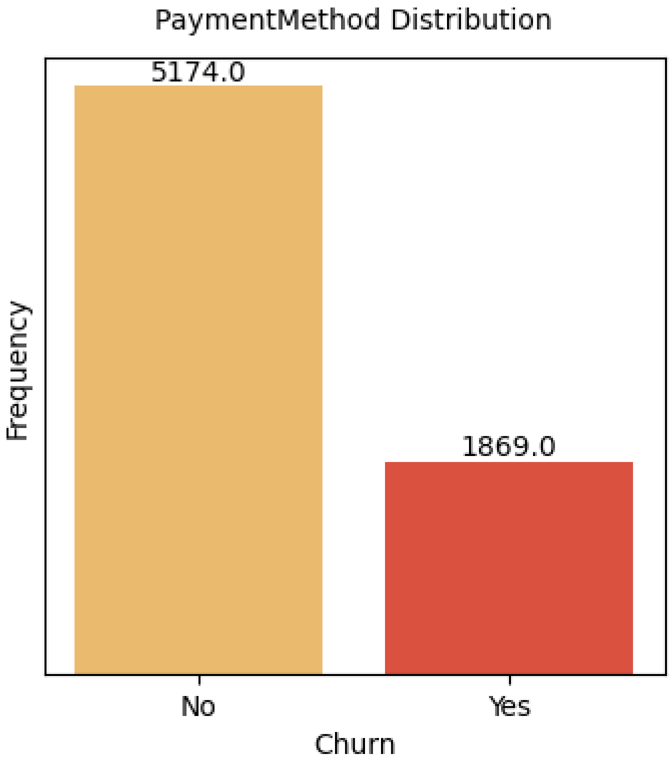
In [194…

```
plt.figure(figsize=(9,4))
ax = sns.countplot(x = 'PaymentMethod',data=df,palette='RdPu')

for i in ax.patches:
    ax.annotate(
        str(i.get_height()),
        (i.get_x()+i.get_width()/2,i.get_height()),
        ha='center',va='bottom')

plt.title('PaymentMethod Distribution',pad=10,size=10)
plt.yticks([])
plt.ylabel('Frequency')
plt.show()
```



3.1.16 Churn

In [196…
```
plt.figure(figsize=(4,4))
ax = sns.countplot(x = 'Churn',data=df,palette='YlOrRd')

for i in ax.patches:
    ax.annotate(
        str(i.get_height()),
        (i.get_x()+i.get_width()/2,i.get_height()),
        ha='center',va='bottom')

plt.title('PaymentMethod Distribution',pad=10,size=10)
plt.yticks([])
plt.ylabel('Frequency')
plt.show()
```



3.2 Numerical values

3.2.1 tenure

In [201…
```
print('Max Tenure in Months:',np.max(df['tenure']))
```

```
Max Tenure in Months: 72
```

In [202…
```
print('Max Tenure in Months:',np.min(df['tenure']))
```

```
Max Tenure in Months: 0
```

It is not possible to have a tenure of zero. That is the region im dropped the tenure 0 columns

In [204…

```
df.drop(labels=df[df['tenure'] == 0].index, axis=0, inplace=True)
df[df['tenure'] == 0].index
```

Out[204…

```
Index([], dtype='int64')
```

In [206…

```
df.describe()
```

Out[206…

	tenure	MonthlyCharges
count	7032.000000	7032.000000
mean	32.421786	64.798208
std	24.545260	30.085974
min	1.000000	18.250000
25%	9.000000	35.587500
50%	29.000000	70.350000
75%	55.000000	89.862500
max	72.000000	118.750000

In [211…

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 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   object 
 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(1), object(18)
memory usage: 1.2+ MB
```

In [210…

```
df['TotalCharges'] = df['TotalCharges'].astype('float')
```

In [214…

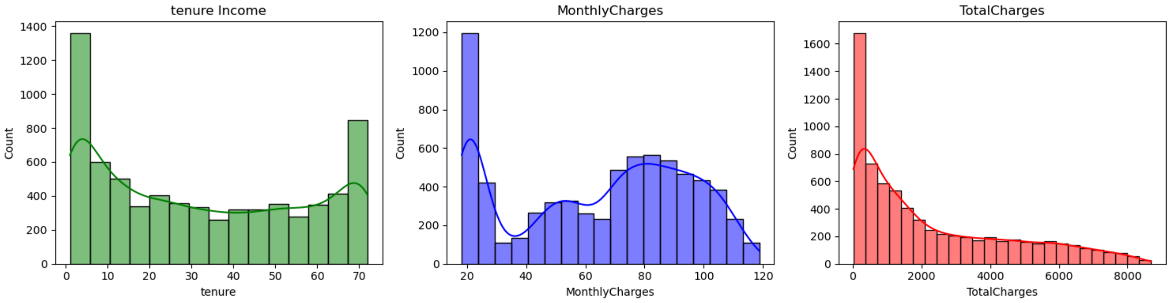
```
numerical_cols = ['tenure', 'MonthlyCharges', 'TotalCharges']
df[numerical_cols].describe()
```

Out[214…

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

In [217…

```
fig, ax = plt.subplots(1, 3, figsize=(15, 4))

# Plot histograms
sns.histplot(data=df, x="tenure", kde=True, ax=ax[0], color='green')
ax[0].set_title("tenure Income")

sns.histplot(data=df, x="MonthlyCharges", kde=True, ax=ax[1], color='blue')
ax[1].set_title("MonthlyCharges")

sns.histplot(data=df, x="TotalCharges", kde=True, ax=ax[2], color='red')
ax[2].set_title("TotalCharges")

plt.tight_layout()
plt.show()
```



4 Categorical vs Categorical

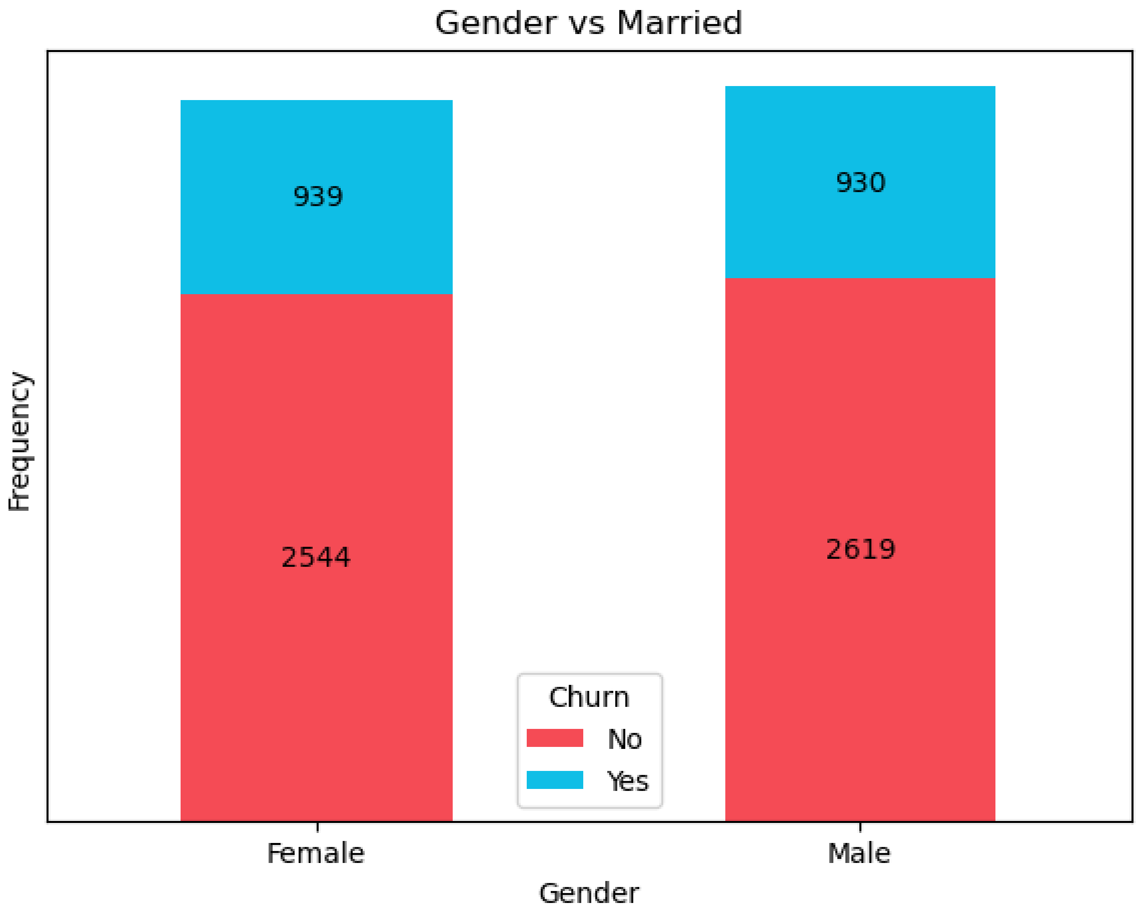
4.1 Gender vs Married

In [218…

```
plt.figure(figsize=(4,4))
ct = pd.crosstab(df.gender, df.Churn)
ax = ct.plot(kind='bar', stacked=True, figsize=(7,5),color=['#f64f59','#12c2e9']

plt.title('Gender vs Married')
plt.xlabel('Gender')
plt.ylabel('Frequency')
plt.xticks(rotation=0)
```

```
for bar in ax.patches:
    width = bar.get_width()
    height = bar.get_height()
    x = bar.get_x()
    y = bar.get_y()

    if height > 0:  # avoid labeling empty bars
        ax.text(x + width/2, y + height/2, str(int(height)),
                ha='center', va='center', color='black', fontsize=10)
plt.yticks([])
plt.show()
```

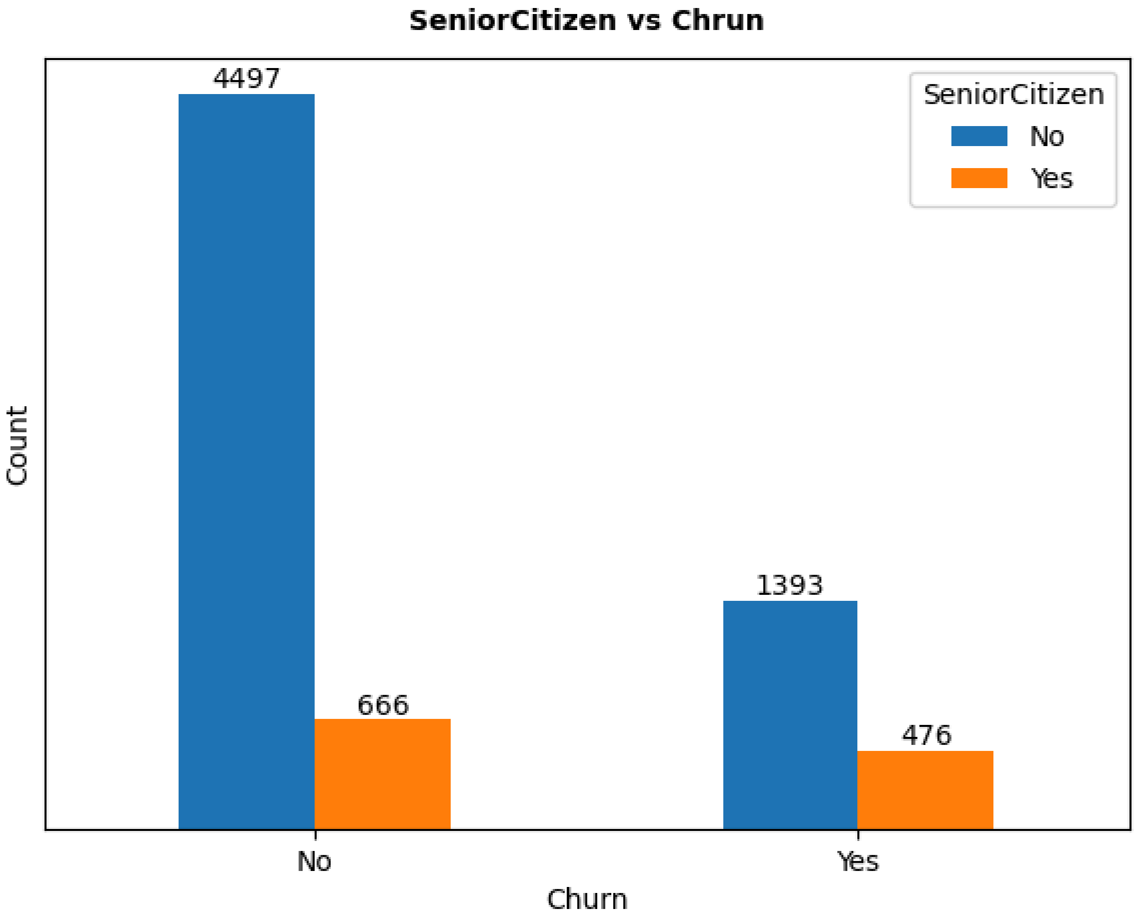
```
<Figure size 400x400 with 0 Axes>
```



4.2 SeniorCitizen vs Chrun

In [249…

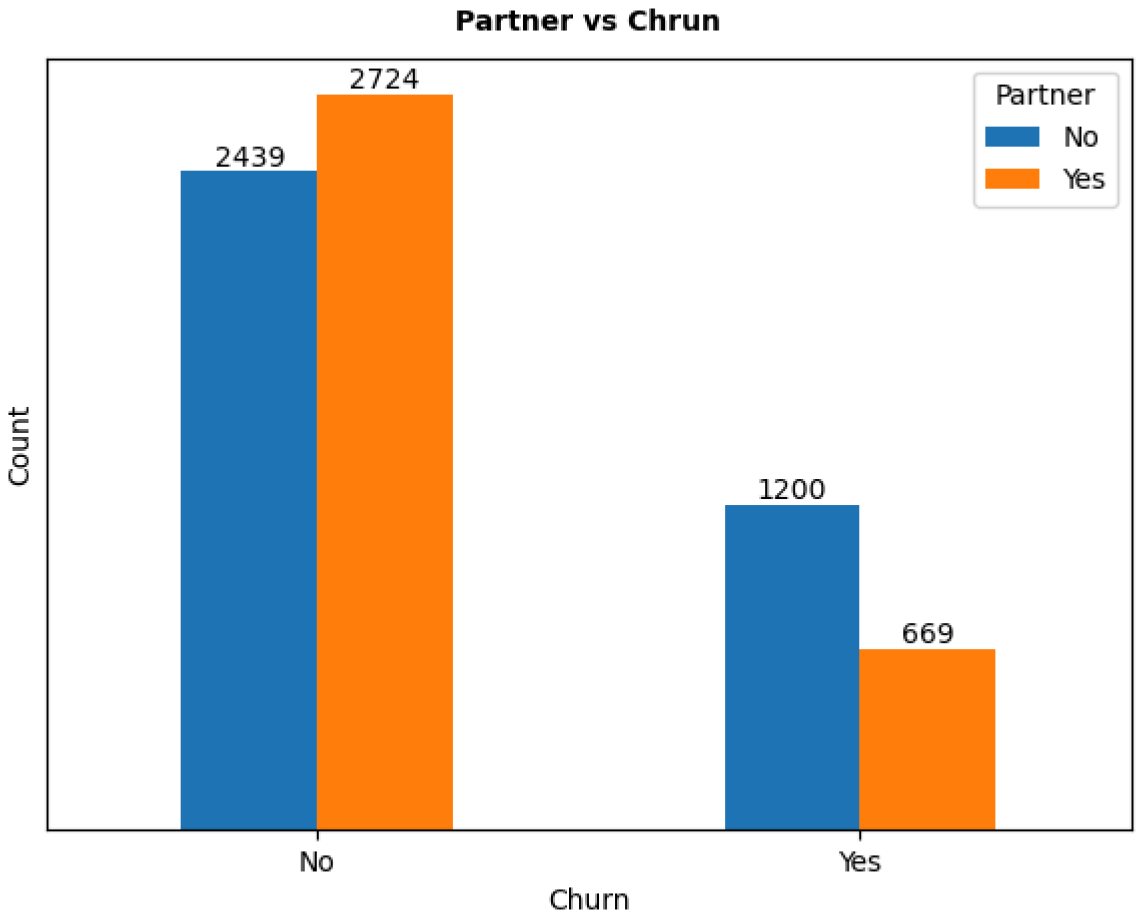
```
ct = pd.crosstab(df.Churn,df.SeniorCitizen)
ax = ct.plot(kind='bar', figsize=(7,5))

plt.title('SeniorCitizen vs Chrun', fontweight='bold',pad=10,size=10)
#plt.xlabel('Internet Service')
plt.ylabel('Count')
plt.xticks(rotation=0)

# ✅ Add labels on each bar
for bar in ax.patches:
    height = bar.get_height()
    if height > 0:  # avoid labeling empty bars
        ax.text(
            bar.get_x() + bar.get_width()/2,   # X position
            height,                            # Y position (top of bar)
            str(int(height)),                  # Text label
            ha='center', va='bottom', fontsize=10
        )
plt.yticks([])
plt.show()
```



4.3 Partner vs Chrun

In [248…

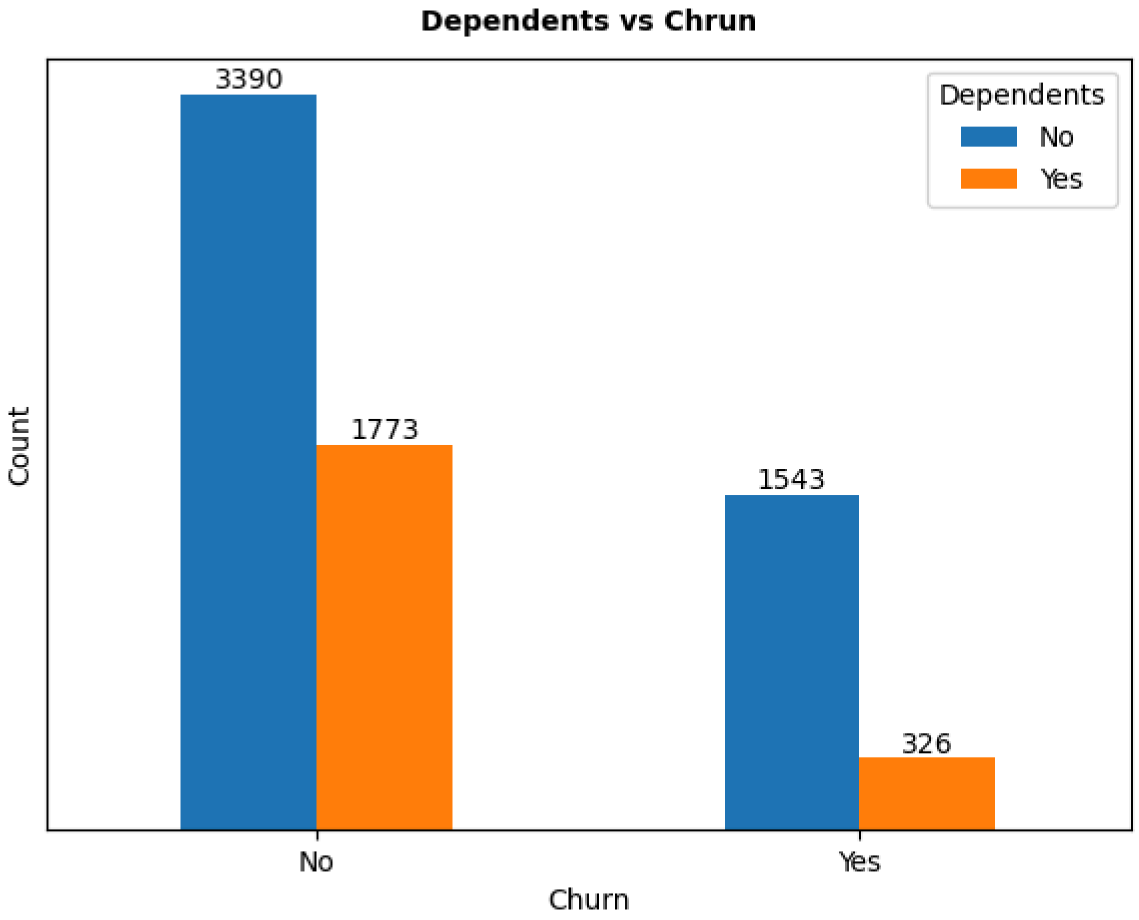
```
ct = pd.crosstab(df.Churn,df.Partner)
ax = ct.plot(kind='bar', figsize=(7,5))

plt.title('Partner vs Chrun', fontweight='bold',pad=10,size=10)
#plt.xlabel('Internet Service')
plt.ylabel('Count')
plt.xticks(rotation=0)

# ✅ Add labels on each bar
for bar in ax.patches:
    height = bar.get_height()
    if height > 0:  # avoid labeling empty bars
        ax.text(
            bar.get_x() + bar.get_width()/2,   # X position
            height,                            # Y position (top of bar)
            str(int(height)),                  # Text label
            ha='center', va='bottom', fontsize=10
        )
plt.yticks([])
plt.show()
```



4.4 Dependents vs Chrun

In [250…

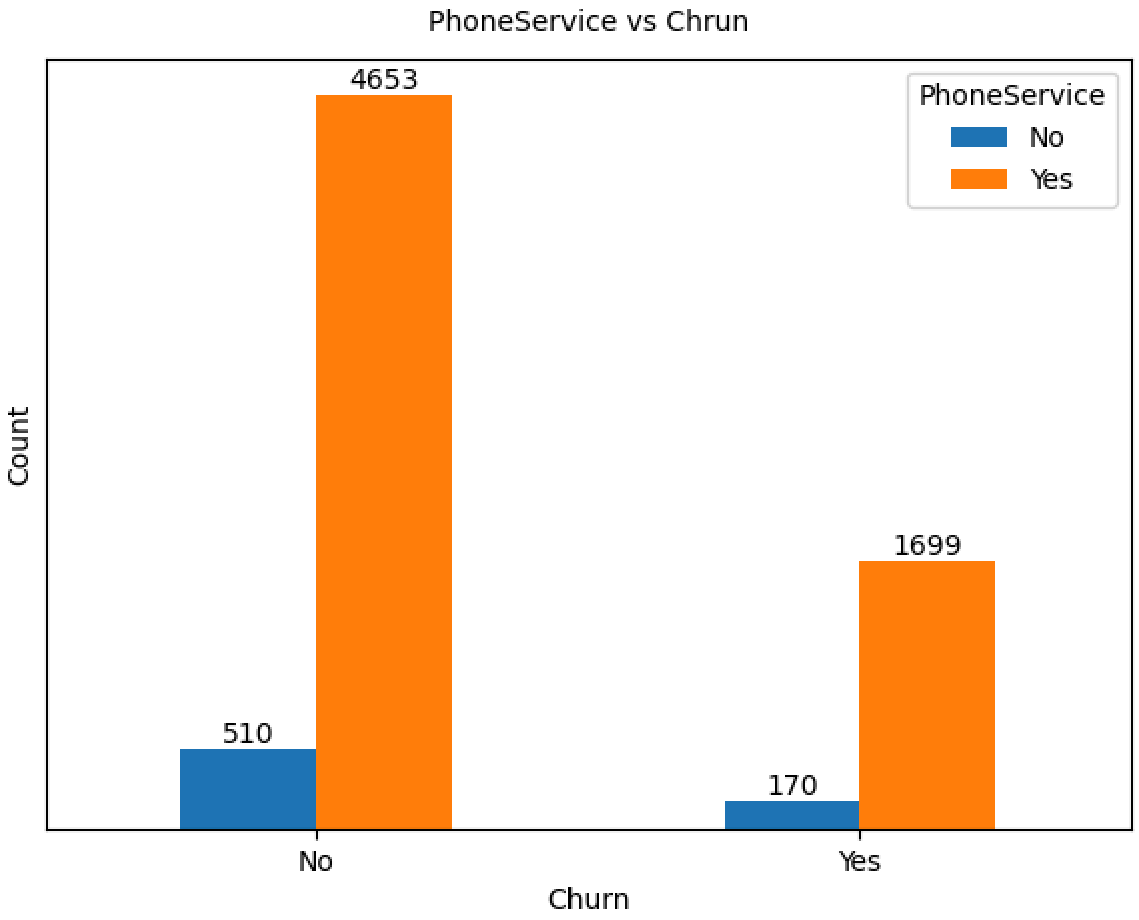
```
ct = pd.crosstab(df.Churn,df.Dependents)
ax = ct.plot(kind='bar', figsize=(7,5))

plt.title('Dependents vs Chrun', fontweight='bold',pad=10,size=10)
#plt.xlabel('Internet Service')
plt.ylabel('Count')
plt.xticks(rotation=0)

# ✅ Add labels on each bar
for bar in ax.patches:
    height = bar.get_height()
    if height > 0:  # avoid labeling empty bars
        ax.text(
            bar.get_x() + bar.get_width()/2,   # X position
            height,                            # Y position (top of bar)
            str(int(height)),                  # Text label
            ha='center', va='bottom', fontsize=10
        )
plt.yticks([])
plt.show()
```



4.4 PhoneService vs Chrun

In [251…

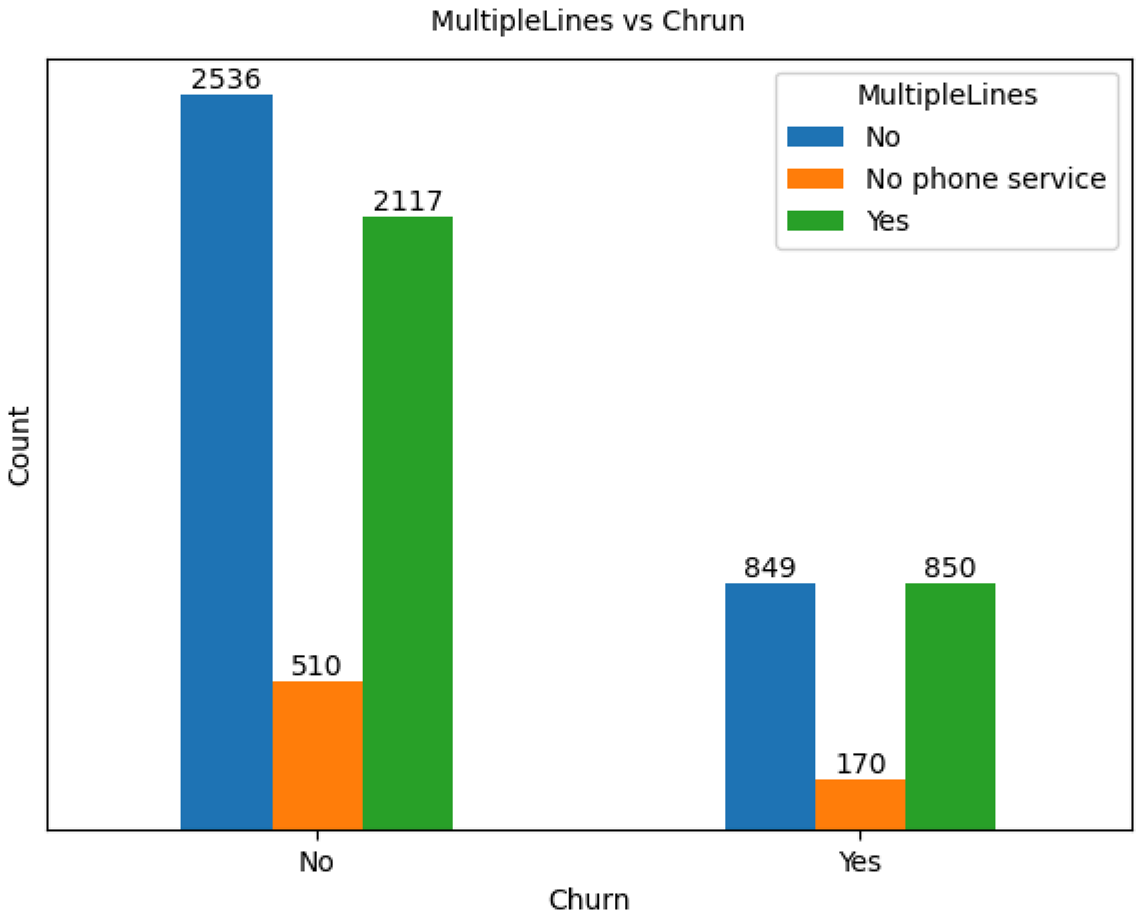
```
ct = pd.crosstab(df.Churn,df.PhoneService)
ax = ct.plot(kind='bar', figsize=(7,5))

plt.title('PhoneService vs Chrun',pad=10,size=10)
#plt.xlabel('Internet Service')
plt.ylabel('Count')
plt.xticks(rotation=0)

# ✅ Add labels on each bar
for bar in ax.patches:
    height = bar.get_height()
    if height > 0:  # avoid labeling empty bars
        ax.text(
            bar.get_x() + bar.get_width()/2,    # X position
            height,                             # Y position (top of bar)
            str(int(height)),                   # Text label
            ha='center', va='bottom', fontsize=10
        )
plt.yticks([])
plt.show()
```



4.5 MultipleLines vs Chrun

In [252…

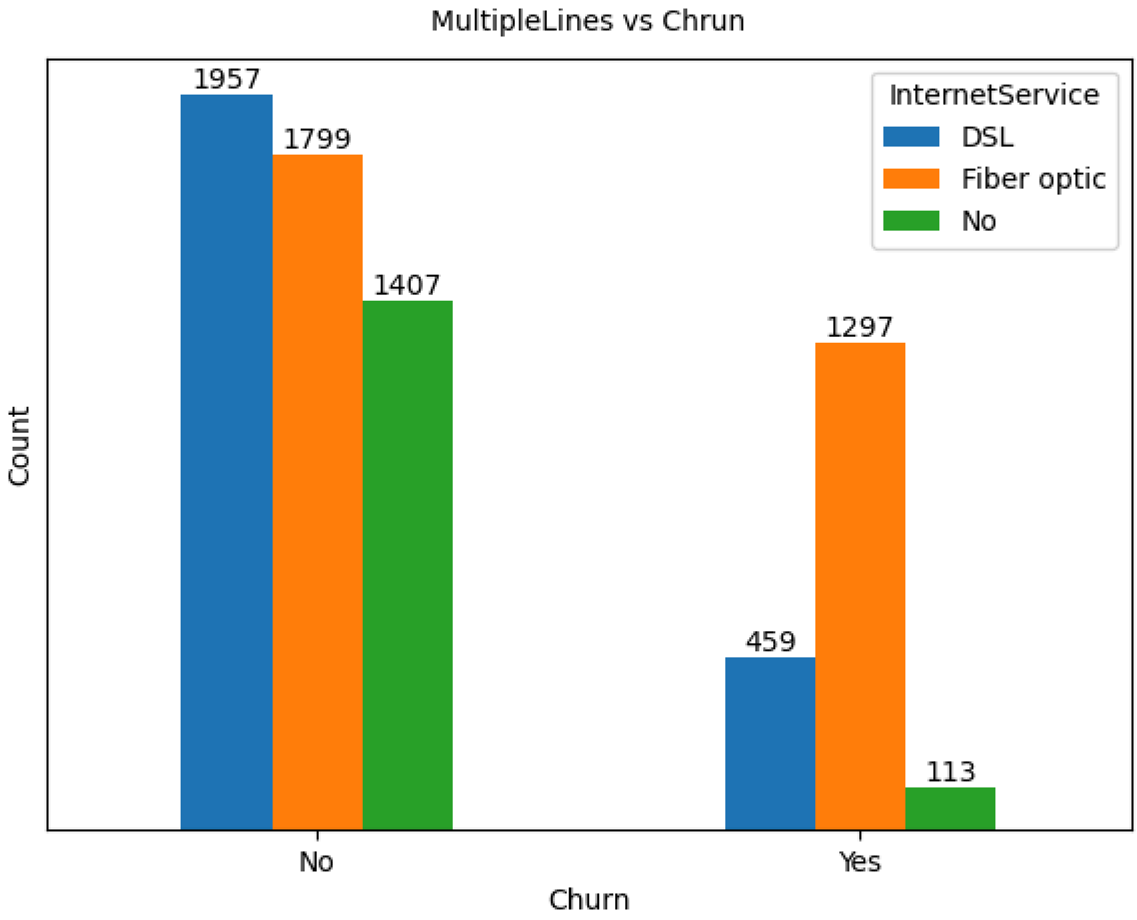
```
ct = pd.crosstab(df.Churn,df.MultipleLines)
ax = ct.plot(kind='bar', figsize=(7,5))

plt.title('MultipleLines vs Chrun',pad=10,size=10)
#plt.xlabel('Internet Service')
plt.ylabel('Count')
plt.xticks(rotation=0)

# ✅ Add labels on each bar
for bar in ax.patches:
    height = bar.get_height()
    if height > 0:  # avoid labeling empty bars
        ax.text(
            bar.get_x() + bar.get_width()/2,   # X position
            height,                            # Y position (top of bar)
            str(int(height)),                  # Text label
            ha='center', va='bottom', fontsize=10
        )
plt.yticks([])
plt.show()
```



4.6 InternetService vs Chrun

In [253…

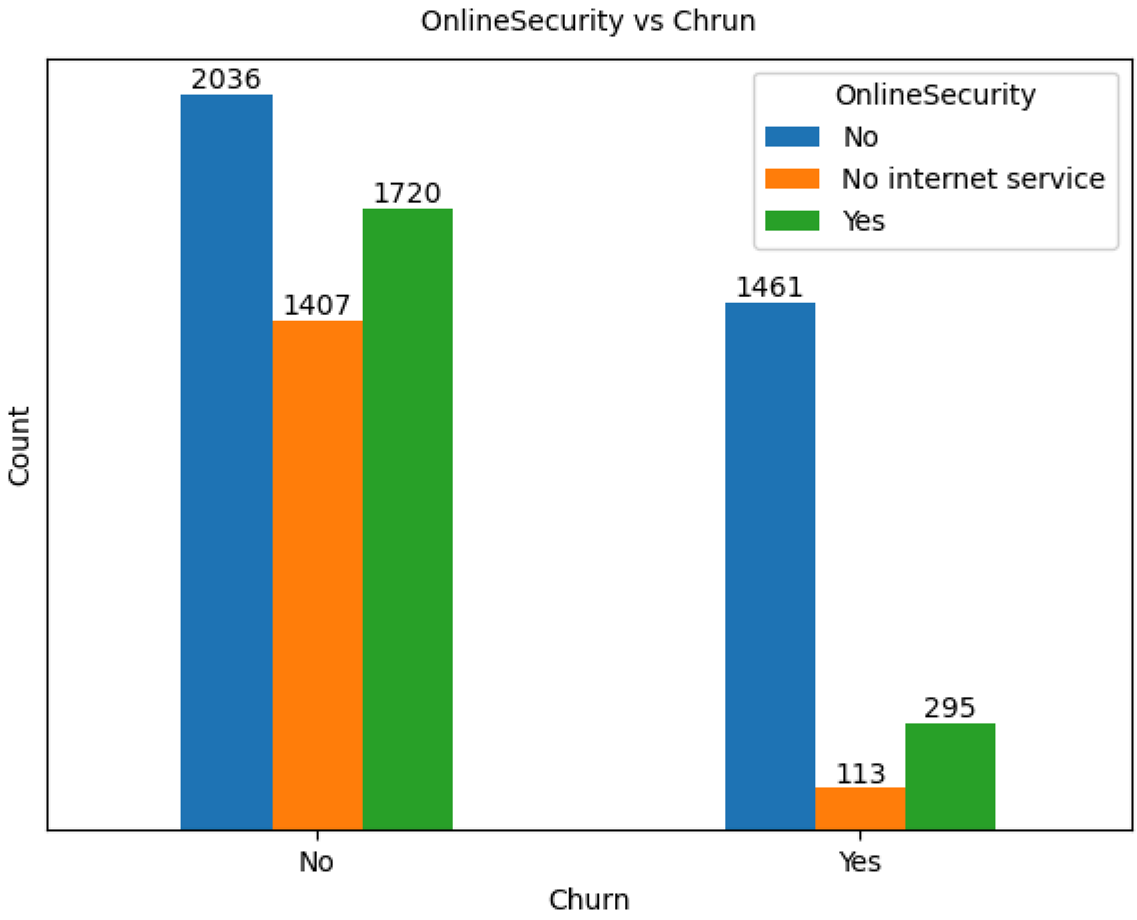
```
ct = pd.crosstab(df.Churn,df.InternetService)
ax = ct.plot(kind='bar', figsize=(7,5))

plt.title('MultipleLines vs Chrun',pad=10,size=10)
#plt.xlabel('Internet Service')
plt.ylabel('Count')
plt.xticks(rotation=0)

for bar in ax.patches:
    height = bar.get_height()
    if height > 0:  # avoid labeling empty bars
        ax.text(
            bar.get_x() + bar.get_width()/2,   # X position
            height,                            # Y position (top of bar)
            str(int(height)),                  # Text label
            ha='center', va='bottom', fontsize=10
        )
plt.yticks([])
plt.show()
```



4.6 OnlineSecurity vs Chrun

In [254…

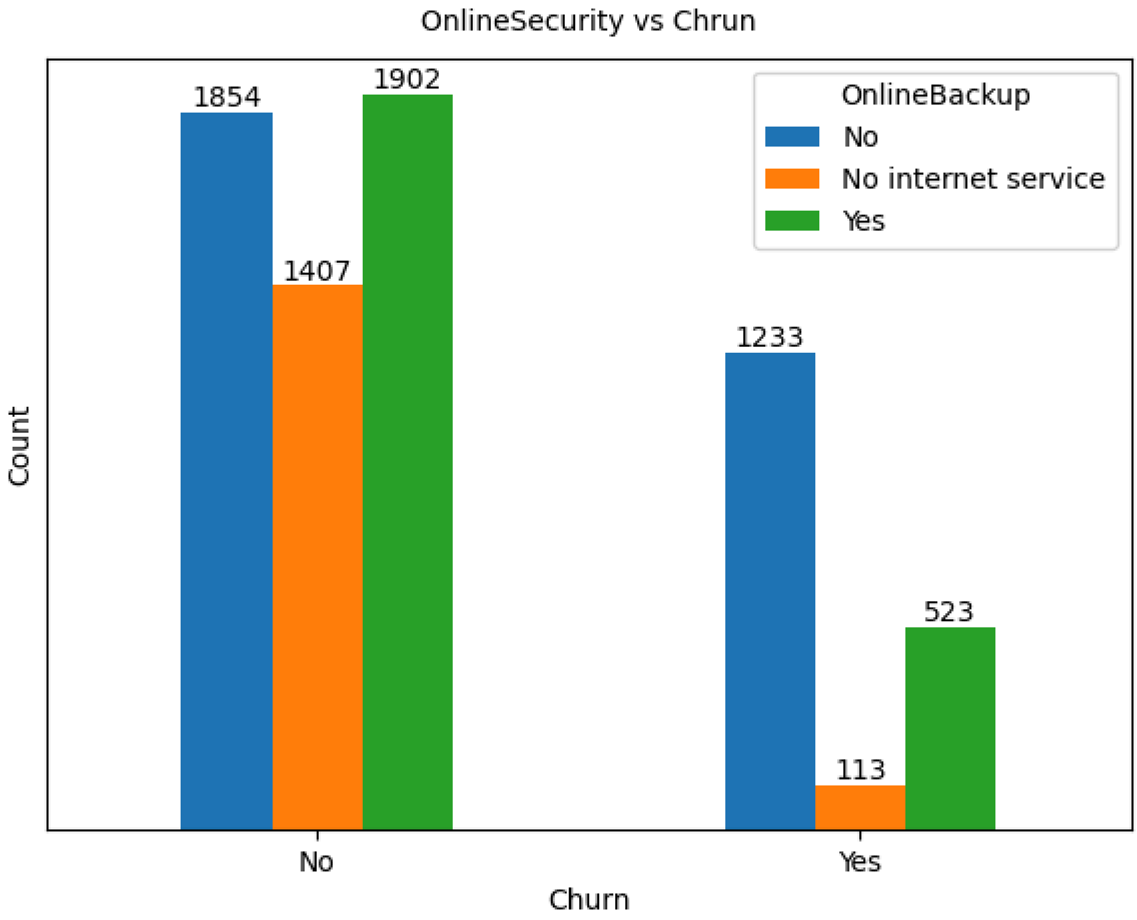
```
ct = pd.crosstab(df.Churn,df.OnlineSecurity)
ax = ct.plot(kind='bar', figsize=(7,5))

plt.title('OnlineSecurity vs Chrun',pad=10,size=10)
#plt.xlabel('Internet Service')
plt.ylabel('Count')
plt.xticks(rotation=0)

for bar in ax.patches:
    height = bar.get_height()
    if height > 0:  # avoid labeling empty bars
        ax.text(
            bar.get_x() + bar.get_width()/2,   # X position
            height,                            # Y position (top of bar)
            str(int(height)),                  # Text label
            ha='center', va='bottom', fontsize=10
        )
plt.yticks([])
plt.show()
```



4.7 OnlineBackup vs Chrun

In [255…

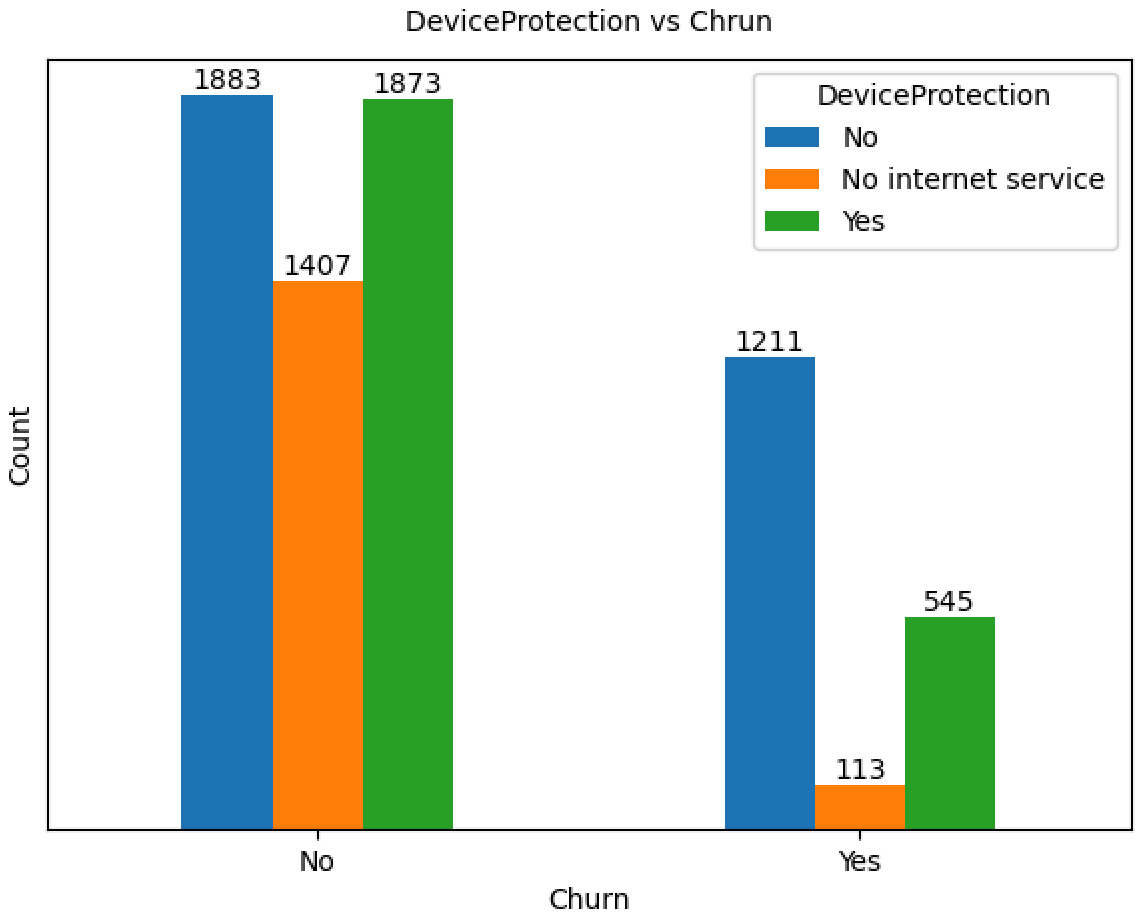
```
ct = pd.crosstab(df.Churn,df.OnlineBackup)
ax = ct.plot(kind='bar', figsize=(7,5))

plt.title('OnlineSecurity vs Chrun',pad=10,size=10)
#plt.xlabel('Internet Service')
plt.ylabel('Count')
plt.xticks(rotation=0)

for bar in ax.patches:
    height = bar.get_height()
    if height > 0:  # avoid labeling empty bars
        ax.text(
            bar.get_x() + bar.get_width()/2,   # X position
            height,                            # Y position (top of bar)
            str(int(height)),                  # Text label
            ha='center', va='bottom', fontsize=10
        )
plt.yticks([])
plt.show()
```



4.8 DeviceProtection vs Chrun

In [257…

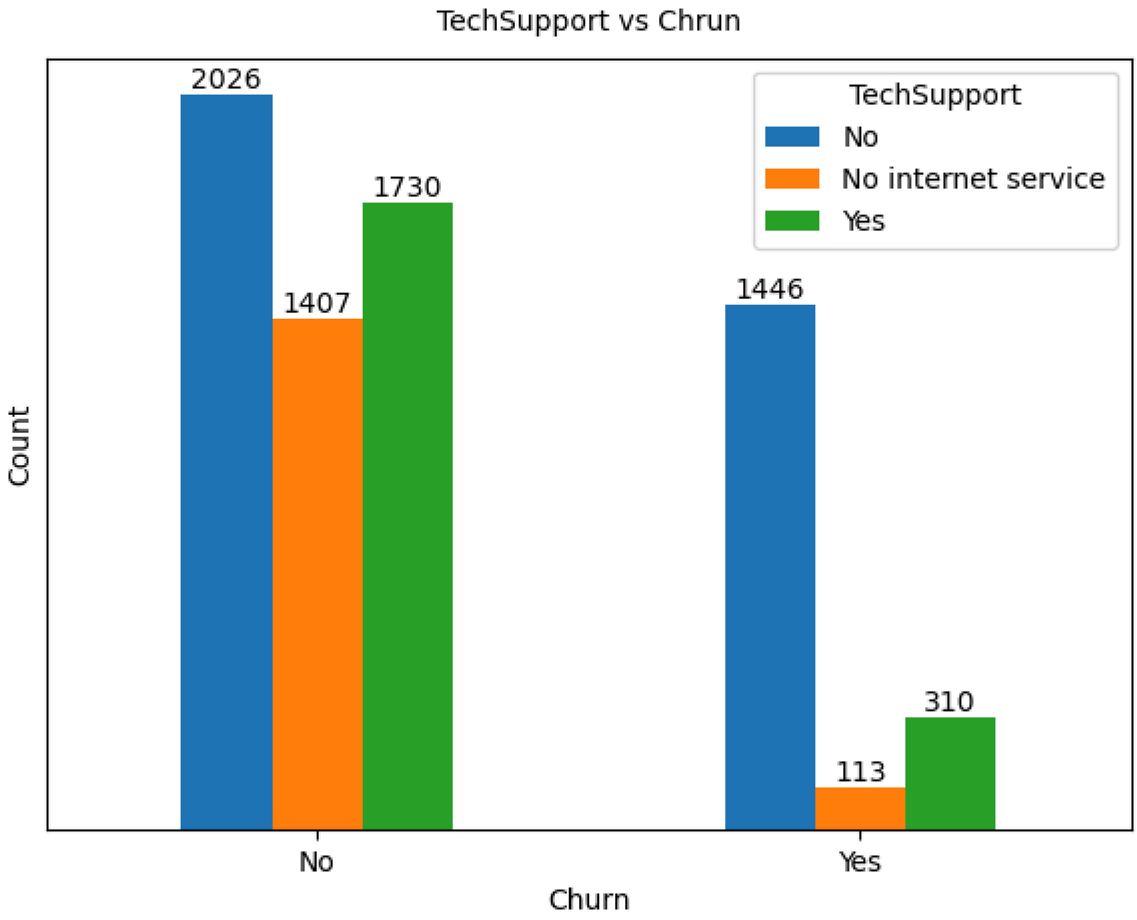
```
ct = pd.crosstab(df.Churn,df.DeviceProtection)
ax = ct.plot(kind='bar', figsize=(7,5))

plt.title('DeviceProtection vs Chrun',pad=10,size=10)
#plt.xlabel('Internet Service')
plt.ylabel('Count')
plt.xticks(rotation=0)

for bar in ax.patches:
    height = bar.get_height()
    if height > 0:  # avoid labeling empty bars
        ax.text(
            bar.get_x() + bar.get_width()/2,   # X position
            height,                            # Y position (top of bar)
            str(int(height)),                  # Text label
            ha='center', va='bottom', fontsize=10
        )
plt.yticks([])
plt.show()
```



4.9 TechSupport vs Chrun

In [258…

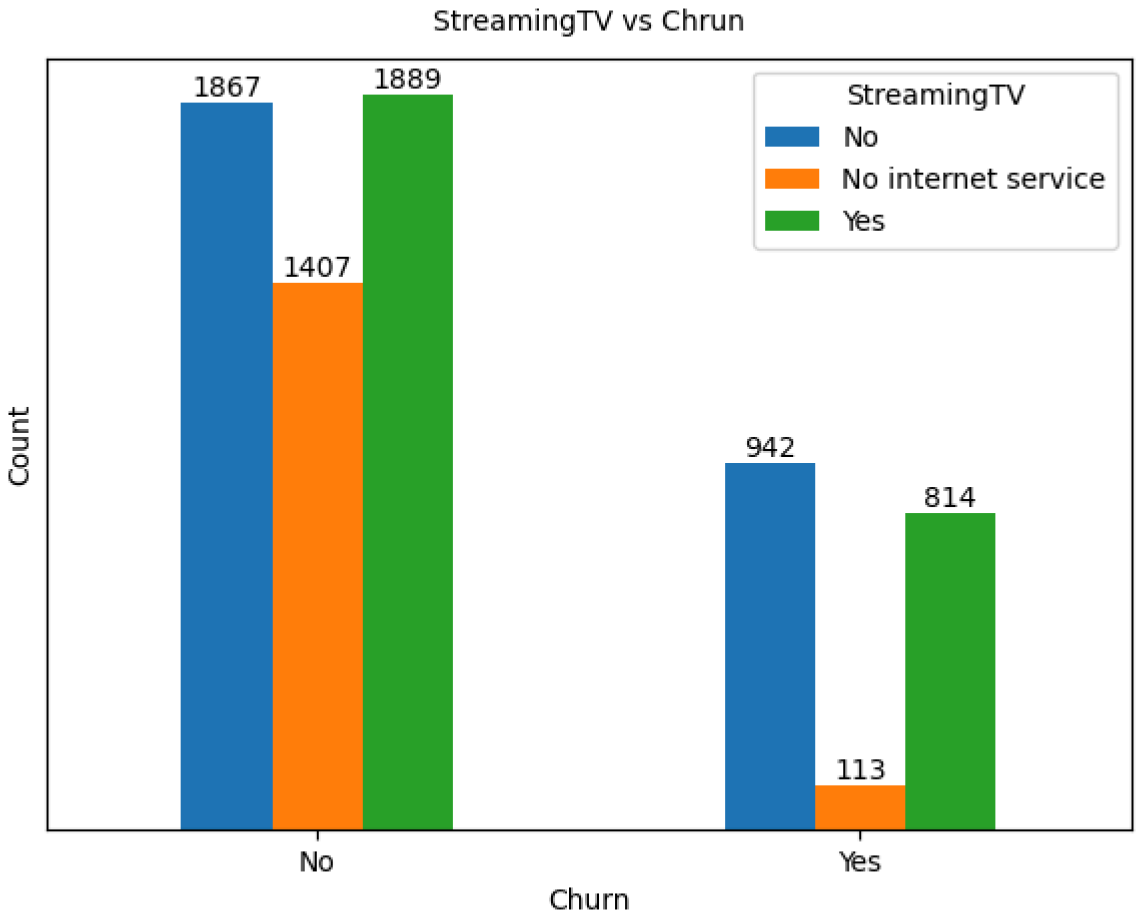
```
ct = pd.crosstab(df.Churn,df.TechSupport)
ax = ct.plot(kind='bar', figsize=(7,5))

plt.title('TechSupport vs Chrun',pad=10,size=10)
#plt.xlabel('Internet Service')
plt.ylabel('Count')
plt.xticks(rotation=0)

for bar in ax.patches:
    height = bar.get_height()
    if height > 0:  # avoid labeling empty bars
        ax.text(
            bar.get_x() + bar.get_width()/2,   # X position
            height,                            # Y position (top of bar)
            str(int(height)),                  # Text label
            ha='center', va='bottom', fontsize=10
        )
plt.yticks([])
plt.show()
```



4.10 StreamingTV vs Chrun

In [259…

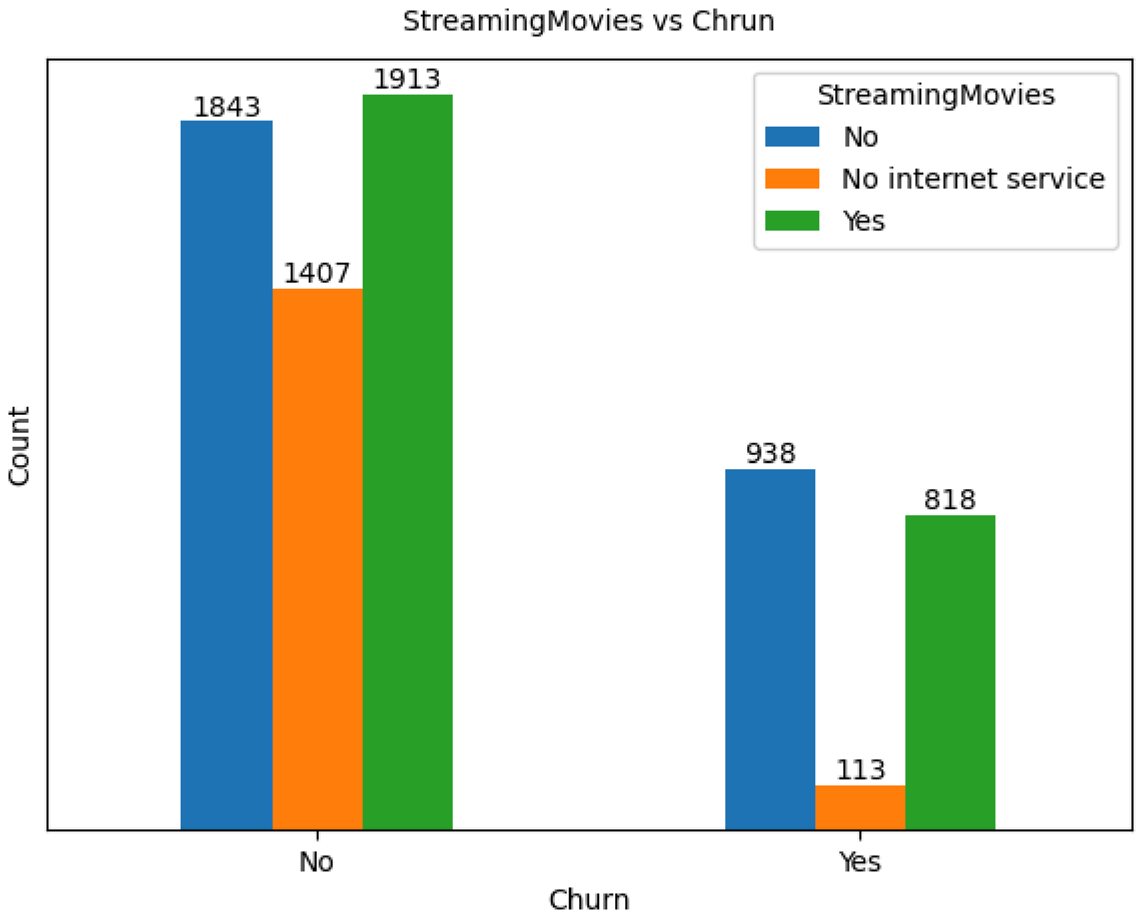
```
ct = pd.crosstab(df.Churn,df.StreamingTV)
ax = ct.plot(kind='bar', figsize=(7,5))

plt.title('StreamingTV vs Chrun',pad=10,size=10)
#plt.xlabel('Internet Service')
plt.ylabel('Count')
plt.xticks(rotation=0)

for bar in ax.patches:
    height = bar.get_height()
    if height > 0:  # avoid labeling empty bars
        ax.text(
            bar.get_x() + bar.get_width()/2,   # X position
            height,                            # Y position (top of bar)
            str(int(height)),                  # Text label
            ha='center', va='bottom', fontsize=10
        )
plt.yticks([])
plt.show()
```



4.10 StreamingMovies vs Chrun

In [260…

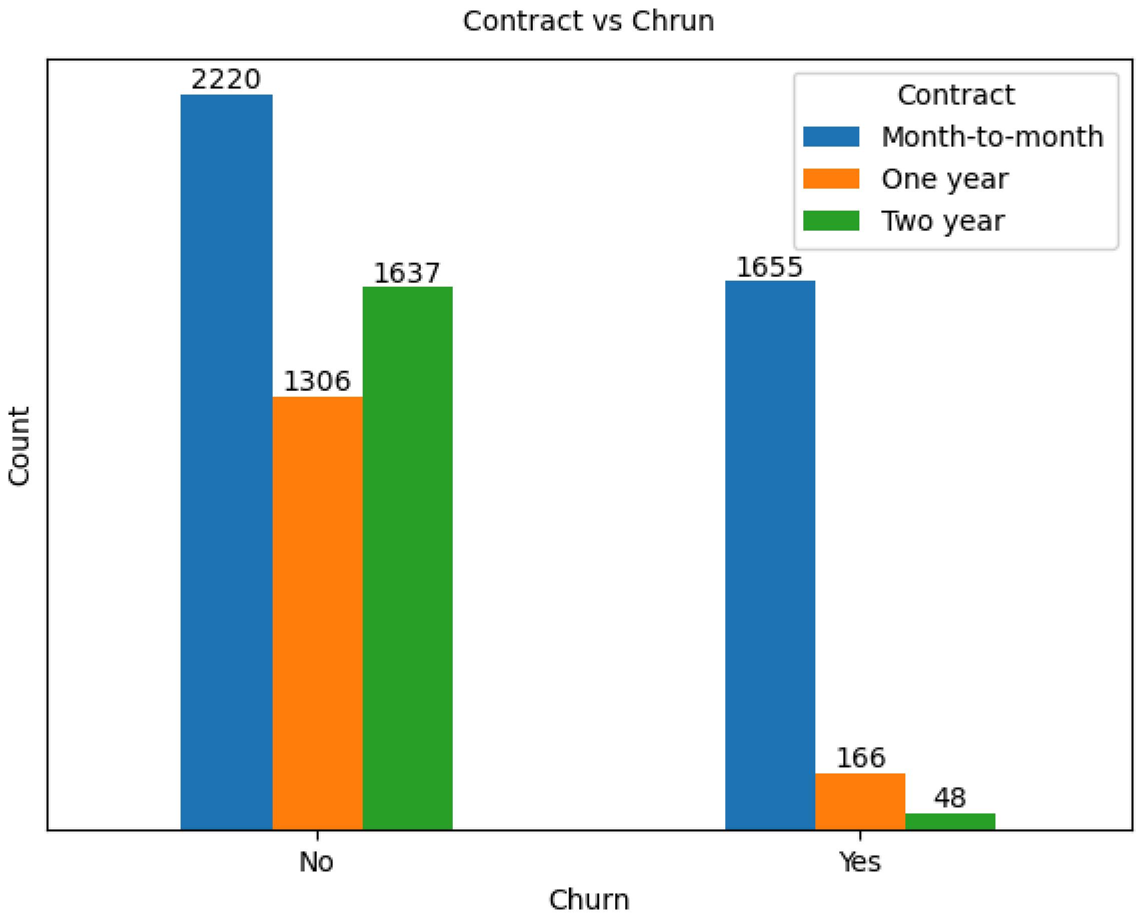
```
ct = pd.crosstab(df.Churn,df.StreamingMovies)
ax = ct.plot(kind='bar', figsize=(7,5))

plt.title('StreamingMovies vs Chrun',pad=10,size=10)
#plt.xlabel('Internet Service')
plt.ylabel('Count')
plt.xticks(rotation=0)

for bar in ax.patches:
    height = bar.get_height()
    if height > 0:  # avoid labeling empty bars
        ax.text(
            bar.get_x() + bar.get_width()/2,   # X position
            height,                            # Y position (top of bar)
            str(int(height)),                  # Text label
            ha='center', va='bottom', fontsize=10
        )
plt.yticks([])
plt.show()
```



4.11 Contract vs Chrun

In [261…

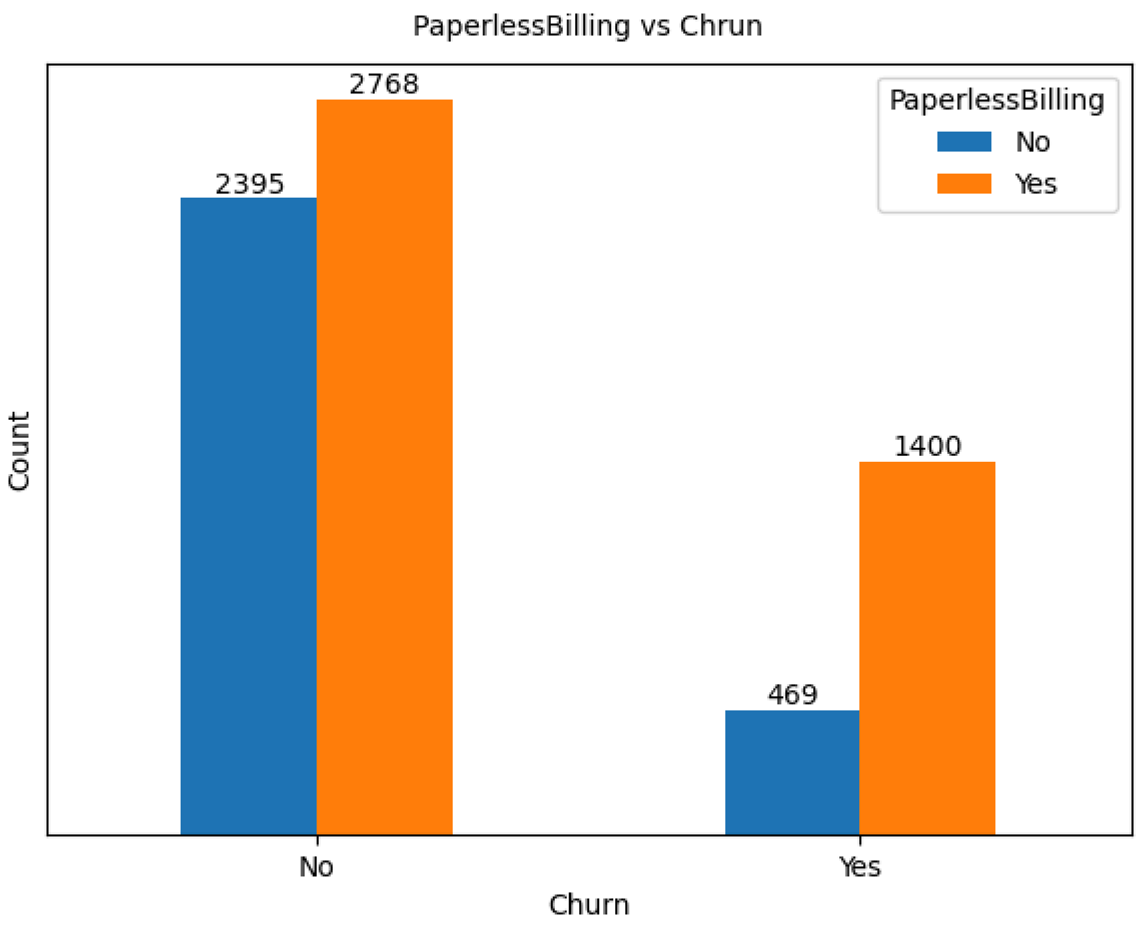
```
ct = pd.crosstab(df.Churn,df.Contract)
ax = ct.plot(kind='bar', figsize=(7,5))

plt.title('Contract vs Chrun',pad=10,size=10)
#plt.xlabel('Internet Service')
plt.ylabel('Count')
plt.xticks(rotation=0)

for bar in ax.patches:
    height = bar.get_height()
    if height > 0:  # avoid labeling empty bars
        ax.text(
            bar.get_x() + bar.get_width()/2,   # X position
            height,                            # Y position (top of bar)
            str(int(height)),                  # Text label
            ha='center', va='bottom', fontsize=10
        )
plt.yticks([])
plt.show()
```



4.11 PaperlessBilling vs Chrun

In [262…

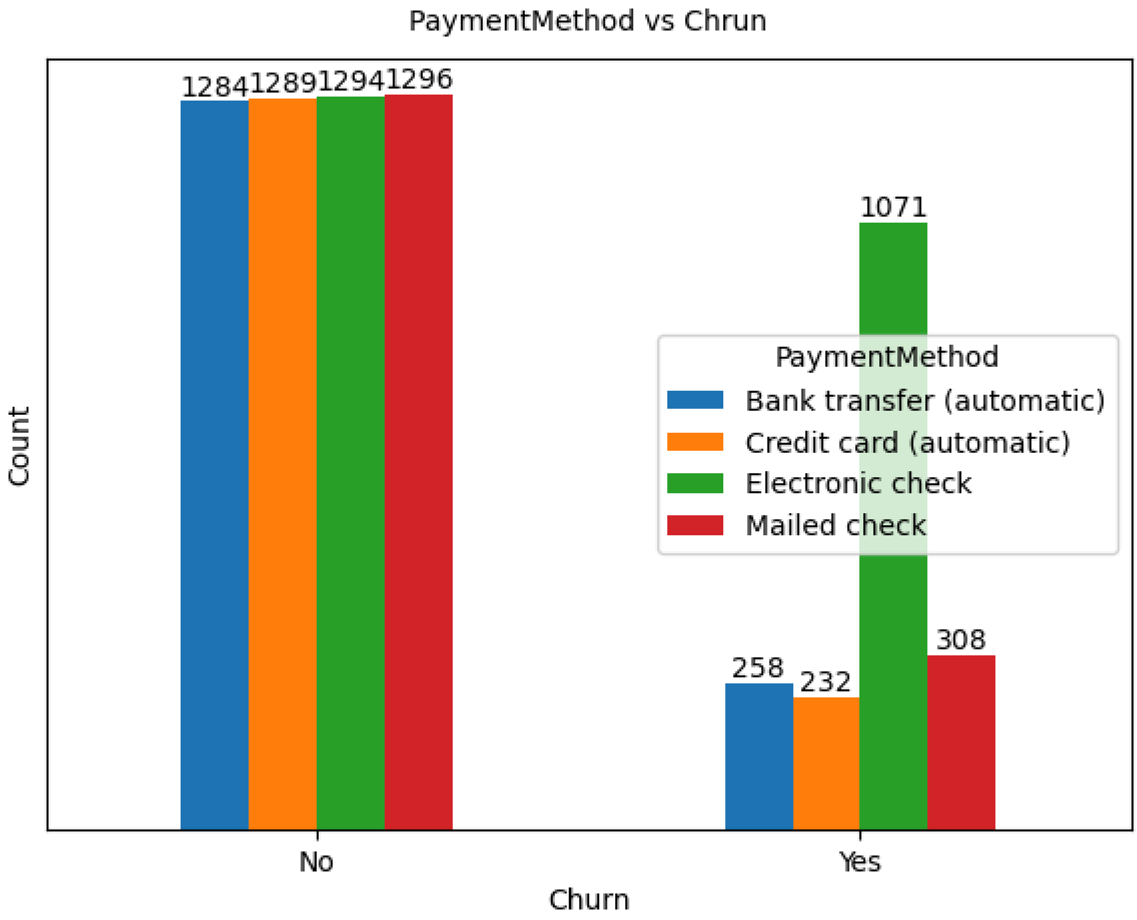
```
ct = pd.crosstab(df.Churn,df.PaperlessBilling)
ax = ct.plot(kind='bar', figsize=(7,5))

plt.title('PaperlessBilling vs Chrun',pad=10,size=10)
#plt.xlabel('Internet Service')
plt.ylabel('Count')
plt.xticks(rotation=0)

for bar in ax.patches:
    height = bar.get_height()
    if height > 0:  # avoid labeling empty bars
        ax.text(
            bar.get_x() + bar.get_width()/2,   # X position
            height,                            # Y position (top of bar)
            str(int(height)),                  # Text label
            ha='center', va='bottom', fontsize=10
        )
plt.yticks([])
plt.show()
```



4.12 PaymentMethod vs Chrun

In [263…

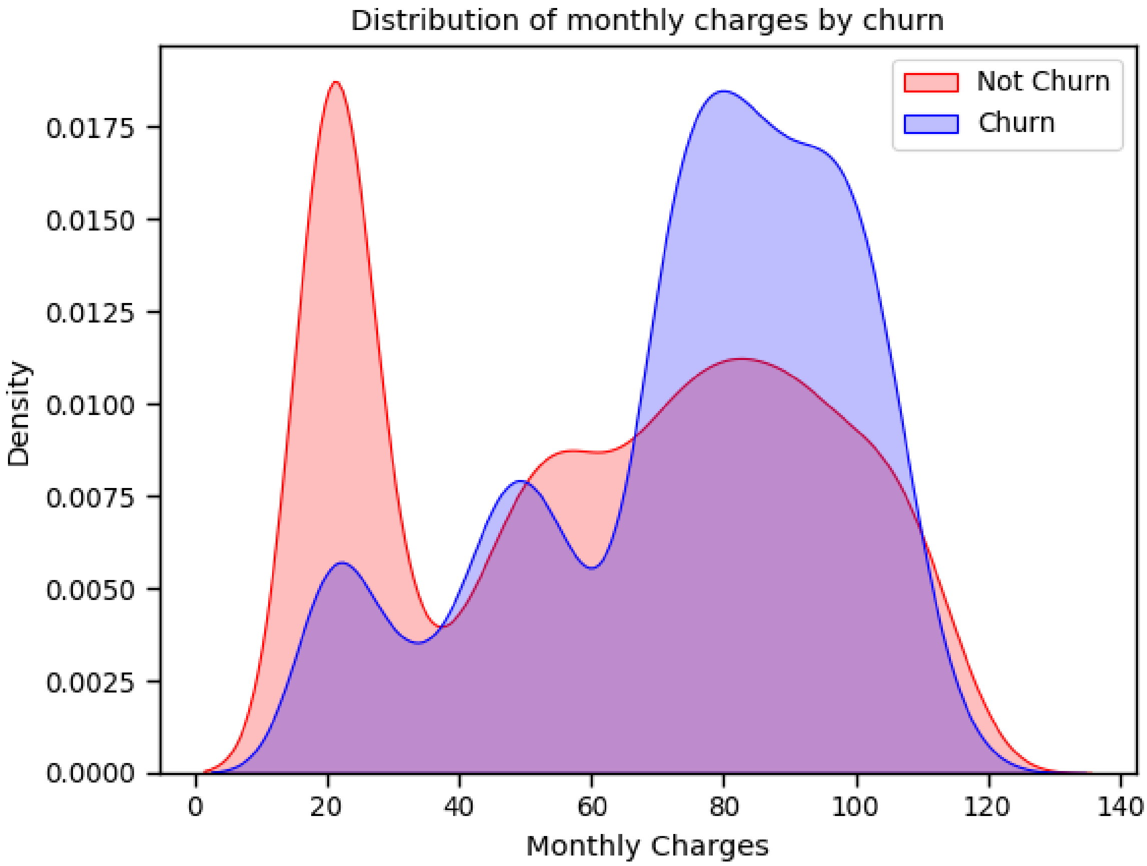
```
ct = pd.crosstab(df.Churn,df.PaymentMethod)
ax = ct.plot(kind='bar', figsize=(7,5))

plt.title('PaymentMethod vs Chrun',pad=10,size=10)
#plt.xlabel('Internet Service')
plt.ylabel('Count')
plt.xticks(rotation=0)

for bar in ax.patches:
    height = bar.get_height()
    if height > 0:  # avoid labeling empty bars
        ax.text(
            bar.get_x() + bar.get_width()/2,   # X position
            height,                            # Y position (top of bar)
            str(int(height)),                  # Text label
            ha='center', va='bottom', fontsize=10
        )
plt.yticks([])
plt.show()
```



4.13 Distribution of monthly charges by churn

In [264…

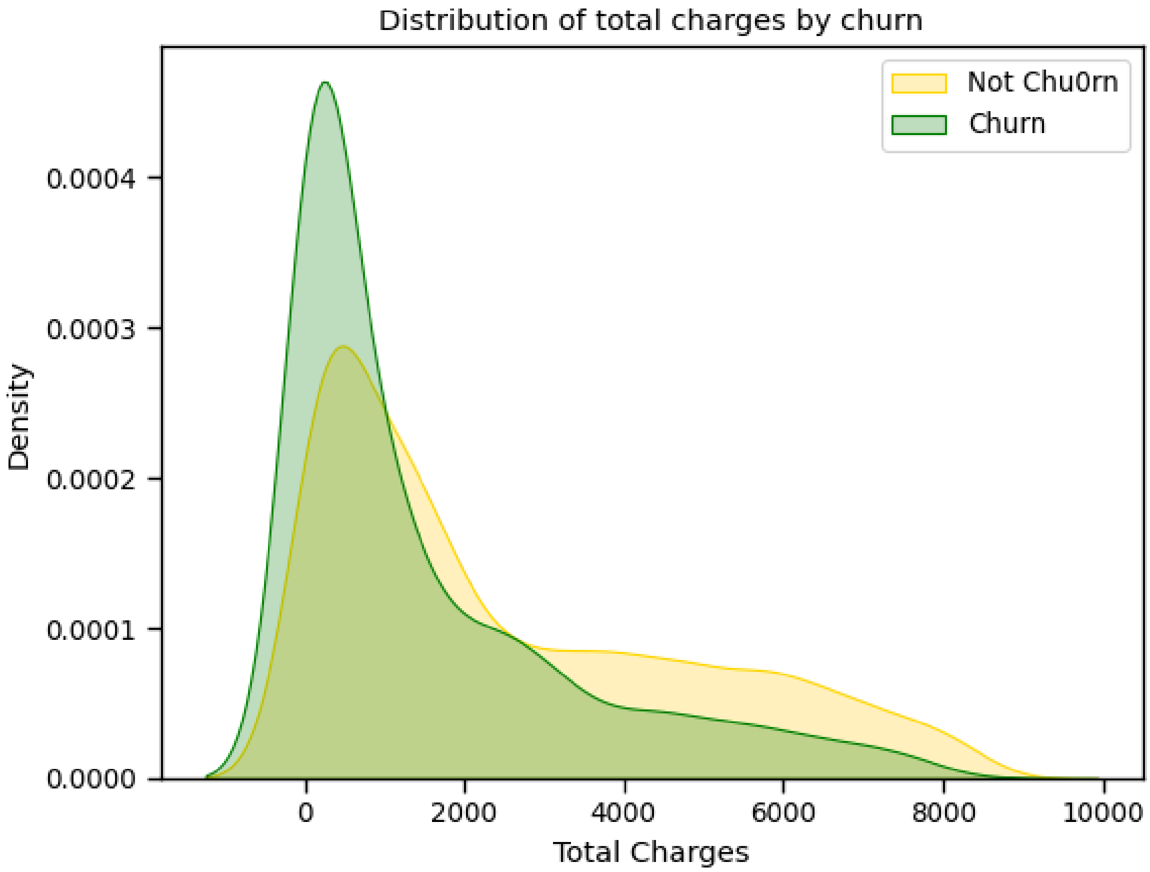
```
sns.set_context("paper",font_scale=1.1)
ax = sns.kdeplot(df.MonthlyCharges[(df["Churn"] == 'No') ],color="Red", shade =
ax = sns.kdeplot(df.MonthlyCharges[(df["Churn"] == 'Yes') ],ax =ax, color="Blue"
ax.legend(["Not Churn","Churn"],loc='upper right');
ax.set_ylabel('Density');
ax.set_xlabel('Monthly Charges');
ax.set_title('Distribution of monthly charges by churn');
```



4.14 Distribution of total charges by churn

In [265…

```
ax = sns.kdeplot(df.TotalCharges[(df["Churn"] == 'No') ],color="Gold", shade = T
ax = sns.kdeplot(df.TotalCharges[(df["Churn"] == 'Yes') ],ax =ax, color="Green",
ax.legend(["Not Chu0rn","Churn"],loc='upper right');
ax.set_ylabel('Density');
ax.set_xlabel('Total Charges');
ax.set_title('Distribution of total charges by churn');
```



5.Data Preprocessing

```
In [297…  df = pd.read_csv('WA_Fn-UseC_-Telco-Customer-Churn.csv')
```

```
In [298…  df.drop(labels=df[df['tenure'] == 0].index, axis=0, inplace=True)
          df[df['tenure'] == 0].index
```

```
Out[298…  Index([], dtype='int64')
```

```
In [299…  df['TotalCharges'] = df['TotalCharges'].astype('float64')
```

drop the unwanted columns

```
In [300…  df.drop(columns=['customerID'],inplace=True)
```

Encoding

```
In [301…  df = pd.get_dummies(df, drop_first=True)
          df = df.astype('int')
```

Creating Dependent and Independent Variables

```
In [291…  X = df.drop(columns='Churn_Yes', axis=1)
          y = df['Churn_Yes']
```

SMOTE Technique

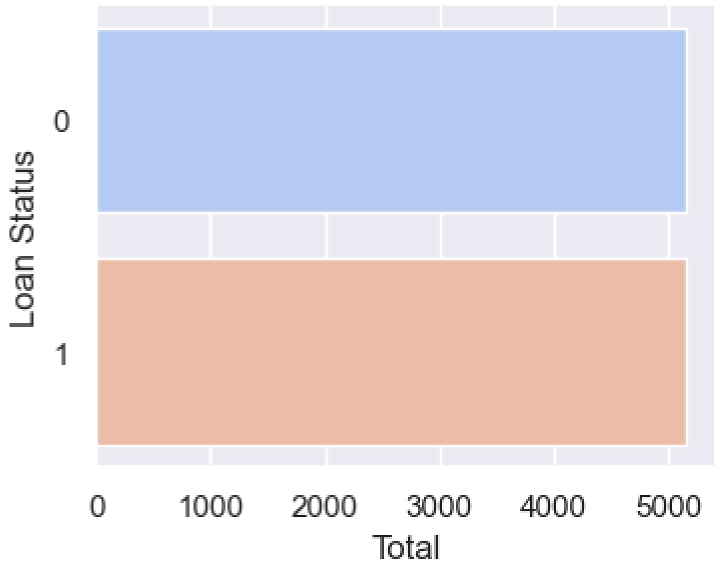
In previous exploration, it can be seen that the number between approved and rejected loan is imbalanced. In this section, oversampling technique will be used to avoid overfitting,

In [303…

```
X, y = SMOTE().fit_resample(X, y)
```

In [304…

```
plt.figure(figsize=(4,3))
sns.set_theme(style="darkgrid")
sns.countplot(y=y, data=df, palette="coolwarm")
plt.ylabel('Loan Status')
plt.xlabel('Total')
plt.show()
```



Splitting data

In [305…

```
X_train,X_test,y_train,y_test = train_test_split(X,y,random_state=0,test_size=0.
```

Scaling data

In [311…

```
sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)
```

Features Selection

In [339…

```
rf = RandomForestClassifier(random_state=42)
rf.fit(X, y)

importances = rf.feature_importances_

rf_df = pd.DataFrame({
    'Feature': X.columns,
    'Importance': importances
}).sort_values(by='Importance', ascending=False)

rf_df
```

Out[339…

	Feature	Importance
3	TotalCharges	0.145851
1	tenure	0.142196
2	MonthlyCharges	0.106652
13	OnlineSecurity_Yes	0.062697
25	Contract_Two year	0.061405
19	TechSupport_Yes	0.053042
24	Contract_One year	0.044592
6	Dependents_Yes	0.028944
15	OnlineBackup_Yes	0.026630
10	InternetService_Fiber optic	0.026080
27	PaymentMethod_Credit card (automatic)	0.025331
4	gender_Male	0.024613
5	Partner_Yes	0.022859
26	PaperlessBilling_Yes	0.021039
17	DeviceProtection_Yes	0.020809
29	PaymentMethod_Mailed check	0.019563
28	PaymentMethod_Electronic check	0.017477
9	MultipleLines_Yes	0.015274
0	SeniorCitizen	0.015136
18	TechSupport_No internet service	0.014257
21	StreamingTV_Yes	0.014170
23	StreamingMovies_Yes	0.014132
16	DeviceProtection_No internet service	0.013137
20	StreamingTV_No internet service	0.012092
12	OnlineSecurity_No internet service	0.011958
14	OnlineBackup_No internet service	0.011389
11	InternetService_No	0.009881
22	StreamingMovies_No internet service	0.007903
7	PhoneService_Yes	0.006060
8	MultipleLines_No phone service	0.004832

In [340…

```
top_features = rf_df['Feature'].head(10).values
print("Selected Top Features:", top_features)

# Create final X
X_selected = X[top_features]
```

```
Selected Top Features: ['TotalCharges' 'tenure' 'MonthlyCharges' 'OnlineSecurity_
Yes'
 'Contract_Two year' 'TechSupport_Yes' 'Contract_One year'
 'Dependents_Yes' 'OnlineBackup_Yes' 'InternetService_Fiber optic']
```

After selecting the top features, again split the data.

In [365…

```
X_train, X_test, y_train, y_test = train_test_split(X_selected, y, test_size=0.3
```

LogisticRegression

In [366…

```
model = LogisticRegression(max_iter=1000)
model.fit(X_train, y_train)

print("Train Score:", model.score(X_train, y_train))
print("Test Score:", model.score(X_test, y_test))
```

```
Train Score: 0.7991145545102379
Test Score: 0.8102001291155584
```

In [367…

```
y_pred = model.predict(X_test)
```

In [368…

```
accuracy_score(y_pred,y_test)
```

Out[368…

```
0.8102001291155584
```

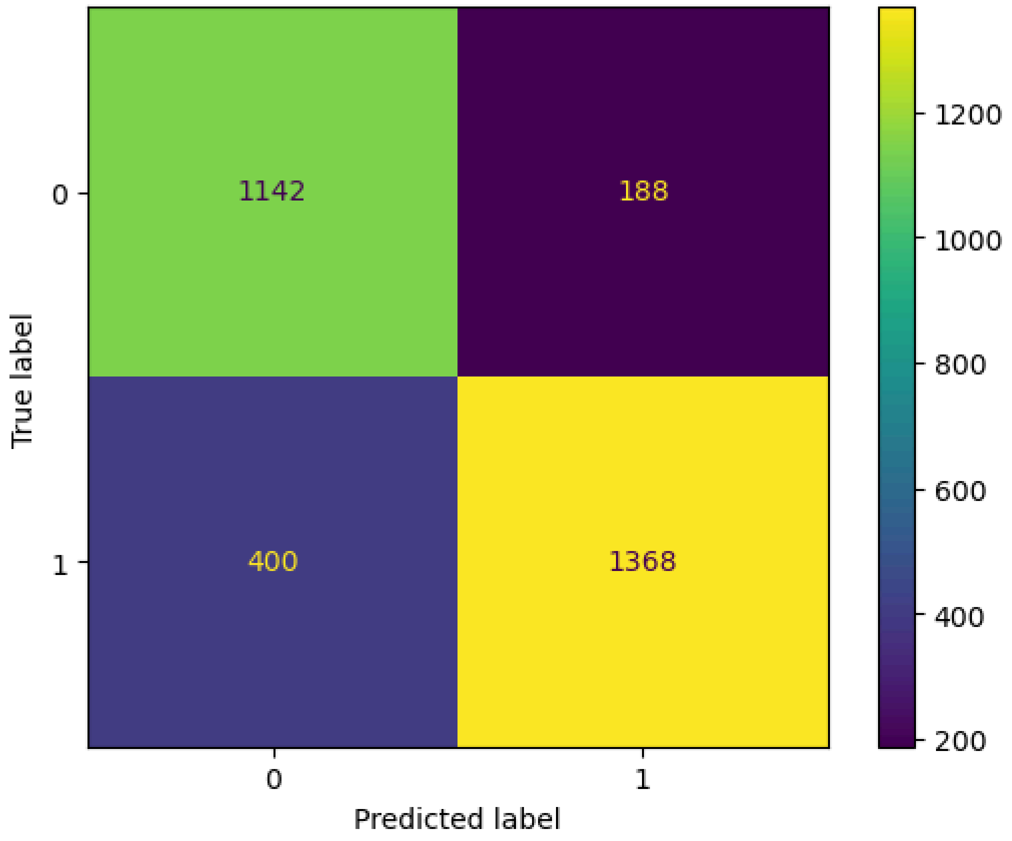
In [369…

```
print(classification_report(y_pred,y_test))
```

```
              precision    recall  f1-score   support

           0       0.74      0.86      0.80      1330
           1       0.88      0.77      0.82      1768

    accuracy                           0.81      3098
   macro avg       0.81      0.82      0.81      3098
weighted avg       0.82      0.81      0.81      3098
```

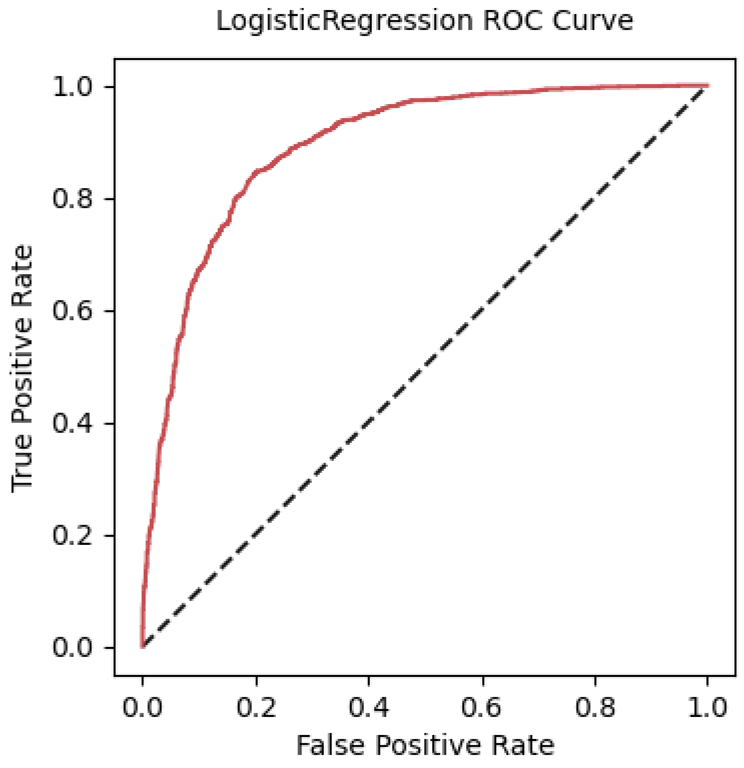
In [370…

```
ConfusionMatrixDisplay.from_predictions(y_pred,y_test)
plt.show()
```



In [378…

```
plt.figure(figsize=(4,4))
y_lg_pred_prob = model.predict_proba(X_test)[:,1]
fpr_rf, tpr_rf, thresholds = roc_curve(y_test, y_lg_pred_prob)
plt.plot([0, 1], [0, 1], 'k--' )
plt.plot(fpr_rf, tpr_rf, label='Random Forest',color = "r")
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('LogisticRegression ROC Curve',fontsize=10,pad=10,size=10)
plt.show();
```



KNN

In [393…

```
knn_model = KNeighborsClassifier()
knn_model.fit(X_train,y_train)
predicted_y = knn_model.predict(X_test)
accuracy_knn = knn_model.score(X_test,y_test)
print("KNN accuracy:",accuracy_knn)
```

```
KNN accuracy: 0.7640413169786959
```

In [394…

```
print("Train Score:", knn_model.score(X_train, y_train))
print("Test Score:", knn_model.score(X_test, y_test))
```

```
Train Score: 0.8180686220254566
Test Score: 0.7640413169786959
```

In [395…

```
y_pred = knn_model.predict(X_test)
```

In [396…

```
accuracy_score(y_pred,y_test)
```

Out[396…

```
0.7640413169786959
```

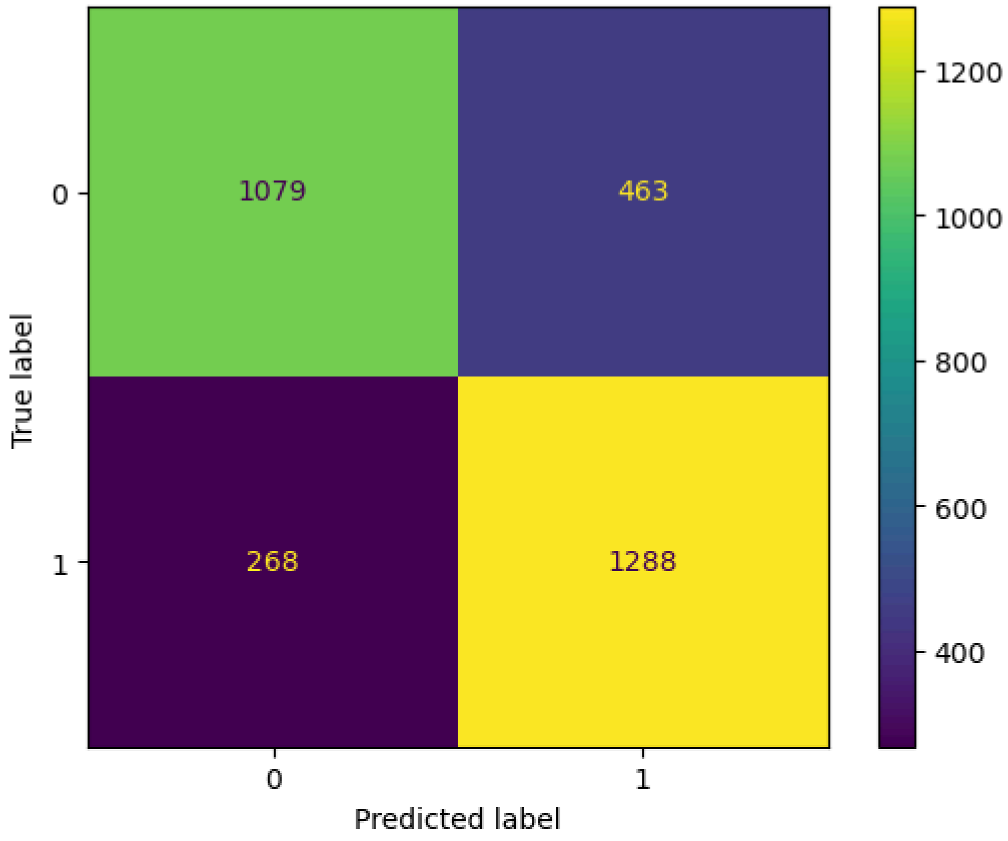
In [397…

```
print(classification_report(y_pred,y_test))
```

```
              precision    recall  f1-score   support

           0       0.70      0.80      0.75      1347
           1       0.83      0.74      0.78      1751

    accuracy                           0.76      3098
   macro avg       0.76      0.77      0.76      3098
weighted avg       0.77      0.76      0.77      3098
```

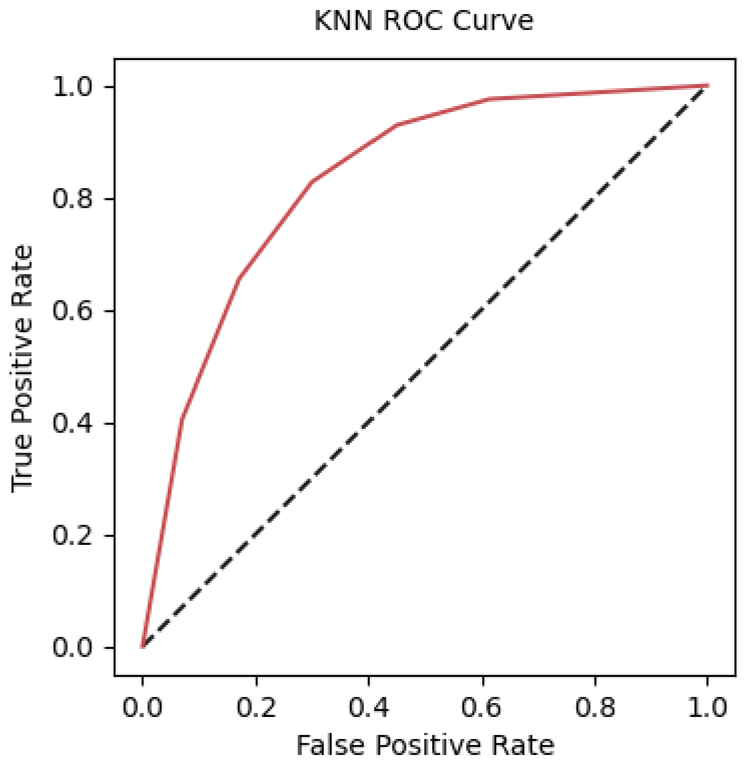
In [398…

```
ConfusionMatrixDisplay.from_predictions(y_test,y_pred)
plt.show()
```



In [399…

```
plt.figure(figsize=(4,4))
y_log_knn_prob = knn_model.predict_proba(X_test)[:,1]
fpr_knn,tpr_knn,thersholds = roc_curve(y_test,y_log_knn_prob )
plt.plot([0,1],[0,1],'k--')
plt.plot(fpr_knn,tpr_knn,label='KNN',color='r')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('KNN ROC Curve',fontsize=10,pad=10,size=10)
plt.show()
```



RandomForestClassifier

In [400…

```
model_rf = RandomForestClassifier()
model_rf.fit(X_train,y_train)
```

Out[400…

```
▾ RandomForestClassifier
RandomForestClassifier()
```

In [401…

```
print('Train Score:',model_rf.score(X_train,y_train))
print('Test Score:',model_rf.score(X_test,y_test))
```

```
Train Score: 0.9798007747648035
Test Score: 0.828921885087153
```

In [402…

```
y_pred = model_rf.predict(X_test)
```

In [403…

```
accuracy_score(y_pred,y_test)
```

Out[403…

```
0.828921885087153
```

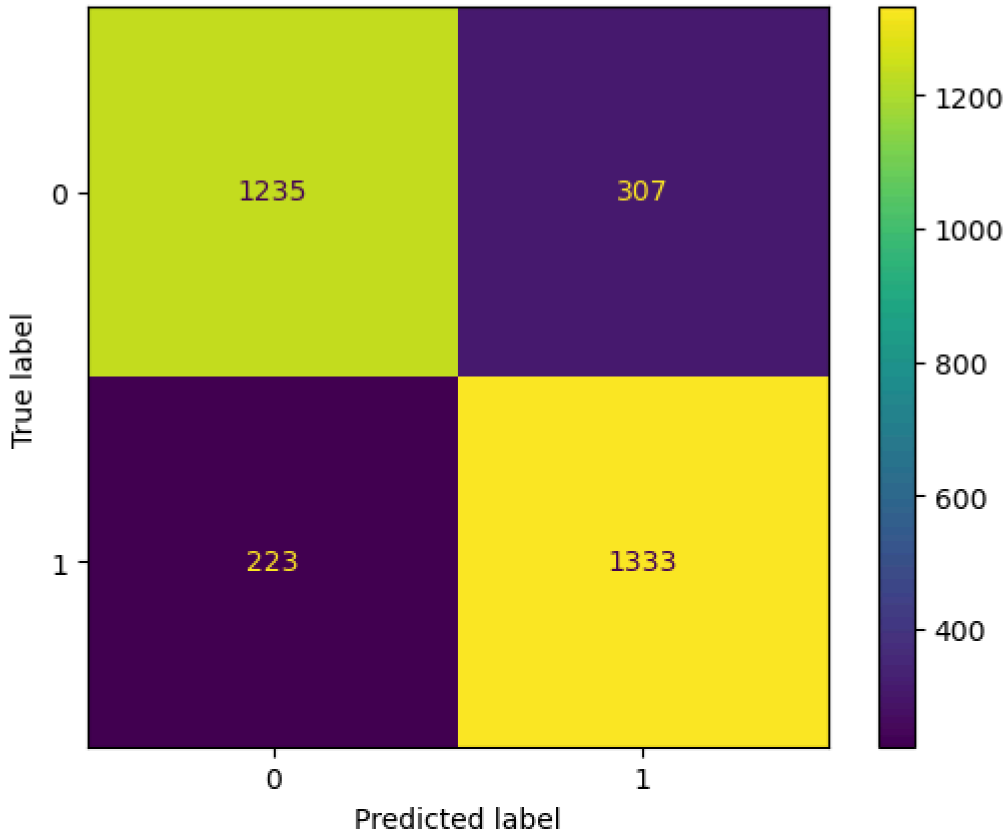
In [404…

```
print(classification_report(y_pred,y_test))
```

```
              precision    recall  f1-score   support

           0       0.80      0.85      0.82      1458
           1       0.86      0.81      0.83      1640

    accuracy                           0.83      3098
   macro avg       0.83      0.83      0.83      3098
weighted avg       0.83      0.83      0.83      3098
```

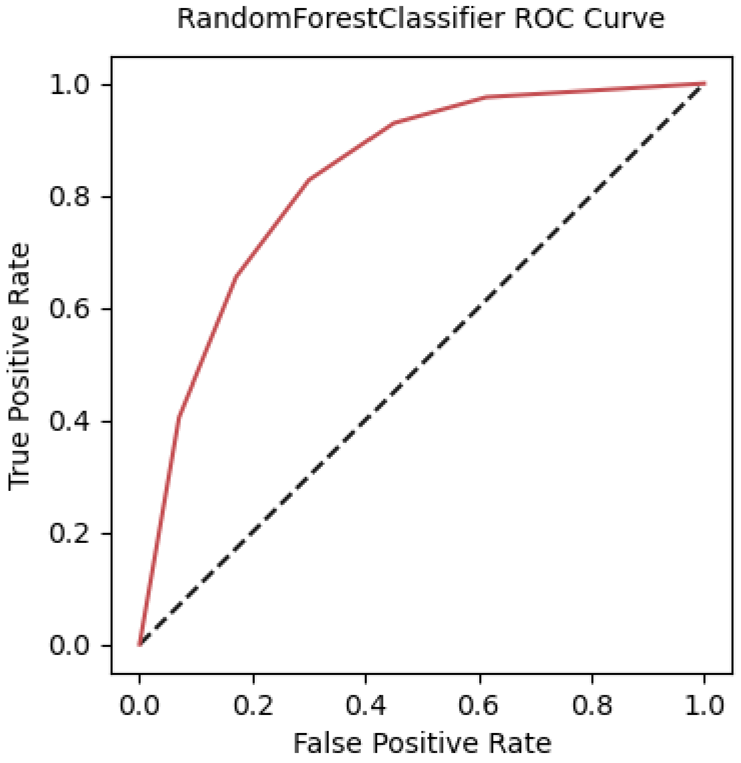
In [405…

```
ConfusionMatrixDisplay.from_predictions(y_test,y_pred)
plt.show()
```



In [406…

```
plt.figure(figsize=(4,4))
proba_rf = model_rf.predict_proba(X_test)[:,1]
fpr_rf,tpr_rf,thersold = roc_curve(y_test,proba_rf)
plt.plot([0,1],[0,1],'k--')
plt.plot(fpr_knn,tpr_knn,label='RF',color='r')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('RandomForestClassifier ROC Curve',fontsize=10,pad=10,size=10)
plt.show()
```



Decision Tree Classifier

In [415…
```
model_dt = DecisionTreeClassifier(criterion='entropy',min_samples_split=100)
model_dt.fit(X_train,y_train)
```

Out[415…
```
▾ DecisionTreeClassifier
DecisionTreeClassifier(criterion='entropy', min_samples_split=100)
```

In [416…
```
print("The Train Score:",model_dt.score(X_train,y_train))
print("The Test Score:",model_dt.score(X_test,y_test))
```

```
The Train Score: 0.8263696734919757
The Test Score: 0.8185926404131698
```

In [417…
```
y_pred_dt = model_dt.predict(X_test)
```

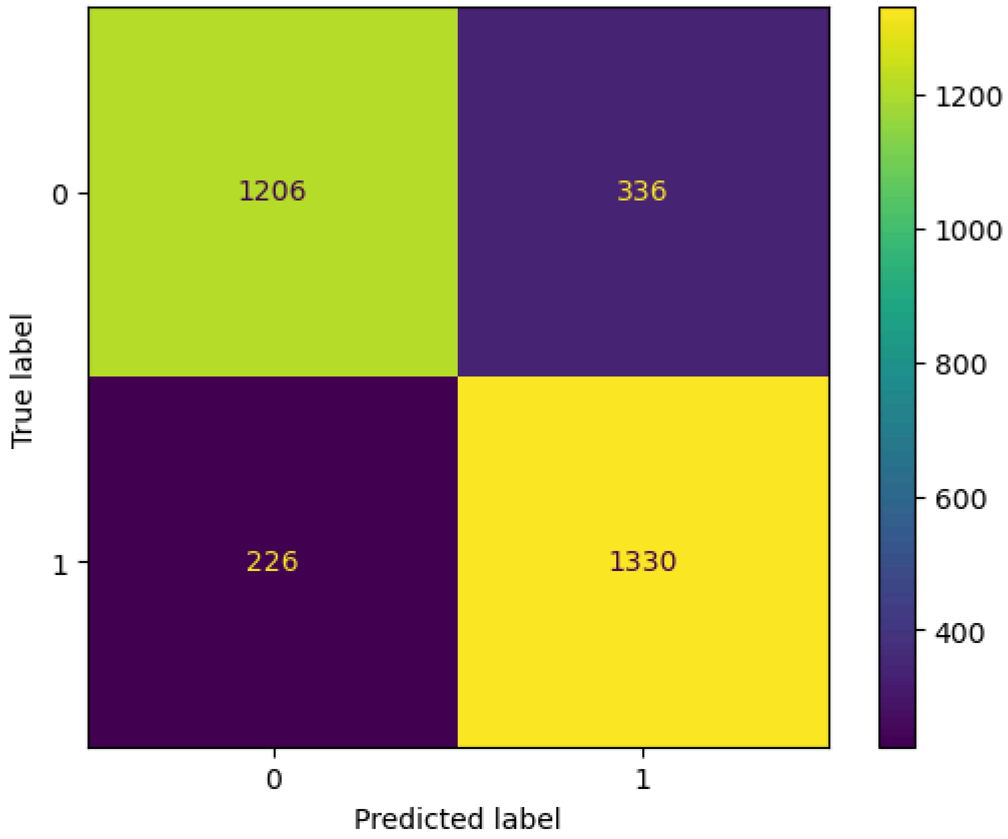
In [418…
```
accuracy_score(y_test,y_pred_dt)
```

Out[418…
```
0.8185926404131698
```

In [419…
```
print(classification_report(y_test,y_pred_dt))
```

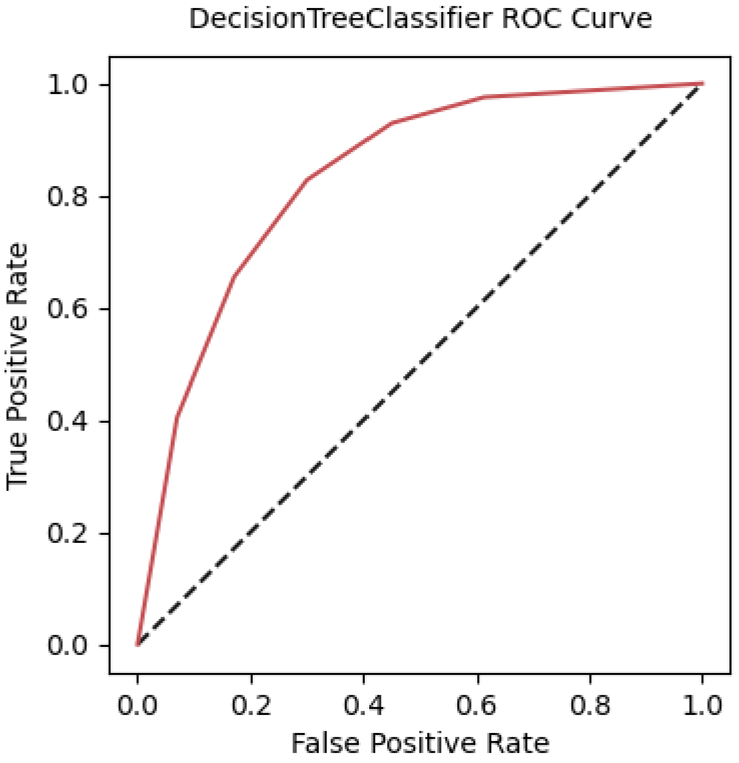
```
              precision    recall  f1-score   support

           0       0.84      0.78      0.81      1542
           1       0.80      0.85      0.83      1556

    accuracy                           0.82      3098
   macro avg       0.82      0.82      0.82      3098
weighted avg       0.82      0.82      0.82      3098
```

In [420…
```
ConfusionMatrixDisplay.from_predictions(y_test,y_pred_dt)
plt.show()
```



In [431…

```
plt.figure(figsize=(4,4))
proba_rf = model_dt.predict_proba(X_test)[:,1]
fpr_rf,tpr_rf,thersold = roc_curve(y_test,proba_rf)
plt.plot([0,1],[0,1],'k--')
plt.plot(fpr_knn,tpr_knn,label='RF',color='r')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('DecisionTreeClassifier ROC Curve',fontsize=10,pad=10,size=10)
plt.show()
```



SVM

In [454…

```
svc = SVC(kernel='rbf', probability=True, max_iter=1000)
svc.fit(X_train, y_train)
```

Out[454…

```
▾ SVC
SVC(max_iter=1000, probability=True)
```

In [455…

```
print('The Train Score:',svc.score(X_train,y_train))
print('The Test Score:',svc.score(X_test,y_test))
```

```
The Train Score: 0.5820420586607638
The Test Score: 0.591994835377663
```

In [456…

```
y_pred_sv = svc.predict(X_test)
```

In [457…

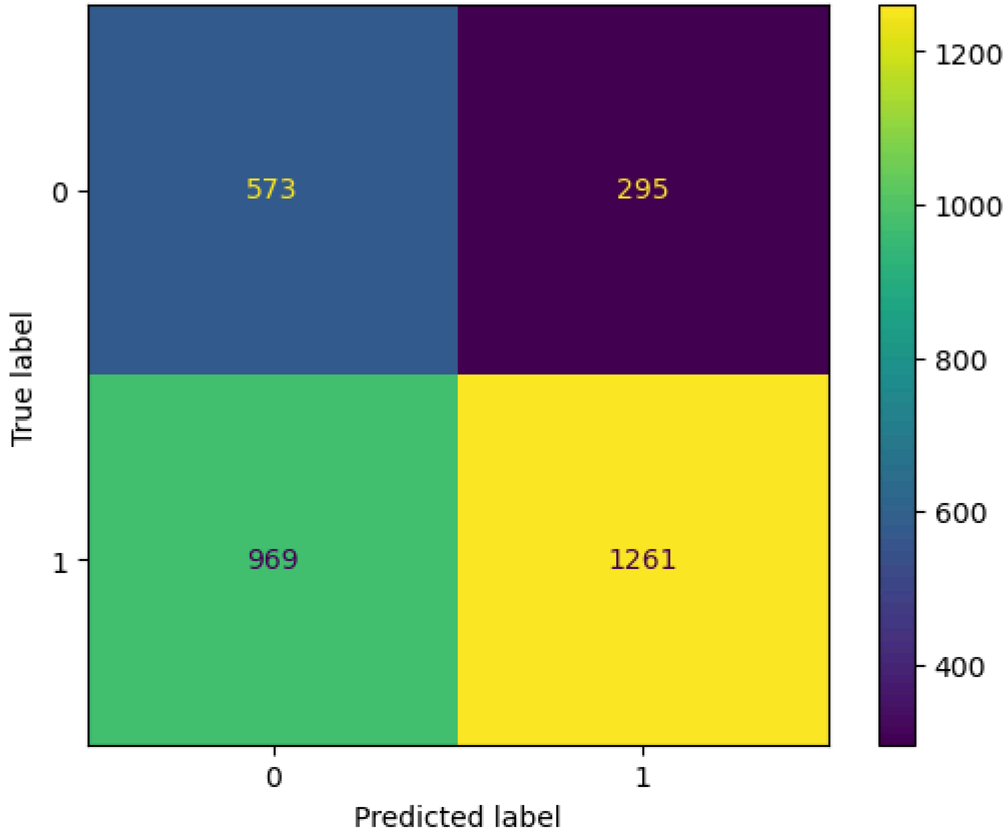
```
accuracy_score(y_pred_sv,y_test)
```

Out[457…

```
0.591994835377663
```

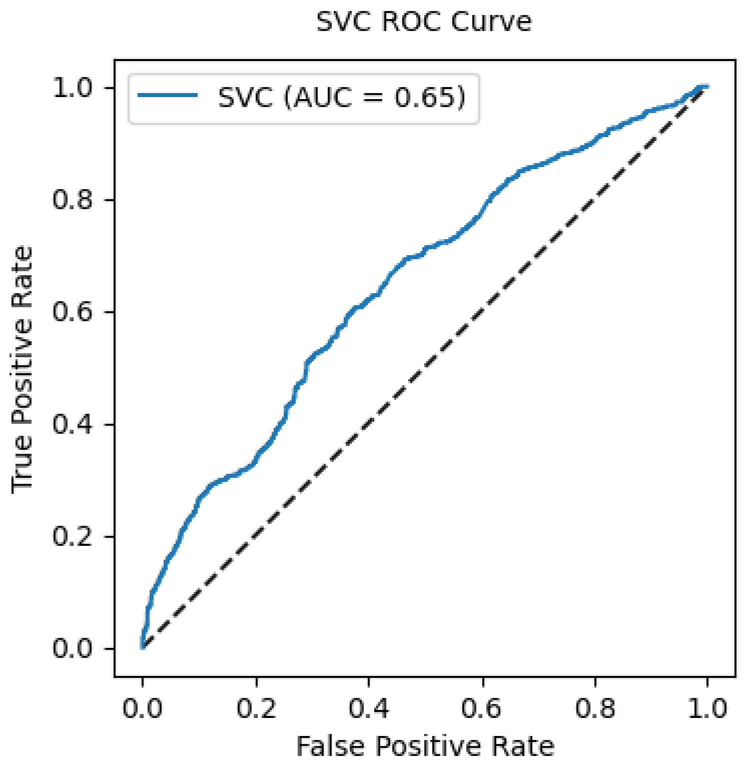
In [458…

```
ConfusionMatrixDisplay.from_predictions(y_pred_sv,y_test)
plt.show()
```



In [459…

```
plt.figure(figsize=(4,4))
proba_svc = svc.predict_proba(X_test)[:, 1]
fpr_svc, tpr_svc, threshold = roc_curve(y_test, proba_svc)
auc_svc = auc(fpr_svc, tpr_svc)

plt.plot([0,1],[0,1],'k--')
plt.plot(fpr_svc, tpr_svc, label=f'SVC (AUC = {auc_svc:.2f})')

plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('SVC ROC Curve', fontsize=10, pad=10)
plt.legend()
plt.show()
```

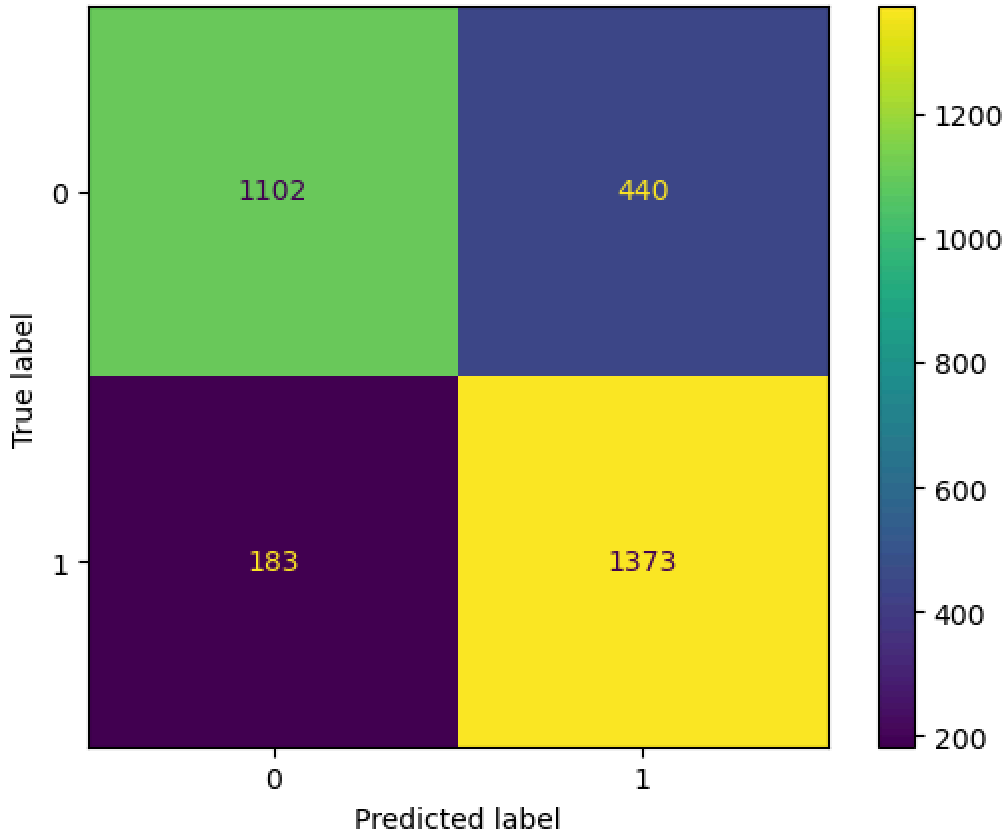


Naive Bayes

In [437…

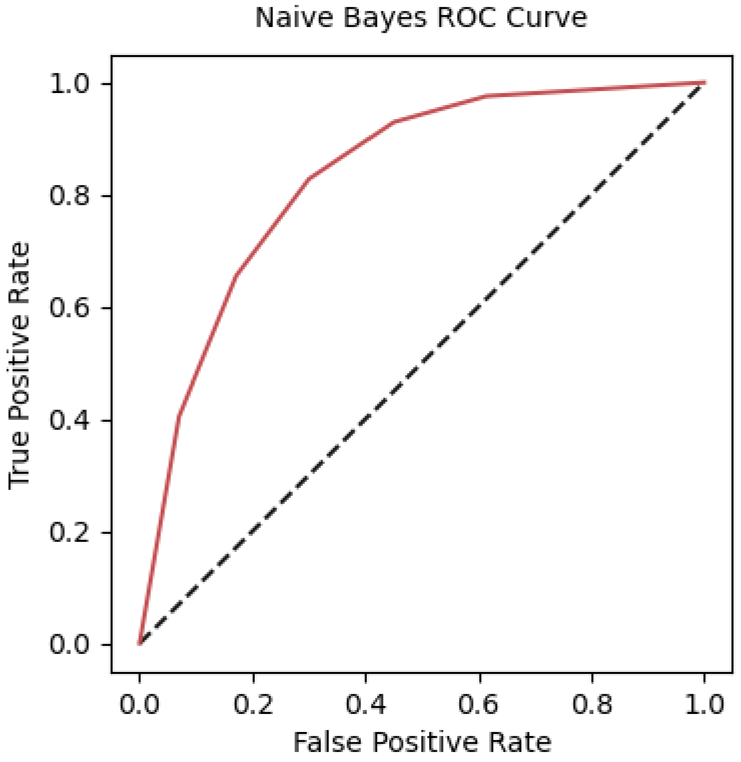
```
NB = GaussianNB()
NB.fit(X_train,y_train)

y_pred_NB = NB.predict(X_test)

print('accuracy_score:',accuracy_score(y_test,y_pred_NB))
print(classification_report(y_test,y_pred_NB))

ConfusionMatrixDisplay.from_predictions(y_test, y_pred_NB)
plt.show()
```

```
accuracy_score: 0.7989025177533893
              precision    recall  f1-score   support

           0       0.86      0.71      0.78      1542
           1       0.76      0.88      0.82      1556

    accuracy                           0.80      3098
   macro avg       0.81      0.80      0.80      3098
weighted avg       0.81      0.80      0.80      3098
```



In [439…

```
plt.figure(figsize=(4,4))
proba_rf = NB.predict_proba(X_test)[:,1]
fpr_rf,tpr_rf,thersold = roc_curve(y_test,proba_rf)
plt.plot([0,1],[0,1],'k--')
plt.plot(fpr_knn,tpr_knn,label='RF',color='r')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Naive Bayes ROC Curve',fontsize=10,pad=10,size=10)
plt.show()
```

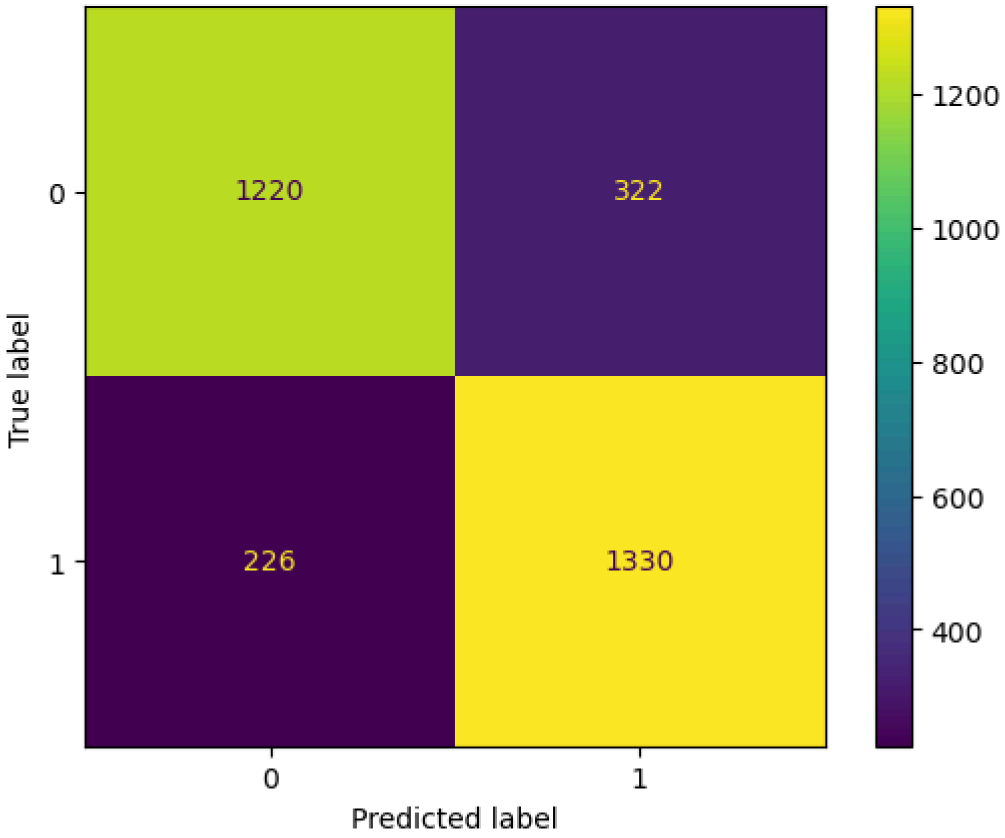


XGBClassifier

In [440…

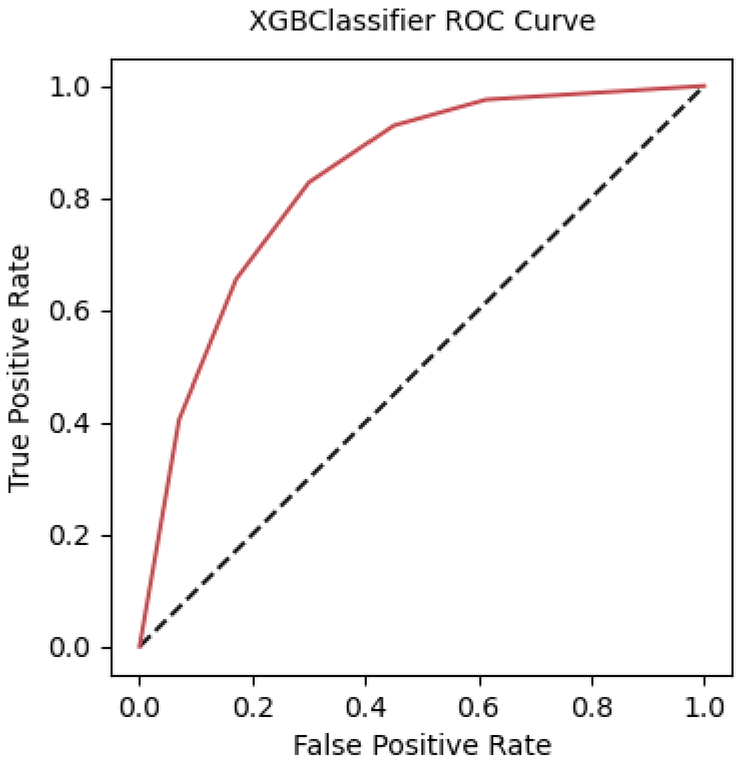
```
xgb = XGBClassifier(eval_metric='logloss', use_label_encoder=False,learning_rate
xgb.fit(X_train,y_train)
y_pred_xgb = xgb.predict(X_test)
print("Test Accuracy - XGBoost:", accuracy_score(y_test, y_pred_xgb))

print(classification_report(y_test,y_pred_xgb))

ConfusionMatrixDisplay.from_predictions(y_test,y_pred_xgb)
plt.show()
```

```
Test Accuracy - XGBoost: 0.8231116849580374
              precision    recall  f1-score   support

           0       0.84      0.79      0.82      1542
           1       0.81      0.85      0.83      1556

    accuracy                           0.82      3098
   macro avg       0.82      0.82      0.82      3098
weighted avg       0.82      0.82      0.82      3098
```



In [441…

```
plt.figure(figsize=(4,4))
proba_rf = xgb.predict_proba(X_test)[:,1]
fpr_rf,tpr_rf,thersold = roc_curve(y_test,proba_rf)
plt.plot([0,1],[0,1],'k--')
plt.plot(fpr_knn,tpr_knn,label='RF',color='r')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('XGBClassifier ROC Curve',fontsize=10,pad=10,size=10)
plt.show()
```

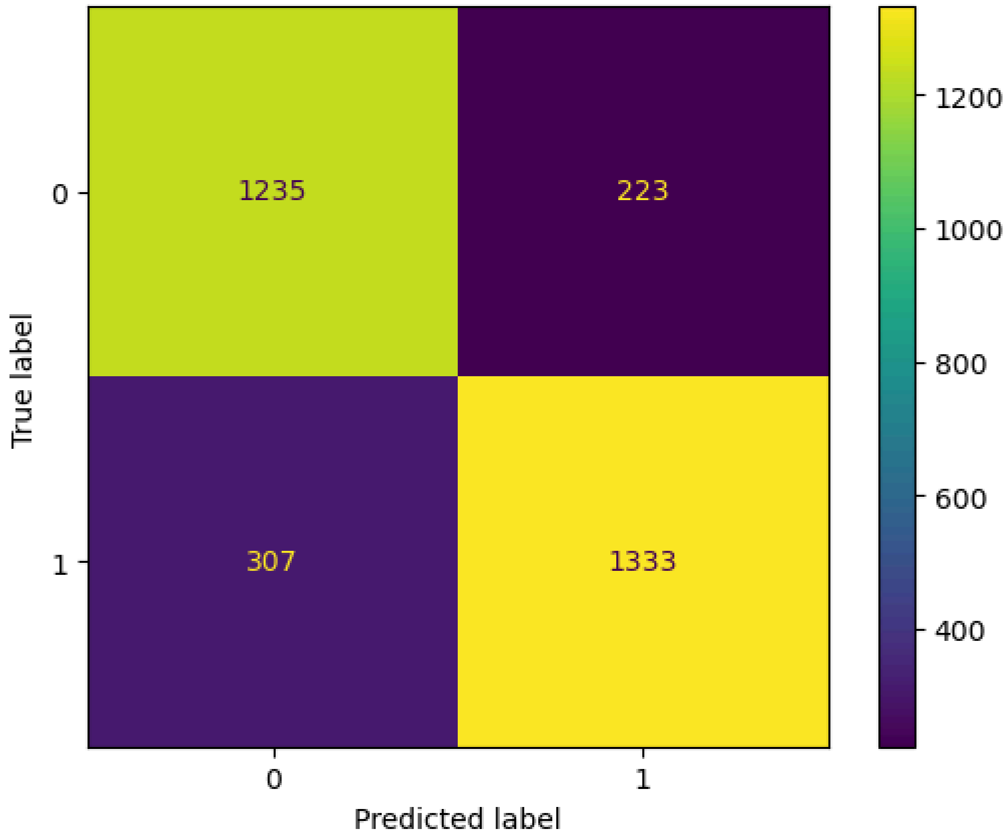


LGBMClassifier

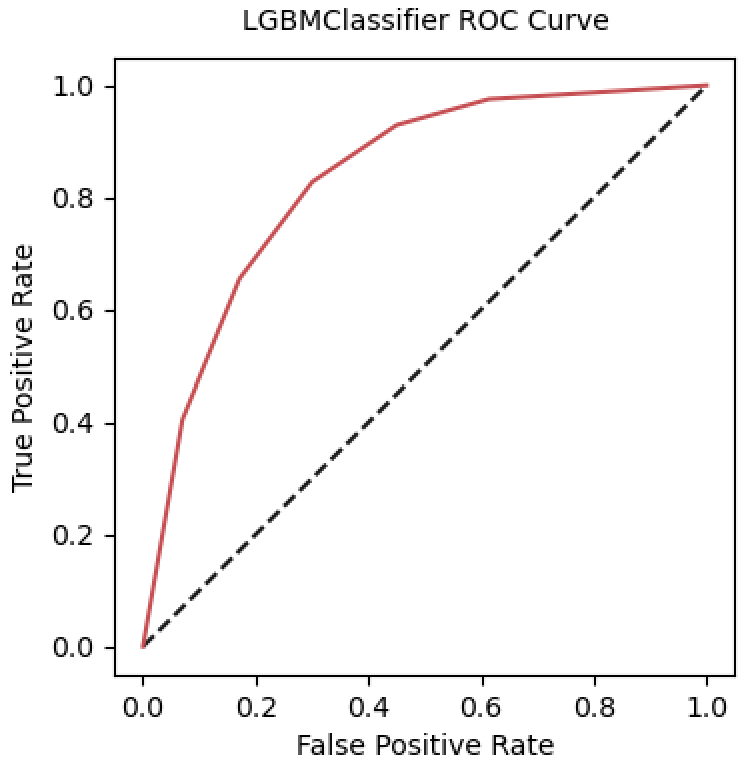
In [442…

```
lgb = LGBMClassifier(colsample_bytree = 1.0, learning_rate =  0.1, max_depth = 9
lgb.fit(X_train,y_train)

y_pred_lgb = lgb.predict(X_test)

print('accuracy_score:',accuracy_score(y_test,y_pred_lgb))

print(classification_report(y_pred_lgb,y_test))

ConfusionMatrixDisplay.from_predictions(y_pred,y_test)
plt.show()
```

```
[LightGBM] [Warning] Found whitespace in feature_names, replace with underlines
[LightGBM] [Info] Number of positive: 3607, number of negative: 3621
[LightGBM] [Info] Auto-choosing row-wise multi-threading, the overhead of testing
was 0.001687 seconds.
You can set `force_row_wise=true` to remove the overhead.
And if memory is not enough, you can set `force_col_wise=true`.
[LightGBM] [Info] Total Bins 443
[LightGBM] [Info] Number of data points in the train set: 7228, number of used fe
atures: 10
[LightGBM] [Info] [binary:BoostFromScore]: pavg=0.499032 -> initscore=-0.003874
[LightGBM] [Info] Start training from score -0.003874
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
accuracy_score: 0.8340865074241446
              precision    recall  f1-score   support

           0       0.79      0.86      0.83      1416
           1       0.88      0.81      0.84      1682

    accuracy                           0.83      3098
   macro avg       0.83      0.84      0.83      3098
weighted avg       0.84      0.83      0.83      3098
```



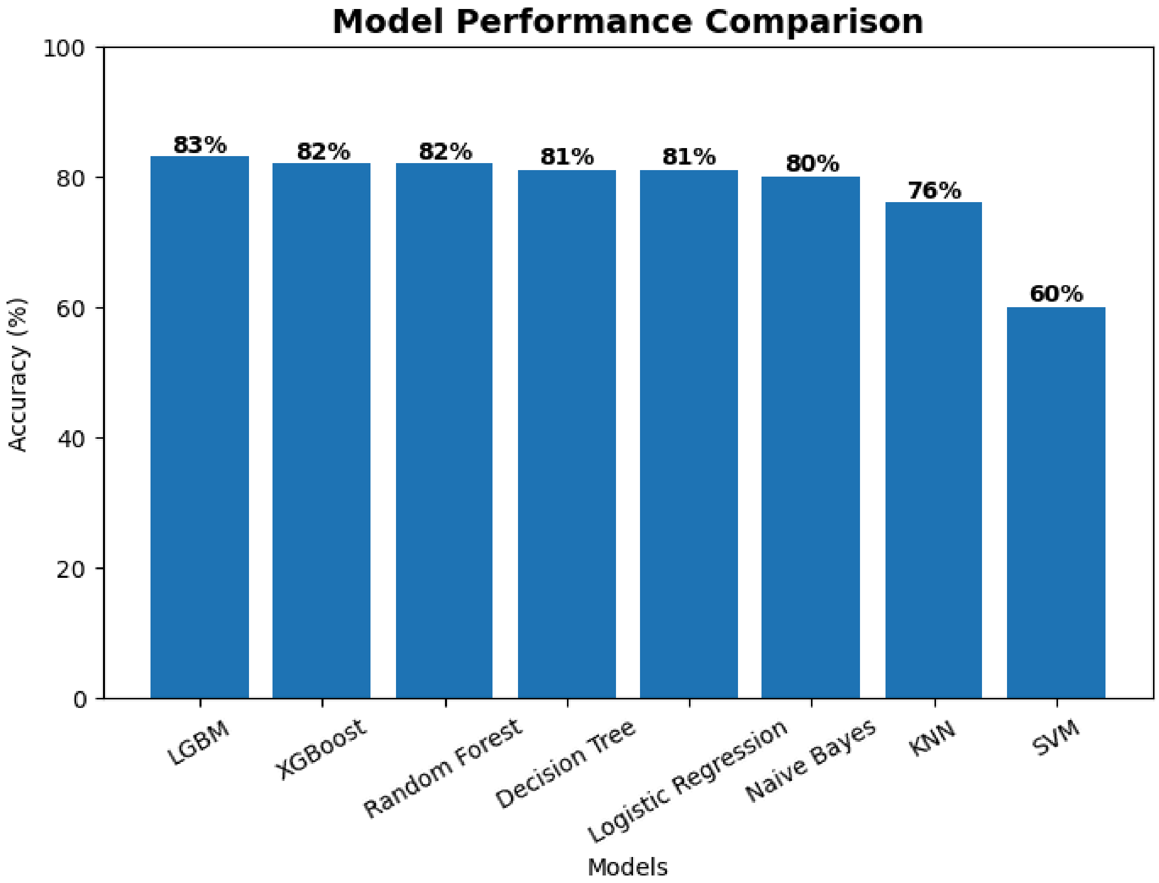
```
In [460…
plt.figure(figsize=(4,4))
proba_rf = lgb.predict_proba(X_test)[:,1]
fpr_rf,tpr_rf,thersold = roc_curve(y_test,proba_rf)
plt.plot([0,1],[0,1],'k--')
plt.plot(fpr_knn,tpr_knn,label='RF',color='r')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('LGBMClassifier ROC Curve',fontsize=10,pad=10,size=10)
plt.show()
```



Ranking Table

In [462…

```
# Model scores
models = ['LGBM', 'XGBoost', 'Random Forest', 'Decision Tree', 'Logistic Regress
scores = [83, 82, 82, 81, 81, 80, 76, 60]
# Plot
plt.figure(figsize=(8,5))
bars = plt.bar(models, scores)
# Add labels on top of each bar
for bar in bars:
    height = bar.get_height()
    plt.text(bar.get_x() + bar.get_width()/2, height, str(height)+'%', ha='cente
# Chart formatting
plt.title('Model Performance Comparison', fontsize=14, fontweight='bold')
plt.xlabel('Models')
plt.ylabel('Accuracy (%)')
plt.ylim(0, 100)
plt.xticks(rotation=30)
plt.show()
```



Conclusion

- After evaluating multiple machine learning models for customer churn prediction, the results clearly show that tree-based ensemble models outperform traditional classifiers. Among all models, the LGBM Classifier delivered the highest accuracy of 83%, closely followed by XGBoost and Random Forest with 82% each. These models are better at capturing complex, non-linear relationships in the data, which is common in churn behavior.
- Models such as Logistic Regression, Naive Bayes, and Decision Tree performed moderately well, indicating that there are still noticeable linear patterns in the data. However, KNN and SVM showed significantly lower performance, making them less suitable choices for this dataset without heavy tuning.
- Overall, based on accuracy and model stability, LGBM is recommended as the final model for deployment. It provides the best balance of performance, speed, and generalization.

PREDICT NEW CUSTOMER

In [469…

```
new_customer = {
    'TotalCharges': 350,
    'tenure': 12,
    'MonthlyCharges': 650.7,
    'OnlineSecurity_Yes': 0,
    'Contract_Two year': 0,
    'TechSupport_Yes': 1,
    'Contract_One year': 1,
    'Dependents_Yes': 0,
    'OnlineBackup_Yes': 1,
    'InternetService_Fiber optic': 1
}


new_data = pd.DataFrame([new_customer])

prediction = lgb.predict(new_data)[0]
probability = lgb.predict_proba(new_data)[:, 1][0]

if prediction == 1:
    print("Result: Customer WILL Churn")
else:
    print("Result: Customer will NOT Churn")

print("Churn Probability:", round(probability, 2))
```

```
Result: Customer WILL Churn
Churn Probability: 0.75
```

In [ ]: