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Customer Churnout Prediction

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[336]:
```
# Import necessary libraries
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt

# Load the dataset
telco_data = pd.read_csv("telco_customer_churn.csv")

# Display basic information about the dataset
print("Shape of the dataset:", telco_data.shape)
print("\nColumns in the dataset:")
print(telco_data.columns)
print("\nSample data:")
print(telco_data.head())

# Summary statistics
print("\nSummary statistics:")
print(telco_data.describe())

# Check for missing values
print("\nMissing values:")
print(telco_data.isnull().sum())

print("\nColumn names : ")
print(telco_data.columns.values)

print("\nColumns Data Types : ")
print(telco_data.dtypes)
# Check for duplicate rows
print("\nDuplicate rows:", telco_data.duplicated().sum())

# Visualize the distribution of the target variable 'Churn'
plt.figure(figsize=(8, 6))
```

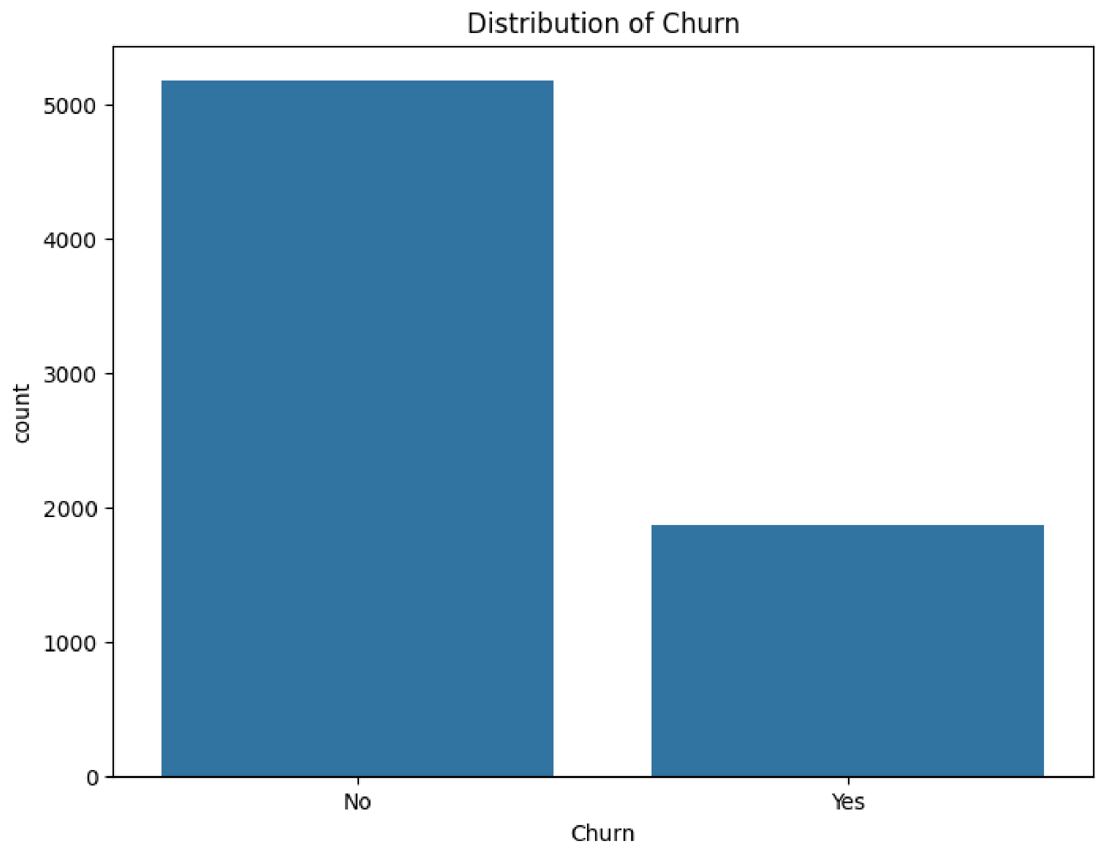
```
sns.countplot(x='Churn', data=telco_data)
plt.title('Distribution of Churn') plt.show()
```

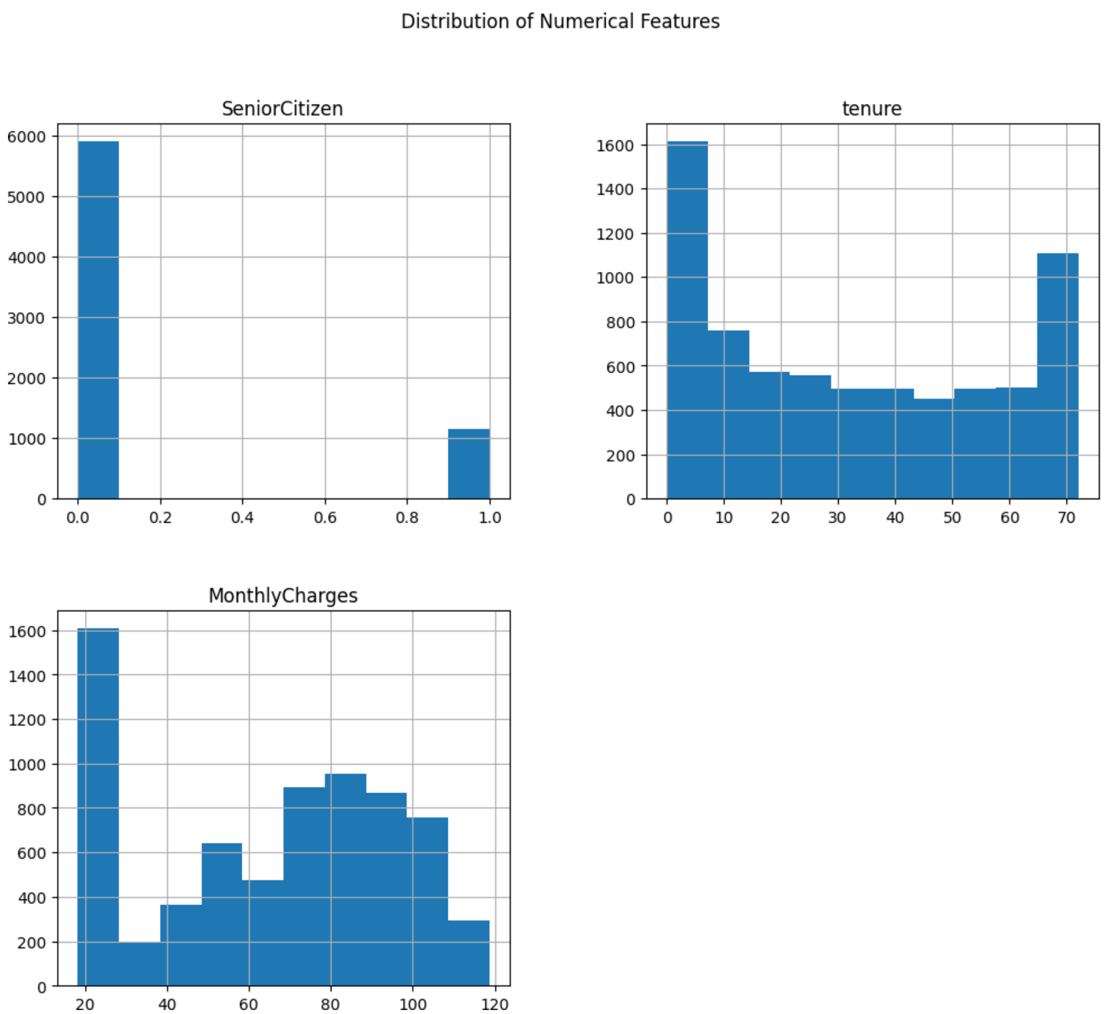
```
# Visualize the distribution of numerical features
numerical_features = telco_data.select_dtypes(include=[np.number]).columns.
↪tolist()
telco_data[numerical_features].hist(figsize=(12, 10))
plt.suptitle('Distribution of Numerical Features')
plt.show()

# Visualize the correlation matrix
plt.figure(figsize=(10, 8))
correlation_matrix = telco_data[numerical_features].corr()
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt=".2f")
plt.title('Correlation Matrix')
plt.show()
```

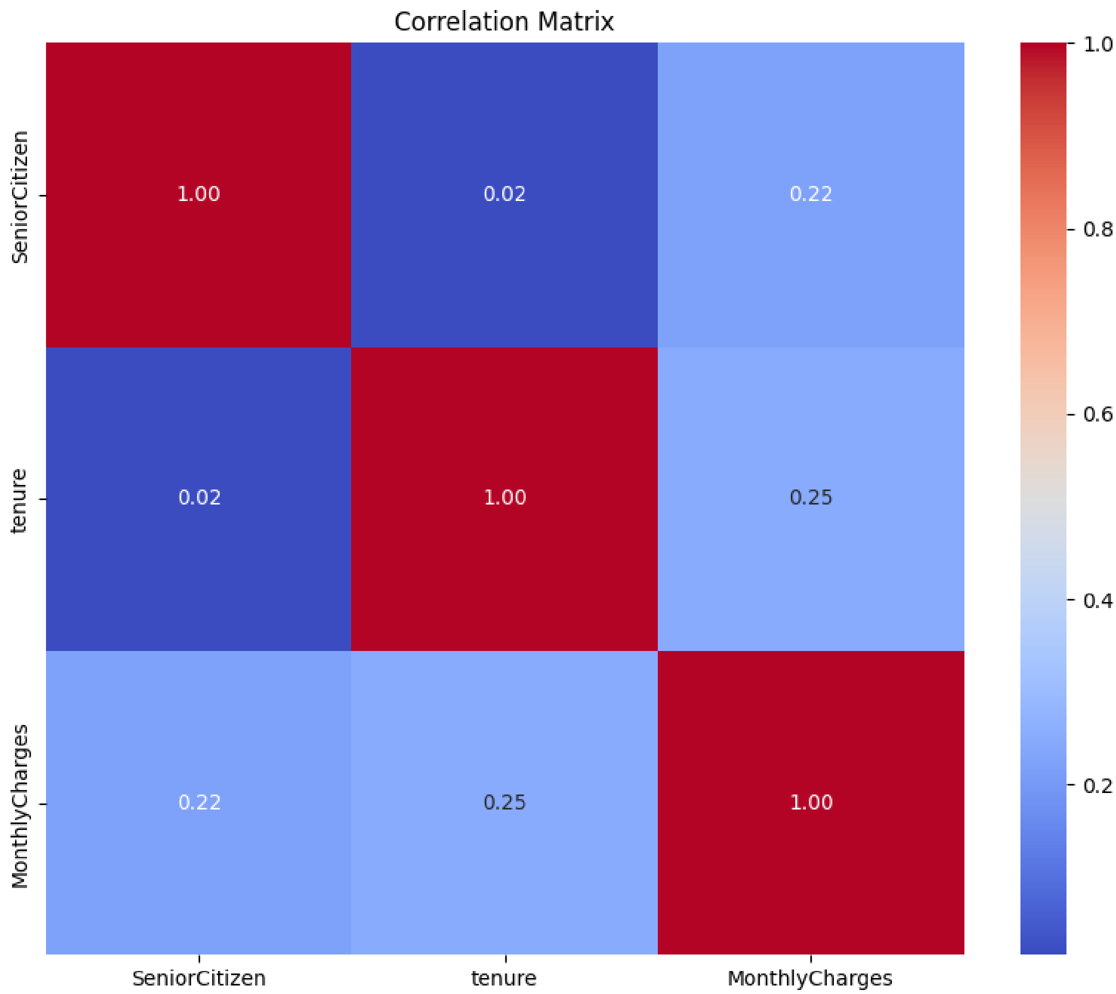
```
Shape of the dataset: (7043, 21)

Columns in the dataset:
Index(['customerID', 'gender', 'SeniorCitizen', 'Partner', 'Dependents',
       'tenure', 'PhoneService', 'MultipleLines', 'InternetService',
       'OnlineSecurity', 'OnlineBackup', 'DeviceProtection', 'TechSupport',
       'StreamingTV', 'StreamingMovies', 'Contract', 'PaperlessBilling',
       'PaymentMethod', 'MonthlyCharges', 'TotalCharges', 'Churn'],
      dtype='object')

Sample data:
   customerID  gender  SeniorCitizen Partner Dependents  tenure PhoneService  \
0  7590-VHVEG  Female              0     Yes         No       1           No
1  5575-GNVDE    Male              0      No         No      34          Yes
2  3668-QPYBK    Male              0      No         No       2          Yes
3  7795-CFOCW    Male              0      No         No      45           No
4  9237-HQITU  Female              0      No         No       2          Yes

      MultipleLines InternetService OnlineSecurity  ... DeviceProtection  \
0  No phone service             DSL             No  ...               No
1                No             DSL            Yes  ...              Yes
2                No             DSL            Yes  ...               No
3  No phone service             DSL            Yes  ...              Yes
4                No     Fiber optic             No  ...               No

  TechSupport StreamingTV StreamingMovies        Contract PaperlessBilling  \
0          No          No              No  Month-to-month              Yes
1          No          No              No        One year               No
2          No          No              No  Month-to-month              Yes
3         Yes          No              No        One year               No
4          No          No              No  Month-to-month              Yes
```

```
                PaymentMethod MonthlyCharges  TotalCharges Churn
0            Electronic check          29.85         29.85    No
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]

Summary statistics:
       SeniorCitizen       tenure  MonthlyCharges
count    7043.000000  7043.000000     7043.000000
mean        0.162147    32.371149       64.761692
std         0.368612    24.559481       30.090047
min         0.000000     0.000000       18.250000
25%         0.000000     9.000000       35.500000
50%         0.000000    29.000000       70.350000
75%         0.000000    55.000000       89.850000
max         1.000000    72.000000      118.750000

Missing values:
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

Column names :
['customerID' 'gender' 'SeniorCitizen' 'Partner' 'Dependents' 'tenure'
 'PhoneService' 'MultipleLines' 'InternetService' 'OnlineSecurity'
 'OnlineBackup' 'DeviceProtection' 'TechSupport' 'StreamingTV'
```

```
 'StreamingMovies' 'Contract' 'PaperlessBilling' 'PaymentMethod'
 'MonthlyCharges' 'TotalCharges' 'Churn']

Columns Data Types :
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

Duplicate rows: 0
```


Distribution of Churn
count
5000
4000
3000
2000
1000
0
No
Yes
Churn


Distribution of Numerical Features
SeniorCitizen
0 1000 2000 3000 4000 5000 6000
0.0 0.2 0.4 0.6 0.8 1.0
tenure
0 200 400 600 800 1000 1200 1400 1600
0 10 20 30 40 50 60 70
MonthlyCharges
0 200 400 600 800 1000 1200 1400 1600
20 40 60 80 100 120



[337]:
```
# 1. Understanding Target Variable

print(100*telco_data['Churn'].value_counts()/len(telco_data['Churn']))
print(telco_data['Churn'].value_counts())
telco_base_data=telco_data.copy()
```

```
No     73.463013
Yes    26.536987
Name: Churn, dtype: float64
No     5174
Yes    1869
Name: Churn, dtype: int64
```

[338]:
```
# 2. Handling Missing Values
telco_data.TotalCharges=pd.to_numeric(telco_data.TotalCharges, errors='coerce')
telco_data.isnull().sum()
```

[338]:
```
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
```

[339]:
```python
# 2.1 Handling Missing Values by dropping NULL containing rows
telco_data.loc[telco_data['TotalCharges'].isnull()==True]
telco_data.dropna(how='any',inplace=True)
telco_data.shape
```

[339]:
```
(7032, 21)
```

[340]:
```python
telco_data
```

[340]:
```
      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]
```

[341]:
```
telco_data.drop(columns=['customerID'],axis=1,inplace=True)
telco_data
```

[341]:
```
      gender  SeniorCitizen Partner Dependents  tenure PhoneService  \
0     Female              0     Yes         No       1           No
1       Male              0      No         No      34          Yes
2       Male              0      No         No       2          Yes
3       Male              0      No         No      45           No
4     Female              0      No         No       2          Yes
...      ...            ...     ...        ...     ...          ...
7038    Male              0     Yes        Yes      24          Yes
7039  Female              0     Yes        Yes      72          Yes
7040  Female              0     Yes        Yes      11           No
7041    Male              1     Yes         No       4          Yes
7042    Male              0      No         No      66          Yes

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

     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  \
0                 Yes           Electronic check           29.85
1                  No               Mailed check           56.95
2                 Yes               Mailed check           53.85
3                  No  Bank transfer (automatic)           42.30
4                 Yes           Electronic check           70.70
...               ...                        ...             ...
7038              Yes               Mailed check           84.80
7039              Yes    Credit card (automatic)          103.20
7040              Yes           Electronic check           29.60
7041              Yes               Mailed check           74.40
7042              Yes  Bank transfer (automatic)          105.65

      TotalCharges Churn
0            29.85    No
1          1889.50    No
2           108.15   Yes
3          1840.75    No
4           151.65   Yes
...            ...   ...
7038       1990.50    No
7039       7362.90    No
7040        346.45    No
7041        306.60   Yes
7042       6844.50    No

[7032 rows x 20 columns]
```

[342]:

```
Data=telco_data.copy()
telco_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 7032 entries, 0 to 7042
Data columns (total 20 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  ----------
 0   gender            7032 non-null   object
 1   SeniorCitizen     7032 non-null   int64
 2   Partner           7032 non-null   object
 3   Dependents        7032 non-null   object
 4   tenure            7032 non-null   int64
 5   PhoneService      7032 non-null   object
 6   MultipleLines     7032 non-null   object
 7   InternetService   7032 non-null   object
 8   OnlineSecurity    7032 non-null   object
 9   OnlineBackup      7032 non-null   object
 10  DeviceProtection  7032 non-null   object
```

```
 11  TechSupport       7032 non-null   object
 12  StreamingTV       7032 non-null   object
 13  StreamingMovies   7032 non-null   object
 14  Contract          7032 non-null   object
 15  PaperlessBilling  7032 non-null   object
 16  PaymentMethod     7032 non-null   object
 17  MonthlyCharges    7032 non-null   float64
 18  TotalCharges      7032 non-null   float64
 19  Churn             7032 non-null   object
dtypes: float64(2), int64(2), object(16)
memory usage: 1.1+ MB
```

[343]:
```
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
for i in telco_data.columns:
    if(telco_data[i].dtype==object):
        telco_data[i]=le.fit_transform(telco_data[i])
telco_data
```

[343]:
```
      gender  SeniorCitizen  Partner  Dependents  tenure  PhoneService  \
0          0              0        1           0       1             0
1          1              0        0           0      34             1
2          1              0        0           0       2             1
3          1              0        0           0      45             0
4          0              0        0           0       2             1
...      ...            ...      ...         ...     ...           ...
7038       1              0        1           1      24             1
7039       0              0        1           1      72             1
7040       0              0        1           1      11             0
7041       1              1        1           0       4             1
7042       1              0        0           0      66             1

      MultipleLines  InternetService  OnlineSecurity  OnlineBackup  \
0                 1                0               0             2
1                 0                0               2             0
2                 0                0               2             2
3                 1                0               2             0
4                 0                1               0             0
...             ...              ...             ...           ...
7038              2                0               2             0
7039              2                1               0             2
7040              1                0               2             0
7041              2                1               0             0
7042              0                1               2             0

      DeviceProtection  TechSupport  StreamingTV  StreamingMovies  Contract  \
0                    0            0            0                0         0
```

```
1                        2         0         0              0       1
2                        0         0         0              0       0
3                        2         2         0              0       1
4                        0         0         0              0       0
...                    ...       ...       ...            ...     ...
7038                     2         2         2              2       1
7039                     2         0         2              2       1
7040                     0         0         0              0       0
7041                     0         0         0              0       0
7042                     2         2         2              2       2

      PaperlessBilling  PaymentMethod  MonthlyCharges  TotalCharges  Churn
0                    1              2           29.85         29.85      0
1                    0              3           56.95       1889.50      0
2                    1              3           53.85        108.15      1
3                    0              0           42.30       1840.75      0
4                    1              2           70.70        151.65      1
...                ...            ...             ...           ...    ...
7038                 1              3           84.80       1990.50      0
7039                 1              1          103.20       7362.90      0
7040                 1              2           29.60        346.45      0
7041                 1              3           74.40        306.60      1
7042                 1              0          105.65       6844.50      0

[7032 rows x 20 columns]
```

[344]:
```
telco_data.corr()
```

[344]:
```
                    gender  SeniorCitizen   Partner  Dependents    tenure  \
gender            1.000000      -0.001819 -0.001379    0.010349  0.005285
SeniorCitizen    -0.001819       1.000000  0.016957   -0.210550  0.015683
Partner          -0.001379       0.016957  1.000000    0.452269  0.381912
Dependents        0.010349      -0.210550  0.452269    1.000000  0.163386
tenure            0.005285       0.015683  0.381912    0.163386  1.000000
PhoneService     -0.007515       0.008392  0.018397   -0.001078  0.007877
MultipleLines    -0.006908       0.146287  0.142717   -0.024975  0.343673
InternetService  -0.002236      -0.032160  0.000513    0.044030 -0.029835
OnlineSecurity   -0.014899      -0.127937  0.150610    0.151198  0.327283
OnlineBackup     -0.011920      -0.013355  0.153045    0.090231  0.372434
DeviceProtection  0.001348      -0.021124  0.165614    0.079723  0.372669
TechSupport      -0.006695      -0.151007  0.126488    0.132530  0.324729
StreamingTV      -0.005624       0.031019  0.136679    0.046214  0.290572
StreamingMovies  -0.008920       0.047088  0.129907    0.022088  0.296785
Contract          0.000095      -0.141820  0.294094    0.240556  0.676734
PaperlessBilling -0.011902       0.156258 -0.013957   -0.110131  0.004823
PaymentMethod     0.016942      -0.038158 -0.156232   -0.041989 -0.370087
MonthlyCharges   -0.013779       0.219874  0.097825   -0.112343  0.246862
```

TotalCharges	0.000048	0.102411	0.319072	0.064653	0.825880
Churn	-0.008545	0.150541	-0.149982	-0.163128	-0.354049

	PhoneService	MultipleLines	InternetService \
gender	-0.007515	-0.006908	-0.002236
SeniorCitizen	0.008392	0.146287	-0.032160
Partner	0.018397	0.142717	0.000513
Dependents	-0.001078	-0.024975	0.044030
tenure	0.007877	0.343673	-0.029835
PhoneService	1.000000	-0.020504	0.387266
MultipleLines	-0.020504	1.000000	-0.108849
InternetService	0.387266	-0.108849	1.000000
OnlineSecurity	-0.014163	0.007306	-0.028003
OnlineBackup	0.024040	0.117276	0.036735
DeviceProtection	0.004718	0.122614	0.045558
TechSupport	-0.018136	0.010941	-0.025626
StreamingTV	0.056393	0.175403	0.108190
StreamingMovies	0.043025	0.181705	0.097967
Contract	0.003019	0.111029	0.099579
PaperlessBilling	0.016696	0.165306	-0.138166
PaymentMethod	-0.005499	-0.176598	0.084504
MonthlyCharges	0.248033	0.433905	-0.322173
TotalCharges	0.113008	0.453202	-0.175691
Churn	0.011691	0.038043	-0.047097

	OnlineSecurity	OnlineBackup	DeviceProtection	TechSupport \
gender	-0.014899	-0.011920	0.001348	-0.006695
SeniorCitizen	-0.127937	-0.013355	-0.021124	-0.151007
Partner	0.150610	0.153045	0.165614	0.126488
Dependents	0.151198	0.090231	0.079723	0.132530
tenure	0.327283	0.372434	0.372669	0.324729
PhoneService	-0.014163	0.024040	0.004718	-0.018136
MultipleLines	0.007306	0.117276	0.122614	0.010941
InternetService	-0.028003	0.036735	0.045558	-0.025626
OnlineSecurity	1.000000	0.184942	0.175789	0.284875
OnlineBackup	0.184942	1.000000	0.187646	0.195581
DeviceProtection	0.175789	0.187646	1.000000	0.240476
TechSupport	0.284875	0.195581	0.240476	1.000000
StreamingTV	0.044399	0.147085	0.275947	0.161168
StreamingMovies	0.056313	0.137083	0.289309	0.162530
Contract	0.373980	0.280617	0.350067	0.425072
PaperlessBilling	-0.157723	-0.012697	-0.037596	-0.113617
PaymentMethod	-0.096593	-0.125534	-0.136460	-0.104544
MonthlyCharges	-0.053576	0.119943	0.163984	-0.008237
TotalCharges	0.254473	0.375556	0.389066	0.276890
Churn	-0.289050	-0.195290	-0.177883	-0.282232

	StreamingTV	StreamingMovies	Contract	PaperlessBilling	\
gender	-0.005624	-0.008920	0.000095	-0.011902	
SeniorCitizen	0.031019	0.047088	-0.141820	0.156258	
Partner	0.136679	0.129907	0.294094	-0.013957	
Dependents	0.046214	0.022088	0.240556	-0.110131	
tenure	0.290572	0.296785	0.676734	0.004823	
PhoneService	0.056393	0.043025	0.003019	0.016696	
MultipleLines	0.175403	0.181705	0.111029	0.165306	
InternetService	0.108190	0.097967	0.099579	-0.138166	
OnlineSecurity	0.044399	0.056313	0.373980	-0.157723	
OnlineBackup	0.147085	0.137083	0.280617	-0.012697	
DeviceProtection	0.275947	0.289309	0.350067	-0.037596	
TechSupport	0.161168	0.162530	0.425072	-0.113617	
StreamingTV	1.000000	0.435354	0.226826	0.097379	
StreamingMovies	0.435354	1.000000	0.232478	0.083901	
Contract	0.226826	0.232478	1.000000	-0.175475	
PaperlessBilling	0.097379	0.083901	-0.175475	1.000000	
PaymentMethod	-0.104782	-0.112009	-0.229636	-0.061348	
MonthlyCharges	0.337156	0.335761	-0.072739	0.351930	
TotalCharges	0.392472	0.398088	0.450306	0.157830	
Churn	-0.036303	-0.038802	-0.396150	0.191454	

	PaymentMethod	MonthlyCharges	TotalCharges	Churn
gender	0.016942	-0.013779	0.000048	-0.008545
SeniorCitizen	-0.038158	0.219874	0.102411	0.150541
Partner	-0.156232	0.097825	0.319072	-0.149982
Dependents	-0.041989	-0.112343	0.064653	-0.163128
tenure	-0.370087	0.246862	0.825880	-0.354049
PhoneService	-0.005499	0.248033	0.113008	0.011691
MultipleLines	-0.176598	0.433905	0.453202	0.038043
InternetService	0.084504	-0.322173	-0.175691	-0.047097
OnlineSecurity	-0.096593	-0.053576	0.254473	-0.289050
OnlineBackup	-0.125534	0.119943	0.375556	-0.195290
DeviceProtection	-0.136460	0.163984	0.389066	-0.177883
TechSupport	-0.104544	-0.008237	0.276890	-0.282232
StreamingTV	-0.104782	0.337156	0.392472	-0.036303
StreamingMovies	-0.112009	0.335761	0.398088	-0.038802
Contract	-0.229636	-0.072739	0.450306	-0.396150
PaperlessBilling	-0.061348	0.351930	0.157830	0.191454
PaymentMethod	1.000000	-0.192500	-0.330594	0.107852
MonthlyCharges	-0.192500	1.000000	0.651065	0.192858
TotalCharges	-0.330594	0.651065	1.000000	-0.199484
Churn	0.107852	0.192858	-0.199484	1.000000

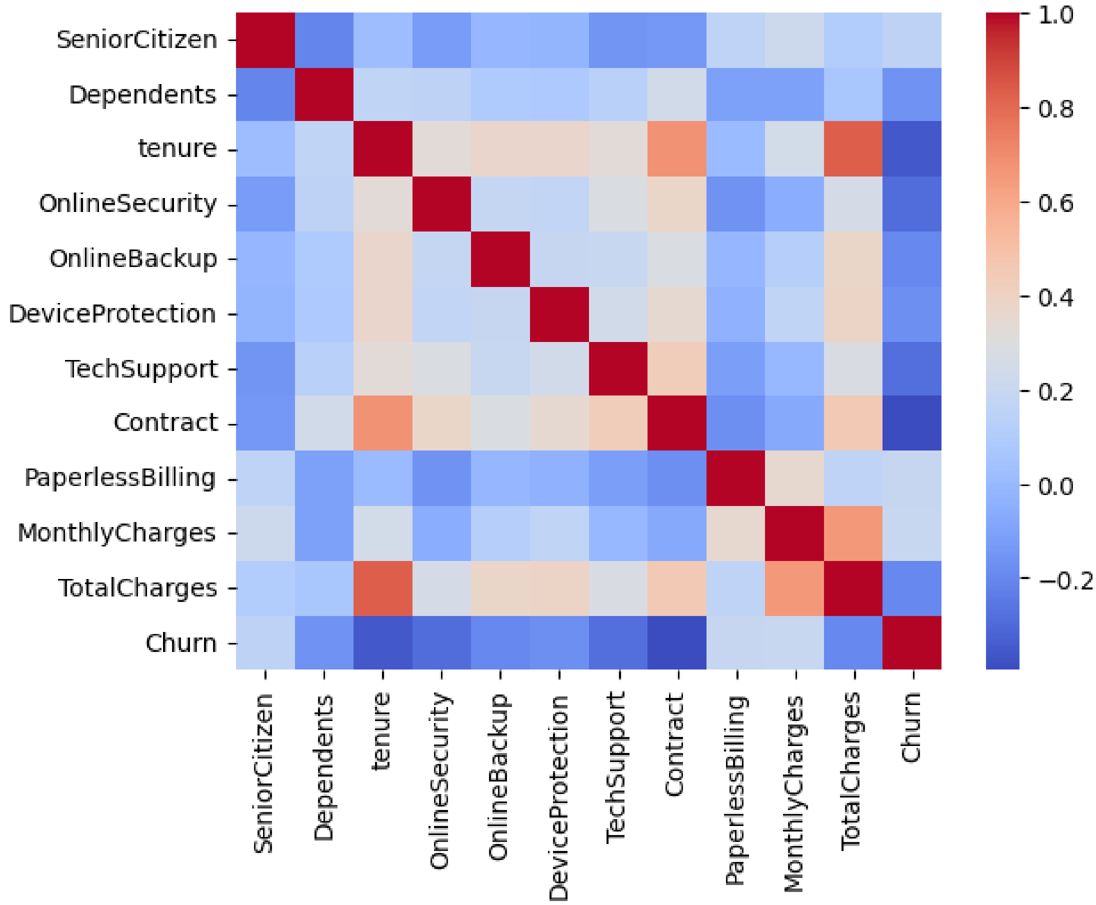
[345]:
```
for i in telco_data.columns:
    if abs(telco_data["Churn"].corr(telco_data[i]))<0.15:
        telco_data.drop(columns=i,inplace=True)
```

```
telco_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 7032 entries, 0 to 7042
Data columns (total 12 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  -----
 0   SeniorCitizen     7032 non-null   int64
 1   Dependents        7032 non-null   int32
 2   tenure            7032 non-null   int64
 3   OnlineSecurity    7032 non-null   int32
 4   OnlineBackup      7032 non-null   int32
 5   DeviceProtection  7032 non-null   int32
 6   TechSupport       7032 non-null   int32
 7   Contract          7032 non-null   int32
 8   PaperlessBilling  7032 non-null   int32
 9   MonthlyCharges    7032 non-null   float64
 10  TotalCharges      7032 non-null   float64
 11  Churn             7032 non-null   int32
dtypes: float64(2), int32(8), int64(2)
memory usage: 494.4 KB
```

[346]:

```
import matplotlib.pyplot as plt
import seaborn as sns
corr=telco_data.corr()
heatmap=sns.heatmap(corr,cmap="coolwarm")
plt.show()
```



[347]:
```
X=telco_data.drop("Churn",axis=1)
Y=telco_data['Churn']
df=telco_data.copy()
```

[348]:
```
from sklearn.model_selection import train_test_split
X_train,X_test,Y_train,Y_test=train_test_split(X,Y,test_size=0.
↪2,random_state=42)
```

[349]:
```
from sklearn.tree import DecisionTreeClassifier
dt=DecisionTreeClassifier(criterion='gini',random_state=100,max_depth=6,min_samples_leaf=8)
dt.fit(X_train,Y_train)
Y_predict=dt.predict(X_test)
from  sklearn.metrics  import  classification_report
from sklearn.metrics import confusion_matrix
print(classification_report(Y_test,Y_predict))
print(confusion_matrix(Y_test,Y_predict))
```

```
              precision    recall  f1-score   support
```

```
              0       0.81      0.90      0.86      1033
              1       0.62      0.43      0.51       374

       accuracy                           0.78      1407
      macro avg       0.72      0.67      0.68      1407
   weighted avg       0.76      0.78      0.76      1407

[[934  99]
 [213 161]]
```

[350]:
```python
from sklearn.ensemble import RandomForestClassifier
rf=RandomForestClassifier(n_estimators=100)
rf.fit(X_train,Y_train)   Y_rf_pred=rf.predict(X_test)
print(classification_report(Y_test,Y_rf_pred))
print(confusion_matrix(Y_test,Y_rf_pred))
```

```
              precision    recall  f1-score   support

              0       0.83      0.90      0.86      1033
              1       0.63      0.49      0.55       374

       accuracy                           0.79      1407
      macro avg       0.73      0.69      0.71      1407
   weighted avg       0.78      0.79      0.78      1407

[[925 108]
 [191 183]]
```

[351]:
```python
from imblearn.combine import SMOTEENN
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
sm=SMOTEENN()
X_resampled,Y_resampled=sm.fit_resample(X,Y)
Xr_train,Xr_test,Yr_train,Yr_test=train_test_split(X_resampled,Y_resampled,test_size=0.
 ↪2,random_state=42)
X_train_scaled = scaler.fit_transform(Xr_train)
X_test_scaled = scaler.transform(Xr_test)
print(Y_resampled.value_counts())
print(Y.value_counts())
```

```
1    3130
0    2679
Name: Churn, dtype: int64
0    5163
1    1869
Name: Churn, dtype: int64
```

[352]:
```
from sklearn.tree import DecisionTreeClassifier
dt=DecisionTreeClassifier(criterion='gini',random_state=100,max_depth=6,min_samples_leaf=8)
dt.fit(X_train_scaled,Yr_train)
Yr_predict=dt.predict(X_test_scaled)
print(classification_report(Yr_test,Yr_predict))
print(confusion_matrix(Yr_test,Yr_predict))
```

```
              precision    recall  f1-score   support

           0       0.92      0.91      0.92       544
           1       0.92      0.93      0.93       618

    accuracy                           0.92      1162
   macro avg       0.92      0.92      0.92      1162
weighted avg       0.92      0.92      0.92      1162

[[495  49]
 [ 41 577]]
```

[353]:
```
from sklearn.ensemble import RandomForestClassifier
rf=RandomForestClassifier(n_estimators=100)
rf.fit(X_train_scaled,Yr_train)
Yr_rf_pred=rf.predict(X_test_scaled)
print(classification_report(Yr_test,Yr_rf_pred))
print(confusion_matrix(Yr_test,Yr_rf_pred))
```

```
              precision    recall  f1-score   support

           0       0.95      0.93      0.94       544
           1       0.94      0.96      0.95       618

    accuracy                           0.95      1162
   macro avg       0.95      0.95      0.95      1162
weighted avg       0.95      0.95      0.95      1162

[[508  36]
 [ 24 594]]
```

[354]:
```
from sklearn.neural_network import MLPClassifier

# Model 6: Neural Network Classifier
print("\nModel 6: Neural Network Classifier")
model_nn = MLPClassifier(hidden_layer_sizes=(100,), max_iter=1000)
model_nn.fit(X_train_scaled, Yr_train)
yr_pred_nn = model_nn.predict(X_test_scaled)
print("Classification Report:")
print(classification_report(Yr_test, yr_pred_nn))
```

```
print("Confusion Matrix:")
print(confusion_matrix(Yr_test, yr_pred_nn))
```

```
Model 6: Neural Network Classifier
Classification Report:
              precision    recall  f1-score   support

           0       0.93      0.93      0.93       544
           1       0.94      0.94      0.94       618

    accuracy                           0.93      1162
   macro avg       0.93      0.93      0.93      1162
weighted avg       0.93      0.93      0.93      1162

Confusion Matrix:
[[504  40]
 [ 40 578]]
```

[355]:
```
from sklearn.model_selection import RandomizedSearchCV
from sklearn.pipeline import Pipeline
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import classification_report, confusion_matrix

# Define pipeline
pipe_dt = Pipeline([
    ('clf', DecisionTreeClassifier())
])

# Define parameter grid
param_grid_dt = {
    'clf__criterion': ['gini', 'entropy'],
    'clf__max_depth': [None, 10, 20, 30, 40, 50],
    'clf__min_samples_split': [2, 5, 10],
    'clf__min_samples_leaf': [1, 2, 4],
    'clf__max_features': ['sqrt', 'log2', None]
}

# Perform GridSearchCV
grid_dt = RandomizedSearchCV(pipe_dt, param_grid_dt, cv=5)
grid_dt.fit(X_train_scaled, Yr_train)

# Print best parameters
print("Best Parameters (GridSearchCV):", grid_dt.best_params_)

# Predict on the testing set using the best model
best_classifier_dt = grid_dt.best_estimator_
```

```
yrr_pred_dt = best_classifier_dt.predict(X_test_scaled)

# Evaluate the model
print("\nClassification Report:")
print(classification_report(Yr_test, yrr_pred_dt))

print("\nConfusion Matrix:")
print(confusion_matrix(Yr_test, yrr_pred_dt))
```

```
Best Parameters (GridSearchCV): {'clf_min_samples_split': 2,
'clf_min_samples_leaf': 1, 'clf_max_features': None, 'clf_max_depth': 30,
'clf_criterion': 'gini'}

Classification Report:
              precision    recall  f1-score   support

           0       0.95      0.92      0.93       544
           1       0.93      0.96      0.94       618

    accuracy                           0.94      1162
   macro avg       0.94      0.94      0.94      1162
weighted avg       0.94      0.94      0.94      1162


Confusion Matrix:
[[501  43]
 [ 27 591]]
```

[356]:
```
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import classification_report
from sklearn.model_selection import RandomizedSearchCV




# Initialize and train Random Forest classifier
rf_clf = RandomForestClassifier(random_state=42)
param_grid = {
    'n_estimators': [50, 100, 200],
    'max_depth': [None, 5, 10],
    'min_samples_split': [2, 5, 10],
    'min_samples_leaf': [1, 2, 4]
}
grid_search = RandomizedSearchCV(rf_clf, param_grid, cv=5, scoring='accuracy')
grid_search.fit(X_train_scaled, Yr_train)

# Get the best estimator
```

```
best_rf_clf = grid_search.best_estimator_

# Evaluate on test data
Yrgd_pred = best_rf_clf.predict(X_test_scaled)
print(classification_report(Yr_test, Yrgd_pred))
```

```
              precision    recall  f1-score   support

           0       0.96      0.94      0.95       544
           1       0.94      0.96      0.95       618

    accuracy                           0.95      1162
   macro avg       0.95      0.95      0.95      1162
weighted avg       0.95      0.95      0.95      1162
```

[357]:
```
from xgboost import XGBClassifier

# Model 7: XGBoost Classifier
print("\nModel 7: XGBoost Classifier")
model_xgb = XGBClassifier()
model_xgb.fit(X_train_scaled, Yr_train)
yr_pred_xgb = model_xgb.predict(X_test_scaled)
print("Classification Report:")
print(classification_report(Yr_test, yr_pred_xgb))
print("Confusion Matrix:")
print(confusion_matrix(Yr_test, yr_pred_xgb))
```

```
Model 7: XGBoost Classifier
Classification Report:
              precision    recall  f1-score   support

           0       0.97      0.94      0.95       544
           1       0.95      0.97      0.96       618

    accuracy                           0.96      1162
   macro avg       0.96      0.96      0.96      1162
weighted avg       0.96      0.96      0.96      1162

Confusion Matrix:
[[511  33]
 [ 18 600]]
```

[358]:
```
telco_data
```

[358]:

```
      SeniorCitizen  Dependents  tenure  OnlineSecurity  OnlineBackup  \
0                 0           0       1               0             2
1                 0           0      34               2             0
2                 0           0       2               2             2
3                 0           0      45               2             0
4                 0           0       2               0             0
...             ...         ...     ...             ...           ...
7038              0           1      24               2             0
7039              0           1      72               0             2
7040              0           1      11               2             0
7041              1           0       4               0             0
7042              0           0      66               2             0

      DeviceProtection  TechSupport  Contract  PaperlessBilling  \
0                    0            0         0                 1
1                    2            0         1                 0
2                    0            0         0                 1
3                    2            2         1                 0
4                    0            0         0                 1
...                ...          ...       ...               ...
7038                 2            2         1                 1
7039                 2            0         1                 1
7040                 0            0         0                 1
7041                 0            0         0                 1
7042                 2            2         2                 1

      MonthlyCharges  TotalCharges  Churn
0              29.85         29.85      0
1              56.95       1889.50      0
2              53.85        108.15      1
3              42.30       1840.75      0
4              70.70        151.65      1
...              ...           ...    ...
7038           84.80       1990.50      0
7039          103.20       7362.90      0
7040           29.60        346.45      0
7041           74.40        306.60      1
7042          105.65       6844.50      0

[7032 rows x 12 columns]
```

[359]:

```python
for i in telco_data.columns:
    print(i)
    print(telco_data[i].unique())
```

```
SeniorCitizen
[0 1]
```

```
Dependents
[0 1]
tenure
[ 1 34  2 45  8 22 10 28 62 13 16 58 49 25 69 52 71 21 12 30 47 72 17 27
  5 46 11 70 63 43 15 60 18 66  9  3 31 50 64 56  7 42 35 48 29 65 38 68
 32 55 37 36 41  6  4 33 67 23 57 61 14 20 53 40 59 24 44 19 54 51 26 39]
OnlineSecurity
[0 2 1]
OnlineBackup
[2 0 1]
DeviceProtection
[0 2 1]
TechSupport
[0 2 1]
Contract
[0 1 2]
PaperlessBilling
[1 0]
MonthlyCharges
[29.85 56.95 53.85 ... 63.1  44.2  78.7 ]
TotalCharges
[  29.85 1889.5   108.15 ...  346.45  306.6  6844.5 ]
Churn
[0 1]
```

[360]:

```
for i in Data.columns:
    print(i)
    print(Data[i].unique())
```

```
gender
['Female' 'Male']
SeniorCitizen
[0 1]
Partner
['Yes' 'No']
Dependents
['No' 'Yes']
tenure
[ 1 34  2 45  8 22 10 28 62 13 16 58 49 25 69 52 71 21 12 30 47 72 17 27
  5 46 11 70 63 43 15 60 18 66  9  3 31 50 64 56  7 42 35 48 29 65 38 68
 32 55 37 36 41  6  4 33 67 23 57 61 14 20 53 40 59 24 44 19 54 51 26 39]
PhoneService
['No' 'Yes']
MultipleLines
['No phone service' 'No' 'Yes']
InternetService
['DSL' 'Fiber optic' 'No']
OnlineSecurity
```

```
['No' 'Yes' 'No internet service']
OnlineBackup
['Yes' 'No' 'No internet service']
DeviceProtection
['No' 'Yes' 'No internet service']
TechSupport
['No' 'Yes' 'No internet service']
StreamingTV
['No' 'Yes' 'No internet service']
StreamingMovies
['No' 'Yes' 'No internet service']
Contract
['Month-to-month' 'One year' 'Two year']
PaperlessBilling
['Yes' 'No']
PaymentMethod
['Electronic check' 'Mailed check' 'Bank transfer (automatic)'
 'Credit card (automatic)']
MonthlyCharges
[29.85 56.95 53.85 ... 63.1  44.2  78.7 ]
TotalCharges
[  29.85 1889.5   108.15 ...  346.45  306.6  6844.5 ]
Churn
['No' 'Yes']
```

[361]:
```
# Taking user input:
sen=input("Enter Yes If Customer is Senior Citizen else Enter No: ")
if sen.lower()=="yes":
    senior=1
elif sen.lower()=="no":
    senior=0
else:
    senior=0
dep=input("Enter Customer's Dependency (Yes or No): ")
if dep.lower()=="yes":
    depend=1
elif dep.lower()=="no":
    depend=0
else:
    depend=0

tenure=int(input("Number of Months the customer has Stayed: "))
ois=input("Whether Customer has Online Security or not (Yes, No or No internet␣
 ↪sevice): ")
if ois.lower()=="yes":
    OnlineSecurity=2
elif ois.lower()=="no":
```

```python
    OnlineSecurity=0
else:
    OnlineSecurity=1

oib=input("Whether the customer has Online Backup or Not (Yes, No or No␣
 ↪internet Service): ")
if oib.lower()=="yes":
    OnlineBackup=2
elif oib.lower()=="no":
    OnlineBackup=0
else:
    OnlineBackup=1

dvp=input("Whether Custom has Device Protection or not (Yes, No or No internet␣
 ↪service): ")
if dvp.lower()=="yes":
    DeviceP=2
elif dvp.lower()=="no":
    DeviceP=0
else:
    DeviceP=1
ts=input("Whether Custom has Tech Support or not (Yes, No or No internet␣
 ↪service): ")
if ts.lower()=="yes":
    TechS=2
elif ts.lower()=="no":
    TechS=0
else:
    TechS=1
con=input("Contract Term of the Customer (Month-to-Month, One Year or Two Year):
 ↪ ")
if con.lower()=="month-to-month":
    Contract=0
elif con.lower()=="one year":
    Contract=1
elif con.lower()=="two year":
    Contract=2

plb=input("Whether the customer has Paperless Billing or Not (Yes or No): ")
if plb.lower()=="yes":
    Bill=1
elif plb.lower()=="two year":
    Bill=0
else:
    Bill=1

month=float(input("The amount charged to the Customer Monthly: "))
```

```
total=float(input("Total Amount charged to the customer: "))

X_input=[senior,depend,tenure,OnlineSecurity,OnlineBackup,DeviceP,TechS,Contract,Bill,month,to

X_input_df=pd.DataFrame([X_input])
X_input_df
```

[361]:

	0	1	2	3	4	5	6	7	8	9	10
0	0	0	2	2	2	0	0	1	1	53.85	108.15

[362]:
```
X_input_df.
↪columns=["SeniorCitizen","Dependents","tenure","OnlineSecurity","OnlineBackup","DeviceProte
X_input_df
```

[362]:

	SeniorCitizen	Dependents	tenure	OnlineSecurity	OnlineBackup \
0	0	0	2	2	2

	DeviceProtection	TechSupport	Contract	PaperlessBilling	MonthlyCharges \
0	0	0	1	1	53.85

	TotalCharges
0	108.15

[363]:
```
X_input_scaled=scaler.transform(X_input_df)
X_input_scaled

Y_input_pred=model_xgb.predict(X_input_scaled)
if Y_input_pred[0]==0:
    predicted="No"
else:
    predicted="Yes"
print("Churn Prediction: ",predicted)
```

```
Churn Prediction:  No
```

[364]:
```
telco_data.head()
```

[364]:

	SeniorCitizen	Dependents	tenure	OnlineSecurity	OnlineBackup \
0	0	0	1	0	2
1	0	0	34	2	0
2	0	0	2	2	2
3	0	0	45	2	0
4	0	0	2	0	0

	DeviceProtection	TechSupport	Contract	PaperlessBilling	MonthlyCharges \
0	0	0	0	1	29.85
1	2	0	1	0	56.95

2	0	0	0	1	53.85
3	2	2	1	0	42.30
4	0	0	0	1	70.70

	TotalCharges	Churn
0	29.85	0
1	1889.50	0
2	108.15	1
3	1840.75	0
4	151.65	1