Customer Churn Prediction

July 19, 2025

[1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn import preprocessing
```

```
/Users/hinalpanchal/opt/anaconda3/lib/python3.9/site-
packages/scipy/__init__.py:155: UserWarning: A NumPy version >=1.18.5 and
<1.25.0 is required for this version of SciPy (detected version 1.26.4
  warnings.warn(f"A NumPy version >={np_minversion} and <{np_maxversion}"
```

[2]:
```
telecom_data = pd.read_csv('Customer_Churn.csv')
telecom_data.head()
```

[2]:
```
   CustomerID  Age  Gender  Tenure  MonthlyCharges    ContractType  \
0           1   49    Male       4           88.35  Month-to-Month
1           2   43    Male       0           36.67  Month-to-Month
2           3   51  Female       2           63.79  Month-to-Month
3           4   60  Female       8          102.34        One-Year
4           5   42    Male      32           69.01  Month-to-Month

  InternetService  TotalCharges TechSupport Churn
0     Fiber Optic        353.40         Yes   Yes
1     Fiber Optic          0.00         Yes   Yes
2     Fiber Optic        127.58          No   Yes
3             DSL        818.72         Yes   Yes
4            None       2208.32          No   Yes
```

[3]:
```
telecom_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 10 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  -----
 0   CustomerID        1000 non-null   int64
 1   Age               1000 non-null   int64
 2   Gender            1000 non-null   object
 3   Tenure            1000 non-null   int64
 4   MonthlyCharges   1000 non-null   float64
 5   ContractType     1000 non-null   object
 6   InternetService  1000 non-null   object
 7   TotalCharges     1000 non-null   float64
 8   TechSupport      1000 non-null   object
 9   Churn            1000 non-null   object
dtypes: float64(2), int64(3), object(5)
memory usage: 78.2+ KB
```

```
[4]: telecom_data.isna().sum()
```

```
[4]: CustomerID         0
     Age                0
     Gender             0
     Tenure             0
     MonthlyCharges     0
     ContractType       0
     InternetService    0
     TotalCharges       0
     TechSupport        0
     Churn              0
     dtype: int64
```

```
[5]: telecom_data.duplicated().sum()
```

```
[5]: 0
```

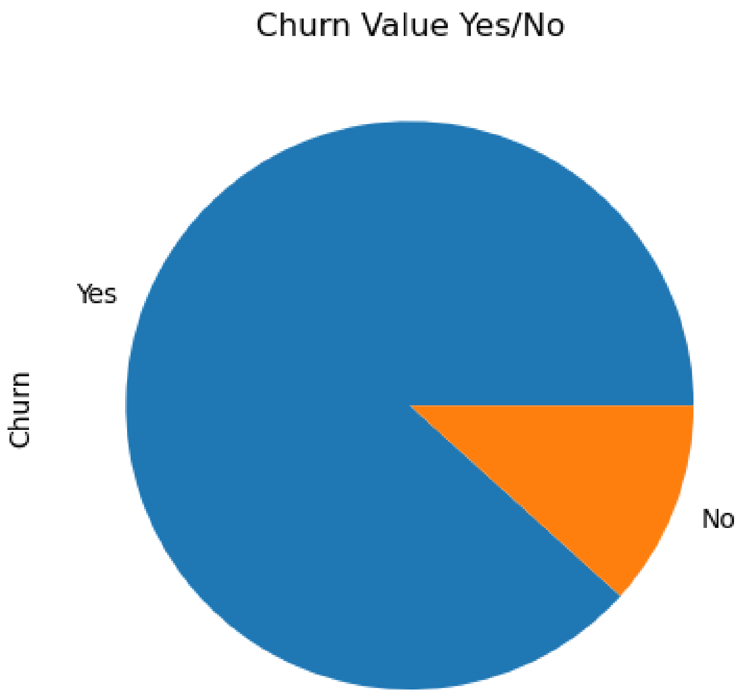
1 EDA

```
[6]: telecom_data['Churn'].value_counts()
```

```
[6]: Yes    883
     No     117
     Name: Churn, dtype: int64
```

```
[7]: telecom_data['Churn'].value_counts().plot(kind='pie')
     plt.title('Churn Value Yes/No')
```

```
[7]: Text(0.5, 1.0, 'Churn Value Yes/No')
```



```
[8]: telecom_data.groupby('Churn')['MonthlyCharges'].mean()
```

```
[8]: Churn
     No     62.54641
     Yes    75.96077
     Name: MonthlyCharges, dtype: float64
```

```
[9]: telecom_data.groupby(['Churn','Gender'])['MonthlyCharges'].mean()
```

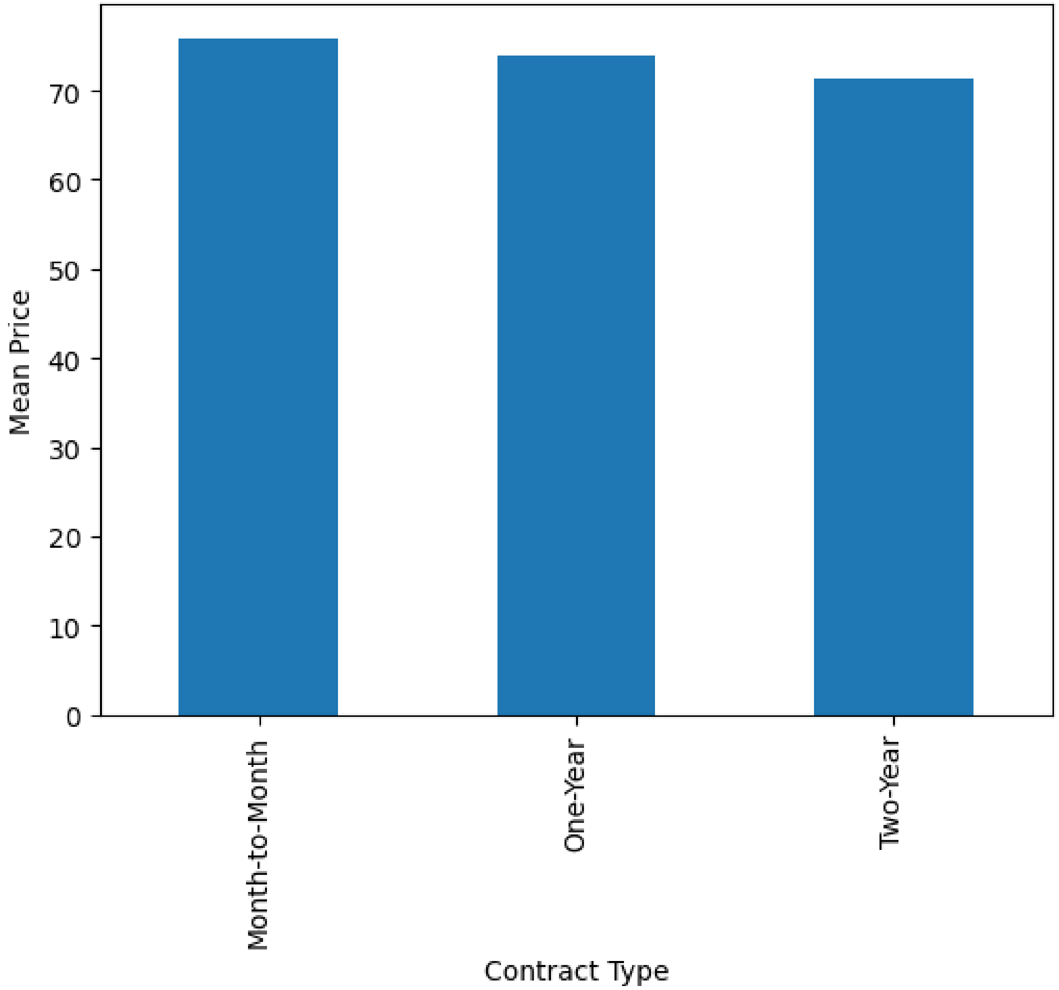
```
[9]: Churn  Gender
     No     Female    65.091912
            Male      59.013878
     Yes    Female    74.975064
            Male      77.082518
     Name: MonthlyCharges, dtype: float64
```

```
[10]: telecom_data.groupby('Churn')['Tenure'].mean()
```

```
[10]: Churn
      No     30.264957
      Yes    17.476784
      Name: Tenure, dtype: float64
```

[11]:
```
telecom_data.groupby('ContractType')['MonthlyCharges'].mean().plot(kind='bar')
plt.ylabel('Mean Price')
plt.xlabel('Contract Type')
```

[11]:
```
Text(0.5, 0, 'Contract Type')
```

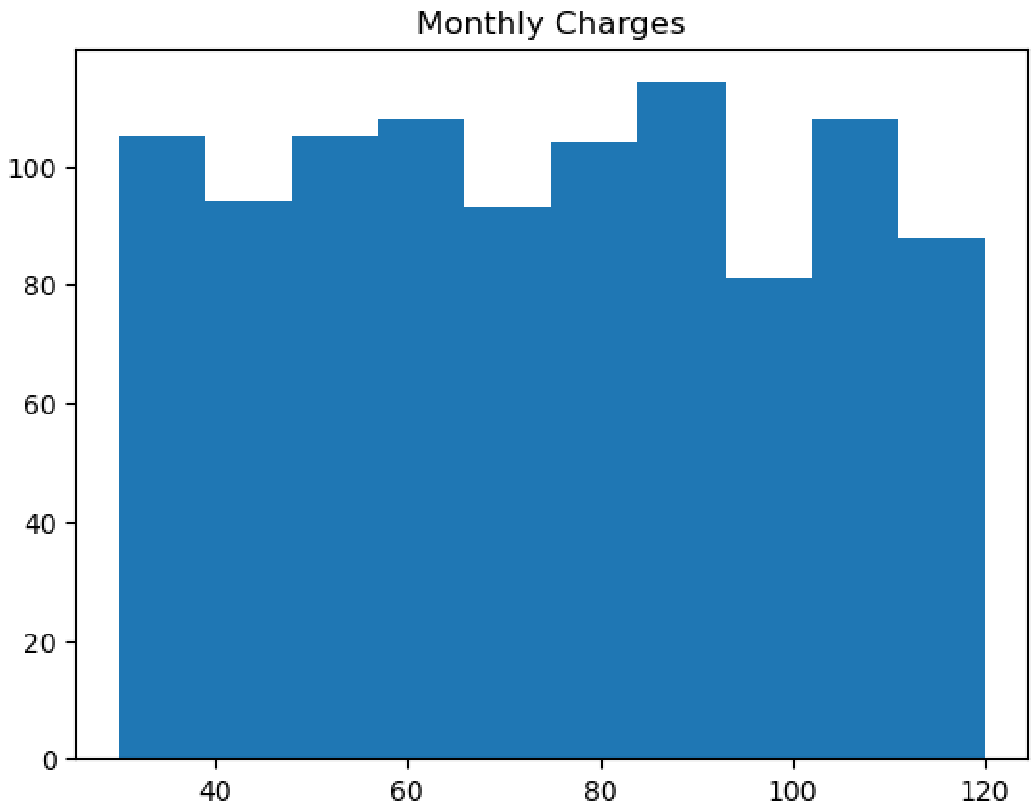


[12]:
```
telecom_data.groupby(['InternetService','Churn'])['TotalCharges'].mean()
```

[12]:
```
InternetService  Churn
DSL              No       1650.001875
                 Yes      1342.233038
Fiber Optic      No       1976.429130
                 Yes      1288.080798
None             Yes      1413.789327
Name: TotalCharges, dtype: float64
```

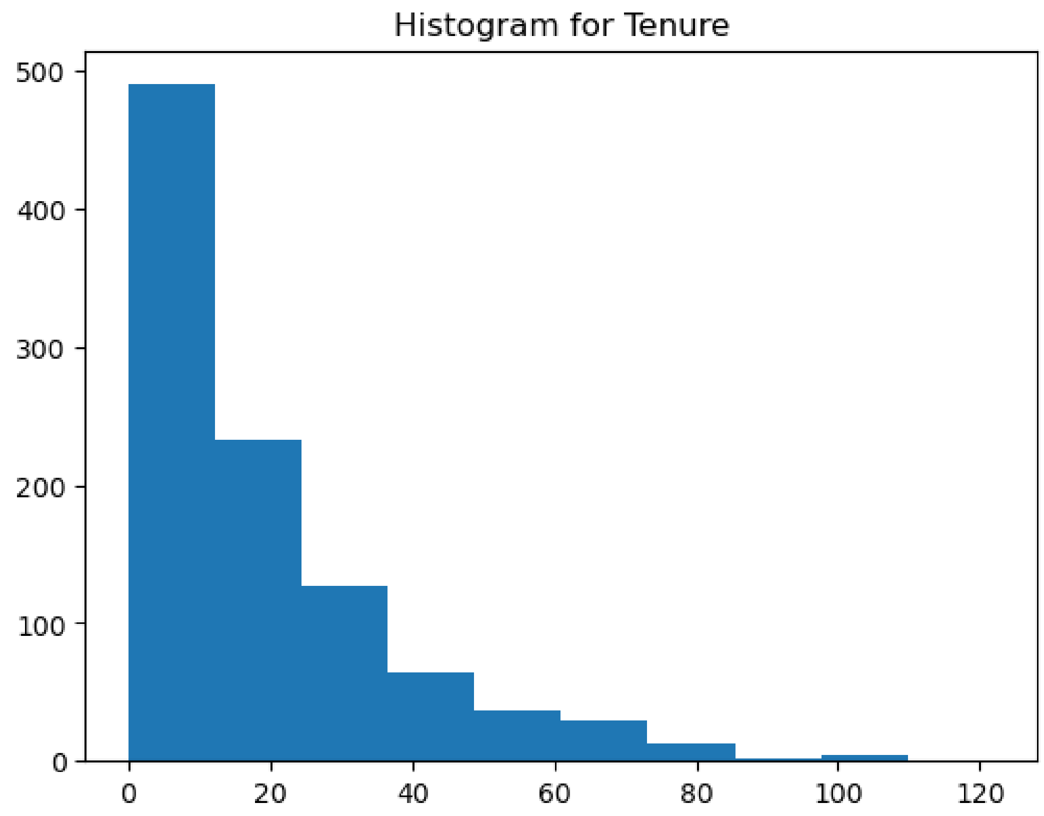
[13]:
```
plt.hist(telecom_data['MonthlyCharges'])
plt.title('Monthly Charges')
```

[13]:
```
Text(0.5, 1.0, 'Monthly Charges')
```



[14]:
```
plt.hist(telecom_data['Tenure'])
plt.title('Histogram for Tenure')
```

[14]:
```
Text(0.5, 1.0, 'Histogram for Tenure')
```



2 Feature Re-Engineering

```
[15]: from sklearn.model_selection import train_test_split
      from sklearn.preprocessing import StandardScaler
      from sklearn.linear_model import LogisticRegression
      from sklearn.metrics import classification_report, confusion_matrix
      from sklearn.pipeline import Pipeline
```

```
[16]: telecom_data.head(1)
```

```
[16]:    CustomerID  Age Gender  Tenure  MonthlyCharges    ContractType  \
      0           1   49   Male       4           88.35  Month-to-Month

        InternetService  TotalCharges TechSupport Churn
      0     Fiber Optic         353.4         Yes   Yes
```

```
[17]: telecom_data.columns
```

```
[17]: Index(['CustomerID', 'Age', 'Gender', 'Tenure', 'MonthlyCharges',
             'ContractType', 'InternetService', 'TotalCharges', 'TechSupport',
             'Churn'],
            dtype='object')
```

[18]:

```
y= telecom_data['Churn']
X= telecom_data[['Age', 'Gender', 'Tenure', 'MonthlyCharges']]
```

[19]:

```
# Gender 1- Female, 0-Male
X.loc[:, 'Gender'] = X['Gender'].apply(lambda x: 1 if x == 'Female' else 0)
```

```
/var/folders/qw/sl7j3jj94ngg0_334hjh2ycm0000gn/T/ipykernel_44305/1439695941.py:2
: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  X.loc[:, 'Gender'] = X['Gender'].apply(lambda x: 1 if x == 'Female' else 0)
```

[20]:

```
X.head(3)
```

[20]:

```
   Age  Gender  Tenure  MonthlyCharges
0   49       0       4           88.35
1   43       0       0           36.67
2   51       1       2           63.79
```

[21]:

```
# Churn Yes=1 ,No=0
# Using apply + lambda
y = y.apply(lambda x: 1 if x == 'Yes' else 0)
```

[22]:

```
y.head(10)
```

[22]:

```
0    1
1    1
2    1
3    1
4    1
5    1
6    1
7    1
8    0
9    1
Name: Churn, dtype: int64
```

[23]:

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

[24]:

```
scaler = StandardScaler()

X_train =scaler.fit_transform(X_train)
```

```
# We dump the data as before Scaling the X_test as there might be lekage when␣
 ↪performing Standard Scaler
```

[25]:
```
import joblib
joblib.dump(scaler,'scaler.pkl')
```

[25]:
```
['scaler.pkl']
```

[26]:
```
X_test = scaler.fit_transform(X_test)
```

[32]:
```
from sklearn.metrics import accuracy_score

def modelperformance(prediction):
    print('Accuracy score on model is {}'.format(accuracy_score(y_test,y_pred)))
```

[33]:
```
from sklearn.model_selection import GridSearchCV
import warnings
warnings.filterwarnings('ignore')
```

3 LOGISTIC REGRESSION

[34]:
```
LogR =LogisticRegression()
LogR.fit(X_train,y_train)
```

[34]:
```
LogisticRegression()
```

[35]:
```
y_pred = LogR.predict(X_test)
```

[36]:
```
modelperformance(y_pred)
```

```
Accuracy score on model is 0.88
```

4 KNN

[37]:
```
from sklearn.neighbors import KNeighborsClassifier
```

[44]:
```
param_grid = {
    'n_neighbors':[3,5,7,9],
    'weights':['uniform','distnace'],
}

gridkn = GridSearchCV(KNeighborsClassifier(),param_grid, cv=5)
```

[45]:
```
gridkn.fit(X_train,y_train)
```

```
[45]: GridSearchCV(cv=5, estimator=KNeighborsClassifier(),
                   param_grid={'n_neighbors': [3, 5, 7, 9],
                               'weights': ['uniform', 'distnace']})
```

```
[46]: gridkn.best_params_
```

```
[46]: {'n_neighbors': 9, 'weights': 'uniform'}
```

```
[47]: y_preds = gridkn.predict(X_test)
```

```
[48]: modelperformance(y_pred)
```

```
Accuracy score on model is 0.88
```

5 SVM

```
[49]: from sklearn.svm import SVC
```

```
[50]: svm =SVC()
      param_grid_svm = {'C':[0.01,0.1,0.5,1],'kernel':['linear','rbf','poly']}
```

```
[51]: gridsvm = GridSearchCV(svm,param_grid_svm,cv=5)
```

```
[52]: gridsvm.fit(X_train,y_train)
```

```
[52]: GridSearchCV(cv=5, estimator=SVC(),
                   param_grid={'C': [0.01, 0.1, 0.5, 1],
                               'kernel': ['linear', 'rbf', 'poly']})
```

```
[53]: gridsvm.best_params_
```

```
[53]: {'C': 0.01, 'kernel': 'linear'}
```

```
[54]: y_pred = gridsvm.predict(X_test)
```

```
[55]: modelperformance(y_pred)
```

```
Accuracy score on model is 0.89
```

6 Decision Tree Classifier

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

      param_grid ={
          'criterion': ["entropy", "gini"],
          'splitter': ['best','random'],
          'max_depth': [None,10,20,30],
          'min_samples_leaf': [1, 2, 4],
          'min_samples_split': [2, 5, 10]
      }
```

[57]:

```
grid_tree = GridSearchCV(DecisionTreeClassifier(),param_grid, cv=5)
```

[58]:

```
grid_tree.fit(X_train,y_train)
```

[58]:

```
GridSearchCV(cv=5, estimator=DecisionTreeClassifier(),
             param_grid={'criterion': ['entropy', 'gini'],
                         'max_depth': [None, 10, 20, 30],
                         'min_samples_leaf': [1, 2, 4],
                         'min_samples_split': [2, 5, 10],
                         'splitter': ['best', 'random']})
```

[59]:

```
grid_tree.best_params_
```

[59]:

```
{'criterion': 'entropy',
 'max_depth': None,
 'min_samples_leaf': 4,
 'min_samples_split': 10,
 'splitter': 'random'}
```

[60]:

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

[61]:

```
modelperformance(y_pred)
```

```
Accuracy score on model is 0.805
```

7 Random Forest Classifier

[63]:

```
from sklearn.ensemble import RandomForestClassifier
```

[65]:

```
rfc_model = RandomForestClassifier()

param_grid = {
    'n_estimators': [32,64,128,256],
    'max_features': [2,3,4],
    'bootstrap':[True,False]
}
```

[66]:

```
rfc = GridSearchCV(rfc_model,param_grid,cv=5)
```

[67]:

```
rfc.fit(X_train,y_train)
```

[67]:

```
GridSearchCV(cv=5, estimator=RandomForestClassifier(),
             param_grid={'bootstrap': [True, False], 'max_features': [2, 3, 4],
                         'n_estimators': [32, 64, 128, 256]})
```

```
[70]: rfc.best_params_
```

```
[70]: {'bootstrap': True, 'max_features': 2, 'n_estimators': 128}
```

```
[68]: y_pred = rfc.predict(X_test)
```

```
[69]: modelperformance(y_pred)
```

```
Accuracy score on model is 0.885
```

```
[71]: best_model = gridsvm.best_estimator_
```

```
[72]: joblib.dump(best_model,'model.pkl')
```

```
[72]: ['model.pkl']
```

```
[ ]:
```