Customer Churn Prediction

Part B: Customer Churn Prediction

Deliverables

1. A data exploration and preprocessing notebook or report that analyzes the dataset, handles missing values, and prepares the data for modeling.

[82]:
```python
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.preprocessing import StandardScaler
import warnings
warnings.simplefilter(action='ignore')

# Load the dataset
file_path = "customer_data.csv"
df = pd.read_csv(file_path)

# Display basic information about the dataset
df.info()
df.head()
```

```
<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      7032 non-null   float64
 20  Churn             7043 non-null   object
dtypes: float64(2), int64(2), object(17)
memory usage: 1.1+ MB
```

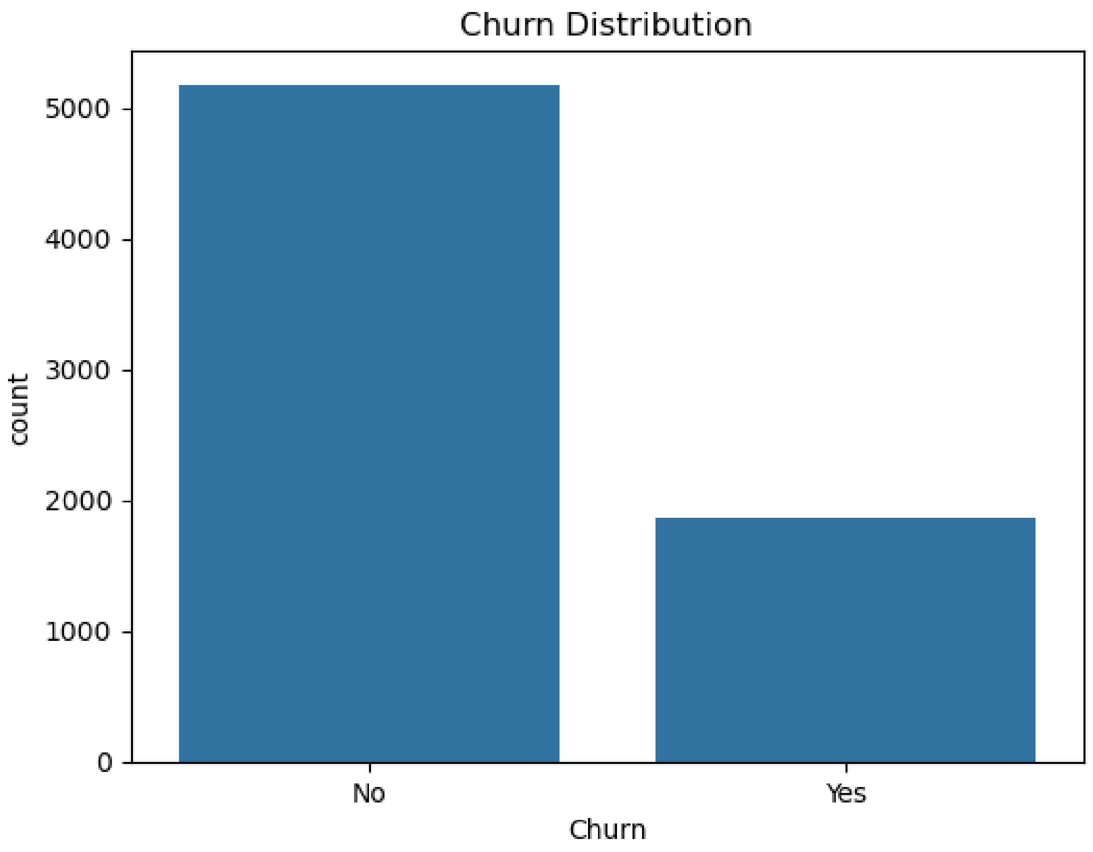
[82]:
```
   customerID  gender  SeniorCitizen Partner Dependents  tenure PhoneService  \
0  7590-VHVEG  Female              0     Yes         No       1           No
1  5575-GNVDE    Male              0      No         No      34          Yes
2  3668-QPYBK    Male              0      No         No       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       1889.50     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]
```

[84]:
```
df.describe()
```

[84]:
```
       SeniorCitizen       tenure  MonthlyCharges  TotalCharges
count    7043.000000  7043.000000     7043.000000   7032.000000
mean        0.162147    32.371149       64.761692   2283.300441
std         0.368612    24.559481       30.090047   2266.771362
```

```
min         0.000000     0.000000       18.250000     18.800000
25%         0.000000     9.000000       35.500000    401.450000
50%         0.000000    29.000000       70.350000   1397.475000
75%         0.000000    55.000000       89.850000   3794.737500
max         1.000000    72.000000      118.750000   8684.800000
```

[86]:
```python
# Visualizing Churn distribution
sns.countplot(x='Churn', data=df)
plt.title('Churn Distribution')
plt.show()
```



[88]:
```python
df.isnull().sum()
```

[88]:
```
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
```

[90]:

```
# Handle missing values in TotalCharges by filling them with the median value
df["TotalCharges"].fillna(df["TotalCharges"].median(), inplace=True)

# Drop the customerID column as it is not useful for prediction
df.drop(columns=["customerID"], inplace=True)

# Convert categorical variables with "Yes/No" values to binary (1/0)
yes_no_cols = ["Partner", "Dependents", "PhoneService", "PaperlessBilling",␣
 ↪"Churn"]
for col in yes_no_cols:
    df[col] = df[col].map({"Yes": 1, "No": 0})

# Convert gender to binary (Male=1, Female=0)
df["gender"] = df["gender"].map({"Male": 1, "Female": 0})

# Keep SeniorCitizen as a numerical feature
df["SeniorCitizen"] = df["SeniorCitizen"].astype(int)

# Identify categorical variables with more than two unique values
multi_category_cols = ["Contract", "InternetService", "PaymentMethod",␣
 ↪"MultipleLines", "OnlineSecurity",
                       "OnlineBackup", "DeviceProtection", "TechSupport",␣
 ↪"StreamingTV", "StreamingMovies"]

# Apply one-hot encoding to multi-category variables
df = pd.get_dummies(df, columns=multi_category_cols, drop_first=True)

# Scale numerical features
scaler = StandardScaler()
df[['tenure', 'MonthlyCharges', 'TotalCharges']] = scaler.
 ↪fit_transform(df[['tenure', 'MonthlyCharges', 'TotalCharges']])
```

```python
# Display the processed dataset info
df.info()
df.head()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 7043 entries, 0 to 7042
Data columns (total 31 columns):
 #   Column                                 Non-Null Count  Dtype
---  ------                                 --------------  -----
 0   gender                                 7043 non-null   int64
 1   SeniorCitizen                          7043 non-null   int32
 2   Partner                                7043 non-null   int64
 3   Dependents                             7043 non-null   int64
 4   tenure                                 7043 non-null   float64
 5   PhoneService                           7043 non-null   int64
 6   PaperlessBilling                       7043 non-null   int64
 7   MonthlyCharges                         7043 non-null   float64
 8   TotalCharges                           7043 non-null   float64
 9   Churn                                  7043 non-null   int64
 10  Contract_One year                      7043 non-null   bool
 11  Contract_Two year                      7043 non-null   bool
 12  InternetService_Fiber optic            7043 non-null   bool
 13  InternetService_No                     7043 non-null   bool
 14  PaymentMethod_Credit card (automatic)  7043 non-null   bool
 15  PaymentMethod_Electronic check         7043 non-null   bool
 16  PaymentMethod_Mailed check             7043 non-null   bool
 17  MultipleLines_No phone service         7043 non-null   bool
 18  MultipleLines_Yes                      7043 non-null   bool
 19  OnlineSecurity_No internet service     7043 non-null   bool
 20  OnlineSecurity_Yes                     7043 non-null   bool
 21  OnlineBackup_No internet service       7043 non-null   bool
 22  OnlineBackup_Yes                       7043 non-null   bool
 23  DeviceProtection_No internet service   7043 non-null   bool
 24  DeviceProtection_Yes                   7043 non-null   bool
 25  TechSupport_No internet service        7043 non-null   bool
 26  TechSupport_Yes                        7043 non-null   bool
 27  StreamingTV_No internet service        7043 non-null   bool
 28  StreamingTV_Yes                        7043 non-null   bool
 29  StreamingMovies_No internet service    7043 non-null   bool
 30  StreamingMovies_Yes                    7043 non-null   bool
dtypes: bool(21), float64(3), int32(1), int64(6)
memory usage: 667.3 KB
```

[90]:

```
   gender  SeniorCitizen  Partner  Dependents    tenure  PhoneService  \
0       0              0        1           0 -1.277445             0
1       1              0        0           0  0.066327             1
```

```
2      1              0        0           0 -1.236724             1
3      1              0        0           0  0.514251             0
4      0              0        0           0 -1.236724             1

   PaperlessBilling  MonthlyCharges  TotalCharges  Churn  …  \
0                 1       -1.160323     -0.994242      0  …
1                 0       -0.259629     -0.173244      0  …
2                 1       -0.362660     -0.959674      1  …
3                 0       -0.746535     -0.194766      0  …
4                 1        0.197365     -0.940470      1  …

   OnlineBackup_No internet service  OnlineBackup_Yes  \
0                             False              True
1                             False             False
2                             False              True
3                             False             False
4                             False             False

   DeviceProtection_No internet service  DeviceProtection_Yes  \
0                                 False                 False
1                                 False                  True
2                                 False                 False
3                                 False                  True
4                                 False                 False

   TechSupport_No internet service  TechSupport_Yes  \
0                            False            False
1                            False            False
2                            False            False
3                            False             True
4                            False            False

   StreamingTV_No internet service  StreamingTV_Yes  \
0                            False            False
1                            False            False
2                            False            False
3                            False            False
4                            False            False

   StreamingMovies_No internet service  StreamingMovies_Yes
0                                False                False
1                                False                False
2                                False                False
3                                False                False
4                                False                False

[5 rows x 31 columns]
```

2. A machine learning model capable of predicting customer churn.

[93]:
```
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score, classification_report,␣
 ↪precision_score, recall_score, f1_score

# Split the data into features and target variable
X = df.drop(columns=["Churn"])
y = df["Churn"]

# Split into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)

# Train a Random Forest model
model = RandomForestClassifier(n_estimators=100, random_state=42)
model.fit(X_train, y_train)

# Make predictions
y_pred = model.predict(X_test)
```

3. An evaluation of model performance using appropriate metrics (such as accuracy, precision, recall, F1 score, etc.)

[96]:
```
# Evaluate the model
accuracy = accuracy_score(y_test, y_pred)
precision = precision_score(y_test, y_pred)
recall = recall_score(y_test, y_pred)
f1 = f1_score(y_test, y_pred)

print("Accuracy:", accuracy)
print("Precision:", precision)
print("Recall:", recall)
print("F1 Score:", f1)
print("Classification Report:")
print(classification_report(y_test, y_pred))
```

```
Accuracy: 0.7934705464868701
Precision: 0.6553030303030303
Recall: 0.46380697050938335
F1 Score: 0.543171114599686
Classification Report:
              precision    recall  f1-score   support

           0       0.83      0.91      0.87      1036
           1       0.66      0.46      0.54       373
```

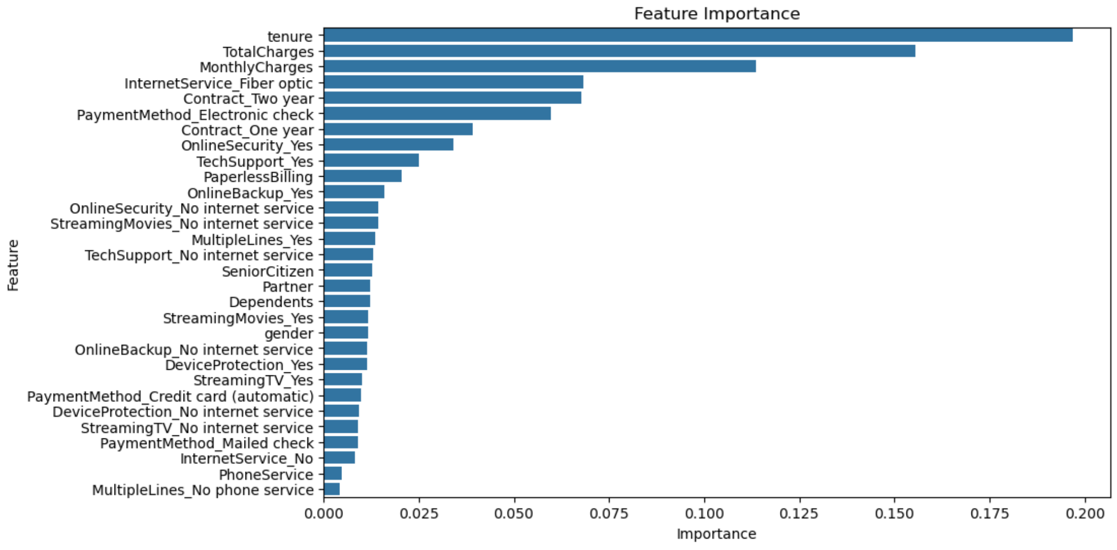
```
    accuracy                           0.79      1409
   macro avg       0.74      0.69      0.70      1409
weighted avg       0.78      0.79      0.78      1409
```

[98]:
```python
# Hyperparameter tuning using GridSearchCV
param_grid = {
    'n_estimators': [50, 100, 150],
    'max_depth': [None, 10, 20],
    'min_samples_split': [2, 5, 10]
}

grid_search = GridSearchCV(RandomForestClassifier(random_state=42), param_grid,␣
 ↪cv=5, scoring='accuracy')
grid_search.fit(X_train, y_train)

# Best model
best_model = grid_search.best_estimator_

# Make predictions
y_pred_best = best_model.predict(X_test)

# Evaluate the model
accuracy = accuracy_score(y_test, y_pred_best)
precision = precision_score(y_test, y_pred_best)
recall = recall_score(y_test, y_pred_best)
f1 = f1_score(y_test, y_pred_best)

print("Best Model Parameters:", grid_search.best_params_)
print("Accuracy:", accuracy)
print("Precision:", precision)
print("Recall:", recall)
print("F1 Score:", f1)
print("Classification Report:")
print(classification_report(y_test, y_pred))
```

```
Best Model Parameters: {'max_depth': 10, 'min_samples_split': 10,
'n_estimators': 150}
Accuracy: 0.808374733853797
Precision: 0.6872727272727273
Recall: 0.5067024128686327
F1 Score: 0.5833333333333334
Classification Report:
              precision    recall  f1-score   support

           0       0.83      0.91      0.87      1036
           1       0.66      0.46      0.54       373
```

```
    accuracy                           0.79      1409
   macro avg       0.74      0.69      0.70      1409
weighted avg       0.78      0.79      0.78      1409
```

[100]:
```
# Feature importance analysis
feature_importances = pd.DataFrame({'Feature': X.columns, 'Importance':␣
↪best_model.feature_importances_})
feature_importances = feature_importances.sort_values(by='Importance',␣
↪ascending=False)

plt.figure(figsize=(10, 6))
sns.barplot(x='Importance', y='Feature', data=feature_importances)
plt.title('Feature Importance')
plt.show()
```



[114]:
```
# Function to predict churn for new data
def predict_churn(new_data):
    new_data = pd.DataFrame(new_data)
    new_data[['tenure', 'MonthlyCharges', 'TotalCharges']] = scaler.
↪transform(new_data[['tenure', 'MonthlyCharges', 'TotalCharges']])
    return best_model.predict(new_data)

# Example new customer data
new_customer = {
    'gender': [1],
    'SeniorCitizen': [0],
    'Partner': [1],
    'Dependents': [0],
    'tenure': [12],
    'PhoneService': [1],
    'PaperlessBilling': [1],
    'MonthlyCharges': [50.0],
    'TotalCharges': [600.0],
    'Contract_One year': [0],
    'Contract_Two year': [1],
    'InternetService_Fiber optic': [1],
    'InternetService_No': [0],
    'PaymentMethod_Credit card (automatic)': [0],
    'PaymentMethod_Electronic check': [1],
    'PaymentMethod_Mailed check': [0],
    'MultipleLines_No phone service': [0],
    'MultipleLines_Yes': [1],
    'OnlineSecurity_No internet service': [0],
    'OnlineSecurity_Yes': [1],
    'OnlineBackup_No internet service': [0],
    'OnlineBackup_Yes': [1],
    'DeviceProtection_No internet service': [0],
    'DeviceProtection_Yes': [1],
    'TechSupport_No internet service': [0],
    'TechSupport_Yes': [1],
    'StreamingTV_No internet service': [0],
    'StreamingTV_Yes': [1],
    'StreamingMovies_No internet service': [0],
    'StreamingMovies_Yes': [1]
}

# Convert to DataFrame and predict
new_customer_df = pd.DataFrame(new_customer)
prediction = predict_churn(new_customer_df)

# Print prediction result
print("Predicted Churn:", "Yes" if prediction[0] == 1 else "No")
```

```
Predicted Churn: No
```

— Interpretation and Actionable Insights — 1. High Monthly Charges and Low Tenure are strong indicators of churn. - Action: Offer discounts or loyalty programs to retain customers early. 2. Customers with No Internet Service are less likely to churn. - Action: Focus retention efforts on high-risk segments like fiber-optic users. 3. Paperless Billing and Electronic Check payment methods correlate with higher churn. - Action: Encourage automatic payments or credit card-based payments to reduce churn.

[117]:
```
# Display the processed dataset info
df.info()
df.head()
```

```
<class 'pandas.core.frame.DataFrame'>
```

```
RangeIndex: 7043 entries, 0 to 7042
Data columns (total 31 columns):
 #   Column                                 Non-Null Count  Dtype
---  ------                                 --------------  -----
 0   gender                                 7043 non-null   int64
 1   SeniorCitizen                          7043 non-null   int32
 2   Partner                                7043 non-null   int64
 3   Dependents                             7043 non-null   int64
 4   tenure                                 7043 non-null   float64
 5   PhoneService                           7043 non-null   int64
 6   PaperlessBilling                       7043 non-null   int64
 7   MonthlyCharges                         7043 non-null   float64
 8   TotalCharges                           7043 non-null   float64
 9   Churn                                  7043 non-null   int64
 10  Contract_One year                      7043 non-null   bool
 11  Contract_Two year                      7043 non-null   bool
 12  InternetService_Fiber optic            7043 non-null   bool
 13  InternetService_No                     7043 non-null   bool
 14  PaymentMethod_Credit card (automatic)  7043 non-null   bool
 15  PaymentMethod_Electronic check         7043 non-null   bool
 16  PaymentMethod_Mailed check             7043 non-null   bool
 17  MultipleLines_No phone service         7043 non-null   bool
 18  MultipleLines_Yes                      7043 non-null   bool
 19  OnlineSecurity_No internet service     7043 non-null   bool
 20  OnlineSecurity_Yes                     7043 non-null   bool
 21  OnlineBackup_No internet service       7043 non-null   bool
 22  OnlineBackup_Yes                       7043 non-null   bool
 23  DeviceProtection_No internet service   7043 non-null   bool
 24  DeviceProtection_Yes                   7043 non-null   bool
 25  TechSupport_No internet service        7043 non-null   bool
 26  TechSupport_Yes                        7043 non-null   bool
 27  StreamingTV_No internet service        7043 non-null   bool
 28  StreamingTV_Yes                        7043 non-null   bool
 29  StreamingMovies_No internet service    7043 non-null   bool
 30  StreamingMovies_Yes                    7043 non-null   bool
dtypes: bool(21), float64(3), int32(1), int64(6)
memory usage: 667.3 KB
```

[117]:
```
   gender  SeniorCitizen  Partner  Dependents    tenure  PhoneService  \
0       0              0        1           0 -1.277445             0
1       1              0        0           0  0.066327             1
2       1              0        0           0 -1.236724             1
3       1              0        0           0  0.514251             0
4       0              0        0           0 -1.236724             1

   PaperlessBilling  MonthlyCharges  TotalCharges  Churn  …  \
0                 1       -1.160323     -0.994242      0  …
```

```
1                  0       -0.259629     -0.173244      0  …
2                  1       -0.362660     -0.959674      1  …
3                  0       -0.746535     -0.194766      0  …
4                  1        0.197365     -0.940470      1  …

   OnlineBackup_No internet service  OnlineBackup_Yes  \
0                             False              True
1                             False             False
2                             False              True
3                             False             False
4                             False             False

   DeviceProtection_No internet service  DeviceProtection_Yes  \
0                                 False                 False
1                                 False                  True
2                                 False                 False
3                                 False                  True
4                                 False                 False

   TechSupport_No internet service  TechSupport_Yes  \
0                            False            False
1                            False            False
2                            False            False
3                            False             True
4                            False            False

   StreamingTV_No internet service  StreamingTV_Yes  \
0                            False            False
1                            False            False
2                            False            False
3                            False            False
4                            False            False

   StreamingMovies_No internet service  StreamingMovies_Yes
0                                False                False
1                                False                False
2                                False                False
3                                False                False
4                                False                False

[5 rows x 31 columns]
```