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


data = pd.read_csv("churn_data_te.csv")


data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 64374 entries, 0 to 64373
Data columns (total 12 columns):
 #   Column             Non-Null Count  Dtype
---  ------             --------------  -----
 0   CustomerID         64374 non-null  int64
 1   Age                64374 non-null  int64
 2   Gender             64374 non-null  object
 3   Tenure             64374 non-null  int64
 4   Usage Frequency    64374 non-null  int64
 5   Support Calls      64374 non-null  int64
 6   Payment Delay      64374 non-null  int64
 7   Subscription Type  64374 non-null  object
 8   Contract Length    64374 non-null  object
 9   Total Spend        64374 non-null  int64
 10  Last Interaction   64374 non-null  int64
 11  Churn              64374 non-null  int64
dtypes: int64(9), object(3)
memory usage: 5.9+ MB
```

```
data.head()
```

	CustomerID	Age	Gender	Tenure	Usage Frequency	Support Calls	Payment Delay	Subscription Type	Contract Length	Total Spend	Last Interaction	Churn
0	1	22	Female	25	14	4	27	Basic	Monthly	598	9	1
1	2	41	Female	28	28	7	13	Standard	Monthly	584	20	0
2	3	47	Male	27	10	2	29	Premium	Annual	757	21	0
3	4	35	Male	9	12	5	17	Premium	Quarterly	232	18	0

```
data.tail()
```

	CustomerID	Age	Gender	Tenure	Usage Frequency	Support Calls	Payment Delay	Subscription Type	Contract Length	Total Spend	Last Interaction	Churn
64369	64370	45	Female	33	12	6	21	Basic	Quarterly	947	14	1
64370	64371	37	Male	6	1	5	22	Standard	Annual	923	9	1
64371	64372	25	Male	39	14	8	30	Premium	Monthly	327	20	1
64372	64373	50	Female	18	19	7	22	Standard	Monthly	540	13	1

```
data.isnull().sum()
```

```
CustomerID           0
Age                  0
Gender               0
Tenure               0
Usage Frequency      0
Support Calls        0
Payment Delay        0
Subscription Type    0
Contract Length      0
Total Spend          0
Last Interaction     0
Churn                0
dtype: int64
```

```
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder, StandardScaler
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import classification_report, accuracy_score, confusion_matrix
```

```
# Detect object columns (categorical)
categorical_cols = data.select_dtypes(include='object').columns
print("Columns that need encoding:", categorical_cols.tolist())
```

```
Columns that need encoding: []
```

```
label_encoders = {}
for column in data.select_dtypes(include='object').columns:
    le = LabelEncoder()
    data[column] = le.fit_transform(data[column])
    label_encoders[column] = le
```

```
X = data.drop('Churn', axis=1)
y = data['Churn']
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

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

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

```
LogisticRegression
LogisticRegression()
```

```
y_pred = model.predict(X_test)

print("Accuracy:", accuracy_score(y_test, y_pred))
```

```
Accuracy: 0.8653980582524272
```

```
print("Confusion Matrix:\n", confusion_matrix(y_test, y_pred))
```

```
Confusion Matrix:
 [[5929  864]
 [ 869 5213]]
```

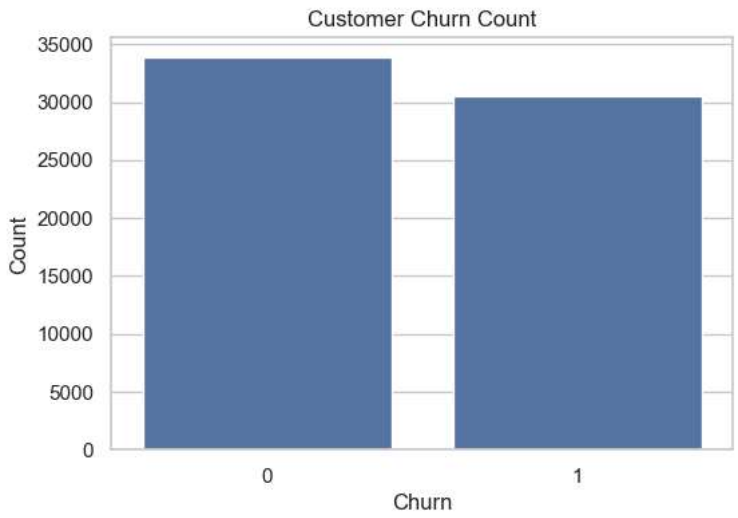
```
print("Classification Report:\n", classification_report(y_test, y_pred))
```

```
Classification Report:
                  precision    recall  f1-score   support

               0       0.87      0.87      0.87      6793
               1       0.86      0.86      0.86      6082

        accuracy                           0.87     12875
       macro avg       0.86      0.86      0.86     12875
    weighted avg       0.87      0.87      0.87     12875
```

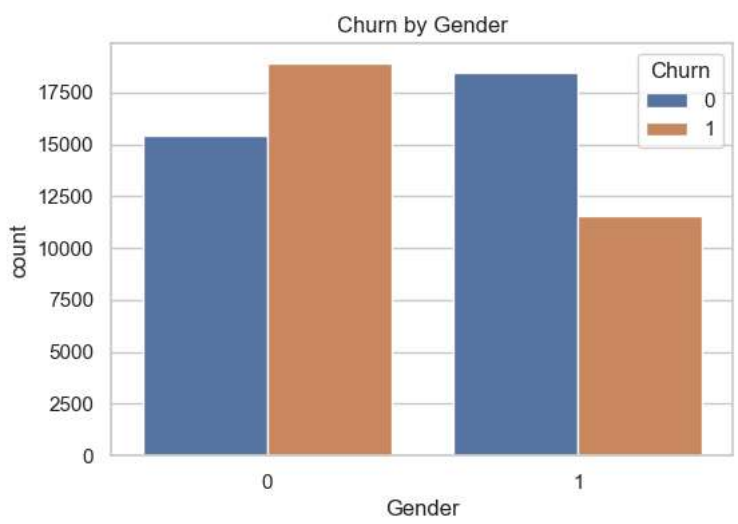
```
import seaborn as sns
```

```
sns.set(style="whitegrid")
```

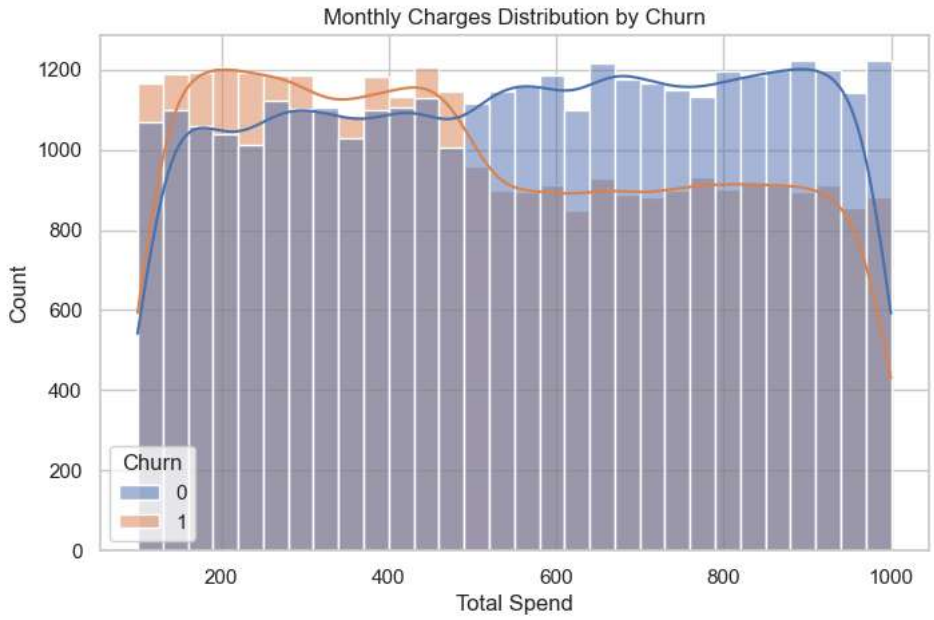
```
plt.figure(figsize=(6, 4))
sns.countplot(data=data, x='Churn')
plt.title('Customer Churn Count')
plt.xlabel('Churn')
plt.ylabel('Count')
plt.show()
```



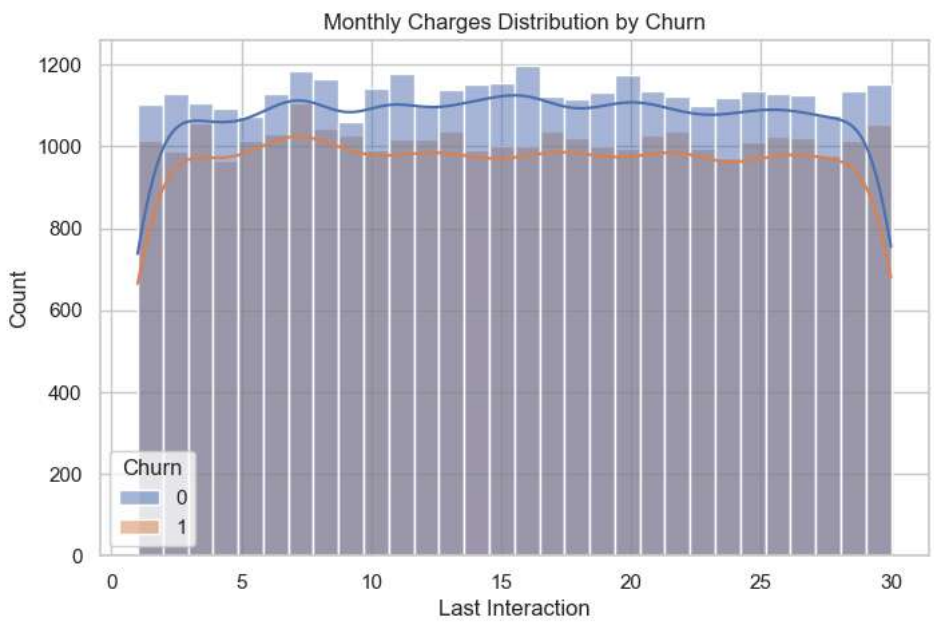

```
plt.figure(figsize=(6, 4))
sns.countplot(data=data, x='Gender', hue='Churn')
plt.title('Churn by Gender')
plt.show()
```



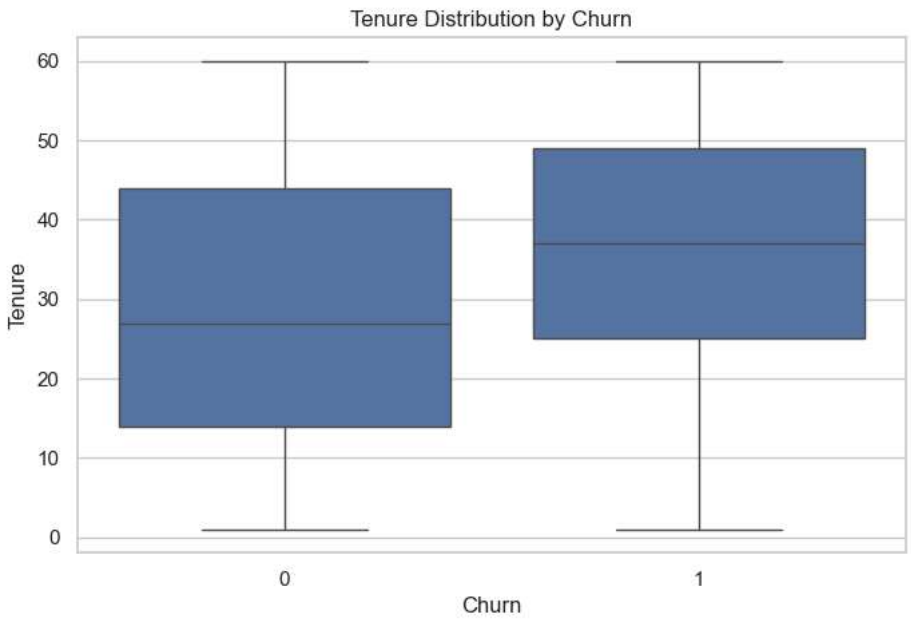

```
plt.figure(figsize=(8, 5))
sns.histplot(data=data, x='Total Spend', hue='Churn', kde=True, bins=30)
plt.title('Monthly Charges Distribution by Churn')
plt.show()
```



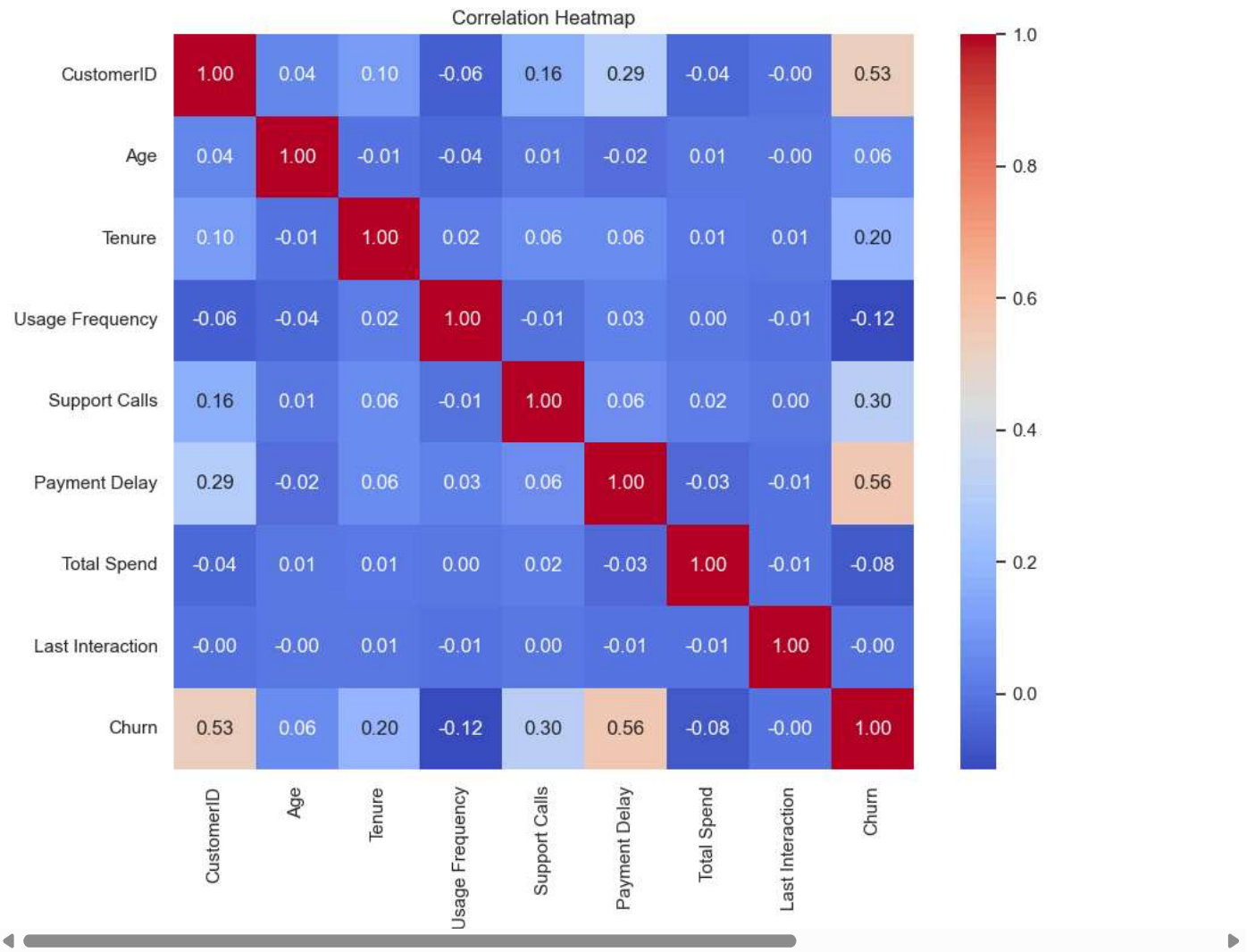

```
plt.figure(figsize=(8, 5))
sns.histplot(data=data, x='Last Interaction', hue='Churn', kde=True, bins=30)
plt.title('Monthly Charges Distribution by Churn')
plt.show()
```



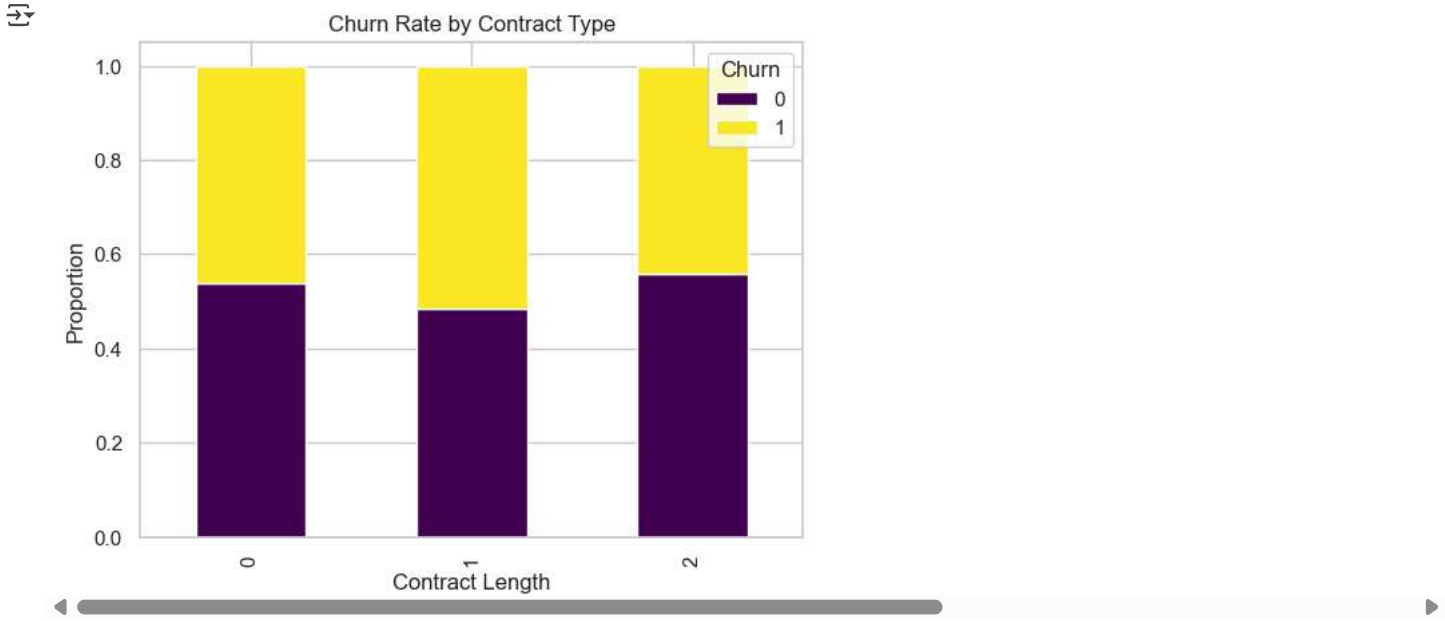

```
plt.figure(figsize=(8, 5))
sns.boxplot(data=data, x='Churn', y='Tenure')
plt.title('Tenure Distribution by Churn')
plt.show()
```



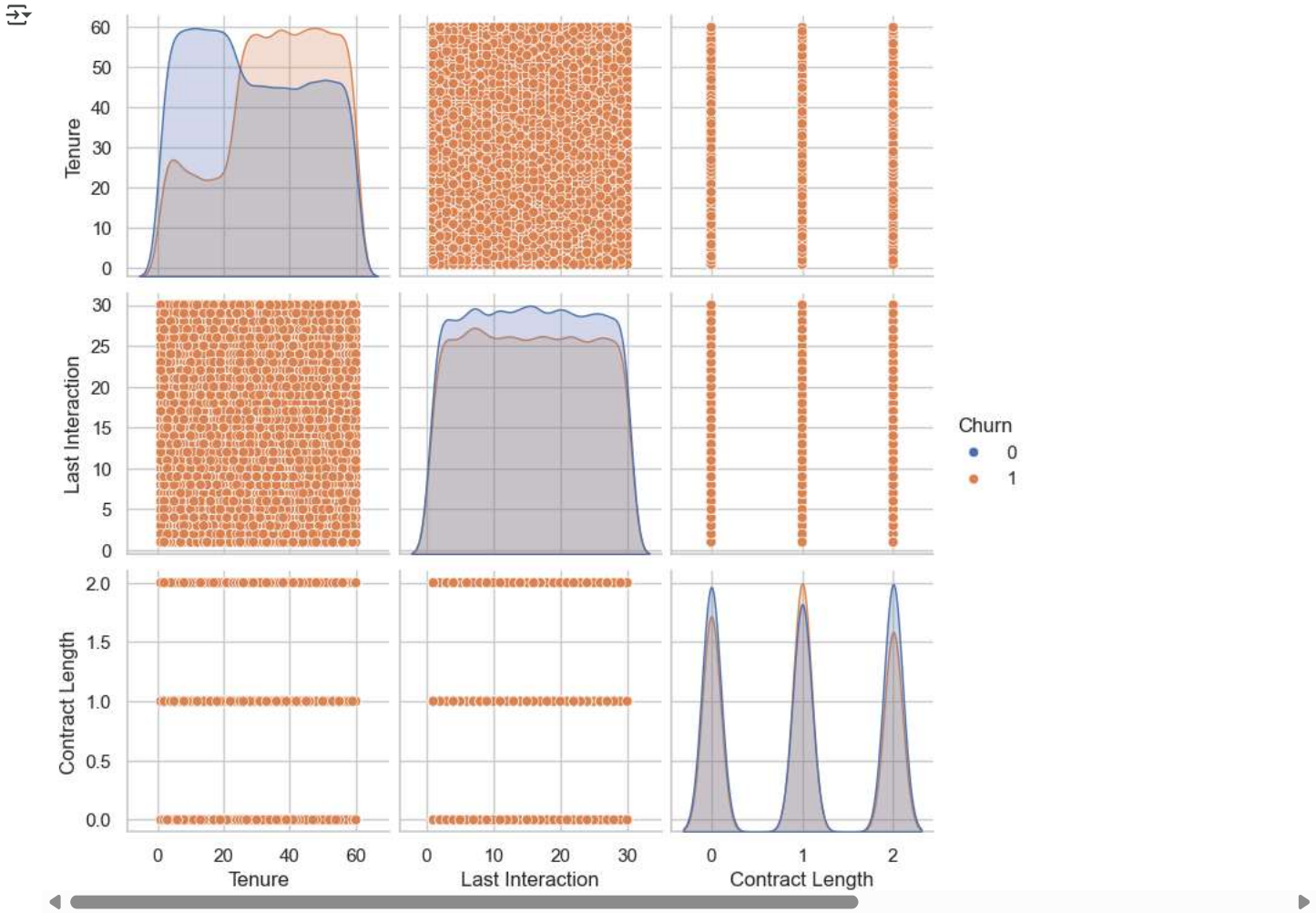

```
plt.figure(figsize=(10, 8))
corr = data.select_dtypes(include=['float64', 'int64']).corr()
sns.heatmap(corr, annot=True, fmt=".2f", cmap='coolwarm')
plt.title('Correlation Heatmap')
plt.show()
```



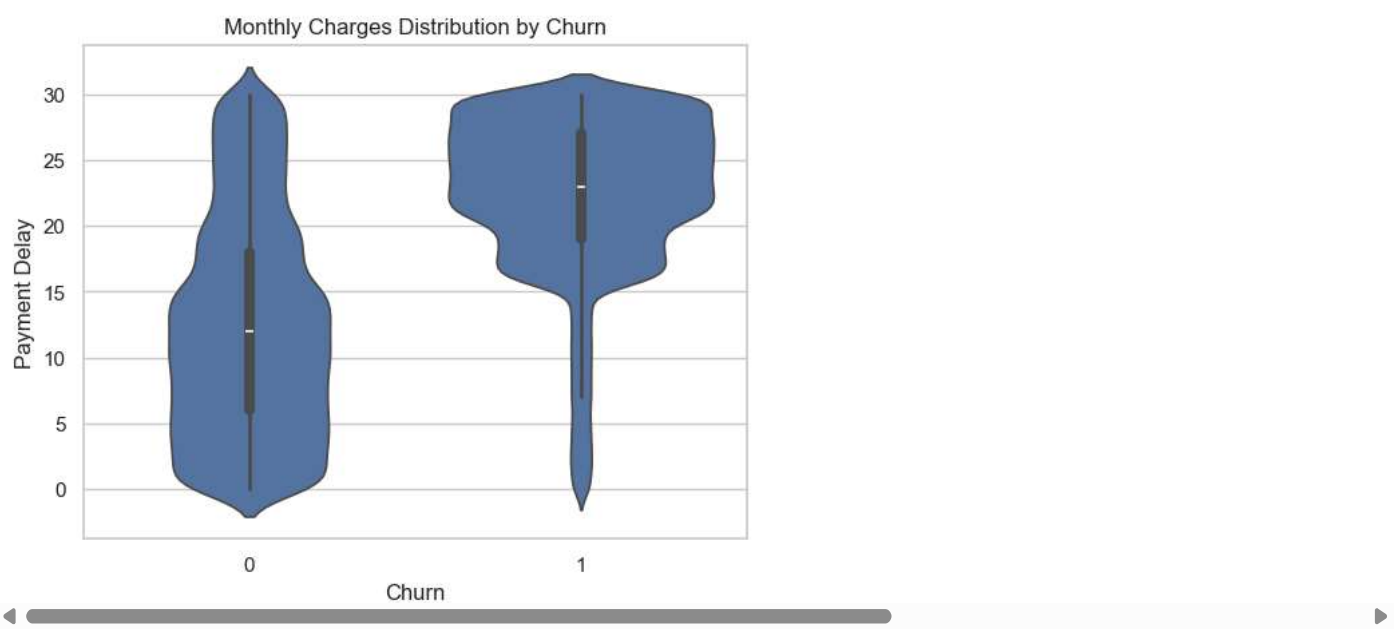
```
contract_churn = pd.crosstab(data['Contract Length'], data['Churn'], normalize='index')
contract_churn.plot(kind='bar', stacked=True, colormap='viridis')
plt.title('Churn Rate by Contract Type')
plt.ylabel('Proportion')
plt.show()
```



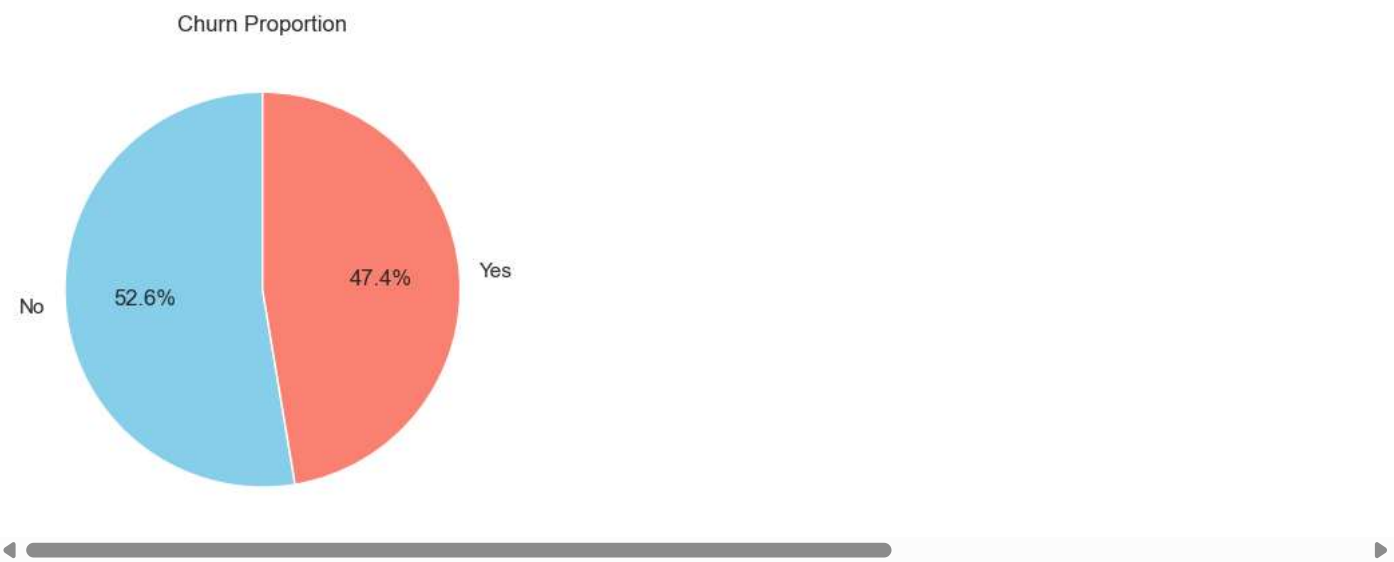

```
sns.pairplot(data[['Tenure', 'Last Interaction', 'Contract Length', 'Churn']], hue='Churn', diag_kind='kde')
plt.show()
```



```
sns.violinplot(x='Churn', y='Payment Delay', data=data)
plt.title('Monthly Charges Distribution by Churn')
plt.show()
```




```
data['Churn'].value_counts().plot.pie(autopct='%1.1f%%', startangle=90, labels=['No', 'Yes'], colors=['skyblue', 'salmon'])
plt.title('Churn Proportion')
plt.ylabel('')
plt.show()
```




```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder, StandardScaler
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import classification_report, confusion_matrix
```

```
data.dropna(inplace=True)
X = data.drop('Churn', axis=1)
y = data['Churn']


X = pd.get_dummies(X, drop_first=True)


X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)


model = RandomForestClassifier(n_estimators=100, random_state=42)
model.fit(X_train, y_train)
```

```
RandomForestClassifier
RandomForestClassifier(random_state=42)
```

```
y_pred = model.predict(X_test)
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

           0       1.00      1.00      1.00      6793
           1       1.00      1.00      1.00      6082

    accuracy                           1.00     12875
   macro avg       1.00      1.00      1.00     12875
weighted avg       1.00      1.00      1.00     12875
```

```
from sklearn.metrics import accuracy_score, confusion_matrix, classification_report

# Predict on the test set
y_pred = model.predict(X_test)


accuracy = accuracy_score(y_test, y_pred)
print("Accuracy:", accuracy)
```

```
Accuracy: 0.9979029126213592
```

```
conf_matrix = confusion_matrix(y_test, y_pred)
print("Confusion Matrix:\n", conf_matrix)
```

```
Confusion Matrix:
 [[6793    0]
 [  27 6055]]
```

```
print("Classification Report:\n", classification_report(y_test, y_pred))
```

```
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00      6793
           1       1.00      1.00      1.00      6082

    accuracy                           1.00     12875
   macro avg       1.00      1.00      1.00     12875
weighted avg       1.00      1.00      1.00     12875
```

```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import accuracy_score, classification_report
from sklearn.svm import SVC
from sklearn.neighbors import KNeighborsClassifier
from xgboost import XGBClassifier


X = data.drop("Churn", axis=1)
y = data["Churn"]


X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

```
Start coding or generate with AI.
```

```
Start coding or generate with AI.
```

```
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)
```

```
svm_model = SVC()
```

```
knn_model = KNeighborsClassifier()
```

```
xgb_model = XGBClassifier(use_label_encoder=False, eval_metric='logloss', verbosity=0)
```

```
svm_model.fit(X_train_scaled, y_train)
```

```
SVC()
```

```
knn_model.fit(X_train_scaled, y_train)
```

```
KNeighborsClassifier()
```

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

```
XGBClassifier(base_score=None, booster=None, callbacks=None,
              colsample_bylevel=None, colsample_bynode=None,
              colsample_bytree=None, device=None, early_stopping_rounds=None,
              enable_categorical=False, eval_metric='logloss',
              feature_types=None, feature_weights=None, gamma=None,
              grow_policy=None, importance_type=None,
              interaction_constraints=None, learning_rate=None, max_bin=None,
              max_cat_threshold=None, max_cat_to_onehot=None,
              max_delta_step=None, max_depth=None, max_leaves=None,
              min_child_weight=None, missing=nan, monotone_constraints=None,
              multi_strategy=None, n_estimators=None, n_jobs=None,
```

```
svm_preds = svm_model.predict(X_test_scaled)
knn_preds = knn_model.predict(X_test_scaled)
xgb_preds = xgb_model.predict(X_test)
```

```
print("SVM Accuracy:", accuracy_score(y_test, svm_preds))
print("SVM Report:\n", classification_report(y_test, svm_preds))
```

```
SVM Accuracy: 0.958368932038835
SVM Report:
                precision    recall  f1-score   support

           0       0.96      0.96      0.96      6793
           1       0.96      0.95      0.96      6082

    accuracy                           0.96     12875
   macro avg       0.96      0.96      0.96     12875
weighted avg       0.96      0.96      0.96     12875
```

```
print("KNN Accuracy:", accuracy_score(y_test, knn_preds))
print("KNN Report:\n", classification_report(y_test, knn_preds))
```

```
KNN Accuracy: 0.930873786407767
KNN Report:
                precision    recall  f1-score   support
```

```
0       0.93      0.94      0.93      6793
1       0.93      0.93      0.93      6082
```