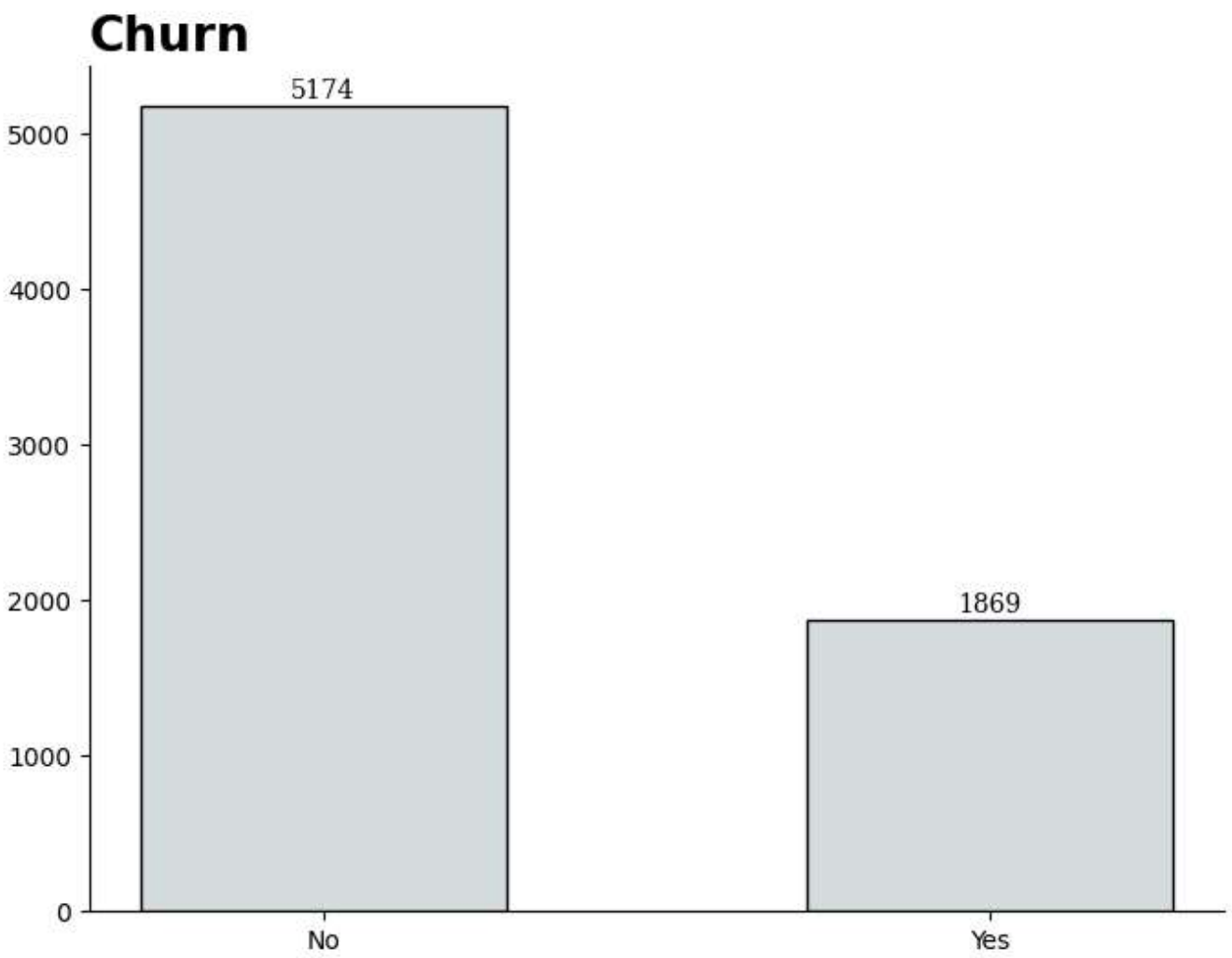
```
import numpy as np
import pandas as pd
# Data Visualization
import seaborn as sn
import matplotlib.pyplot as plt
# K-Means Cluster
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import OrdinalEncoder
encoder = OrdinalEncoder()
from sklearn.cluster import KMeans
import scipy.stats as stats
import matplotlib.pyplot as plt
import math


df = pd.read_csv("/content/WA_Fn-UseC_-Telco-Customer-Churn.csv")


df.head(2)
df["SeniorCitizen"]= df["SeniorCitizen"].map({0: "No", 1: "Yes"})


df.isnull().sum(axis = 0)
```

```
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
```

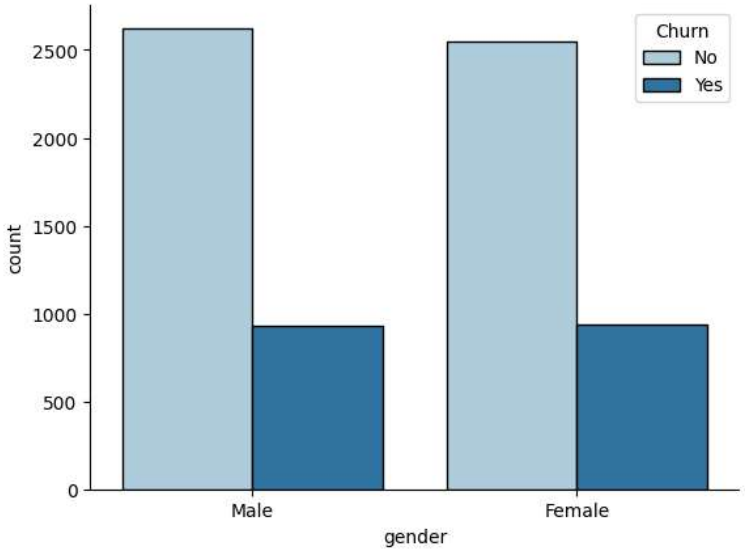
```
print(f'This dataset contains infomation on {df.shape[0]} customers and {df.shape[1]} attri
```

```
This dataset contains infomation on 7043 customers and 21 attributes, with NO missing v
```

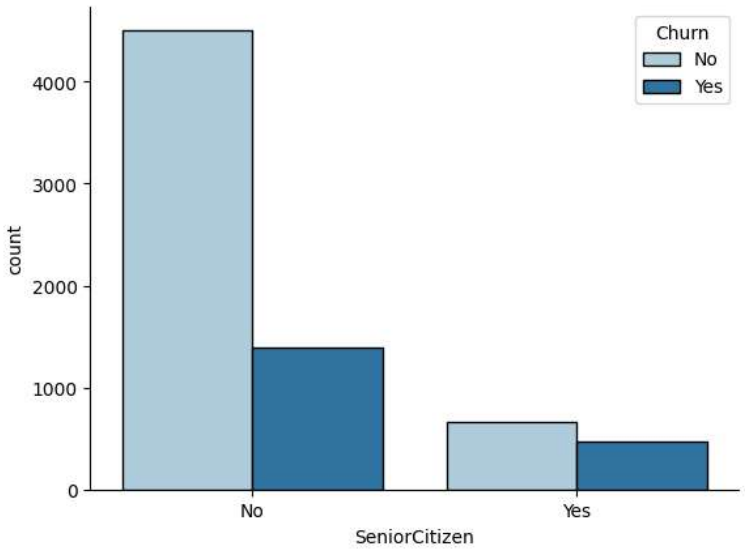
```
#Visualizing our dataset


#churn



fig, ax = plt.subplots(1,1, figsize=(8, 6))
data_temp = df['Churn'].value_counts().sort_index()
ax.bar(data_temp.index, data_temp,
          edgecolor='black', color='#d4dddd',
          width=0.55 )
ax.set_title('Churn', loc='left', fontsize=19, fontweight='bold')
for i in data_temp.index:
    ax.annotate(f"{data_temp[i]}",
                   xy=(i, data_temp[i] + 100),

                   va = 'center', ha='center',fontweight='light', fontfamily='serif',
                   color='black')
for s in ['top', 'right']:
    ax.spines[s].set_visible(False)
```



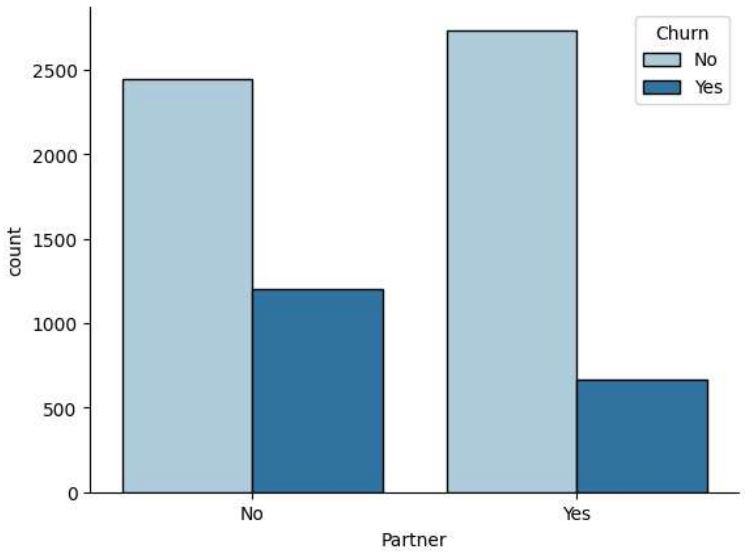
```
def CountPlot_Table (feature):
    # Create Count Plot for Churn Vs Feature
    sn.countplot(x=feature, hue="Churn", data=df, palette="Paired", edgecolor = 'Black', or
    sn.despine()
    # Create a plot for proportions
    temp_table = pd.DataFrame(round(df.groupby(feature)['Churn'].value_counts(normalize = T
    table = plt.table(cellText=temp_table.values,
          rowLabels=temp_table.index,
          colLabels=temp_table.columns,
          bbox=(1.5, 0,0.4 , 0.45))
    table.auto_set_font_size(False)
    table.set_fontsize(12)
    plt.show()


demo_features = ['gender','SeniorCitizen','Partner','Dependents']
for feature in demo_features:
    CountPlot_Table(feature)
```



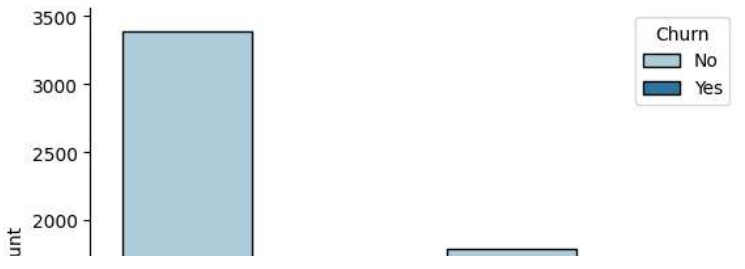
	Churn
('Female', 'No')	0.7308
('Female', 'Yes')	0.2692
('Male', 'No')	0.7384
('Male', 'Yes')	0.2616



	Churn
('No', 'No')	0.7639
('No', 'Yes')	0.2361
('Yes', 'No')	0.5832
('Yes', 'Yes')	0.4168

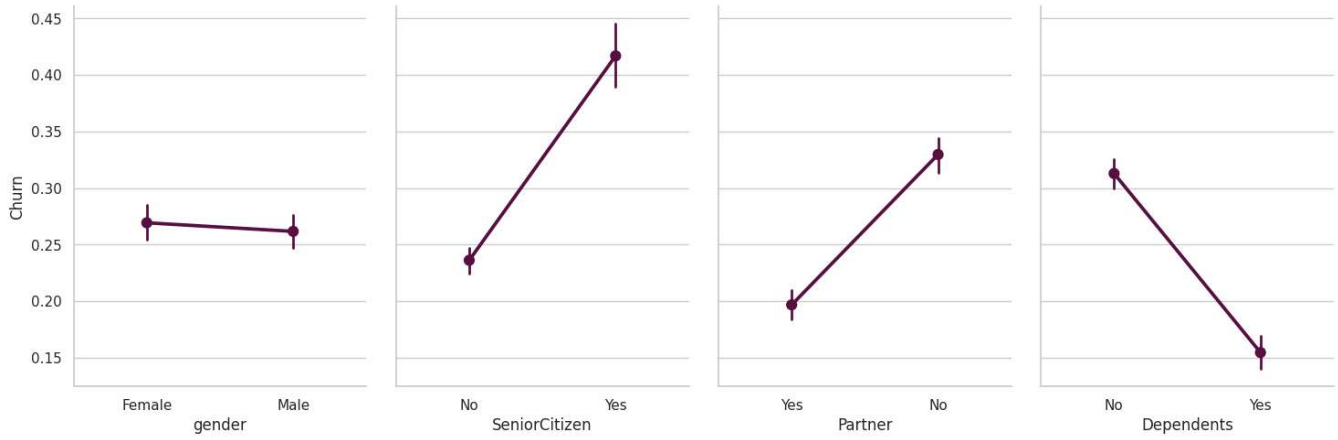


	Churn
('No', 'No')	0.6704
('No', 'Yes')	0.3296
('Yes', 'No')	0.8034
('Yes', 'Yes')	0.1966



```
df2 =df.copy()
df2["Churn"]= df2["Churn"].map({"No" : 0 , "Yes": 1})
sn.set_theme(style ='whitegrid')
g=sn.PairGrid(df2, y_vars = 'Churn',
              x_vars = ['gender','SeniorCitizen','Partner','Dependents'], height = 5, aspect
g.map(sn.pointplot, scale = 1, errwidth =2, color = 'xkcd:plum')
```

```
<seaborn.axisgrid.PairGrid at 0x7946079c5810>
```




```
import numpy as np
import pandas as pd
import scipy.stats as stats
import matplotlib.pyplot as plt
import math

Male_Churn = df2[df2["gender"] == 'Male'].Churn
Female_Churn = df2[df2["gender"] == 'Female'].Churn

t_statstics = stats.ttest_ind(a= Male_Churn,
                b= Female_Churn,
                equal_var=False)    # Assume samples have equal variance?
t_statstics
```

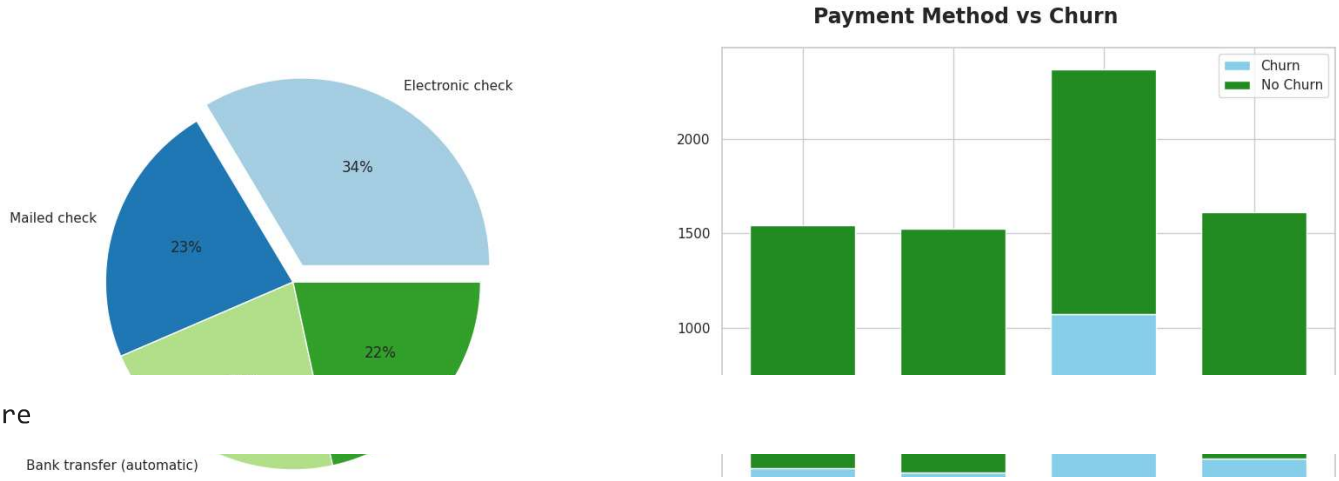
```
TtestResult(statistic=-0.7226104987857616, pvalue=0.4699432354173566,
df=7035.411941818457)
```

```
Dependents_No = df2[df2["Dependents"] == 'No'].Churn
Dependents_Yes = df2[df2["Dependents"] == 'Yes'].Churn

t_statstics1 = stats.ttest_ind(a= Dependents_No, b= Dependents_Yes, equal_var=False)
print(t_statstics1)
t_statstics2 = stats.ttest_ind(a= df2[df2["Partner"] == 'No'].Churn, b=  df2[df2["Partner"]
print(t_statstics2)
t_statstics3 = stats.ttest_ind(a= df2[df2["SeniorCitizen"] == 'No'].Churn, b=  df2[df2["Sen
print(t_statstics3)
```

```
TtestResult(statistic=15.409078802902004, pvalue=2.1775286391572522e-52, df=5051.620204
TtestResult(statistic=12.84172504320383, pvalue=2.5291143492203677e-37, df=6972.4985711
TtestResult(statistic=-11.58073209133662, pvalue=9.364391561685353e-30, df=1485.9754409
```

```
#Payment Method


data = df['PaymentMethod'].value_counts()
keys = df['PaymentMethod'].unique()

# declaring exploding pie
explode = [0.1, 0, 0, 0]
# define Seaborn color palette to use
palette_color = sn.color_palette('Paired')
# plotting data on chart

fig, ax = plt.subplots(1, 2, figsize=(20, 7))
ax[0].pie(data, labels=keys, colors=palette_color,
        explode=explode, autopct='%.0f%%')

# create data

yes_churn = [258, 232, 1071, 308]
no_churn = [1286, 1290,1294, 1304]
ax[1].bar(keys, yes_churn, label='Churn', color = 'skyblue',edgecolor='white', width = 0.7)
ax[1].bar(keys, no_churn, label='No Churn', bottom=yes_churn, color = 'forestgreen', edgeco
ax[1].legend()
fig.text(0.60, 0.92, 'Payment Method vs Churn', fontsize=17, fontweight='bold')
```

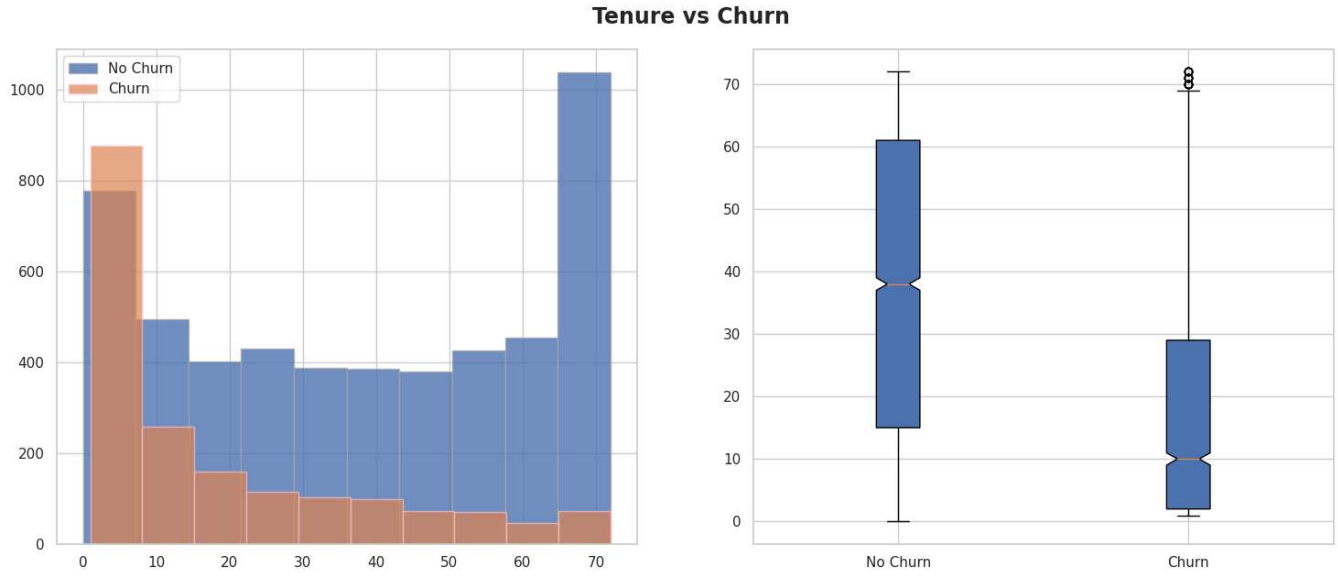
```
Text(0.6, 0.92, 'Payment Method vs Churn')
```



#Tenure

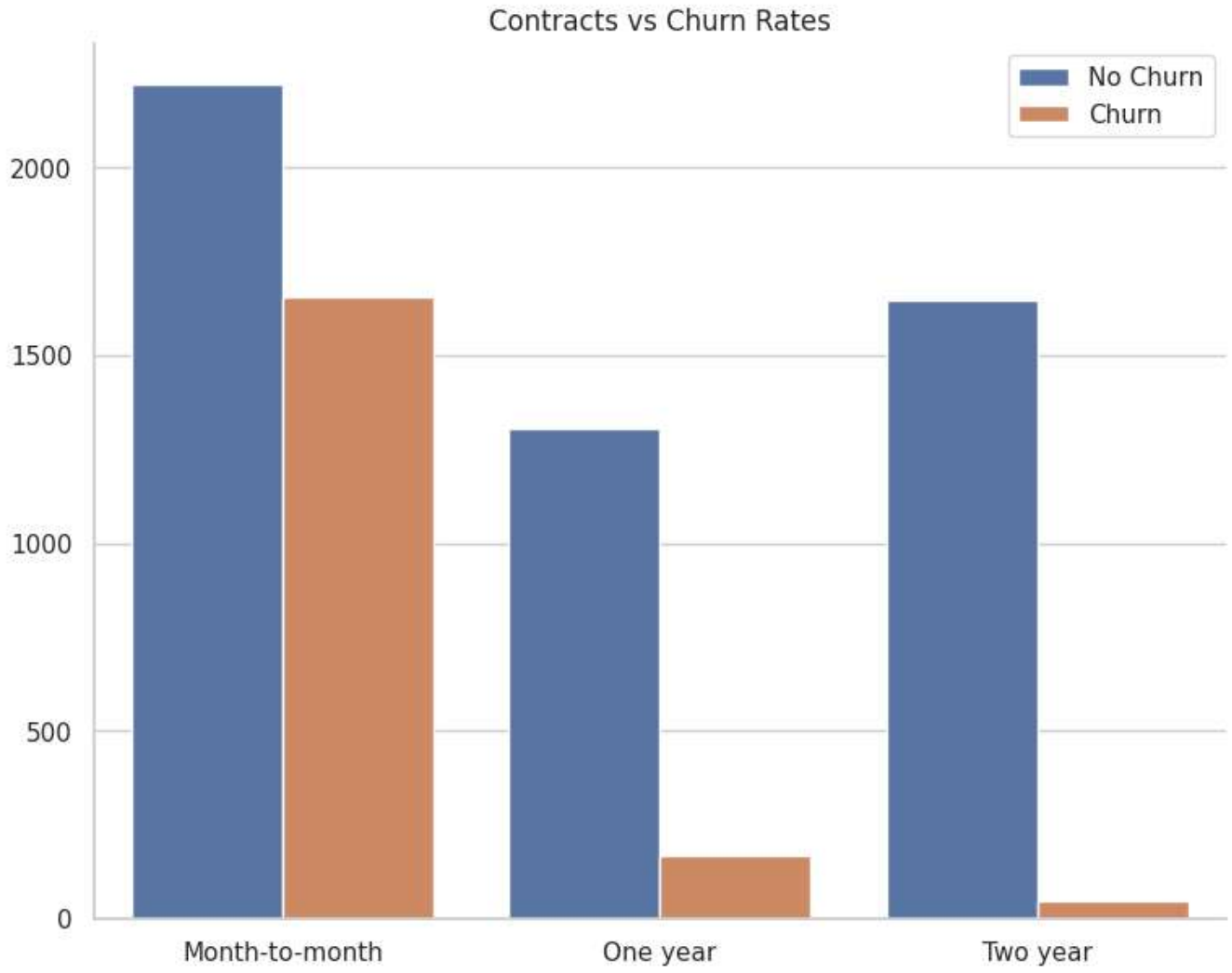
```
Churn_0 = df2[df2["Churn"] == 0]
Churn_1 = df2[df2["Churn"] == 1]
# plotting first histogram
fig, ax = plt.subplots(1, 2, figsize=(18, 7))
ax[0].hist(Churn_0.tenure, label='No Churn', alpha=.8, edgecolor='darkgrey')
# plotting second histogram
ax[0].hist(Churn_1.tenure, label='Churn', alpha=0.7, edgecolor='pink')
ax[0].legend()

columns = [Churn_0.tenure, Churn_1.tenure]
ax[1].boxplot(columns, notch=True, patch_artist=True)
plt.xticks([1, 2], ["No Churn", "Churn"])
fig.text(0.45, 0.92, 'Tenure vs Churn', fontsize=17, fontweight='bold')
```

```
Text(0.45, 0.92, 'Tenure vs Churn')
```



#Contracts

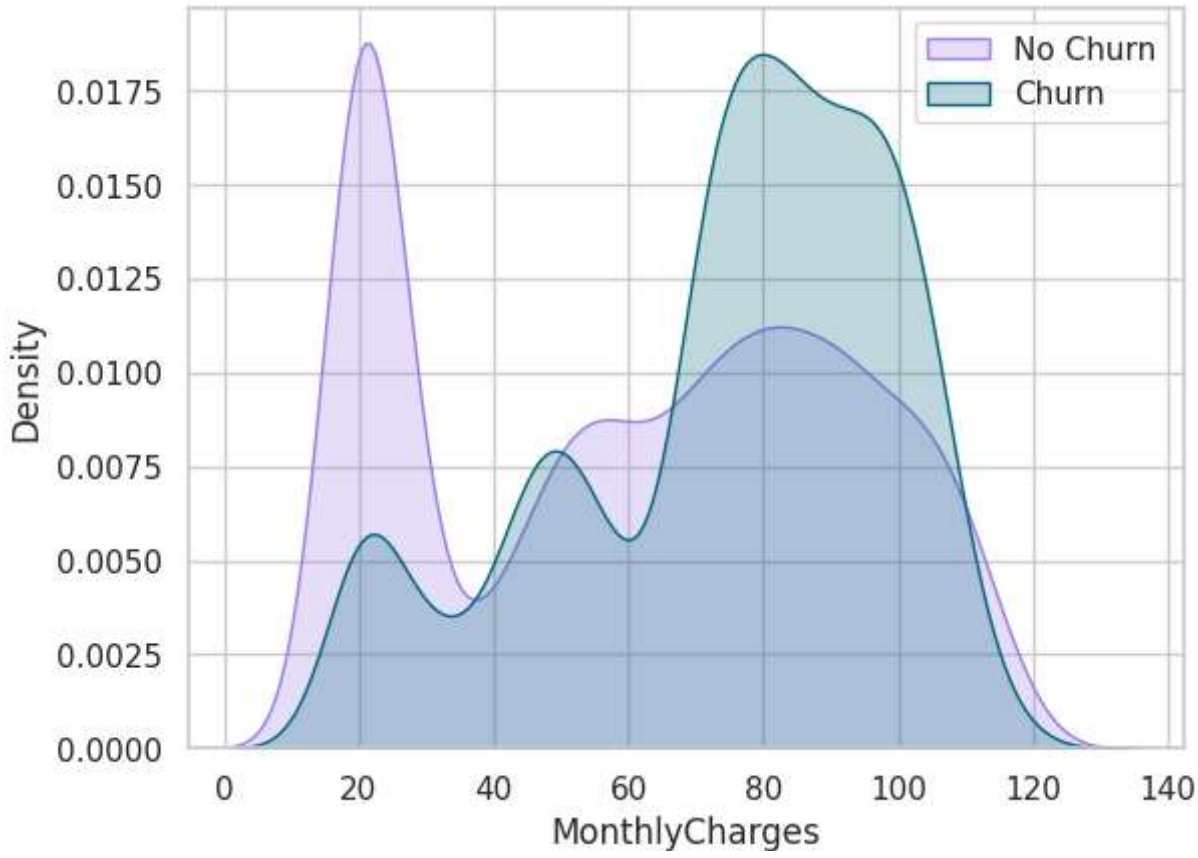
```
plt.figure(figsize=(9,7))
ax = sn.countplot(x="Contract", hue="Churn", data=df).set(title='Contracts vs Churn Rates',
sn.despine()
plt.legend(title='', loc='upper right', labels=['No Churn', 'Churn'])
plt.show(g)
```



#Monthly Charges

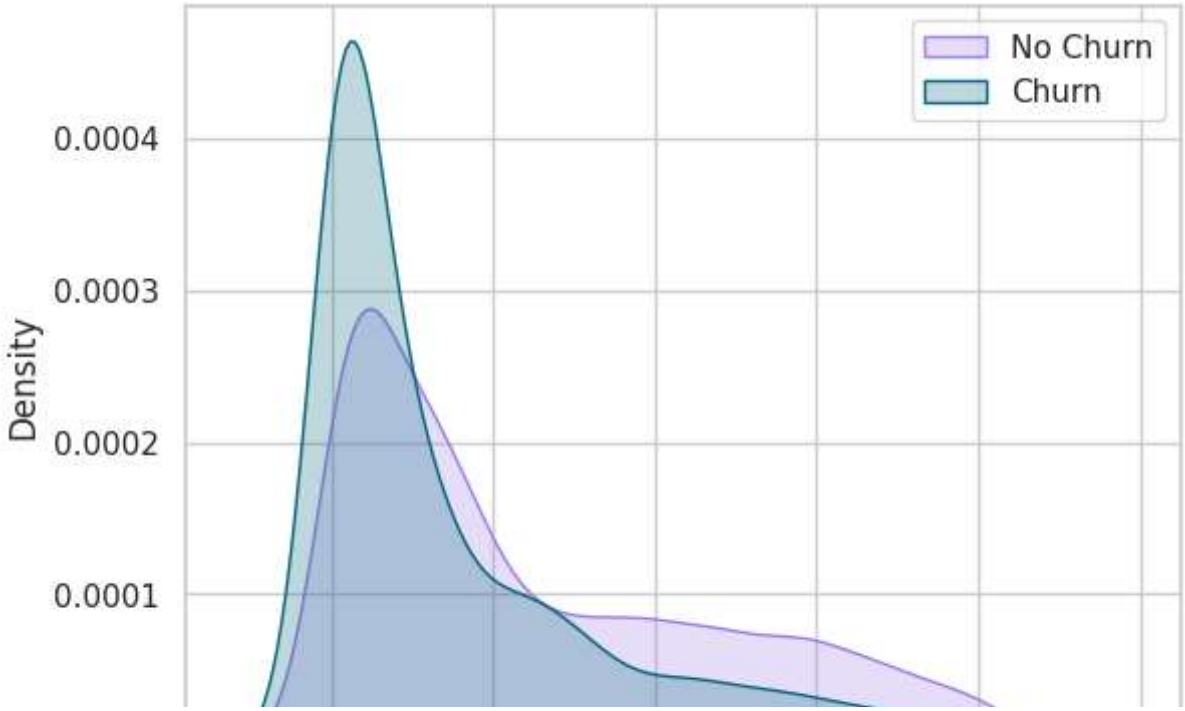
```
ax = sn.kdeplot(Churn_0.MonthlyCharges, color="#9C7FE8", shade = True)
ax = sn.kdeplot(Churn_1.MonthlyCharges, color="#00677C", shade = True)
ax.legend(["No Churn","Churn"],loc='upper right')
```

```
<ipython-input-49-7744798802cf>:1: FutureWarning:

`shade` is now deprecated in favor of `fill`; setting `fill=True`.
This will become an error in seaborn v0.14.0; please update your code.

  ax = sn.kdeplot(Churn_0.MonthlyCharges, color="#9C7FE8", shade = True)
<ipython-input-49-7744798802cf>:2: FutureWarning:

`shade` is now deprecated in favor of `fill`; setting `fill=True`.
This will become an error in seaborn v0.14.0; please update your code.

  ax = sn.kdeplot(Churn_1.MonthlyCharges, color="#00677C", shade = True)
<matplotlib.legend.Legend at 0x79460a857be0>
```

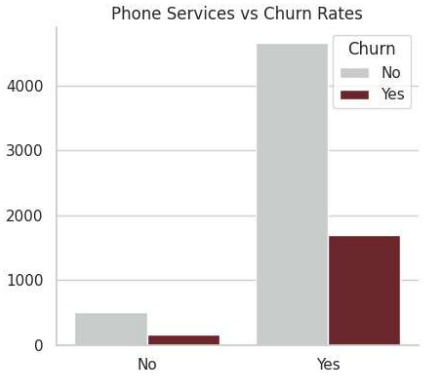


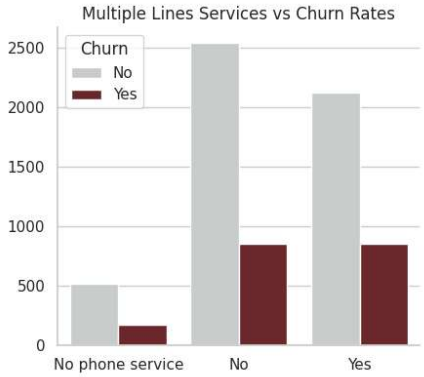

```
#Total Charges


pd.set_option('mode.chained_assignment', None)
Churn_0['TotalCharges'] = pd.to_numeric(Churn_0['TotalCharges'],errors = 'coerce')
Churn_1['TotalCharges'] = pd.to_numeric(Churn_1['TotalCharges'],errors = 'coerce')

ax = sn.kdeplot(Churn_0.TotalCharges, color="#9C7FE8", shade = True)
ax = sn.kdeplot(Churn_1.TotalCharges, color="#00677C", shade = True)
ax.legend(["No Churn","Churn"],loc='upper right')
```

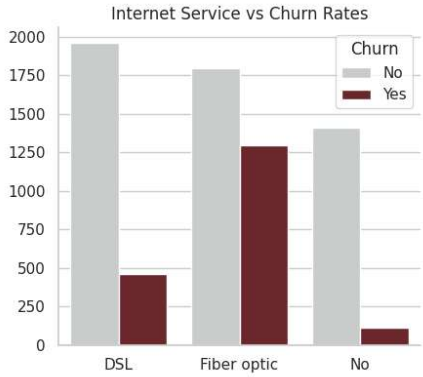
```
<ipython-input-52-2a2fdf0c3a21>:5: FutureWarning:

`shade` is now deprecated in favor of `fill`; setting `fill=True`.
This will become an error in seaborn v0.14.0; please update your code.

  ax = sn.kdeplot(Churn_0.TotalCharges, color="#9C7FE8", shade = True)
<ipython-input-52-2a2fdf0c3a21>:6: FutureWarning:

`shade` is now deprecated in favor of `fill`; setting `fill=True`.
This will become an error in seaborn v0.14.0; please update your code.

  ax = sn.kdeplot(Churn_1.TotalCharges, color="#00677C", shade = True)
<matplotlib.legend.Legend at 0x794606b99a50>
```

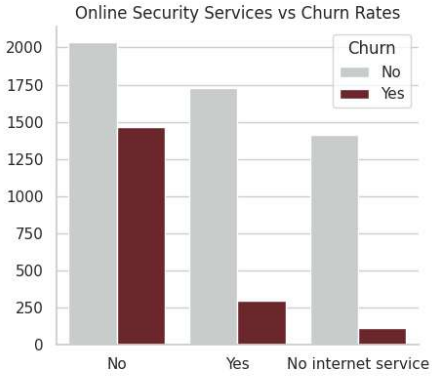


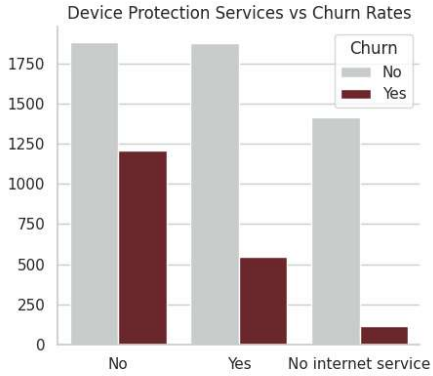

```
fig, axes = plt.subplots(nrows=3, ncols=3, figsize=(14,12))
# Gray for No Churn, highlight Churn!
colors = ["#C7CDCB", "#781B24"]
# Set custom color palette
sn.set_palette(sn.color_palette(colors))
# Graphing
sn.countplot(x="PhoneService", hue="Churn", data=df, ax=axes[0,0]).set(title='Phone Service
sn.countplot(x="MultipleLines", hue="Churn", data=df, ax=axes[0,1]).set(title='Multiple Lin
sn.countplot(x="InternetService", hue="Churn", data=df, ax=axes[0,2]).set(title='Internet S
sn.countplot(x="OnlineSecurity", hue="Churn", data=df, ax=axes[1,0]).set(title='Online Secu
sn.countplot(x="DeviceProtection", hue="Churn", data=df, ax=axes[1,1]).set(title='Device Pr
sn.countplot(x="TechSupport", hue="Churn", data=df, ax=axes[1,2]).set(title='Tech Support S
sn.countplot(x="StreamingTV", hue="Churn", data=df, ax=axes[2,0]).set(title='Streaming Tv S
sn.countplot(x="StreamingMovies", hue="Churn", data=df, ax=axes[2,1]).set(title='Streaming
sn.countplot(x="OnlineBackup", hue="Churn",data=df, ax=axes[2,2]).set(title='Online Back up
sn.despine()
plt.tight_layout()
plt.show()
```

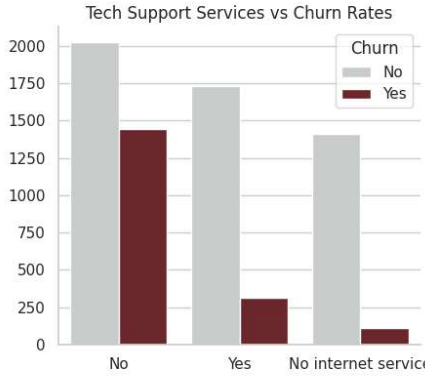

Phone Services vs Churn Rates
Churn
No
Yes
4000
3000
2000
1000
0
No
Yes

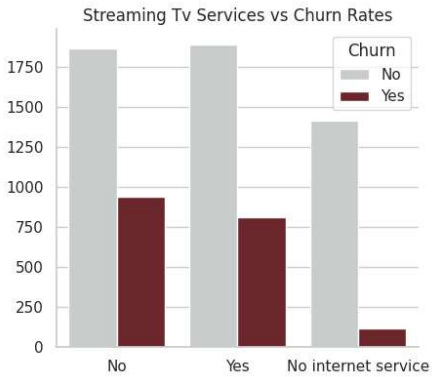

Multiple Lines Services vs Churn Rates
Churn
No
Yes
2500
2000
1500
1000
500
0
No phone service
No
Yes

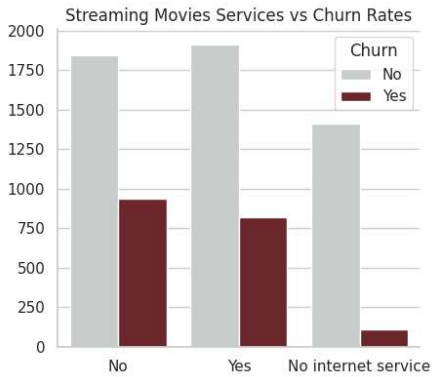

Internet Service vs Churn Rates
Churn
No
Yes
2000
1750
1500
1250
1000
750
500
250
0
DSL
Fiber optic
No

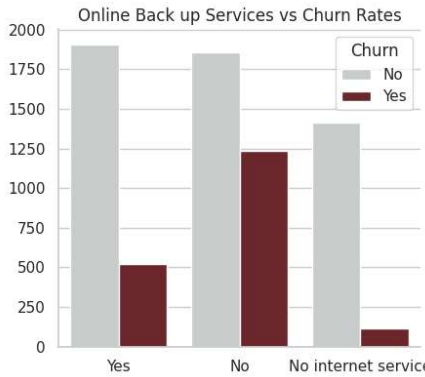

Online Security Services vs Churn Rates
Churn
No
Yes
2000
1750
1500
1250
1000
750
500
250
0
No
Yes
No internet service


Device Protection Services vs Churn Rates
Churn
No
Yes
1750
1500
1250
1000
750
500
250
0
No
Yes
No internet service


Tech Support Services vs Churn Rates
Churn
No
Yes
2000
1750
1500
1250
1000
750
500
250
0
No
Yes
No internet service


Streaming Tv Services vs Churn Rates
Churn
No
Yes
1750
1500
1250
1000
750
500
250
0
No
Yes
No internet service


Streaming Movies Services vs Churn Rates
Churn
No
Yes
2000
1750
1500
1250
1000
750
500
250
0
No
Yes
No internet service


Online Back up Services vs Churn Rates
Churn
No
Yes
2000
1750
1500
1250
1000
750
500
250
0
Yes
No
No internet service

```
## 1) Prepare Data
df_cluster = df.copy()
df_cluster = df_cluster.drop(['customerID', 'TotalCharges'], axis=1)
## Scale Tenure and Monthly Charges
scaler = StandardScaler()
df_cluster[['tenure', 'MonthlyCharges']] = scaler.fit_transform(df_cluster[['tenure', 'Mont

#Selecting all variables except tenure and Monthly Charges
df_cluster[df_cluster.columns[~df_cluster.columns.isin(['tenure','MonthlyCharges'])]] = enc


## 2) K-Means Clusters
def optimise_k_means(data, max_k):
    means = []
    inertias = []

    for k in range(1,max_k):
        kmeans = KMeans(n_clusters=k)
        kmeans.fit(data)
        means.append(k)
        inertias.append(kmeans.inertia_)

    fig = plt.subplots(figsize=(10, 7))
    plt.plot(means, inertias, 'o-', color = 'black')
    plt.xlabel("Number of Clusters")
    plt.ylabel("Inertia")
    plt.grid(True)
    plt.show()


optimise_k_means(df_cluster, 10)
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870: FutureWarning:
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870: FutureWarning:
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870: FutureWarning:
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/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870: FutureWarning:
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/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870: FutureWarning:
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870: FutureWarning:
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870: FutureWarning:
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870: FutureWarning:
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870: FutureWarning:
  warnings.warn(
```
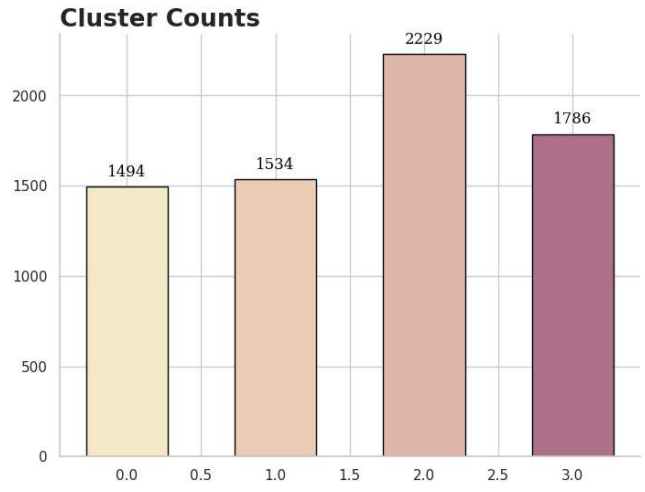
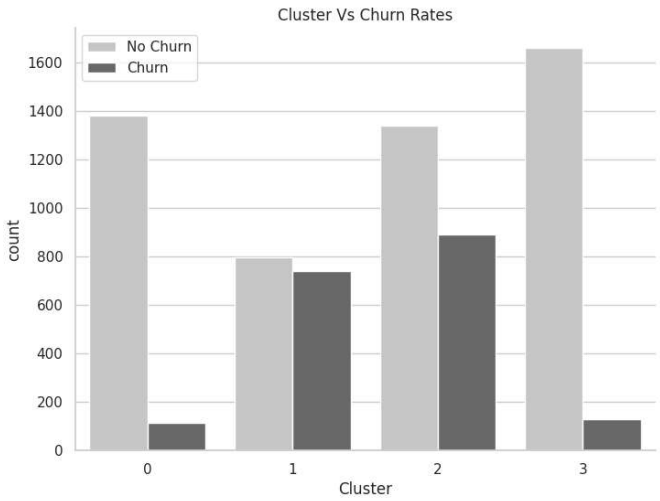


```
# K-Means cluster analysis
kmeans = KMeans(n_clusters = 4,  random_state=10)
kmeans.fit(df_cluster)
# Save cluster group as a column value in our data_frame
df_cluster['Cluster'] = kmeans.labels_
```

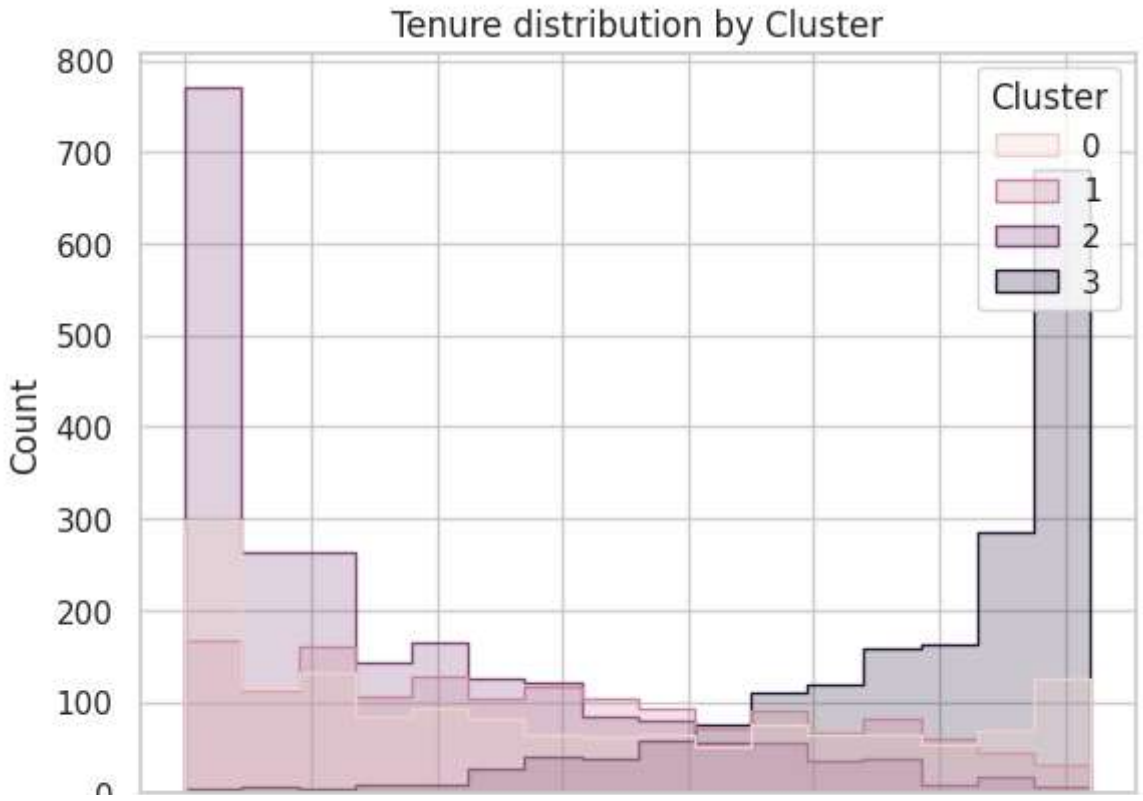
```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870: FutureWarning:
  warnings.warn(
```

```
# Cluster Counts
fig, ax = plt.subplots(1,2, figsize=(18, 6))
data_temp = df_cluster['Cluster'].value_counts().sort_index()
ax[0].bar(data_temp.index, data_temp,
          edgecolor='black', color=['#F5E8C7', '#ECCCB2', '#DEB6AB', '#AC7088']
       ,width=0.55 )
ax[0].set_title('Cluster Counts', loc='left', fontsize=19, fontweight='bold')
for i in data_temp.index:
    ax[0].annotate(f"{data_temp[i]}",
                   xy=(i, data_temp[i] + 80),
                   va = 'center', ha='center',fontweight='light', fontfamily='serif',
                   color='black')
for s in ['top', 'right']:
    ax[0].spines[s].set_visible(False)


sn.countplot(x='Cluster', hue="Churn", palette="Greys", data=df_cluster)
sn.despine()
plt.legend(title='', loc='upper left', labels=['No Churn', 'Churn'])
plt.title("Cluster Vs Churn Rates")
plt.show()
```

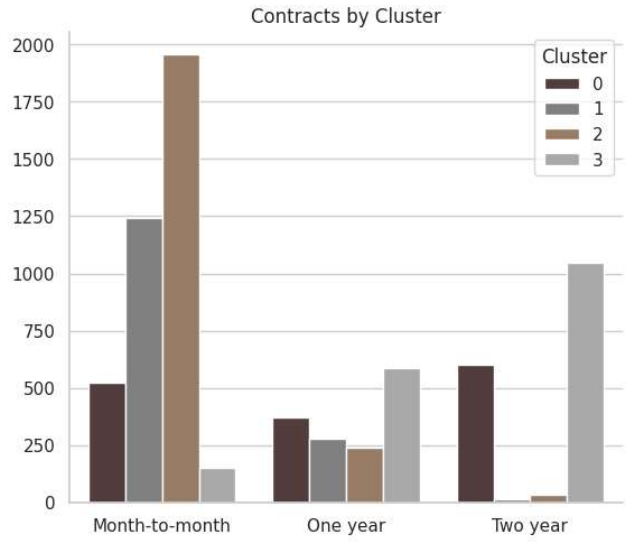


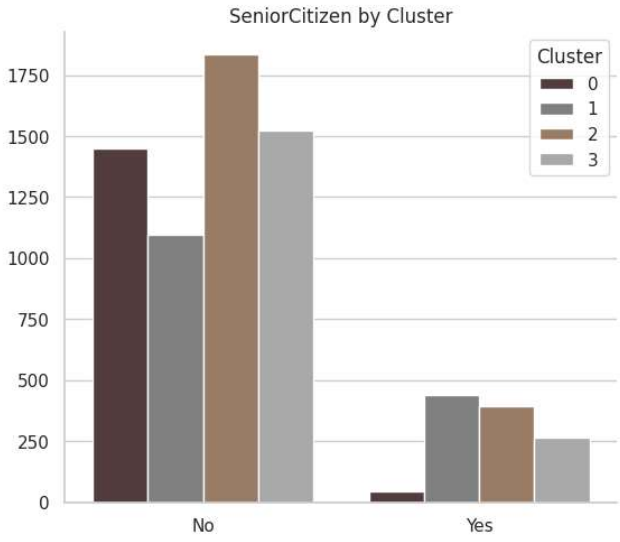


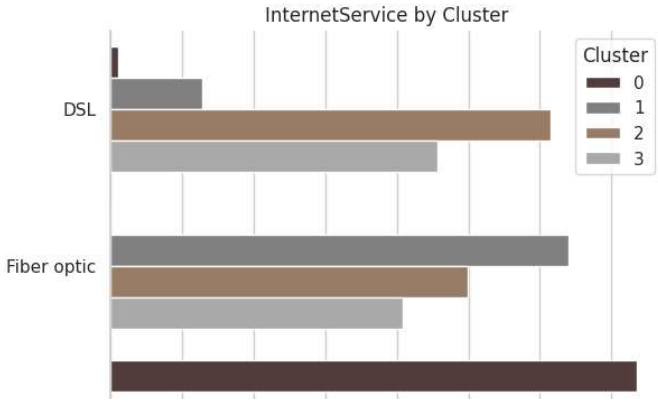

```
df['Cluster'] = df_cluster['Cluster']
sn.histplot(data=df, x="tenure", hue="Cluster", element="step")
plt.title('Tenure distribution by Cluster')
plt.show()
```

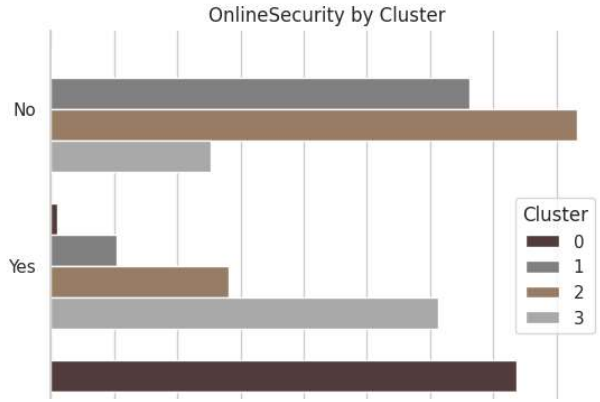



```
fig, axes = plt.subplots(nrows=2, ncols=2, figsize=(14,12))
sn.despine()

# Gray for No Churn, highlight Churn!
colors = ["#553939", "#808080", "#A27B5C","#A9A9A9"]
# Set custom color palette
sn.set_palette(sn.color_palette(colors))
ax = sn.countplot(x="Contract", hue="Cluster", data=df, ax = axes[0,0]).set(title='Contract
ax = sn.countplot(x="SeniorCitizen", hue="Cluster", data=df, ax = axes[0,1]).set(title='Sen
ax = sn.countplot(y='InternetService', hue="Cluster", data=df,ax = axes[1,0]).set(title='In
ax = sn.countplot(y='OnlineSecurity', hue="Cluster", data=df, ax = axes[1,1]).set(title='On
sn.despine()
```


Contracts by Cluster
Cluster
0
1
2
3
2000
1750
1500
1250
1000
750
500
250
0
Month-to-month
One year
Two year


SeniorCitizen by Cluster
Cluster
0
1
2
3
1750
1500
1250
1000
750
500
250
0
No
Yes


InternetService by Cluster
Cluster
0
1
2
3
DSL
Fiber optic


OnlineSecurity by Cluster
Cluster
0
1
2
3
No
Yes